SIP Supplement: Arizona's State Implementation Plan Supplement for Clean Air Act § 110 (a)(2): Implementation of the 2010 Sulfur Dioxide National Ambient Air Quality Standards

Air Quality Division
August 2, 2022

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COMPLETENESS CRITERIA
(40 C.F.R. PART 51, APPENDIX V, § 2.0)

Appendix V § 2.1 - Administrative Materials

(a)   A formal signed, stamped, and dated letter of submittal from the Governor or his designee, requesting EPA approval of the plan or revision thereof (hereafter "the plan"). If electing to submit a paper submission with a copy in electronic version, the submittal letter must verify that the electronic copy provided is an exact duplicate of the paper submission.

Please see the attached cover letter for this SIP submission and attached delegation of authority from Misael Cabrera, Director of ADEQ, to Daniel Czecholinski, Director of the ADEQ Air Quality Division, authorizing Mr. Czecholinski to perform any act the ADEQ Director is authorized to perform under the state air quality statutes, including the submission of SIPs to EPA.

(b)   Evidence that the State has adopted the plan in the State code or body of regulations; or issued the permit, order, consent agreement (hereafter "document") in final form. That evidence shall include the date of adoption or final issuance as well as the effective date of the plan, if different from the adoption/issuance date.

Please refer to Appendices B and C.

(c)   Evidence that the State has the necessary legal authority under State law to adopt and implement the plan.

Arizona is authorized to adopt and implement SIPs under Arizona Revised Statutes (A.R.S.) §§ 49-104, 49-106, 49-404, and 49-425. Copies of the statutes are attached in Appendix B.

(d)   A copy of the actual regulation, or document submitted for approval and incorporation by reference into the plan, including indication of the changes made (such as redline/strikethrough) to the existing approved plan, where applicable. The submission shall include a copy of the official State regulation/document, signed, stamped, and dated by the appropriate State official indicating that it is fully enforceable by the State. The effective date of any regulation/document contained in the submission shall, whenever possible, be indicated in the regulation/document itself; otherwise the State should include a letter signed, stamped, and dated by the appropriate State official indicating the effective date. If the regulation/document provided by the State for approval and incorporation by reference into the plan is a copy of an existing publication, the State submission should, whenever possible, include a copy of the publication cover page and table of contents.

Please refer to Appendices B and C.

(e)   Evidence that the State followed all of the procedural requirements of the State's laws and constitution in conducting and completing the adoption/issuance of the plan.

Evidence that ADEQ followed procedural requirements of Arizona State laws and constitution in adopting this plan can be found in Appendix C.

(f)   Evidence that public notice was given of the proposed change consistent with procedures approved by EPA, including the date of publication of such notice.

Proof that ADEQ gave notice of the SIP Supplement in accordance with A.R.S. § 49-444 is attached as Appendix C.

(g)   Certification that public hearing(s) were held in accordance with the information provided in the public notice and the State's laws and constitution, if applicable and consistent with the public hearing requirements in 40 CFR 51.102.

The certification and other documents related to the public hearing are attached in Appendix C.

(h)   Compilation of public comments and the State's response thereto.

A compilation of any comments received, and the State's responses are attached as the Responsiveness Summary in Appendix C.

Appendix V § 2.1 - Technical Support

(a)   Identification of all regulated pollutants affected by the plan.

The supplement applies to sulfur dioxide (SO_2).

(b)   Identification of the locations of affected sources including the EPA attainment/ nonattainment designation of the locations and the status of the attainment plan for the affected areas(s).

This is an infrastructure plan, as such, it will apply to the entire State of Arizona once approved.

(c)   Quantification of the changes in plan allowable emissions from the affected sources; estimates of changes in current actual emissions from affected sources or, where appropriate, quantification of changes in actual emissions from affected sources through calculations of the differences between certain baseline levels and allowable emissions anticipated as a result of the revision.

Not applicable.

(d)   The State's demonstration that the national ambient air quality standards, prevention of significant deterioration increments, reasonable further progress demonstration, and visibility, as applicable, are protected if the plan is approved and implemented. For all requests to redesignate an area to attainment for a national primary ambient air quality standard, under section 107 of the Act, a revision must be submitted to provide for the maintenance of the national primary ambient air quality standards for at least 10 years as required by section 175A of the Act.

Not applicable to this submission.

(e)   Modeling information required to support the proposed revision, including input data, output data, models used, justification of model selections, ambient monitoring data used, meteorological data used, justification for use of offsite data (where used), modes of models used, assumptions, and other information relevant to the determination of adequacy of the modeling analysis.

See Chapter 6.

(f)   Evidence, where necessary, that emission limitations are based on continuous emission reduction technology.

See Chapters 2 through 6.

(g)   Evidence that the plan contains emission limitations, work practice standards and recordkeeping/reporting requirements, where necessary, to ensure emission levels.

Please see Section 1.2.1 of this submission.

(h)   Compliance/enforcement strategies, including how compliance will be determined in practice.

See Section 1.2.1 of this submission.

(i)   Special economic and technological justifications required by any applicable EPA policies, or an explanation of why such justifications are not necessary.

Not applicable.

1   GENERAL

Chapter one provides a general overview of the sulfur dioxide (SO_2) Infrastructure State Implementation Plan (SIP) supplement to address Clean Air Act (CAA) § 110 (a)(2)(D)(i). Section 1.1 addresses the statement of intent and the purpose of this submission. Section 1.2 briefly examines the SO_2 National Ambient Air Quality Standards (NAAQS). Section 1.2.1 discusses the regulatory background of the laws and regulations in place in Arizona to mitigate SO_2 emissions.

1.1   Statement of Introduction and Purpose

This submission is a supplement to the "Arizona State Implementation Plan Revision under the Clean Air Act (CAA) § 110(a)(1) and (2); Implementation of the 2010 Sulfur Dioxide (SO_2) National Ambient Air Quality Standard" (2013 I-SIP submittal).

CAA § 110(a)(1) requires States to submit SIPs within a three-year period following the promulgation of new or revised NAAQS to provide for implementation, maintenance, and enforcement of such standards. Each of these SIPs must address certain essential elements or the "infrastructure" of the state's air quality management programs under CAA § 110(a)(2). These elements, detailed in CAA § 110(a)(2)(A) through (M), include provisions for monitoring, emissions inventories, and modeling designed to assure attainment and maintenance of the NAAQS.

United States Environmental Protection Agency (U.S. EPA or EPA) issued a new primary NAAQS for oxides of sulfur as measured by SO_2, which became effective on August 23, 2010.[1] The new primary NAAQS established a new 1-hour standard at a level of 75 parts per billion (ppb), based on the 3-year average of the annual 99th percentile of 1-hour maximum daily concentrations.[2]

Typically, when new NAAQS are promulgated, CAA §§ 110(a)(1) and 110(a)(2) require each state to develop and submit a plan to the EPA that addresses the implementation, maintenance, and enforcement of the NAAQS. The Arizona Department of Environmental Quality (ADEQ) submitted the initial SO_2 infrastructure SIP in 2013, but the plan did not address CAA § 110(a)(2)(D)(i)(I). Therefore, after reviewing ADEQ's 2013 SO_2 infrastructure SIP, EPA proposed a partial approval and partial disapproval of the submittal in 2016.[3] Therefore, this supplement will address CAA § 110(a)(2)(D)(i)(I) (prongs 1 and 2).

 Prongs 1 and 2 are referred to as the "Good Neighbor" provision. Prong 1 requires adequate provisions to ensure that any source or other emissions activity within the State do not contribute significantly to the nonattainment areas in another State. Prong 2 requires adequate provisions to ensure that any source or other emissions activity within the State will not contribute significantly to the maintenance of the NAAQS in any other State.

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[1] 75 FR 35519 (June 22, 2010).

[2] *Id.*

[3] 81 FR 31571 (May 19, 2016).

1.2   Regulatory Background

This section will examine ADEQ's history of regulating SO_2 in Arizona and the actions EPA has taken in response to specific SO_2 emitting facilities within the State. As mentioned in section 1.1, EPA issued a new primary SO_2 NAAQS, which became effective on August 23, 2010.[4] A short while later, on May 25, 2011, Arizona's then Governor, Jan Brewer, recommended to EPA that two separate areas, the existing Hayden and Miami SO_2 planning areas, should be designated nonattainment for the new standard. Arizona's two recommended nonattainment areas included all areas with monitored violations of the new standard and the primary emissions sources that likely contributed to those violations. Information accompanying the Governor's letter demonstrated that ADEQ met the minimum monitoring requirements.[5]

On October 29, 2012, ADEQ submitted a revision to the Arizona New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs.[6] ADEQ anticipated at the time of the submission that the NSR/PSD SIP revision would bring areas under the jurisdiction of ADEQ into compliance with the federal NSR/PSD SIP requirements.

On February 6, 2013, EPA notified ADEQ by letter of its intention to designate the Hayden and Miami planning areas as nonattainment as recommended by Governor Brewer in 2011.[7] EPA also indicated its intention to address designations for all other areas in separate future actions.[8] At the time of the 2013 Infrastructure SIPS submission, EPA had not issued a final strategy for evaluating areas recommended as unclassifiable, and the data for SO_2 was unavailable to do a complete analysis of interstate transport impacts.

On August 21, 2015, EPA finalized and promulgated the SO_2 Data Requirements Rule (DRR), which directs State air agencies to characterize the current SO_2 air quality concentrations or enact federally enforceable permit limits below 2000 tons per year (tpy) for facilities with actual SO_2 emissions at 2,000 tpy or more based on the National Emissions Inventory (NEI). [9] The DRR "establishes the minimum criteria for identifying the emissions sources and associated areas for which air agencies must characterize SO_2 air quality."[10] Using the criteria laid out in the rule, Arizona submitted a list containing five sources to EPA on January 15, 2015.[11] On March 18, 2016, EPA sent a letter to ADEQ's then Director

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[4] *Id.*

[5] *See* Letter from Arizona Governor Brewer to Jared Blumenfeld, U.S. ENVTL PROT. AGENCY Region IX Administrator, and the enclosed *Arizona Air Quality Designations, Final Proposed Boundary Recommendations for the 2010 Primary National Ambient Air Quality Standard for Sulfur Dioxide, April 25, 2011,* available at http://www.epa.gov/so2designations/region9r.html (last accessed May 1, 2022).

[6] Arizona State Implementation Plan Revision under Clean Air Act Section 110(a)(1) and (2): Implementation of the 2010 Sulfur Dioxide (SO2) National Ambient Air Quality, Arizona Department of Environmental Quality, pg. 7 (July 23, 2013).

[7] *See* Letter from Arizona Governor Brewer to Jared Blumenfeld, U.S. ENVTL PROT. AGENCY Region IX Administrator, and the enclosed *Arizona Air Quality Designations, Final Proposed Boundary Recommendations for the 2010 Primary National Ambient Air Quality Standard for Sulfur Dioxide, April 25, 2011,* available at http://www.epa.gov/so2designations/region9r.html (last accessed May 1, 2022).

[8] *Id.*

[9] 80 FR 51052 (Aug. 21, 2015).

[10] *Id.*

[11] *See* Letter from Eric Massey, Director of Air Quality at the Arizona Department of Environmental Quality to Jared Blumenfeld, Regional Administrator for the U.S. ENVIRONMENTAL PROTECTION AGENCY Region IX, titled *Arizona SO2 Information for the Data Requirements Rule*, January 15, 2016.

of Air Quality, Eric Massey, confirming EPA's review of the list and their intent not to add additional sources to it at that time.[12]

On May 4, 2018, EPA released a notice of final rulemaking approving the revisions to the Arizona SIP that corrected the deficiencies in ADEQ's SIP-approved rules for issuing NSR permits for stationary sources. The approval focused on the CAA's preconstruction permit requirements for major sources and major modifications related to this submission. The final rule approved the nonattainment NSR requirements for sources that could contribute to a violation of any NAAQS—which includes SO_2 emitting facilities.[13]

On March 12, 2019, EPA issued a final rule approving ADEQ's SIP for the Miami SO_2 Nonattainment Area.[14]

On November 5, 2020, EPA issued a final rule partially approving and partially disapproving Arizona's SIP revision for ADEQ's Hayden SO_2 Nonattainment Area's control measures for copper smelters. EPA approved the base year and projected emissions inventories and affirmed that NSR requirements were met.[15] Specifically, EPA found that the rule ADEQ submitted, Arizona Administrative Code (A.A.C.) R18-2-B1302 (Limits on SO_2 Emissions from the Hayden Smelter) was largely consistent with the CAA but conflicted with some of the rule provisions under CAA sections 110 and 172(c)(6).[16]

On November 10, 2020, EPA issued a final rule that provided Arizona with limited approval and limited disapproval of the revisions to the SIP submitted for the Hayden SO_2 Nonattainment Area. [17] In this action, the agency disapproved the attainment demonstration, reasonable further progress (RFP), reasonably available control measures (RACM), reasonably available control technology (RACT), enforceable emissions limitations and control measures, and contingency measures.[18]

On January 31, 2022, EPA issued a final rule finding that Arizona's Hayden and Miami SO_2 Nonattainment Area's failed to attain the 2010 SO_2 NAAQS.[19] ADEQ is revising the Hayden and Miami SO_2 plans to bring the areas into attainment and anticipates submitting the revised SIPS in 2023.

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[12] *See* Letter from Eric Massey, Director of Air Quality at the Arizona Department of Environmental Quality to Jared Blumenfeld, Regional Administrator for the U.S. ENVIRONMENTAL PROTECTION AGENCY Region IX, titled *Arizona SO2 Information for the Data Requirements Rule*, January 15, 2016.

[13] 83 FR 19631, 19632 (May 4, 2018).

[14] 84 FR 8813 (March 12, 2019).

[15] 85 FR 70483,70485 (Nov. 5, 2020).

[16] *Id.*

[17] *Id.*

[18] 85 FR 71547 (Nov. 10, 2020).

[19] 87 FR 4805 (Jan. 31, 2022)

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1.2.1   SIP Approved Statutes and Rules Regulating SO₂ Emissions in Arizona

This section will examine the Arizona Revised Statutes (A.R.S.) and rules for regulating SO$_2$ emissions. Table 1 below lists the relevant State and local statutes and regulations approved into the SIP that aid in mitigating SO$_2$ emissions within the State. The statutes and rules are cited in facility permits to aid in protecting visibility and PSD as required under CAA Title I, Part C. The table breaks down the statutes and rules according to category, affiliated agency, and when the measure was implemented at the State level and approved into the Arizona SIP.

Table 1 SIP Approved Statutes and Rules Regulating SO$_2$ Emissions in Arizona		
Statute/Rule	**Date Implemented**	**Description of Regulation**
Control Measures and Emissions		
Control Measures and Emissions- ADEQ Programs		As required by the CAA, these statutes provide the authority for State and local air quality management programs to
A.R.S.§ 49-107 Local Delegation of State Authority	State effective date July 1, 1987. EPA approved on November 2, 2015 (80 Federal Register (FR) 67319). Supplemented on September 6, 2013, and July 2, 2014.	adopt and implement control measures and plans to assure attainment and maintenance of the 2010 SO$_2$ air quality standards of Arizona. The statutes aid in decreasing SO$_2$ emissions by providing the State and local air quality
A.R.S. § 49-402 State and County Control	State effective date October 29, 2012. Approved by EPA on September 23, 2014 (79 FR 56655). Supplemented on September 6, 2013.	management programs with the authority to adopt regulatory rules and plans to curb or stop SO$_2$ emissions.
A.R.S. § 49-404 State Implementation Plan	State effective date September 1, 1999. Approved by EPA on June 8, 2000 (65 FR 36653).	
A.R.S. § 49-406 Nonattainment Area Plan	State effective date August 11, 1998. Approved by EPA on June 8, 2000 (65 FR 36353).	
A.R.S. § 49-421 Definitions	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-424 Duties of Department	State effective date April 18, 2014. Approved by EPA on May 1, 2017 (77 FR 66398).	
A.R.S. § 49-425 Rules; Hearing	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-541(1) (a-c) Definitions	State effective date August 9, 2001. Approved by EPA on May 22, 2013 (78 FR 30209).	
Control Measures and Emissions- County Programs		
A.R.S. § 49-471 Definitions	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-473 Board of Supervisors	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-479 Rules; Hearing	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
Ambient Air Quality Monitoring		
Ambient Air Quality Monitoring- ADEQ Programs		These rules and statutes allow Arizona to maintain its extensive monitoring network operated by State and local
A.R.S. § 49-404 State Implementation Plan	State effective date September 1, 1999. Approved by EPA on June 8, 2000 (65 FR 36653).	agencies. The network is designed to collect, compile, and analyze ambient air quality data in attainment and nonattainment areas of the State. Operating agencies track data recovery, quality control, and quality assurance
A.R.S. § 49-422 Powers and Duties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	parameters for all instruments operated at various network sites. Criteria pollutant concentrations, such as SO$_2$, are measured with instruments meeting EPA certification as Federal Reference or Equivalent Methods. All data collected
A.R.S. 49-424 Duties of Department	State effective date April 18, 2014. Approved by EPA on May 1, 2017 (77 FR 66398).	within the SO$_2$ compliance network is compared to the NAAQS, statistically analyzed for trends, and recorded quarterly in EPA's Air Quality Monitoring System. As required by the Code of Federal Regulations (C.F.R.), Title 40, Part 58, the

Ambient Air Quality Monitoring- County Programs		State and county agencies ADEQ, Maricopa County Air Quality Department (MCAQD), Pima Department of Environmental Quality (PDEQ), and Pinal County Air Quality Control District (PCAQCD) annually submit EPA network monitoring plans. These plans identify the purpose of each monitor and provide evidence that both the siting and the operation of each monitor meets the network design, quality assurance, and other federal requirements of 40 C.F.R. Part 58.
A.R.S. § 49-476.01 Monitoring	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	

On June 22, 2010, EPA established minimum requirements for SO_2 monitoring networks.[20] Information contained in Arizona's boundary recommendations demonstrates that the State's network meets or exceeds these requirements.[21] These rules and statutes aid Arizona in monitoring SO_2 concentrations and emissions.

Enforcement of Control Measures		
Enforcement of Control Measures- ADEQ Programs		These statutes and rules allow the State and local agencies to implement control and enforcement programs for permitted sources of air contamination and those sources not regulated through permitting programs (i.e., open burns, construction, vacant land, etc.). As part of the SIP enforcement program, ADEQ and local agencies track all committed SIP control measures and work with the entities responsible for those measures to provide any needed assistance and ensure timely implementation. If any agency or entity fails to implement a committed measure, the county can file an action in a superior court for an injunction or any other relief provided by law. Similarly, if the county fails to ensure the implementation of measures, the ADEQ Director is authorized, through the State Attorney General, to seek relief provided by law to ensure the implementation of all measures.
A.R.S. § 49-103 Department Employees; Legal Counsel	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-106 Statewide Applications of the Rules	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-107 Local Delegation of State Authority	State effective date July 1, 1987. Approved by EPA on November 2, 2015 (80 FR 67319). Supplemented on September 6, 2013, and July 2, 2014.	A.R.S. Title 49, Chapter 3, Articles 1, 2, and 3 establish ADEQ and local agency's authority for preconstruction review and permitting. Under the air permits program, sources that emit regulated pollutants are required to obtain a permit before constructing, changing, replacing, or operating any equipment or process which may cause air pollution. This includes equipment designed to reduce air pollution. Permits are also required if an existing facility that causes air pollution transfers ownership, relocates, or otherwise changes operations.
A.R.S. § 49-402 State and County Control	State effective date October 29, 2012. EPA approved on September 23, 2014 (79 FR 56655). Supplemented on September 6, 2013.	
A.R.S. § 49-404 State Implementation Plan	State effective date September 1, 1999. Approved by EPA on June 8, 2000 (65 FR 36653).	
A.R.S. § 49-422 Powers and Duties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-424 Duties of Department	State effective date April 18, 2014. Approved by EPA on May 1, 2017 (77 FR 66398).	ADEQ and county permitting agencies operate air quality permit compliance programs to ensure the implementation of emission limits and other control measures for permitted sources. These programs include scheduled and unscheduled inspections conducted at major sources annually, as well as compliance assistance initiatives. Permit and SIP enforcement authority are also provided in A.R.S. §§ 49- 460 through 463 and 49-510 through 513, under which the State or county may issue orders of abatement and, through the Attorney General or County Attorney, seek injunctive relief for any violations of the air quality provisions of the law.
A.R.S. § 49-425 Rules; Hearing	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-433 Special Inspection Warrant	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-435 Hearings on Orders of Abatement	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-441 Suspension and Revocation of Conditional Order	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	This legal framework aids in decreasing SO_2 emissions by ensuring sources adhere to permit conditions and remedial measures. It also allows agencies to issue orders of abatement and seek injunctive relief for any violations.
A.R.S. § 49-460 Violations; Production of Records	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-461 Violations; Order of Abatement	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-462 Violations; Injunctive Relief	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	

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[20] 75 FR 35519 (Jun. 22, 2010).

[21] *See* Letter from Arizona Governor Brewer to Jared Blumenfeld, U.S. Envtl. Prot. Agency Region IX Administrator, and the enclosed *Arizona Air Quality Designations, Final Proposed Boundary Recommendations for the 2010 Primary National Ambient Air Quality Standard for Sulfur Dioxide, April 25, 2011,* available at http://www.epa.gov/so2designations/region9r.html (last accessed May 1, 2022).

A.R.S. § 49-463 Violations; Civil Penalties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
Enforcement of Control Measures- County Programs	
A.R.S. § 49-473 Board of Supervisors	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-476.01 Monitoring	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-488 Special Inspection Warrant	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-490 Hearings on Orders of Abatement	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-495 Suspension and Revocation of Conditional Order	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-502 Violations; Classification	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-510 Violations; Production of Records	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-511 Violations; Order of Abatement	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-512 Violations; Injunctive Relief	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-513 Violations; Civil Penalties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
Emergency Powers	
Emergency Powers- ADEQ Programs	
A.R.S. § 49-462 Violations; Injunctive Relief	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.R.S. § 49-465 Air Pollution Emergency	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
A.A.C. R18-2-220 Air Pollution Emergency Episodes	State effective date September 26, 1990. Approved by EPA on October 15, 2012 (77 FR 62452).
Emergency Powers- County Programs	
A.R.S. § 49-512 Violations; Injunctive Relief	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).
MCAQD Rule 600 Emergency Episodes	County effective date July 13, 1988. Approved by EPA on March 18, 1999 (64 FR 13351)
PCAQD Title 17, Chapter 17.32, Article I, Emergency Episodes	County effective date June 29, 1993. Approved by EPA on December 20, 2000 (65 FR 79742)
PCAQD Code Title 17, Chapter 2, Article 7, Air Pollution Emergency Episodes	County effective date June 29, 1993. Approved by EPA on December 20, 2000 (65 FR 79742)
Emission Monitoring and Reporting	
Emission Monitoring and Reporting- ADEQ Programs	

The statutes and rules in this section authorize the State to take actions to alleviate or prevent an emergency health risk to the public due to air pollution or likely exceedance of the NAAQS. If invoked and applied to a source of SO_2, the statutes could restrict or even prohibit the source from producing SO_2 emissions if the Governor declares that the source is contributing to an emergency situation.

A.A.C. R18-2-220, "Air Pollution Emergency Episodes," is similar to the emergency episode statutes because it includes procedures for the ADEQ Director to implement to prevent pollution concentrations that could cause significant harm to public health. [22] The procedures include governmental and public notification of the nature of the episode and, at the directive of the Governor's office, possible curtailment of industrial and commercial activities. Similar provisions for determining air pollution emergency episodes, advisory procedures, and control actions are included within the Maricopa, Pima, and Pinal Counties codes.

On October 15, 2012, the EPA approved into the Arizona SIP the Arizona Emergency Episode Plan, which EPA found is substantively identical to the CAA section 110(a)(2)(G).[23] The significant harm level for SO_2 at 40 C.F.R. 51.151 is unchanged and ADEQ's emergency episode rules and procedures approved into the SIP on October 15, 2012, meet the requirements for SO_2.[24]

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[22] Approved into the SIP as A.A.C. R9-3-219 at 47 FR 42572 (Sept. 28, 1982).

[23] 77 FR 62452, 62453 (Oct. 15, 2012).

[24] 77 FR 62452 (Oct. 15, 2012).

A.R.S. § 49-422 Powers and Duties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	These rules and statutes provide the State and county with the authority to require any sources of air contaminants to monitor, sample, or perform other studies to quantify emissions of air contaminants or levels of air pollution that may be reasonably attributable to that source. This legal framework allows Arizona to monitor sources, ensuring that SO_2 and other air pollutant emissions stay within the NAAQS.
A.R.S. § 49-424 Duties of Department	State effective date April 18, 2014. Approved by EPA on May 1, 2017 (77 FR 66398).	
A.A.C. R18-2-313 Existing Source Emission Monitoring	State effective date February 15, 2001. Approved by EPA on November 5, 2012 (77 FR 66405).	
A.A.C. R18-2-327 Annual Emissions Inventory Questionnaire	State effective date December 7, 1995. Approved by EPA on November 5, 2012 (77 FR 66405).	
Emission Monitoring and Reporting- County Programs		
A.R.S. § 49-476.01 Monitoring	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
MCAQD Rule 100 (except sections 200.24, 200.73, and 200.104 (c)) General Provisions and Definitions	State effective date February 3, 2016. Approved by EPA on April 5, 2019 (84 FR 13543).	
Air Quality Modeling		
Air Quality Modeling- ADEQ Programs		These statutes allow Arizona to retain the authority to perform air quality modeling for predicting the effect of emissions on ambient air quality. Where applicable, all modeling analyses for demonstrating attainment and maintenance of the NAAQS meet EPA's most recent guidance on air quality models. Furthermore, all information and data are available to EPA as required. The statutes will not decrease the emission of SO_2 but allow ADEQ and local air quality management programs to model pollutant fluctuations that could lead to control measures and further air quality planning that could decrease SO_2.
A.R.S. § 49-406 Nonattainment Area Plan	State effective date August 11, 1998. Approved by EPA on June 8, 2000 (65 FR 36353).	
A.R.S. § 49-422 Powers and Duties	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-424 Duties of Department	State effective date April 18, 2014. Approved by EPA on May 1, 2017 (77 FR 66398).	
Air Quality Modeling- County Programs		
A.R.S. § 49-473 Board of Supervisors	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
A.R.S. § 49-474 County Control Boards	State effective date August 24, 2014. Approved by EPA on November 5, 2012 (77 FR 66398).	
New Source Review and Prevention of Significant Deterioration		
New Source Review and Prevention of Significant Deterioration- ADEQ Programs		The rules in this section compose Arizona's federally approved NSR Program. Under this program, all new sources and modifications to existing sources in Arizona are subject to the State requirements for preconstruction review and permitting pursuant to A.A.C. Title 18, Chapter 2, Articles 2 and 4, or relevant county rules. All major sources and major modifications to existing major sources in the State are also subject to the rules' nonattainment new source review provisions.

Arizona also has an approved PSD program (excluding greenhouse gases (GHG)) for areas under its CAA permitting jurisdiction under sections 160 through 165 of the CAA. The PSD program applies to major sources in attainment areas. The previous Arizona PSD FIP has been codified for GHG for Arizona from 40 C.F.R. 52.37 to 40 C.F.R. 52.144, where the State's PSD program is listed.[25] MCAQD and PDEQ currently implement the Federal PSD program under 40 C.F.R. 52.21 for all regulated NSR pollutants as defined under 40 C.F.R. 52.21(b)(50) pursuant to delegation agreements with the State and EPA.

ADEQ has original jurisdiction over major sources in Pinal County but has delegated that jurisdiction to PCAQD. Under the delegation agreement between ADEQ and PCAQD, the county must enforce the State's major NSR rules or its own rules if they are more stringent. |
A.A.C. R18-2-101 (except (20)) Definitions	State effective date February 1, 2020. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-217 Designation and Classification of Attainment Areas	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-218 Limitations of Pollutants in Classified Attainment Areas	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-301 Definitions	State effective date February 1, 2020. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-302 Applicability; Registration; Classes of Permits	State effective date March 21,2017. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-302.01 Source Registration Requirements	State effective date February 1, 2020. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-304 Permit Application Processing Procedures	State effective date February 1, 2020. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-306 Permit Contents	State effective date March 21,2017. EPA approved June 16, 2021 (86 FR 31927).	

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[25] *See* 83 FR 19631 (May 4, 2018).

		Arizona's NSR program acts as a safeguard protecting the State from pollution increases when a facility is modified or a new facility is built. The NSR program requires facilities to install control measures as part of a pre-permitting process. Similarly, Arizona's PSD program applies to new major sources or existing sources undergoing major modifications for pollutants in attainment and unclassifiable areas. These programs limit SO_2 emissions through the installation of control technology and other mitigation measures during the pre-permitting process.
A.A.C. R18-2-306.01 Permits Containing Voluntarily Accepted Emission Limitations and Standards	State effective date March 21,2017. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-317 Facility Changes Allowed Without Permit Revisions-- Class I	State effective date August 7, 2012. Approved by EPA on June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-317.01 Facility Changes that Require a Permit Revision--Class II	State effective date August 7, 2012. Approved by EPA on June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-317.02 Procedures for Certain Changes that Do Not Require a Permit Revision-- Class II	State effective date August 7, 2012. Approved by EPA on June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-319 Minor Permit Revision	State effective date March 21,2017. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-320 Significant Permit Revisions	State effective date March 21,2017. EPA approved June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-334 Minor New Source Review	State effective date February 1, 2020. Approved by EPA on June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-401 Definitions	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-403 Permits for Sources Located in Nonattainment Areas	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-406 Permit Requirements for Sources Located in Attainment and Unclassifiable Areas	State effective date February 1, 2020. Approved by EPA on June 16, 2021 (86 FR 31927).	
A.A.C. R18-2-407 Air Quality Impact Analysis and Monitoring Requirements	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-408 Innovative Control Technology	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-410 Visibility and Air Quality Related Value Protection	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-411 Permit Requirements for Sources that Locate in Attainment or Unclassifiable Areas and Cause or Contribute to a Violation of any National Ambient Air Quality Standard	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
A.A.C. R18-2-412 PALs	State effective date March 21, 2017. Approved by EPA on May 4, 2018 (83 FR 19631).	
New Source Review and Prevention of Significant Deterioration- County Programs		
MCAQD Rule 100 General Provisions; General Provisions and Definitions	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 200 Permits and Fees; Permit Requirements	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 210 Permits and Fees; Title V Permit Provisions	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 220 Permits and Fees; Non-title V Permit Provisions	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 240 Permits and Fees; Federal Major New Source Review	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 241 Permits and Fees; Minor New Source Review	State effective date December 11, 2019. Approved by EPA on February 15, 2022 (87 FR 8418).	
MCAQD Rule 510 (excluding Appendix G) Air Quality Standards	State effective date November 1, 2006. Approved by EPA on November 9, 2009 (74 FR 57612).	

MCAQD Rule 600 Emergency Episodes	State effective date July 13, 1988. Approved by EPA on March 18, 1999 (64 FR 13351).
PCAQD 1-3-140 Definitions (General)	State effective date July 29, 1998. Approved by EPA on November 13, 2002 (67 FR 68764).
PCAQD 2-7-260 Standards	State effective date June 29, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-010 Purpose (Permits and Permit Revisions)	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1--030 Definitions (General provisions relating to permits and permit revisions)	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-040 Applicability and Classes of Permits	State effective date October 12, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-050 Permit Application Requirements	State effective date October 12, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-065 Permit Review by the EPA and Affected States	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-081 Permit Conditions	State effective date February 22, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-082 Emission Standards and Limitations	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-083 Compliance Provisions	State effective date February 22, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-1-084 Voluntarily Accepted EPA Enforceable Emissions Limitations; Applicability; Reopening; Effective Date.	State effective date February 22, 1995. Approved by EPA on December 20, 2000 (65 FR 79742).
PCAQD 3-3-200 Purpose (Permit Requirements for New Major Sources and Major Modifications to Existing Major Sources)	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-203 Definitions (Permit Requirements for New Major Sources and Major Modifications to Existing Major Sources)	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-205 Application Requirements	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-210 Application Review Process	State effective date February 22, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-250 Permit and Permit Revision Requirements for Sources Located in Attainment and Unclassifiable Areas	State effective date February 22, 1995. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-260 Air Quality Impact Analysis and Monitoring Requirements	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-270 Innovative Control Technology	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-275 Air Quality Models	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).
PCAQD 3-3-280 Visibility Protection	State effective date November 3, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).

MCAQD Rule 322 Power Plant Operations	State effective date October 17, 2007. Approved by EPA on October 14, 2009 (74 FR 52693).	
MCAQD Rule 323 Fuel Burning Equipment from Industrial/ Commercial/ Institutional (ICI) Sources	State effective date October 17, 2007. Approved by EPA on October 14, 2009 (74 FR 52693).	
MCAQD Rule 324 Stationary Reciprocating Internal Combustion Engines	State effective date October 17, 2007. Approved by EPA on October 14, 2009 (74 FR 52693).	
Miscellaneous Programs		
PCAQD 2-1-030 Sulfur Oxide (Sulfur Dioxide)	State effective date June 29, 1993. Approved by EPA on April 9, 1996 (61 FR 15717).	This rule establishes the primary and secondary NAAQs for SO_2 in Pinal County. This rule ensures a threshold for SO_2 emissions within the County.
A.A.C. R18-2-202 Sulfur Oxide (Sulfur Dioxide)	State effective date August 7, 2012. Approved by EPA on September 23, 2014 (79 FR 56655). Supplemented on September 6, 2013.	This rule establishes the primary and secondary NAAQs for SO_2 for the State of Arizona. This rule ensures a threshold for SO_2 emissions within the State.
EPA Approved Source-Specific Requirements		
Arizona Electric Power Cooperative's Apache Generating Station; Significant Revision No. 59195 to Air Quality Control Permit No. 55412, excluding section V.D.	Effective at the state level on May 13, 2014. Approved by EPA on April 10, 2015 (80 FR 19220).	This permit revision was part of a source-specific revision approved by EPA that established an alternative to best available retrofit technology (BART), which aligns with 40 C.F.R. 51.308(e)(2) and (3), which allows states to adopt alternative measures in lieu of source-specific BART controls if they can demonstrate that the alternative measures provide greater reasonable progress towards natural visibility conditions than BART. Under the alternatives, the Apache steam units were converted from primarily coal-fired units to a unit that combusts natural gas or retrofitted with selective non-catalytic reduction (SNCR) control technology. In 2015 EPA determined that the alternatives provide greater reasonable progress towards natural visibility conditions than BART and included lower emissions of SO_2. As a result, EPA withdrew the Arizona federal implementation plan (FIP) provisions that addressed BART for Apache.
Cholla Power Plant; Significant Permit Revision No. 61713 to Operating Permit No. 53399	Effective at the state level on October 16, 2015. Approved by EPA on March 27, 2017 (82 FR 15139).	The permit fulfills the CAA § 169A requirements, incorporates the facility's control strategies and compliance methods resulting from ADEQ's 2015 BART reassessment, and includes the retirement of several of the facilities' outdated machinery resulting in reduced emissions in SO_2. The permit also allowed the withdrawal of FIP provisions applicable to Cholla since the changes to the permit incorporated the enforceable emission limitations and requirements for monitoring, recordkeeping and reporting previously promulgated in the FIP.
Coronado Generating Station; Permit # 64169 (as amended by Significant Revision # 63088) Cover Page and Attachment "E" BART Alternatives	Effective at the state level on November 9, 2017. Approved by EPA on October 10, 2017 (82 FR 46903).	This permit revision implement's the Coronado facility's BART Alternatives in Attachment E of the permit. The attachment is effective under State law and replaces the Arizona Regional Haze FIP provisions which applied to Coronado. [26]The Coronado BART Alternative aligns with 40 C.F.R. 51.308(e)(2) and (3), which allows states to adopt alternative measures in lieu of source-specific BART controls if they can demonstrate that the alternative measures provide greater reasonable progress towards natural visibility conditions than BART. EPA stated in 2017 that "the Coronado BART Alternative would achieve reasonable progress towards natural visibility conditions than would be achieved through the installation and operation of BART at Coronado.[27] The revision helps control SO_2 through the introduced visibility controls.
A.A.C. R18-2-B1302 Limits on SO_2 Emissions from the Hayden Smelter excluding sections (E)(4) and (6)	Effective at the state level on December 14, 2018. [28]	This rule applies directly to the Hayden Asarco copper smelter and establishes emissions limitations for SO_2 and monitoring, recordkeeping, and reporting requirements for those limits.
Appendix 14 Procedures for Sulfur Dioxide and Lead Fugitive Emissions Studies for the Hayden Smelter	Effective at the state level on May 7, 2017. Approved by EPA on November 14, 2018 (83 FR 56739).	This rule directs the Hayden Asarco copper smelter to conduct fugitive emissions studies to derive a measurement or accurate estimate of total fugitive sulfur dioxide and lead emissions from the facility's operating process. The Appendix requires dates, times, and durations of the events, causes of malfunctions, and descriptions of process changes. The rule further directs the source to modify the study methods based on the data and lessons learned from previous

[26] 82 FR 46903 (Oct. 10, 2017).
[27] 82 FR 46903, 46904 (Oct. 10, 2017).
[28] A.A.C. R18-2-B1302 was not approved by EPA into the Arizona SIP, however, it is enforceable at the State level.

		studies and to submit the modified methods before conducting future emissions studies. The rule does not decrease SO₂ emissions directly but aids the State in maintaining compliance by requiring the documentation of certain events occurring at the facility.
A.A.C. R18-2-C1302 Limits on SO₂ Emissions from the Miami Smelter excluding subsection (E)(6)	Effective at the state level on December 14, 2018. Approved by EPA on November 14, 2018 (83 FR 56736).	This rule applies directly to the Freeport Miami Copper Smelter and establishes limits on SO₂ and monitoring, recordkeeping, and reporting requirements for those limits. The rule decreases SO₂ by setting facility emissions limits. The rule also aids the State in maintaining compliance by requiring the documentation of certain events occurring at the facility.

Applicable National Regulations		
National Emissions Standards for Hazardous Air Pollutants (NESHAP)		
40 C.F.R. § 63 Subpart QQQ Primary Copper Smelting	Finalized on June 12, 2002 (67 FR 40491).	Subpart QQQ establishes the national requirements for primary copper smelters, as well as "establishes requirements to demonstrate initial and continuous compliance with all applicable emissions limitations, work practices standards, and operation and maintenance requirements." [29] The requirements under Subpart QQQ aid in limiting emissions from common sources of emissions, including SO₂, at copper smelting facilities.
Miscellaneous		
Mercury Air Toxics Standards (MATS)	Finalized on September 9, 2020 (85 FR 55744).	The National Emissions Standards for Hazardous Air Pollutants for Coal and Oil-Fired Electric Utility Steam Generating Units, also known as MATS, allows EPA to reduce power plant emissions of toxic air pollutants, including sulfur dioxide, by setting standards to reduce pollution from EGUs with a capacity of 25 megawatts or more. The standards must address all hazardous air pollutants emitted at a source category.[30] Under the program, EPA "must set emission standards for existing sources in the category that are at least as stringent as the emission reductions achieved by the average of the top 12 percent best controlled sources."[31] The MATS requirements aid in limiting emissions from EGUs by addressing all hazardous air pollutants, including SO₂, at a relevant source.
Arizona Federal Implementation Plan Provisions Under 40 C.F.R. § 52.145		
Source-Specific Federal Implementation Plan for Regional Haze at Nelson Lime Plant (i)	40 C.F.R. § 52.145 (i) (April 13, 2016)	EPA promulgated the FIP provisions for the Nelson Lime Plant to fill in gaps or correct the inadequate portions of the Arizona State Implementation Plan for Regional Haze. The FIP includes enforceable emission limitations and other control measures to attain the national ambient air quality standards. The FIP controls and emissions limits aid in limiting SO₂ emissions.
Source-Specific Federal Implementation Plan for Regional Haze at Rillito Cement Plant (k)	40 C.F.R. § 52.145 (k) (April 13, 2016)	EPA promulgated the FIP provisions for the Rillito Cement Plant to fill in gaps or correct the inadequate portions of the Arizona State Implementation Plan for Regional Haze. The FIP includes enforceable emission limitations and other control measures to attain the national ambient air quality standards. The FIP controls and emissions limits aid in limiting SO₂ emissions.
Source-Specific Federal Implementation Plan for Regional Haze at Hayden Copper Smelter	40 C.F.R. § 52.145 (l) (April 13, 2016)	EPA promulgated the FIP provisions for the Hayden Copper Smelter to fill in gaps or correct the inadequate portions of the Arizona State Implementation Plan for Regional Haze. The FIP includes enforceable emission limitations and other control measures to attain the national ambient air quality standards. The FIP controls and emissions limits aid in limiting SO₂ emissions.
Source-Specific Federal Implementation Plan for Regional Haze at Miami Copper Smelter	40 C.F.R. § 52.145 (m) (April 13, 2016)	EPA promulgated the FIP provisions for the Miami Copper Smelter to fill in gaps or correct the inadequate portions of the Arizona State Implementation Plan for Regional Haze. The FIP includes enforceable emission limitations and other control measures to attain the national ambient air quality standards. The FIP controls and emissions limits aid in limiting SO₂ emissions.

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[29] 40 C.F.R. § Part 63, Subpart QQQ (2012).

[30] Cleaner Power Plants, U.S. Env't Prot. Agency, https://www.epa.gov/mats/cleaner-power-plants (last visited July 7, 2022).

[31] Basic Information about Mercury and Air Toxics Standards, U.S. Env't Prot. Agency, https://www.epa.gov/mats/basic-information-about-mercury-and-air-toxics-standards (last visited July 7, 2022).

The data in this chart was pulled directly from the following sources: The Arizona Revised Statutes, Title 49, Chapters 1 and 3; the Arizona Administrative Code, Title 18, Chapter 2; 40 C.F.R. §53.120; Maricopa County Air Pollution Control Rules and Regulations; and the Pinal County Code of Regulations.

For the reasons discussed in Table 1, Arizona's SO$_2$ emissions should not grow to concentrations that would significantly impact the nonattainment, maintenance, or attainment of the SO$_2$ NAAQS in other states.

2   SO₂ EMISSIONS TRENDS IN ARIZONA AND SOUTHWESTERN U.S.

Chapter 2 discusses, as the title suggests, the SO₂ emissions trends in Arizona and the southwestern portion of the country. Section 2.1 examines the SO₂ emissions inventory in Arizona and the southwestern U.S. Section 2.2 reviews the stationary sources. Section 2.3 examines the major stationary sources identified as emitting 100 tpy or more within 80 km of the Arizona border. Section 2.4 discusses the impact of SO₂ emissions from minor stationary sources. Finally, section 2.5 examines the impact of SO₂ emissions from Arizona's mobile sources. This section concludes that the SO₂ emission from Arizona's major and minor stationary sources and mobile sources will not contribute significantly to the SO₂ nonattainment in another state or interfere with the maintenance of the NAAQS in another state.

2.1   SO₂ Emissions Inventory in Arizona and the Southwestern U.S.

This section examines ADEQ's emissions analysis results to determine what sources contribute more to SO₂ emissions in the region and where the sources are located. ADEQ obtained the emissions data used in this section from EPA's NEI and Tier 1 Emissions Trends Reports. [32] In Figure 1, ADEQ used EPA's State Tier 1 Criteria Air Pollutants (CAPS) Emission Trends data to show Arizona's annual SO₂ emissions trends, which increased from 1990 to 1997 before sharply declining from 240,000 tons in 1997 to 123,000 tons in 1999. The emissions then continued to slowly decline to around 44,000 tons in 2019. ADEQ determined that the decline in emissions was mainly due to the decrease in SO₂ emissions from fuel combustion for electric utilities from 1997 to 2019-- a nearly 114,000 tons decrease.

Figure 1 Annual SO₂ Emissions in Arizona by Source from 1990-2019
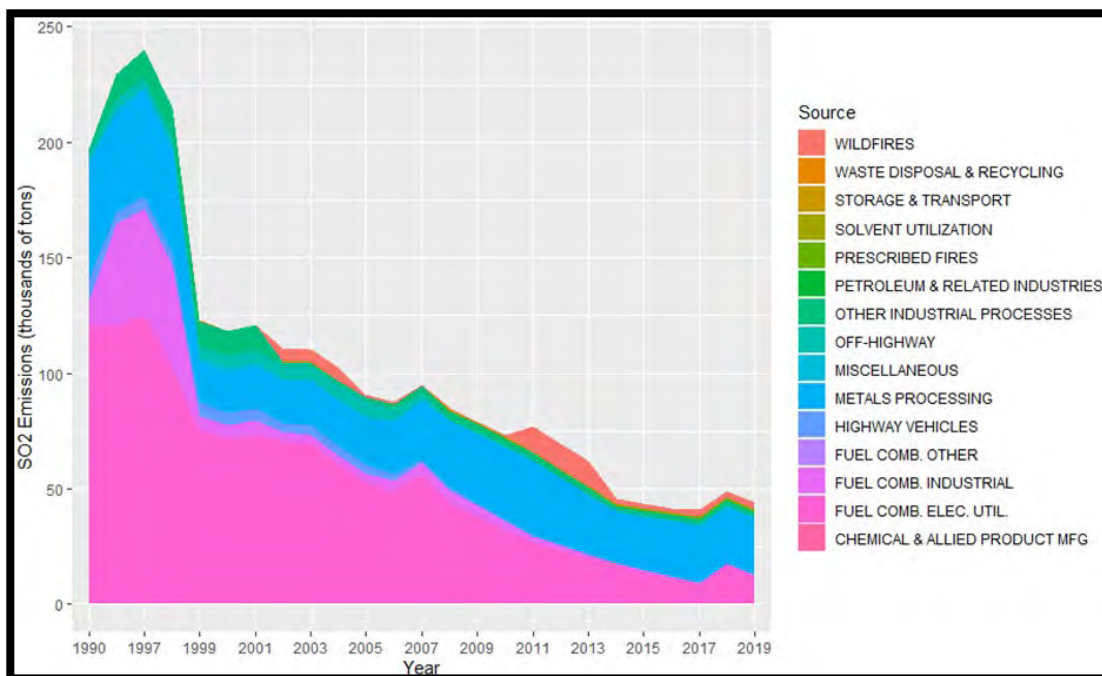
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[32] Air Pollutant Emissions Trends Data, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data (last accessed March 15, 2022); National Emissions Inventory, U.S. ENVTL. PROT. AGENCY,https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei (last accessed March 15, 2022).

Figure 2 also used EPA's CAPs trend data to highlight the country's SO_2 emissions in the Southwest region.[33] The emissions decrease observed between 1990 and 2002 partially resulted from states implementing the Federal Acid Rain Program (ARP), which was implemented in two phases, with the first phase starting in 1995, while the second phase began in 2000.[34]

Emissions decreases were also attributed to the shift from coal to lower sulfur fuel, natural gas, or other renewable energy sources for electric generation. Additional decreases came from metal processing, industrial fuel combustion, mobile sources; petroleum industries; and chemical sectors. The emissions in these sectors decreased so dramatically that they are now considered negligible, accounting for under 15% of Arizona's total SO_2 emissions in 2019. [35]

The emissions from wildfires were first included in the 2002 NEI and have continued to be included. Since 2002 there has been a measurable increase in wildfire SO_2 emissions in Arizona, from 18,000 tpy in 2002 to 37,000 tpy in 2019.[36]

Figure 2 Annual SO₂ Emissions in the Southwest U.S.

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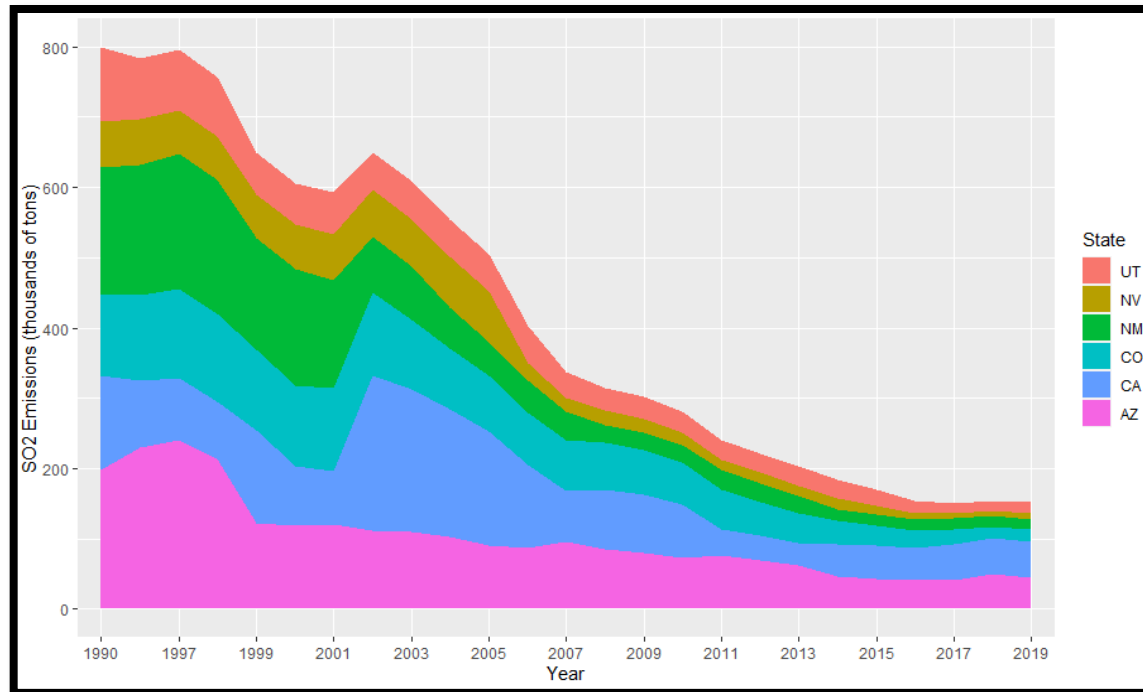
[33] *Id*.

[34] Acid Rain Program, U.S. Envtl. Prot. Agency, https://www.epa.gov/acidrain/acid-rain-program (last accessed March 15, 2022).

[35] Based on the data extrapolated from Figure 2.

[36] Air Pollutant Emissions Trends Data, U.S. Envtl. Prot. Agency, https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data (last accessed March 15, 2022).; National Emissions Inventory, Envtl. Prot. Agency,https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei (last accessed March 15, 2022).

In Figure 3 below, ADEQ used EPA's CAPs Trend Data to depict the emissions emitted by each source category in the Southwestern US region. In 1990, the SO_2 emissions from electric utilities accounted for 367,00 tpy of the total emissions in the southwest, and over the years decreased to 42,000 tpy in 2019. As shown in the figure, the total emissions in the southwest decreased from 800,000 tpy in 1990 to 152,000 tpy in 2019. As previously mentioned in regards to Figure 2, the overall decline in emissions is driven by a decrease in SO_2 emissions from fuel combustion by electric utilities.

Figure 3 Annual SO$_2$ Emissions in the Southwest U.S. by Source
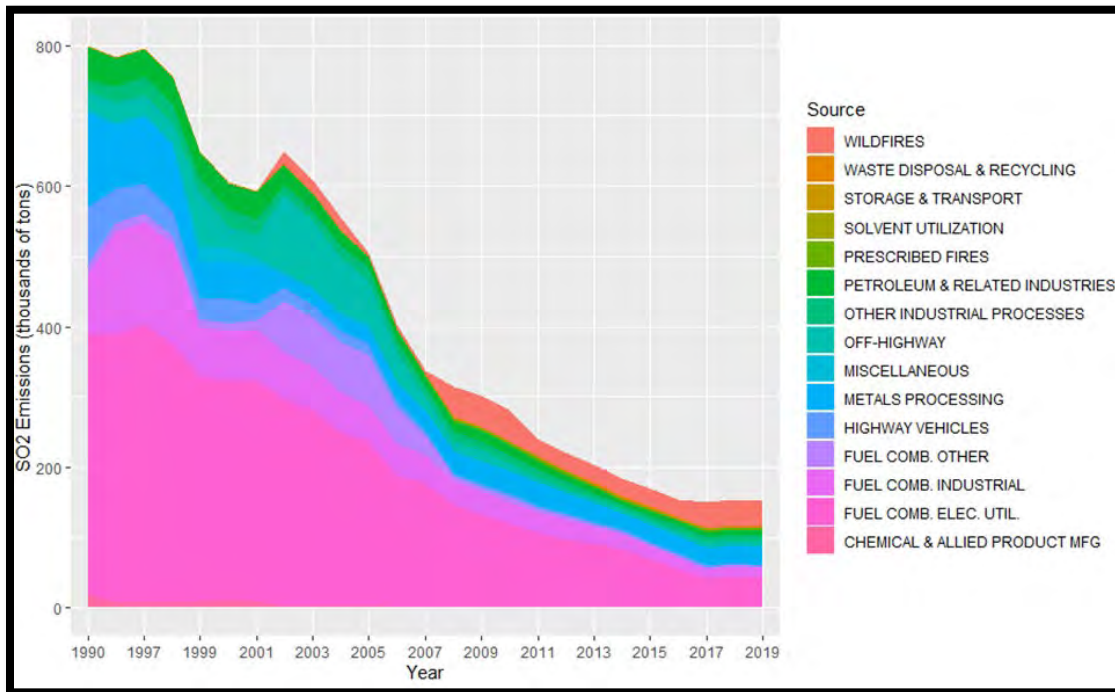
Figure 4 further highlights the decrease in the emissions from electric utilities by State. As depicted, electric utilities were at their peak in 1997; Arizona alone had 126,000 tons of SO_2 emissions from electricity generation. The data shows that Arizona was not the only State with high SO_2 emissions from electric generation in the 1990s; Colorado and New Mexico's SO_2 emissions were close to Arizona's with 99,000 tons and 85,000 tons, respectively.

As of 2019, the emissions from Arizona, Colorado, and New Mexico have declined to below 12,000 tons. In Nevada and Utah, SO_2 emissions were 51,000 and 33,000 tons in 1997 and decreased to 5,000 and 9,000 tons in 2019, respectively.

Figure 4 Annual SO₂ Emissions in the Southwest U.S. from Electricity
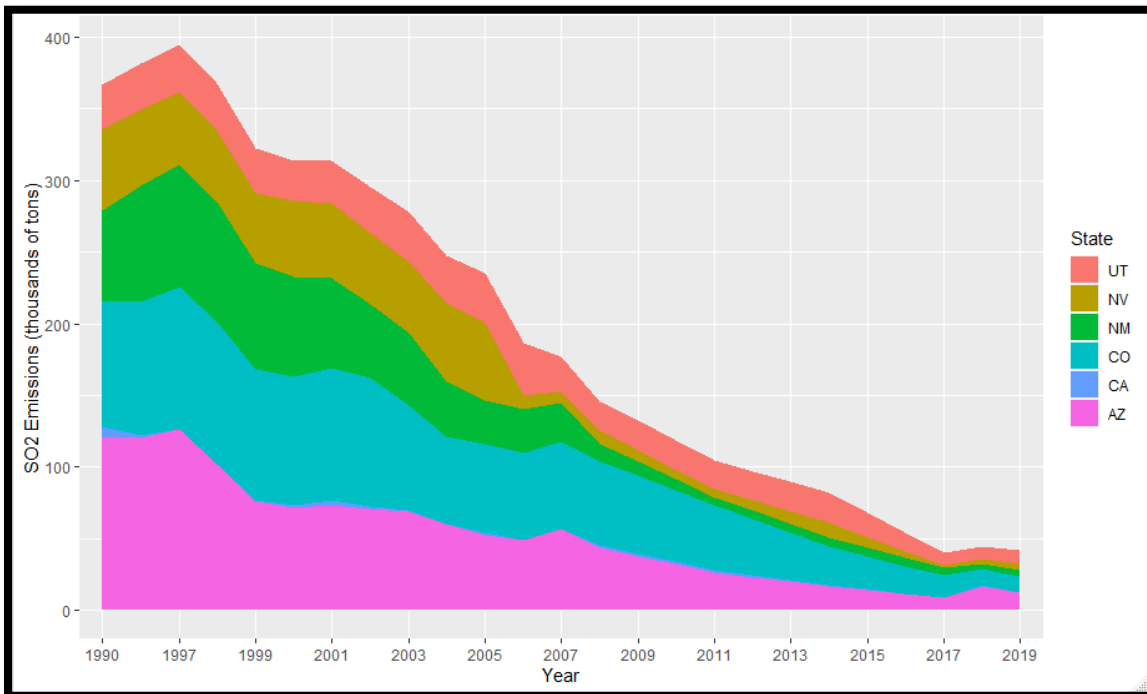
Figure 5 shows SO_2 emissions from industrial fuel combustion by State. Unlike the emissions from fuel combustion for electric utilities, emissions from smaller industrial combustion sources are not estimated yearly. Instead, industrial emissions are estimated every 3 years in the NEI. As seen below, the emissions from industrial fuel combustion peaked in 1996 with 44,000 tons in Arizona, 40,000 tons in Utah, and 34,000 tons in New Mexico. However, by 2019, the estimated emissions in these states decreased to 400, 2,000, and 4,000 tons, respectively. California had a 10,000-ton decrease in emissions, with fewer reductions occurring between 1996 to 2019.

ADEQ linked the reduction in emissions from industrial fuel combustion to the industry shifting away from using coal as fuel. Additionally, during this period, industries that used diesel gasoline to fuel stationary generators saw widespread SO_2 reductions associated with applying federal ultra-low-sulfur diesel requirements.[37]

Figure 5 Annual SO₂ Emissions in the Southwest U.S. from Industrial Fuel Combustion

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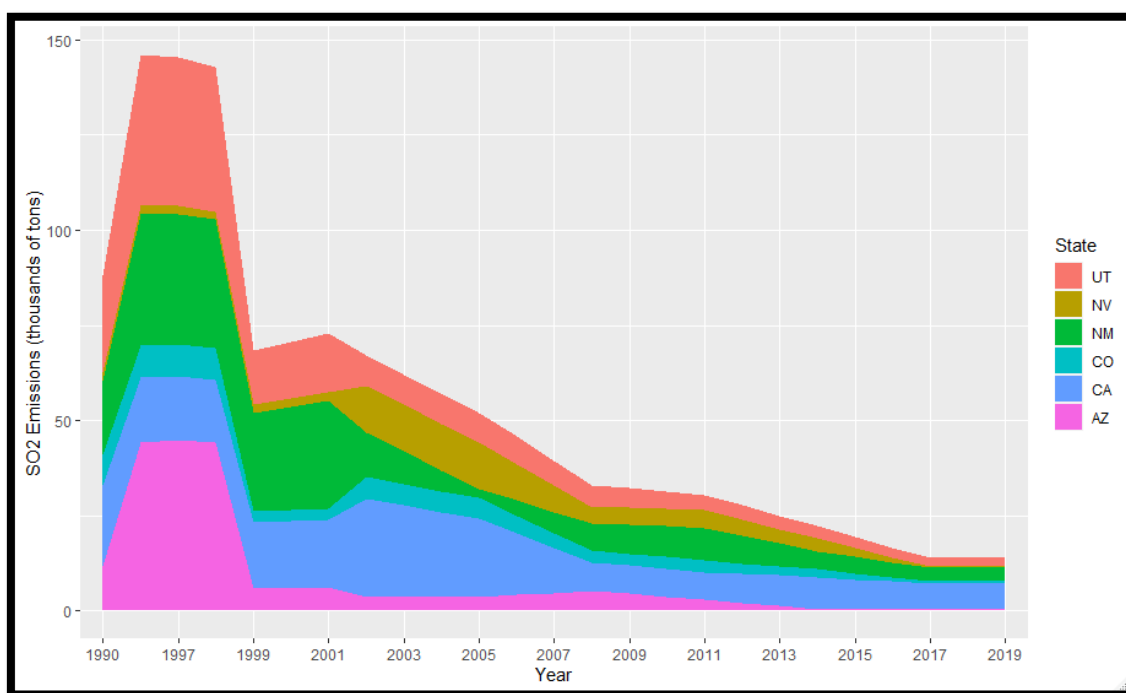
[37] U.S. ENVTL. PROT. AGENCY, Diesel Fuel Standards and Rulemakings, Envtl. Prot. Agency, https://www.epa.gov/diesel-fuel-standards/diesel-fuel-standards-and-rulemakings (last accessed March 15, 2022).

Figure 6 shows the SO$_2$ emissions from metal processing by State. Arizona and New Mexico dominated emissions from metal processing until 2002. Since then, nearly all metal processing emissions have been from Arizona. In New Mexico, the emissions went from 50,000 tons in 1990 to less than 1,000 tons in 2002. Although, the metal processing emissions in Arizona have decreased from 50,000 tons in 1990 to 24,000 tons in 2019.

Overall, emissions from metal processing have fluctuated between 20,000 and 30,000 tons since 2002. However, ADEQ estimates that new controls installed by the copper smelters in 2018 will result in a further emissions reduction. According to the 2019 emissions data, Arizona copper smelters emitted 2,357 tons of SO$_2$ in 2019. The reduction in emissions is attributed to the installation of emission controls and the partial shutdown of the ASARCO facility in 2019. However, this reduction is believed to be temporary because it does not reflect the emissions the facility would produce if operating at maximum capacity for an extended period.

Figure 6 Annual SO$_2$ Emissions in the Southwest U.S. from Metal Processing
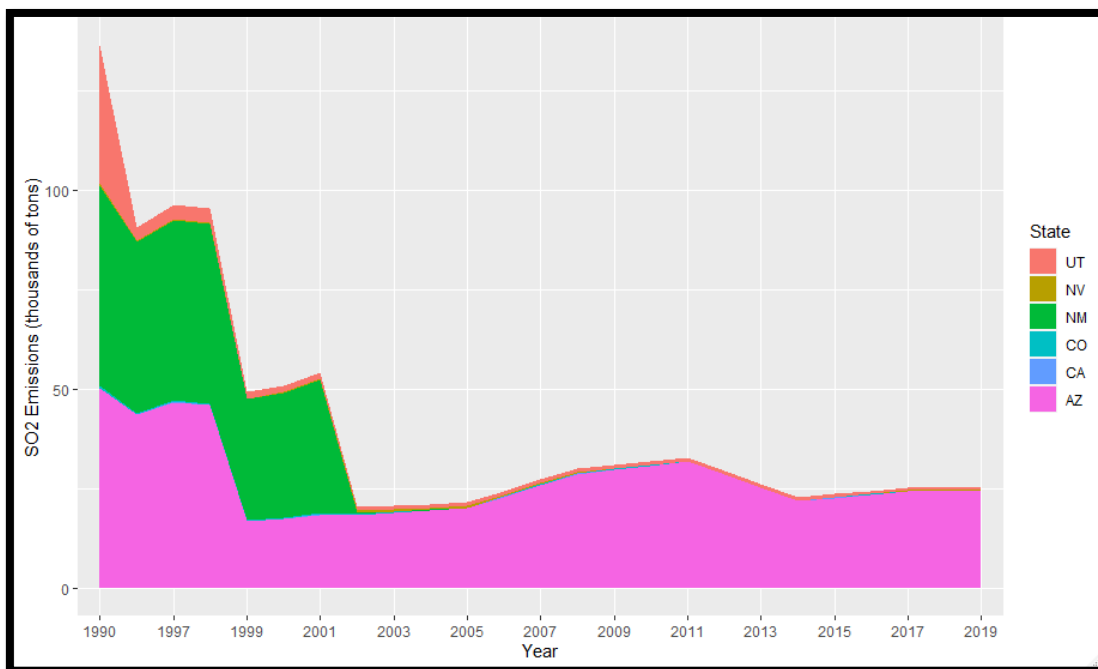
Figure 7 depicts the Southwest's annual SO_2 emissions from wildfires. As mentioned in Figure 2, wildfire emissions were first included in the NEI in 2002 and have been continuously included. Since 2002 the emissions from wildfires have increased, not only because of more frequent fires but because of improved methodologies in emission estimates. As Figure 7 shows, wildfires can make up a substantial portion of the region's annual SO_2 emissions.

Figure 7 Annual SO_2 Emissions in the Southwest U.S. from Wildfires
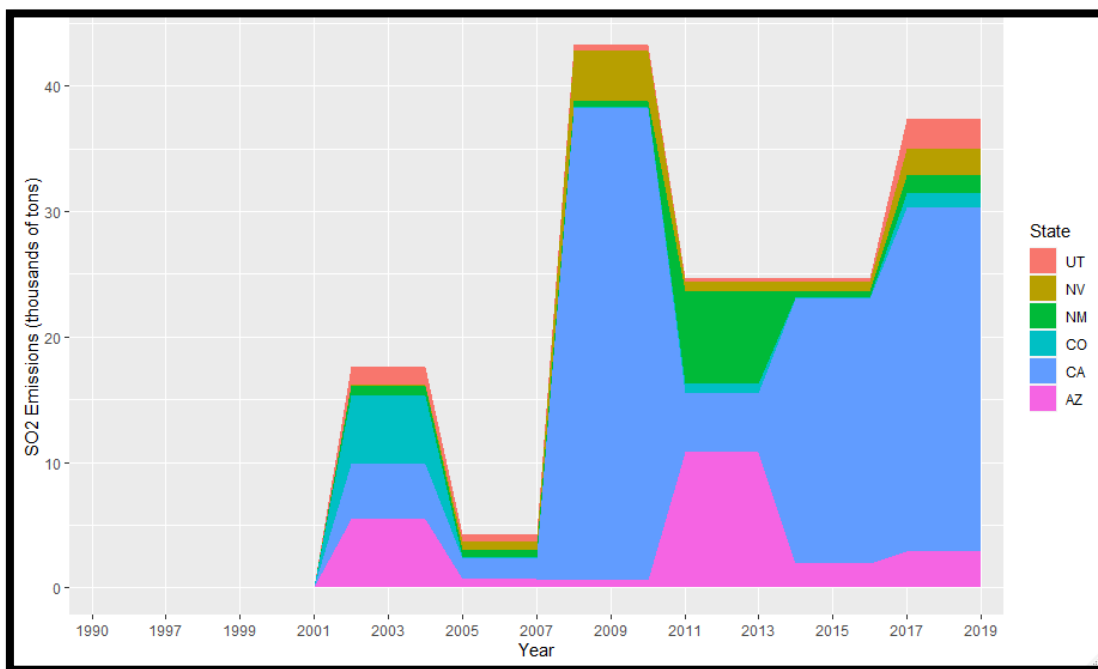
After examining the emissions analysis results, Arizona's significant sources of SO_2 emissions are from electric generation, industrial fuel combustion, metal processing, and wildfires. However, after installing machinery that primarily runs on natural gas, low sulfur diesel, and other renewable fuel sources to comply with the applicable regional haze and PSD requirements mentioned in Section 1.2.1, there has been a significant decrease in the emission from electricity generation and industrial fuel combustion. The SO_2 emissions from metal processing should also decrease due to newly installed control measures, source-specific rules, and FIPs applicable to the State's copper smelters. The SO_2 emissions from wildfires have not decreased. In the next section, this supplement will explore the methodology utilized to screen out minor sources of SO_2 emissions in Arizona and neighboring states.

2.2   Stationary Sources

This section will examine the stationary sources responsible for most emissions of SO_2 within Arizona and in neighboring states close to the Arizona border. ADEQ examined emissions sources from U.S. facilities, including those outside of ADEQ's jurisdiction (permitted by federal agencies, county, tribal agencies, and neighboring states), by utilizing the emissions data from 2008, 2011, 2014, and the 2017 NEI.[38] ADEQ did not consider international SO_2 emissions sources or receptors in this analysis because EPA previously approved the international pollution element of Arizona's 2010 SO_2 I-SIP.[39]

Instead, for these combined datasets, ADEQ considered all point sources of SO_2 emission with both latitudes between 30.2° and 38.2° degrees north and longitude between 107.7° and 116.2° degrees west. Below in Table 2, ADEQ summarizes the number of facilities included in this domain by jurisdiction and their respective total emissions by NEI years.

Table 2 Number of SO$_2$ Emitting Facilities in Arizona and the Surrounding Areas with Emissions from 2008, 2011, 2014, and 2017					
Jurisdiction	Number of Facilities	Annual Emissions (tons of SO$_2$)			
		2008	2011	2014	2017
Arizona	217	75,319	60,994	39,907	34,797
Navajo Nation (multi-state)	14	14,230	16,586	12,104	8,785
New Mexico	107	12,915	6,795	5,963	5,655
Nevada	30	943	1,426	2,506	1
Pima County, Arizona	10	2,884	2,193	1,092	59
Clark County, Nevada	115	755	877	792	978
Maricopa County, Arizona	157	307	390	440	691
Pinal County, Arizona	80	73	48	63	63
Southern Ute Indian Tribe, Utah	192	6	18	56	105
Pima Association of Governments, Arizona	25	34	35	50	64
Colorado	75	37	37	33	7
California	175	60	23	10	11
Utah	47	7	9	2	2
Salt River Indian Community, Arizona	13				15
Total	1,257	107,570	89,431	63,018	51,233

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[38] U.S. Envtl. Prot. Agency, 2008 National Emissions Inventory (NEI) Data, U.S. Envtl. Prot. Agency, https://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data (last accessed March 15, 2022); U.S. Envtl. Prot. Agency, 2011 National Emissions Inventory (NEI) Data, U.S. Envtl. Prot. Agency, https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data(last accessed March 15, 2022; U.S. Envtl. Prot. Agency, 2014 National Emissions Inventory (NEI) Data, U.S. Envtl. Prot. Agency, https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data(last accessed March 15, 2022; and U.S. Envtl. Prot. Agency, 2017 National Emissions Inventory (NEI) Data, U.S. Envtl. Prot. Agency, https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data (last accessed March 15, 2022.

[39] 83 FR 42214 (Jun. 28, 2016).

In Figure 8 (below), ADEQ used the SO$_2$ One-Pager modeling guidance of an initial receptor area up to 50 km from dominant emission sources and, conversely, an initial source area of interest covering up to 50 km from violating monitors. However, to be conservative, ADEQ considered some monitors up to 80 km from the Arizona border but found none of the monitors to be violating. The bounding box in Figure 8 is over 130 km from the Arizona border at all points and thus contains the entire 50 km disc around any monitor of interest.

Each circle marker is approximately proportional to the source's maximum SO$_2$ emissions across the NEIs. The largest circle marker represents emissions over 10,000 tpy and the smallest circle markers represent emissions of less than 1,000 tpy. Initially, ADEQ set the screening threshold to 0.5 tpy of SO$_2$ emissions, screening out sources that consistently emitted de minimis amounts. Subsequently, ADEQ also screened out all facilities that emitted under 100 tpy in every NEI year between 2008 and 2017.

Figure 8 Sources of SO$_2$ Emissions Above 0.5 tpy in Arizona and Neighboring States Within 130km of the Arizona Border
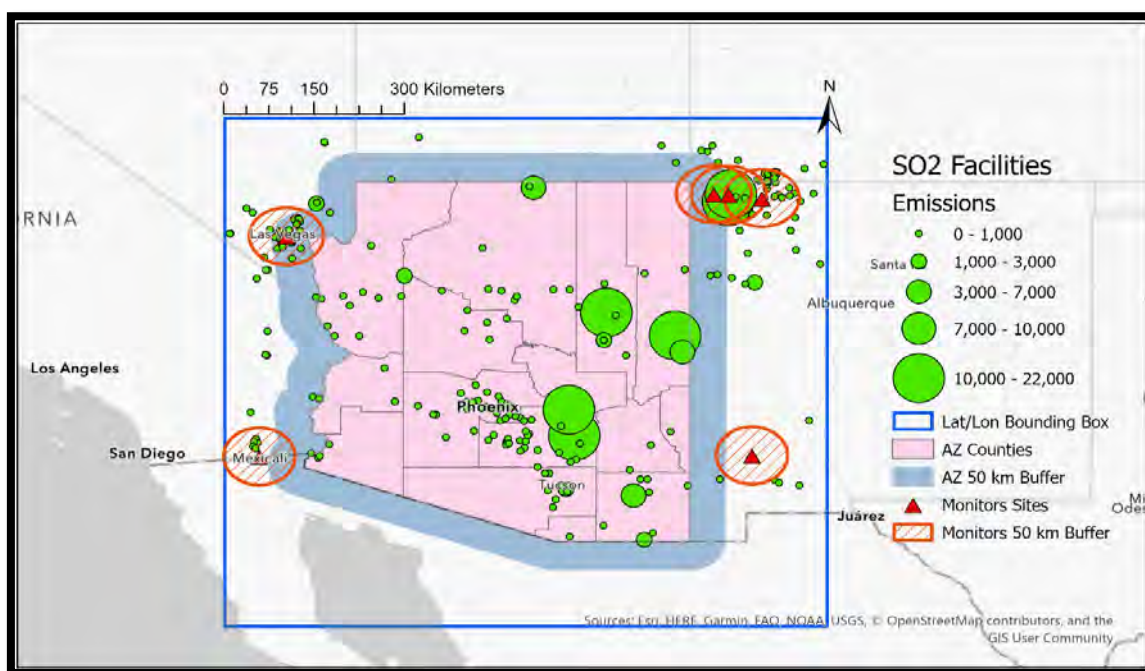
For Figure 8, ADEQ used NEI data to highlight the instate facilities that emit more than a de minimis amount of SO$_2$ (0.5 tpy) and the SO$_2$ monitors within 80 km of the Arizona border. To be conservative, ADEQ considered some monitors up to 80 km from the Arizona border even though modeling guidance suggests an initial receptor area up to 50 km from dominant emission sources and initial source areas of interest covering up to 50 km from the violating monitors. Furthermore, ADEQ screened out all facilities that emitted under 100 tons of SO$_2$ every NEI year. The resulting set of 22 facilities in Arizona and neighboring states is summarized in Figure 9 below.

Figure 9 Annual SO₂ Emissions in the Southwest U.S. By Facility
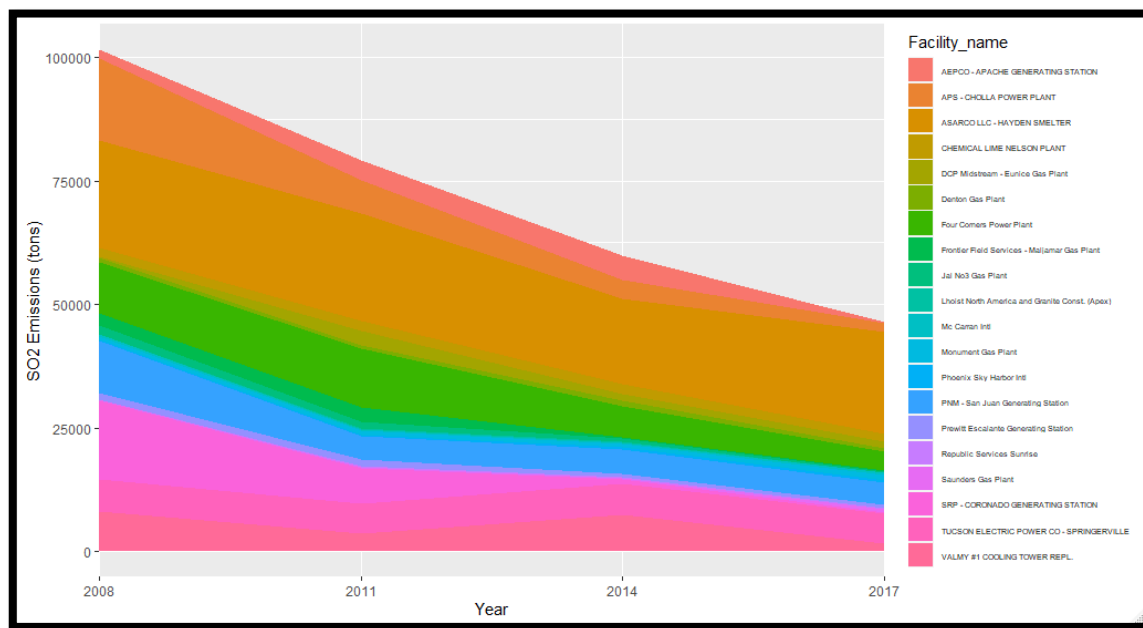
Aside from the 22 sources with actual emissions greater than 100 tpy, discussed in Figure 9, ADEQ found eight additional facilities with permitted Potential to Emit (PTE) over 100 tpy of SO₂ in Arizona. Table 3 on the next page lists facilities in Arizona with PTE over 100 tpy of SO₂ and facilities in or within 80 km of Arizona with actual emissions of over 100 tpy of SO₂ in the featured NEI years.

Facility Name	State	Distance to Border (km)	2008	2011	2014	2017	PTE
ASARCO LLC. – Hayden Copper Smelter	Arizona	165	21,742	21,747	17,433	20,499[40]	2,524
Arizona Public Service (APS) - Cholla Power Plant	Arizona	150	16,421	6,738	3,807	1,755	5,563
Salt River Project (SRP)- Coronado Generating Station	Arizona	21	15,900	7,352	908	222	3,312
Public Service Company of New Mexico (PNM)-San Juan Generating Station*	New Mexico	NA	10,649	4,741	4,989	4,525	
APS-Four Corners Power Plant*	New Mexico	NA	10,398	11,822	6,317	3,770	
Freeport McMoRan- Miami Copper Smelter	Arizona	175	7,091	10,119	4,505	3,930[41]	644
Tucson Electric Power (TEP)-Springerville Generating Station	Arizona	10	6,562	6,050	6,221	6,195	10,800
SRP-Navajo Generating Station*	Arizona	11	3,816	4,643	5,666	5,015	
TEP-Irvington	Arizona	175	2,884	2,193	1,092	17	722
Catalyst Paper Inc.- Snowflake*[42]	Arizona	118	2,556	2,896			
Lhoist North America of Arizona Nelson	Arizona	84	1,955	1,995	1,997	1,678	3,691
Arizona Electric Power Cooperative (AEPCO) - Apache Generating Station	Arizona	80	1,903	3,920	4,812	311	1,293
Prewitt Escalante Generating Station*	New Mexico	NA	1,202	1,257	732	729	
Lhoist North America of Arizona-Douglas[43]	Arizona	65	1,013				4,421
Reid-Gardner Generating Station *[44]	Nevada	NA	941	1,423	2,506		
San Juan River Gas Plant*	New Mexico	NA	571	621	91	274	
Gallup Refinery*	New Mexico	NA	313	49	40	51	
McCarran Intl.*	Nevada	NA	264	272	265	467	
Phoenix Sky Harbor Intl.**	Arizona	243	252	290	275	476	
Lhoist North America - APEX*	Nevada	NA	180	229	152	140	
Republic Services- Sunrise*	Nevada	NA	163	197	209	191	
Resolute Natural Resources Co. - Aneth Unit*[45]	Utah	NA	4	118	118		
APS Yucca Power Plant	Arizona	1	2	5	1	1	5,318
Calportland-Rillito Cement Plant	Arizona	198	6	9	4	5	11,348
Freeport McMoRan -Sierrita Mine	Arizona	193				34	221
Novo Biopower, LLC.	Arizona	119		66		1	225
Phoenix Cement	Arizona	207	10	1	7	1	401
Valencia Power Plant	New Mexico	NA	0	0	0	0	200
TEP-North Loop Generating Station	Arizona	195				0	5,160
CMC Steel Fabricator Inc.	Arizona	288		28		35	163

Table 3 Facility SO$_2$ Emissions in Recent NEI Years with PTE in TPY

* ADEQ could not obtain PTE data. ** Actual emissions include emissions from mobile sources, which are not subject to the permitting program. The airport has a non-title V permit which primarily covers its emergency generators and gasoline

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[40] The PTE of 2,524 tons/year for Asarco Hayden Smelter went into effect in July 2018 in a permit revision after a Convert Retrofit Project which drastically reduced SO$_2$ emissions from the facility. Before July 2018, the facility PTE was around 70,000 tons per year from an old permit issued in 2007. The facility's annual SO$_2$ emissions was 7999.7 tons in 2018 and 2018.9 tons in 2019.

[41] The PTE of 644 tons/year for the Freeport Miami Smelter went into effect after November 2017 in a permit revision after facility undertook a project which drastically reduced SO$_2$ emissions from the facility. Before November 2017, the facility PTE was around 10,368 tons per year from an old permit issued in 2012. The facility's annual SO$_2$ emissions was 232.5 tons in 2018 and 457.5 tons in 2019.

[42] Catalyst to permanently close Snowflake recycle paper mill, Catalyst Paper, https://www.catalystpaper.com/media/news/community/catalyst-permanently-close-snowflake-recycle-paper-mill (last accessed (last accessed March 15, 2022).

[43] 1971 Sulfur Dioxide National Ambient Air Quality Standards Douglas Maintenance Area, Ariz. Dept. of Envtl. Quality, https://static.azdeq.gov/pn/1971_so2_plan.pdf (last accessed March 15, 2022).

[44] Reid Gardner Generating Station Permanently Shut Down, POWERGEN International, https://www.power-eng.com/2017/03/17/reid-gardner-generating-station-permanently-shut-down/#gref (last accessed March 15, 2022).

[45] Elk to buy Resolute Energy's Greater Aneth EOR Unit, Oil and Gas Journal , https://www.ogj.com/general-interest/article/17288976/elk-to-buy-resolute-energys-greater-aneth-eor-unit (last accessed March 15, 2022).

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No other facilities emitted over 100 tpy of SO_2 in the given geographic bounding box shown in Figure 8 or had PTE over 100 tpy in Arizona. Note that the emission reductions from 2008 to 2017 came predominantly from the largest power plants in the region, other than the Navajo Generating Station, which saw SO_2 emissions increasing from 3,816 tpy in 2008 to 5,015 tpy in 2017. At the end of 2019, the Navajo Generating Station coal-fired plant permanently shut down, contributing to the continued downward trend of emissions from the power sector.[46] The following sections provide background information on the 14 facilities in Arizona with actual emissions or PTE exceeding 1,000 tpy of SO_2.

Stationary Sources with Significant SO_2 Emissions in Arizona (> 1000 tpy)

This section further examines the facilities in Table 3 in Arizona emitting over 1000 tpy or having PTE over 1000 tpy. ADEQ provides background information on the stationary source, including: location and date of establishment, operational changes, shutdowns, fuel switches, and past and upcoming emission controls. ADEQ focused on control measures dating from 2008 or later, both for brevity and because newer controls might have replaced older controls. The 1,000 tpy threshold was chosen because EPA requires agencies to use the same threshold to characterize air quality near the sources located in highly populated areas. However, for sources located outside of metropolitan areas of at least 1 million population, the threshold was 2,000 tpy.[47] Additionally, modeling of actual emissions from facilities under 1,000 tpy conducted by other states suggests that these facilities would not contribute to a violation of the 2010 SO_2 NAAQS.[48] Based on modeling and control measures ADEQ has determined that facilities with actual SO_2 emissions or PTE below 1,000 tpy will not contribute significantly to SO_2 nonattainment or interference with maintenance in other states.

2.2.1   Hayden Copper Smelter
ASARCO and its parent company GrupoMexico own the Hayden copper smelter. The facility is in Gila County, Arizona, approximately 70 miles (113 km) northeast of Tucson, and has a PTE of 2,524 tpy. Currently, the Hayden copper smelter utilizes an oxygen flash smelting process in addition to converters and anode furnaces to produce anode copper. On December 1, 2018, as part of their Converter Retrofit Project (CRP), ASARCO installed several SO_2 controls measures to ensure compliance with the 1-hour SO_2 NAAQS. Since mid-October 2019, the Hayden copper smelter has not been operating, and it is unknown if or when the smelter will resume normal operations. The ASARCO smelter is currently under a FIP for regional haze.[49]

2.2.2   Miami Copper Smelter
The Freeport McMoRan Inc. Miami copper smelter in Gila County, Arizona, is approximately 90 miles (145 km) east of Phoenix, and has a PTE of 644 tpy. The smelter consists of a primary furnace (IsaSmelt technology), a secondary furnace (ELKEM electric furnace), four Hoboken-style converters, two oxygen

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[46]Navajo Generating Station, Salt River Project, https://www.srpnet.com/about/stations/ngs/default.aspx (last accessed March 15, 2022).

[47] 80 FR 51052 (Aug. 21, 2015).

[48] Technical Justification to Support a Designation of Attainment of the 1- hour Sulfur Dioxide (SO2) NAAQS for Connecticut, Connecticut Dept. of Energy and Envtl. Prot., https://portal.ct.gov/-/media/DEEP/air/SO2/SO2DesignationTSDfinal13Mar2013pdf.pdf (last accessed April 4, 2022).

[49] 79 FR 52420 (Sept. 3, 2014).

plants, and an acid plant for treating all process gases.[50] On July 21, 2014, ADEQ issued Class I Significant Permit Revision No. 58409 to Freeport, authorizing the construction of the Smelter Upgrade Project.[51] The permit authorized the facility to operate with a maximum throughput of 1,000,000 tpy of copper concentrate but required the facility to install SO_2 capture and control upgrades. The upgrades were completed in January of 2018.[52] The Miami smelter is currently under a FIP for regional haze. [53]

2.2.3　　Lhoist Chemical Lime Company - Nelson Plant

The Nelson Plant is a lime manufacturing and limestone processing plant owned and operated by Lhoist. The plant is located approximately 100 miles (161 km) west of Flagstaff, in Yavapai County, Arizona, and has a maximum PTE of 4,424 tpy.[54] The facility uses negative pressure baghouses to limit its emissions.[55] ADEQ monitoring data shows that emissions from the Nelson plant have remained relatively stable over the years. Kilns 1 and 2 are currently under a regional haze FIP.[56]

2.2.4　　Lhoist Chemical Lime Company - Douglas Plant

The Douglas Plant is a lime plant owned and operated by Lhoist. The plant is in Paul Spur, Arizona, approximately 110 miles (177 km) southeast of Tucson, in Cochise County. The facility has a maximum PTE of 4,535 tpy.[57] In 2008, the SO_2 emissions from the Douglas lime plant were 1,013 tons.[58] The plant has an emissions limit of 1.0 pounds of SO_2 per million British Thermal Units (BTU) heat input. The facility ceased operations in 2009; however, the company retains the permit and can resume operations anytime.

2.2.5　　Arizona Electric Power Cooperative - Apache Generating Station

The Apache Generating Station is owned and operated by Arizona Electric Power Cooperative and is located approximately 50 miles (80 km) east of Tucson in Cochise County, Arizona, with a PTE of 1,293 tpy. The facility has 605 megawatts (MW) of gross generating capacity and consists of three EGUs. Each EGU has several control measures applied to it to limit emissions. The updates as well as switching to natural gas fuel, contributed to the facility's decreased emissions from 7,812 tpy in 2014 to 311 tpy in 2017. The generating station was initially issued a regional haze BART FIP; however, the FIP provisions were incorporated later into the State's SIP.[59]

2.2.6　　Arizona Public Service - Cholla Generating Station

The Cholla Generating Station is owned and operated by Arizona Public Service and PacificCorp, and is located approximately 80 miles (129 km) east of Flagstaff in Navajo County, Arizona, with a PTE of 5,563

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[50] Freeport McMoRan North America Miami, Freeport McMoRan webpage, https://fcx.com/operations/north-america (last accessed October 19, 2020)

[51] Miami SO2 Nonattainment Area State Implementation Plan Revision, Ariz. Dept. of Envtl. Quality, submitted to the U.S. ENVTL. PROT. AGENCY, Feb. 26, 2020.

[52] Additional information on the upgrades made to the Miami smelter are available in Appendix A.

[53] 79 FR 52420 (Sept. 3, 2014).

[54] AZMILS Data for the Nelson Quarry, Ariz. Dept. of Mines and Mineral Resources Mining Collection, Ariz. Dept. of Mines and Mineral Resources, http://docs.azgs.az.gov/OnlineAccessMineFiles/M-R/NelsonquarryYavapai78-1.pdf (last accessed April 17, 2002).

[55] Lhoist North America, Nelson Plant Permit No. 63592, Ariz. Dept. of Envtl. Quality.

[56] 79 FR 52420 (Sept. 3, 2014); 80 FR 21176(April 17, 2015).

[57] Lhoist North America, Douglas Plant Permit No. 42804, Ariz. Dept. of Envtl. Quality

[58] U.S. ENVTL. PROT. AGENCY, 2008 National Emissions Inventory (NEI) Data, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data (last accessed March 15, 2022).

[59] 80 FR 19220 (April 10, 2015).

tpy. The facility consists of four primarily coal-fired EGUs, with a total plant-wide generating capacity of 1,180 gross MW. It houses Units 1, 2, and 3, owned and operated by APS, and Unit 4, owned by PacifiCorp and operated by APS. Over the last ten years, the facility has made operational changes and installed emission control devices that ensure an SO_2 removal efficiency of 95% on a 30-day rolling average basis for Units 2, 3, and 4. While APS closed Unit 2 in 2015, units 1 and 3 are still running. APS has decided to close the remaining Cholla units by 2025.[60] The SO_2 emissions at the Cholla Generating Station have declined from 2008 at 16,421 tons to 2017 at 1,755 tons. This trend is expected to continue as the various units cease operation. The generating station was initially issued a regional haze BART FIP; however, the FIP provisions were incorporated into the State's SIP.[61]

2.2.7   Tucson Electric Power - Springerville Generating Station

The Springerville Generating Station is located approximately 6 miles (10 km) west of New Mexico in Apache County, Arizona, and is owned by Tucson Electric Power and operated by Salt River Project with a PTE of 10,800 tpy. The station is a steam electric generating station that consists of four coal-fired generating units designated as Unit 1, Unit 2, Unit 3, and Unit 4.[62] All four units burn coal during normal operations, except during the start-up and flame stabilization period when fuel oil is fired. Units 1 and 2 use spray dry absorbers, and Units 3 and 4 are equipped with wet Flue Gas Desulfurization (FGD) and combust low sulfur powder river basin coal. The SO_2 emissions from Springerville Generating Station have consistently been around 6,000 tpy from 2008 to 2017. The facility has an accepted a combined emission limit of 10,800 tpy for all four units, and its Integrated Resource Plan (IRP) states that Units 1 and 2 are scheduled to shut down in 2027 and 2032, respectively.[63] But, currently, no federally mandated shutdown dates exist for any of the units.

2.2.8   Salt River Project - Coronado Generating Station

The Coronado Generating Station is owned and operated by Salt River Project and located in Apache County, 13 miles (21 km) west of New Mexico, with a PTE of 3,312 tpy. Coronado is a two-unit, coal-fired, steam electric generating station. On April 13, 2016, there was a significant permit revision to add requirements for regional haze, including 3 interim operational strategies to curtail operations of unit U1B, which has a 389 MW capacity and set a 1,970 tpy cap on SO_2 emissions. Unit U2B has a 384 MW capacity and is equipped with selective catalytic reduction (SCR) for reducing NO_x emissions. SRP plans to split Unit U2B SCR to adequately process emissions from U1B and U2B units. [64]

On January 21, 2009, SRP obtained approval to install flue gas desulfurization systems on units U1B and U2B. SO_2 emissions from Coronado Generating Station have declined sharply from 15,900 tons in 2008 to 222 tons in 2017 after the controls discussed above were installed. Coronado Generating Station is scheduled to retire no later than 2032; however, the permit has no enforceable shutdown dates. The

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[60] 'Historic' Ariz. Plan for coal towns may ripple nationally, E&E News, https://www.eenews.net/articles/historic-ariz-plan-for-coal-towns-may-ripple-nationally/#:~:text=In%20addition%20to%20the%20Cholla,Station%2C%20which%20shuttered%20in%202019 (last accessed March 15, 2022).

[61] 82 FR 15139 (March 27, 2017).

[62] Springerville Generating Station, Salt River Project, https://www.srpnet.com/about/stations/springerville.aspx (last accessed March 15, 2022).

[63] TEP Integrated Resource Plan, Tucson Electric Power, https://docs.tep.com/wp-content/uploads/2019/06/03-TEP-June-IRP-Advisory-Council-Existing-Resources.pdf (last accessed June 20, 2019).

[64] Coronado Generating Station, Salt River Project, https://srpnet.com/about/stations/coronado.aspx (last accessed in March 15, 2022).

generating station was initially issued a regional haze BART FIP; however, the FIP provisions were later incorporated into the State's SIP.[65]

2.2.9   Salt River Project - Navajo Generating Station

The Navajo Generating Station was owned and operated by Salt River Project and located in Coconino County, Arizona, on the Navajo Indian Reservation, 7 miles (11 km) south of Utah. The station ceased operations on November 18, 2019. When the generating station was operational, it consisted of three coal-fired units, each with a 750 MW capacity. Before it shut down, the SO_2 emissions from the facility increased from 3,816 tons in 2008 to 5,015 tons in 2017.

2.2.10   Tucson Electric Power - Irvington Generating Station

The Irvington Generating Station is located in Pima County, in Tucson, Arizona, with a PTE of 772 tpy. Tucson Electric Power has replaced the facility's old EGU units 1 and 2 with ten 19 MW reciprocating internal combustion engines (RICE). The RICE engines can quickly ramp up to support an intermittent change in renewable resources. The switch to the RICE units decreased SO_2 emissions from 2,884 tons in 2008 to a laudable 17 tons in 2017. Unit 4 is currently subject to a regional haze FIP.[66]

2.2.11   Snowflake Inc. - Catalyst Paper

Snowflake Inc.'s Catalyst Paper was in Snowflake, Arizona; however, the facility ceased operations on September 30, 2012.

2.2.12   Arizona Public Service - Yucca Power Plant

The Yucca power plant is a natural gas-fueled plant owned by Arizona Public Service and Imperial Irrigation District but solely operated by APS. The facility is located in Yuma, Arizona, about 162 miles (260 km) southwest of Phoenix, and has a PTE of 5,318 tpy. The facility operates eight units, one steam boiler and seven combustion turbines. The combined units have a capacity of 362 MW. There are no SO_2 control devices installed on any of the units. The facility is a peaker plant, primarily used in the summer when air conditioning power demands are high.[67] The SO_2 emissions from this facility have been under 2 tpy over the last 10 years despite having higher maximum allowable emissions.

2.2.13   Calportland - Rillito Cement Plant

The Rillito Cement Plant is owned and operated by Calportland and is located about 10 mi (16 km) northwest of Tucson in Rillito, Arizona. The facility produces cement and aggregate. If the plant operates 24 hours a day throughout the year, the PTE would be 11,347 tons of SO_2 annually. However, the facility's actual emissions reported in 2017 were 5 TYP. The facility's current permit requires it to record the daily sulfur content of fuel used in the engines and report any daily period in which the sulfur content exceeds 0.8%. Kiln 4 of the cement plant is currently under a regional haze FIP.[68]

2.2.14   Tucson Electric Power - North Loop Generating Station

The North Loop Generating Station is a gas peaker plant owned and operated by Tucson Electric Power. The facility is located about 16 miles (25 km) northwest of Tucson in Marana, Arizona. The facility consists of one primary unit that runs on natural gas and three that run on fuel oil but are not historically operated.[69] Each of the three turbines – if fired on fuel oil exclusively for 8760 hours per year

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[65] 82 FR 46903 (Oct. 10, 2017).

[66] 79 FR 52420 (Sept. 3, 2014).

[67] Arizona Public Service – Yucca Power Plant Permit No. 31876, Ariz. Dept. of Envtl. Quality.

[68] 81 FR 83144 (Nov. 21, 2016).

[69] Tucson Electric Power Company North Loop Generating Station Permit No. 24821, Ariz. Dept. of Envtl. Quality.

as allowed by permit – would emit about 1,720 tons of SO_2 per year. The total PTE for this facility is 5,160 tons of SO_2 per year. However, the actual emissions are much less than the PTE. The highest actual annual emissions in the past 5 years were 0.1 tons in 2019. The allowed PTE has been retained in the event there is no natural gas available. In addition, the three units have also been kept to convert and use if needed in future projects.

2.3   Less Significant SO₂ Stationary Sources Near Arizona's Borders

Figure 10 shows that most of the facilities listed as sources of SO$_2$ emitted less than 1,000 tons of SO$_2$ in every NEI year examined. As mentioned in Section 2.1, each circle marker is approximately proportional to the source's maximum SO$_2$ emissions across the NEIs. The largest circle marker represents emissions over 10,000 tpy and the smallest circle markers represent emissions of less than 1,000 tpy. The resulting set of facilities is summarized in Table 3.

Figure 10 Sources of SO₂ Emissions in Arizona and Neighboring States Within 130 km of the Arizona Border
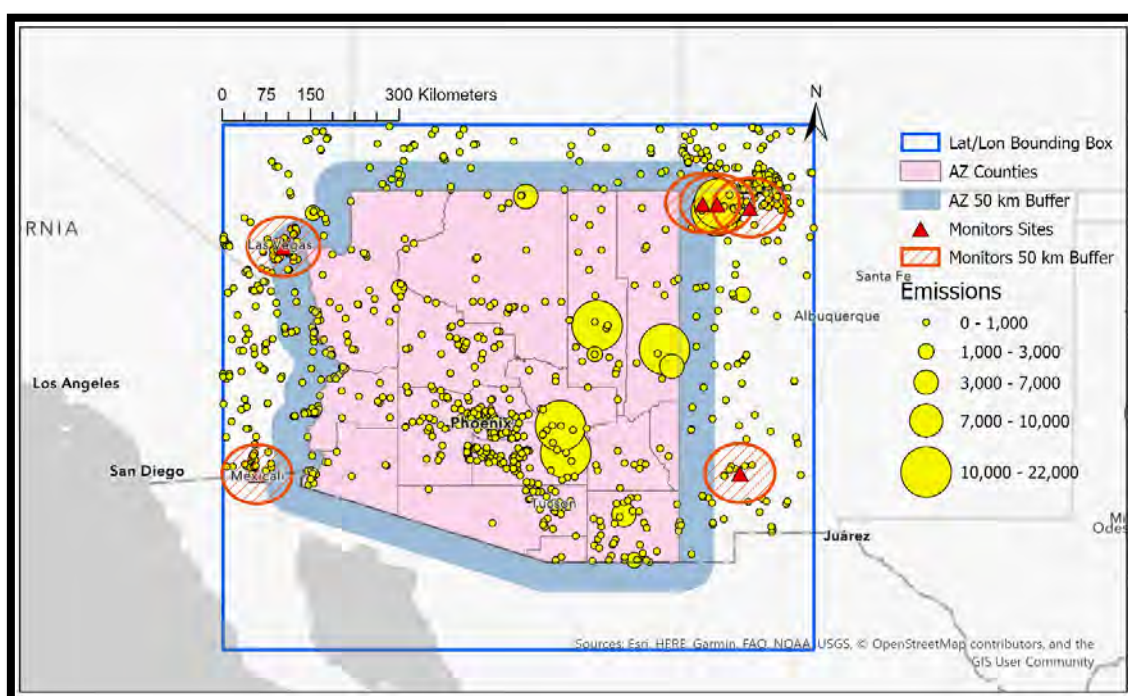
Table 3 Number of SO2 Emitting Facilities in Arizona and Surrounding Areas with Emissions from Recent NEI Years.[70]

Jurisdiction	Number of Facilities	Annual Emissions (tons SO_2)			
		2008	2011	2014	2017
Arizona	60	75,308	60,983	39,899	34,791
Maricopa County, Arizona	28	304	386	437	688
California	13	56	21	8	8
Colorado	7	36	35	31	6
New Mexico	39	12,913	6,792	5,960	5,652
Nevada	5	943	1426	2,506	1
Clark County, Nevada	41	750	873	787	974
Pima Association of Governments, Arizona	5	34	35	50	64
Pima County, Arizona	5	2884	2193	1092	59
Pinal County, Arizona	26	71	44	62	62
Southern Ute Indian Tribe, Utah	22	5	17	55	91
Navajo Nation (multi-state)	10	14,229	16,586	12,104	8,785
Utah	3	6	8	2	1
Salt River Indian Community, Arizona	4				14
Total	268	107,539	89,399	62,993	51,196
The emissions listed in this table for California, Colorado, New Mexico, Utah, and Nevada are not statewide. The emissions in the table are from facilities in the buffer zone, as shown in Figure 10.					

2.4   Mobile Source SO$_2$ Emissions in Arizona Border Counties

Arizona has 15 counties, among which 10 share a border with another state or Mexico. According to the 2017 National Emissions Inventory, on-road and non-road mobile SO_2 emissions in Arizona were 404 tpy. Emissions from border counties accounted for approximately 125 tons of SO_2 (31%) of the state total. Excluding SO_2 emissions from counties that only share a border with Mexico, the bordering counties' SO_2 emissions account for 77 tons of SO_2 (19%) of the state total.

The mobile source SO_2 emissions from counties bordering the State are below the 100 tons threshold ADEQ used to screen out smaller facilities for further analysis. Furthermore, mobile emissions are scattered out in small quantities over large geographic areas, allowing greater dispersion before reaching Arizona's border. Therefore, mobile emissions in Arizona will not contribute to SO_2 exceedance in other states.

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[70] The emissions listed in Table 4 are not statewide emissions from California, Colorado, Utah, New Mexico, and Nevada, but emissions from facilities located within the buffer zone of Figure 10.

3   STATEWIDE SO$_2$ CONCENTRATIONS AND AMBIENT AIR MONITORING TRENDS

Chapter 3 discusses Arizona's statewide SO$_2$ concentrations and ambient air monitoring trends. Section 3.1 examines the design values, and historical trends of SO$_2$ monitored data in Arizona. Section 3.2 identifies the air quality monitors currently violating the NAAQS in Arizona. Lastly, Section 3.3 identifies the air quality monitors that violated the NAAQS.

3.1   Design Values and Historic Trends

The design values for SO$_2$ concentrations at the monitors in Arizona and neighboring states are presented in Table 4 and Table 5 below. The hourly monitoring data from 1990 to 2020 was obtained from EPA's Air Quality System (AQS) database. The data came from monitors in Arizona and monitors within 80 km of Arizona's border in neighboring states. ADEQ selected monitors within 80 km of the Arizona border to ensure that all concentrations attributed to the State were accounted for. The data collected from the monitors was used to calculate the one-hour SO$_2$ design value at the specific monitoring sites using the three-year average of the 99th percentile of the annual distribution of daily maximum one-hour average SO$_2$ concentration, rounded to the nearest whole part per billion. The calculated design values have been color-coded to provide additional information on the completeness of the data used in the calculation.

Since ADEQ collected the monitoring data over 30 years, some monitors listed ceased operations and are currently inactive. To ensure all the data was captured, ADEQ analyzed both active and inactive monitors separately.

For active monitors, the design values show that monitors in Gila County, AZ, do not meet the 2010 SO$_2$ NAAQS in all years ADEQ analyzed. The Miami and Hayden areas have been designated nonattainment for the 2010 SO$_2$ NAAQS at 75 ppb.[71] No other active monitors are currently violating the 2010 SO$_2$ NAAQS in Arizona or neighboring states. The highest SO$_2$ design value for the remaining monitors in the past 5 years is 13 ppb which is well below the NAAQS by 83%. Note that the monitors in Waterflow, New Mexico, and Shiprock, New Mexico have SO$_2$ design values above 75 ppb from 1990 to 2007 and 2010 to 2012, respectively. This high SO$_2$ concentration has been linked to emissions from nearby coal-fired power plants: San Juan generating station and Four Corners power plant. The combined SO$_2$ emissions from these two power plants consistently decreased from their peak (81,000 tons) in 1997 to their minimum in 2020 (2,700 tons).

There are several inactive monitors located throughout Arizona and nearby states. For various reasons, these monitors are no longer used to collect emissions data. These inactive monitors listed in Table 5 showed that the design values in Miami, Arizona; Bayard, New Mexico; Silver City, New Mexico; and Hidalgo County, New Mexico exceeded the current SO$_2$ NAAQS in the 1990s. However, since 2003, only one of these monitors- the Miami, Arizona monitor- has exceeded the current SO$_2$ NAAQS. This monitor continued exceeding until it was closed in 2017. Excluding the Miami monitor, since 2004, the highest design value for inactive monitors was 15 ppb from 2004 to 2006 at the monitor in Tucson, Arizona.[72]

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[71] Sulfur Dioxide (2010) Designated Area/ State Information, U.S. ENVTL. PROT. AGENCY, https://www3.epa.gov/airquality/greenbook/tbtc.html (last accessed November 2, 2020)
[72] EPA's Air Quality System (AQS) database, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/aqs. (last accessed March 15, 2022).

Table 4 SO₂ Design Value Trends at Active AQS Monitors in Arizona and the Surrounding States

Site ID/ Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
04-007-0011 Payson, AZ																								148	178	199	200	221	175	172	105	90
04-007-0012 Miami, AZ																								117	179	196	194	159	127	111	87	56
04-007-1001 Hayden, AZ	404	328	321	301						209	193	218	225	260	268	289	276	286	273	284	282	259	285	266	282	246	280	295	282	226	134	65
04-013-3002 Phoenix, AZ	12	21	24	26	18	14	17	22	25	28	27	23	19	15	15	14	15	14	12	10	9	9	9	8	8	7	7	7	7	7	6	6
04-013-9812 Phoenix, AZ																						8	9	9	9	9	8	9	8	8	7	6
04-013-9997 Phoenix, AZ															9	9	8	8	8	7	6	6	6	6	6	5	5	6	6	5	5	4
04-019-1028 Tucson, AZ																					3	4	4	6	6	6	4	3	2	2	1	1
06-025-0005 Calexico, CA					40	36	35	30	28	26	25	18	10	2	2	2	19	21	24	10	9	8	7	6	7	7	8	7	6	6	6	6
32-003-0540 Las Vegas, NV																						8	8	8	8	7	7	6	6	5	5	4
35-045-0009 Bloomfield, NM							61	50	43	31	26	26	24	23	20	19	18	13	8	5	5	7	8	9	7	5	3	2	2	2	1	1
35-045-1005 Waterflow, NM	168	163	188	207	225	229	257	291	328	287	242	157	114	85	82	85	78	77	56	40	20	20	19	23	21	13	8	8	11	12	11	10
35-045-1233 Shiprock, NM																					163	149	107	58		13	8	7	6	5	8	8

Despite incomplete data, yellow cells are considered regulatory "valid" violations of the NAAQS and used for designation decisions

Dark orange cells are considered regulatory invalid because of data incompleteness. This data is not used for re-designation.

Red cells represent a non-regulatory monitor.

Bold indicates the design value is above the 2021 SO2 NAAQS

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Table 5 SO₂ Design Value Trends at Inactive AQS Monitors in Arizona and Surrounding States

Site ID/Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
04-007-0009 Miami, AZ										103	114	124	126	132	125	122	120	132	141	132	121	111	107	105	122	145	146	130				
04-013-3003 Scottsdale, AZ								10	10	10	13	13	13	9	9	9	10	10	9	7	7											
04-019-1011 Tucson, AZ	21	16	17	17	17	15	14	14	13	13	13	12	12	12	15	15	15	14	13	10	9											
04-012-8000 Wenden, AZ																								2	2	2						
32-003-0022 Apex, NV									10	9	6	5	5	7																		
32-003-0539 Las Vegas, NV									15	15	14	13	12	12	10	10	9	8	7													
35-017-0001 Bayard, NM	253	228	189	157	159	136	116	95	97	103	128	137	121																			
35-017-0008 Silver City, NM	179	168	124	107	89	75	66																									
35-017-1003 Silver City, NM								138	145	171	157	159	90	61	10	6	5	4	3	3	2	1	1	1	1	1						
35-023-0005 Hidalgo Co., NM	238	257	245	206	186	179	165	143	166	181	142	67	6																			
35-045-0008 Farmington, NM				50	49	51	50	49	46	46	43	38	32	30																		
35-045-0017 Farmington, NM	53	53	56	55	58	53	57	52	60																							

Despite incomplete data, yellow cells are considered regulatory "valid" violations of the NAAQS and used for designation decisions

Dark orange cells are considered regulatory invalid because of data incompleteness. This data is not used for re-designation.

Red cells represent a non-regulatory monitor.

Bold Indicates the design value is above the 2010 SO2 NAAQS

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3.2   Current Violating Monitors

This section lists the monitoring areas currently violating the 2010 SO_2 NAAQS and examines the details unique to the surrounding areas and the impacts those features have on SO_2 concentrations.

3.2.1   The Hayden Old Jail Monitoring Site

The violating monitor in Hayden, Arizona, is located at the monitoring site known as Hayden Old Jail (04-007-1001). The monitor began collecting SO_2 concentration data in 1979. In the past 30 years, the monitor's highest SO_2 design value occurred in 1990 at 404 ppb, and the lowest SO_2 design value occurred in 2021 at 65 ppb due to the facility not operating. The primary source of SO_2 in the monitoring area is Asarco's Hayden copper smelter and concentrator. The smelter's emissions are attributed to the facility's main stack and fugitive emissions from the smelter building itself.[73] The monitor is located close to the smelter, in an area primarily impacted by fugitive SO_2 emissions. The Freeport Miami copper smelter is within the 50 km buffer zone surrounding the Hayden facility. Currently, the monitor is showing that the data is clean; however, because the facility is currently not operational, the monitoring data is not an indicator of normal operations.

3.2.2   The Miami Jones Ranch, Miami Ridgeline & Miami Townsite Monitoring Areas

There are two violating monitors in Miami, Arizona, and one just outside the town of Miami. The monitoring network in the Miami nonattainment area consists of the Miami Jones Ranch (04-007-0011), Miami Townsite (04-007-0012), and Miami Ridgeline (04-007-0009) monitors.

ADEQ began monitoring SO_2 concentration at the Ridgeline monitor in 1995 and closed the monitor in 2017 after site access and safety became challenging to maintain. In 2013, ADEQ installed the Miami Jones Ranch and Miami Townsite SO_2 monitors, which are still active. In the past 30 years, these monitors' highest SO_2 design value occurred in 2017 at 221 ppb, and the lowest SO_2 design value occurred in 2021 at 56 ppb. ADEQ has determined that the primary source of SO_2 concentration in the Miami area is the Freeport Miami copper smelter. The facility emitted 3,930 tons of SO_2 in 2017. The Asarco's Hayden copper smelter and concentrator are located within the 50 km buffer zone surrounding the Miami facility.

3.2.3   The Contribution of the Miami and Hayden Copper Smelters to the SO_2 Concentrations in Other States

ADEQ utilized the screening distance of 50 km set by EPA around each point source which ADEQ could reasonably expect modeled SO_2 impact to occur. The closest state border from either Hayden or Miami is the Arizona-New Mexico border, about 165 km from the Hayden copper smelter and 175 km from the Miami copper smelter. Based on ADEQ's analysis, the Hayden and Miami copper smelters are a significant distance from the Arizona border and will not have any meaningful impact on SO_2 concentrations outside of Arizona. In addition, the California, Nevada, and New Mexico monitors located within 80km of the Arizona border have measured design values below the 2010 SO_2 NAAQS of 75 ppb since 2013.

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[73] Arizona State Implementation Plan Revision, Sulfur Dioxide National Ambient Air Quality Standards, Hayden Nonattainment Area, Ariz. Dept. of Envtl. Quality, submitted to the U.S. ENVTL. PROT. AGENCY on March 8, 2017.

3.3 Past Violating and Inactive Monitors

This section lists the monitoring areas that have previously violated the 2010 SO$_2$ NAAQS and the no longer active monitors. This section will examine the details unique to the surrounding areas and the impacts those features have on SO$_2$ concentrations.

3.3.1 Bayard and Silver City, New Mexico

The high concentration of SO$_2$ in Bayard and Silver City, New Mexico, was attributed to the Hurley Smelter and Concentrator, which was the primary source of SO$_2$ emissions in Grant County in the 1990s. The Hurley Smelter permanently closed in 2002, which is consistent with the SO$_2$ design values trends observed at Bayard and Silver City, New Mexico.[74] The monitor in Bayard, New Mexico, ceased operations in 2002, and the SO$_2$ design values at the Silver City, New Mexico monitor dropped below the current SO$_2$ NAAQS. The distance separating Bayard and Silver City is less than 10 miles (16 km); therefore, both cities were affected by the Hurley Smelter and Concentrator SO$_2$ emissions.

3.3.2 Hidalgo County, New Mexico

The elevated SO$_2$ concentrations in Hidalgo County were caused by the Hidalgo Copper Smelter, which operated from 1971 to 1999.[75] The SO$_2$ monitor in Hidalgo County ceased operation in 2002. The SO$_2$ design value at the monitor in Hidalgo County was only 6 ppb in 2002. [76]

3.3.3 Waterflow and Shiprock, New Mexico

The monitor in Waterflow, New Mexico, is located next to Four Corners Power Plant (4 km) and 11 km from San Juan Generating Station in New Mexico. The Waterflow monitor measured SO$_2$ concentrations above 75 ppb until 2007. The non-regulatory monitor in Shiprock is located approximately 19 km from Four Corners Power Plant and 24 km from San Juan Generating Station. The monitoring concentration in Shiprock, New Mexico, was above 75 ppb from 2010 to 2012.

The elevated SO$_2$ concentration measured in the past at the monitors in Waterflow and Shiprock, New Mexico, is attributed to the nearby power plants. However, the combined emissions from Four Corners power plants and San Juan generating station decreased by 77% in 2013 from their highest level (81,000 tons) in 1997. The decrease is partially attributed to changes made at the Four Corners Power Plant. In 2013 the facility closed three generators initially installed in the 1960s and updated the facility's remaining generators.[77] In addition, in 2018, Four Corners installed selective catalytic reduction controls.

As mentioned above, the monitoring areas that had previously violated the 2010 SO$_2$ NAAQS are currently attaining the NAAQS. The attainment is due to the closure of the Hurley Smelter in Grant County, New Mexico, and the Hidalgo Copper Smelter in Hidalgo County, New Mexico. The lack of violations can also be attributed to the changes made at the Four Corners Power Plant.

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[74] Town of Hurley, Silver City Chamber of Commerce, http://www.silvercity.org/hurley (last accessed March 16, 2022).

[75] Chronicle of a Journey, New Mexico Tech, Playas Training and Research Center, http://ptrc.emrtc.nmt.edu/history.html (last accessed March 16, 2020).

[76] Based on the monitoring data and the emissions from the smelter.

[77] Coal-burning Four Corners Power Plant will cut back on operations, APS says. Ryan Randazzo, https://www.google.com/url?q=https://www.azcentral.com/story/money/business/energy/2021/03/12/aps-four-corners-power-plant-reduce-operations-one-generator/4655198001/&sa=D&source=docs&ust=1654786731938828&usg=AOvVaw3t8MA-jucShF9AZ8fQPOIn (last accessed March 12, 2021).

4   DATA FROM MONITORS OUTSIDE OF THE STATE THAT COULD BE IMPACTED BY ARIZONA SO₂ EMISSIONS

Previously in Chapter 3, ADEQ examined design values from air quality monitors in Arizona and within 80 km of the Arizona border. In this chapter, ADEQ will examine the results presented in the previous chapter in more detail, specifically focusing on monitors outside of the State that Arizona's SO2 emissions could impact.

To accomplish this, ADEQ began by examining all sources of SO_2 emissions within 50 km of the border. Once the sources within 50 km were reviewed, ADEQ turned its focus to significant stationary sources with emissions greater than 100 tpy, specifically those discussed in Section 2.2. With the major stationary sources identified, ADEQ sought out and reviewed any modeling studies completed at those facilities.[78]

ADEQ also identified the air quality monitors within 80 km of the Arizona border that would pick up any SO_2 emissions transported outside the State by registering any SO_2 concentrations higher than those attributed to local sources. The monitors identified are listed in Table 6 below.

Table 6 Air Quality Monitors Identified for SO₂ Emissions Transport Purposes	
Monitor Site ID	Monitor Location
06-025-0005	Calexico, California
32-003-0540	Las Vegas, Nevada
35-017-1003	Silver City, New Mexico
35-045-0009	Bloomfield, New Mexico
35-045-1005	Waterflow, New Mexico
35-045-1233	Shiprock, New Mexico

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[78] Modeling Report for SO2 NAAQS Designation for Arizona Electric Power Cooperative (AEPCO)- Apache Generating Station, Ariz. Dept. of Envtl. Quality, January 2017; Modeling Report for SO2 NAAQS Designation for Tucson Electric Power Co. (TEP) Springerville Generating Station, Ariz. Dept. of Envtl. Quality, January 2017; and Modeling Report for SO2 NAAQS Designation for Arizona Public Service (APS)- Cholla Generating Station, Ariz. Dept. of Envtl. Quality, January 2017.

At these six monitors, ADEQ found that most had measured concentrations of SO_2 at natural background levels (i.e., concentrations attributed to minor local sources), as shown in Chapter 3 in Table 5 and Table 6 (SO_2 design values for monitors in Arizona and the surrounding neighboring states). Based on previous modeling studies, ADEQ determined the background SO_2 concentration ranged between 2 ppb and 8 ppb. ADEQ also determined that any SO_2 design value below 10 ppb is considered background SO_2 concentrations. The Calexico, Las Vegas, Silver City, and Bloomfield monitors have all measured SO_2 concentrations at background levels since 2009, indicating that SO_2 concentrations at these monitors are not linked to any significant active sources of SO_2 emissions in Arizona.

The Waterflow monitor is located next to the Four Corners Power Plant and about 10 km from San Juan Generating Station. Similarly, the Shiprock monitor is located within 25 km of the facilities influencing the Waterflow monitor. The Shiprock monitor, a non-regulatory monitor, measured SO_2 design values above the 2010 SO_2 NAAQS from 2010 to 2012. When combined, the Four Corners Power Plant and the San Juan Generating Station produced 21,047 tons of SO_2 in 2008 and 8,295 tons in 2017. ADEQ determined that concentrations outside the average background concentrations measured at the Shiprock and Waterflow monitors are linked to the nearby Four Corners Power Plant and San Juan Generating Station. Chapter 5 discusses the methodology used to make this determination.

Once ADEQ identified the monitors, ADEQ sought out SO_2 nonattainment areas in California, Colorado, New Mexico, Nevada, and Utah; focusing on monitors close to the Arizona border. As a result, ADEQ found that Grant County, New Mexico, where the Silver City monitor was located and initially designated as nonattainment for the 1971 SO_2 NAAQS in 1978, due to the SO_2 emissions from the Hurley Smelter and Concentrator. [79] The Hurley Smelter shutdown in 2002, and the Grant County area has since been re-designated to maintenance status for the 1971 SO_2 NAAQS.

Even with the area re-designated, ADEQ examined the monitor data and determined that from 2005 to 2015, the highest hourly SO_2 concentration measured at the Silver City monitor was 6 ppb, indicating primarily background SO_2 concentrations. Additionally, the highest SO_2 design value at the Silver City monitor from 2010 to 2015 was 2 ppb. The Silver City monitor ceased recording data in 2015. [80] The Silver City monitor was the only monitor identified stationed in an SO_2 maintenance area.

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[79] Federal Register Notices Related to Sulfur Dioxide (1971) Designations and Classifications, U.S. ENVTL. PROT. AGENCY, New Mexico, https://www3.epa.gov/airquality/greenbook/sfrnrpt3.html#NM (last accessed March 16, 2022).

5   METEOROLOGICAL ANALYSIS OF IDENTIFIED MAINTENANCE AREAS

Chapter 5 examines the results of the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, which shows the trajectory of the air parcels reaching Waterflow and Shiprock monitors during a period of measured SO_2 concentration higher than 10 ppb. ADEQ ran the model during hours when the measured SO_2 concentrations were greater than or equal to 15 ppb over the last five years. The model was run at elevations of 100 meters, 500 meters, and 1500 meters using North American Mesoscale Forecast System (NAMS) meteorology data to determine where the concentration near the two monitors originated. Section 5.1 displays the HYSPLIT modeling results for the Waterflow monitor, and section 5.2 depicts the HYSPLIT modeling results for the air monitor located in Shiprock, New Mexico. Besides the background concentration, the additional SO_2 measured at Shiprock and Waterflow monitors is clearly from nearby local sources. The monitor in Waterflow, New Mexico, is next to Four Corners Power Plant and about 10 km from San Juan Generating Station, both of which are in New Mexico. The monitor in Shiprock is located within 25 km of the power plants influencing the Waterflow monitor. When combined, the two power plants' emissions were 21.047 tons of SO_2 in 2008 and 8,295 tons in 2017.

The HYSPLIT trajectories in Figures 12 and 13 on the modeled days consistently passed over Four Corners Power Plant and San Juan Generating Station. Furthermore, ADEQ backtracked these trajectories to areas outside of Arizona except on three occasions:

- The 100m, 500m, and 1500m air parcels at the Waterflow monitoring site on October 17, 2016, at 9:00 AM, passed over Arizona. However, this path occurred in areas away from the State's significant SO_2 sources, as shown below in Figure 11.

- The 1500m air parcel at the Waterflow monitoring site on July 22, 2017, at 9:00 AM, was backtracked near a large facility in Arizona, as shown in Figure 12. However, this air parcel originates at a level much higher than the height reached by plumes from the industrial smoke stack. Therefore, ADEQ determined that the facility in Arizona did not impact the Waterflow monitor on this specific day.

- The 100 m air parcel at the Shiprock monitoring site on July 26, 2018, at 4:00 PM, was backtracked in Arizona to an area surrounded by small facilities, as shown in Figure 13. Therefore, Arizona determined that facilities within the State did not impact the Shiprock monitor on this particular day.

- Based on HYSPLIT modeling results, ADEQ determined that higher concentrations of SO_2 measured at the monitors in Waterflow and Shiprock, New Mexico, were caused by emissions from the San Juan Generating Station and Four Corners Power Plant. Since significant SO_2 sources in Arizona are not upwind of the Shiprock and Waterflow monitors, Arizona emissions will not contribute to the elevated SO_2 levels observed at these monitors.
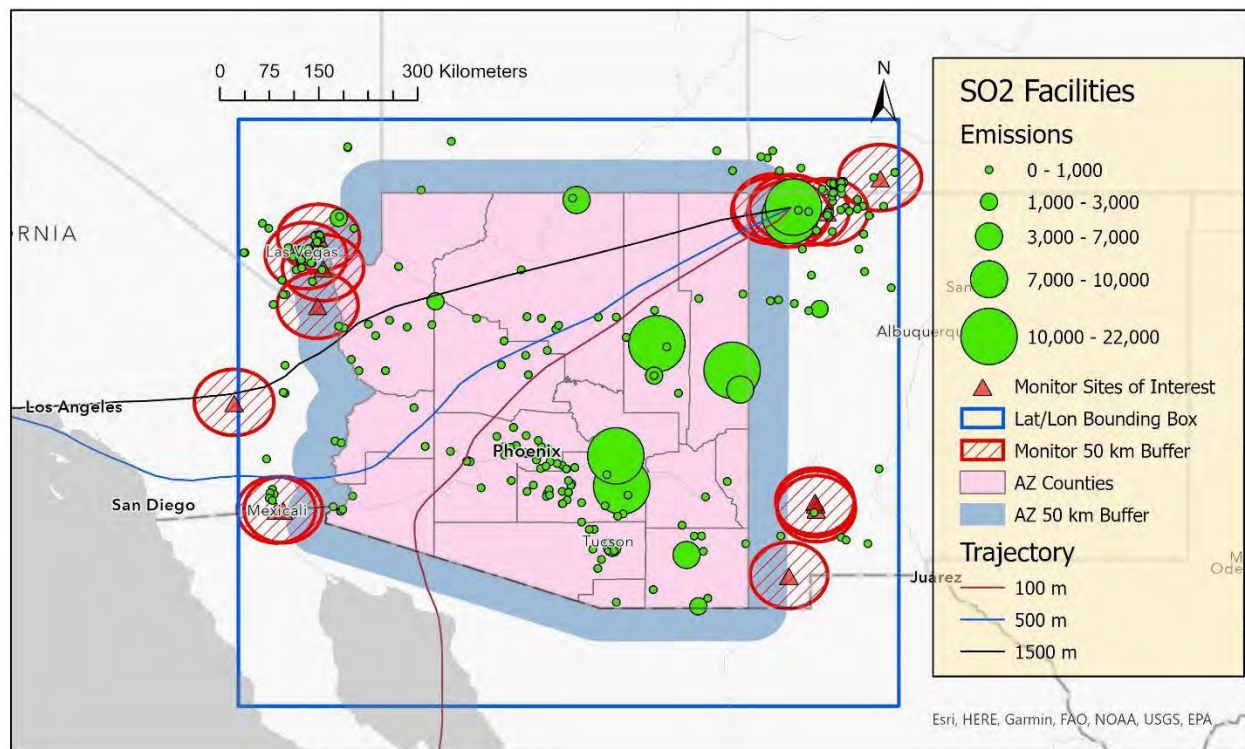
Figure 11 Trajectory of Air Parcel from Waterflow, New Mexico, on October 17, 2016, at 9:00 AM, with Locations of SO₂ Facilities
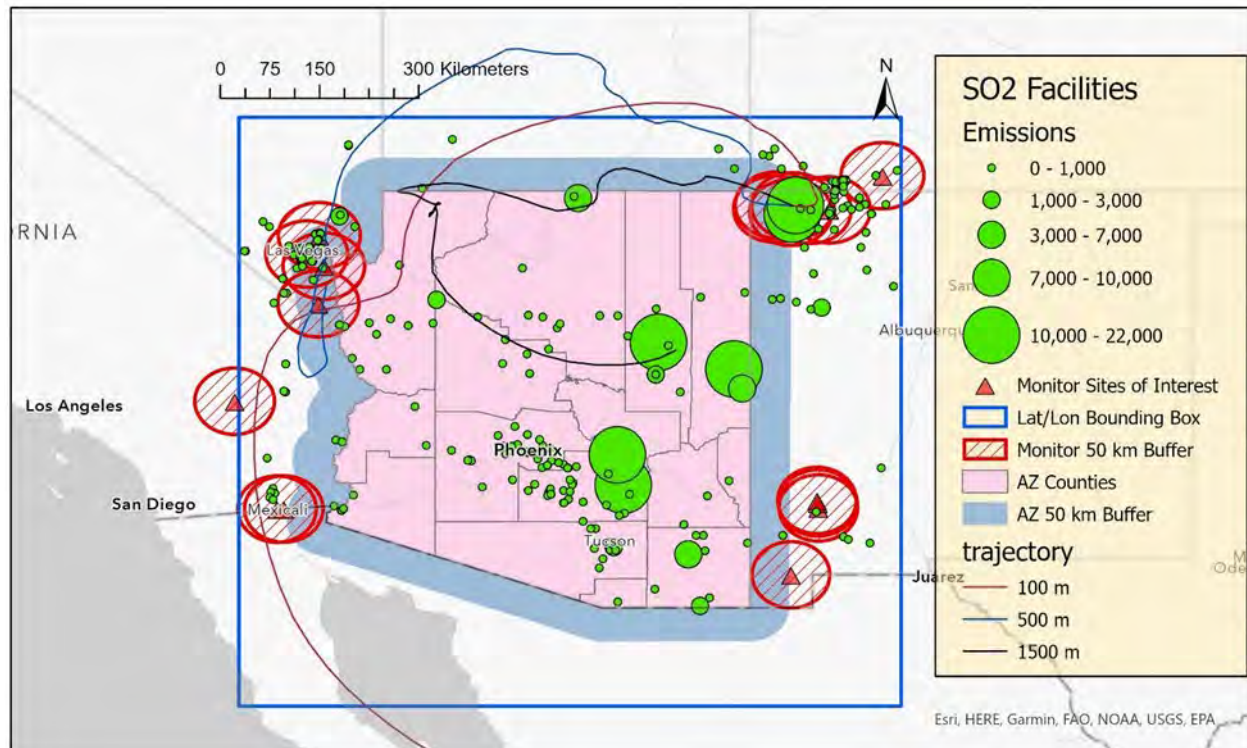
Figure 12 Trajectory of Air Parcel from Waterflow, New Mexico on June 22, 2017, at 9:00 AM with Locations of SO₂ Facilities.
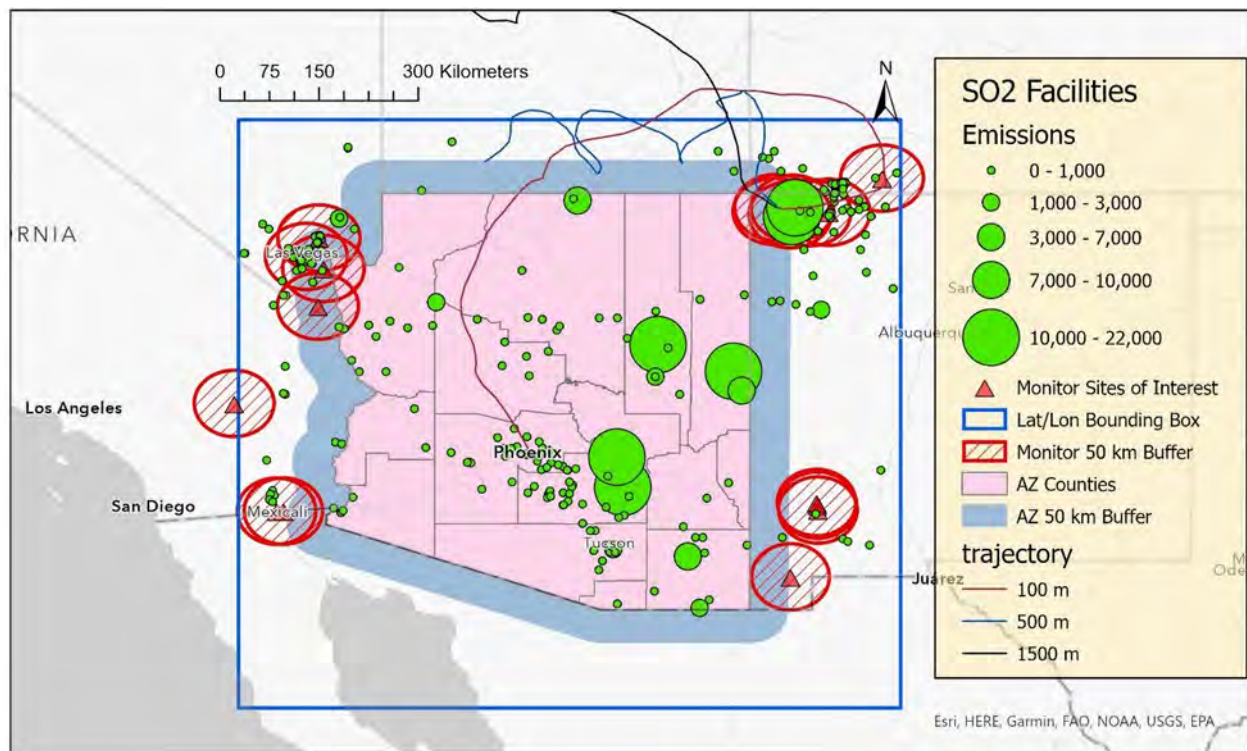
Figure 13 Trajectory of Air Parcel from Shiprock, New Mexico on July 26, 2018, at 4:00 PM with Locations of SO₂ Facilities.

5.1   Backward Trajectories of Air Parcels at the Monitor in Waterflow, New Mexico

Figure 14 Backward Trajectories of Air Parcels at the Monitor in Waterflow, NM
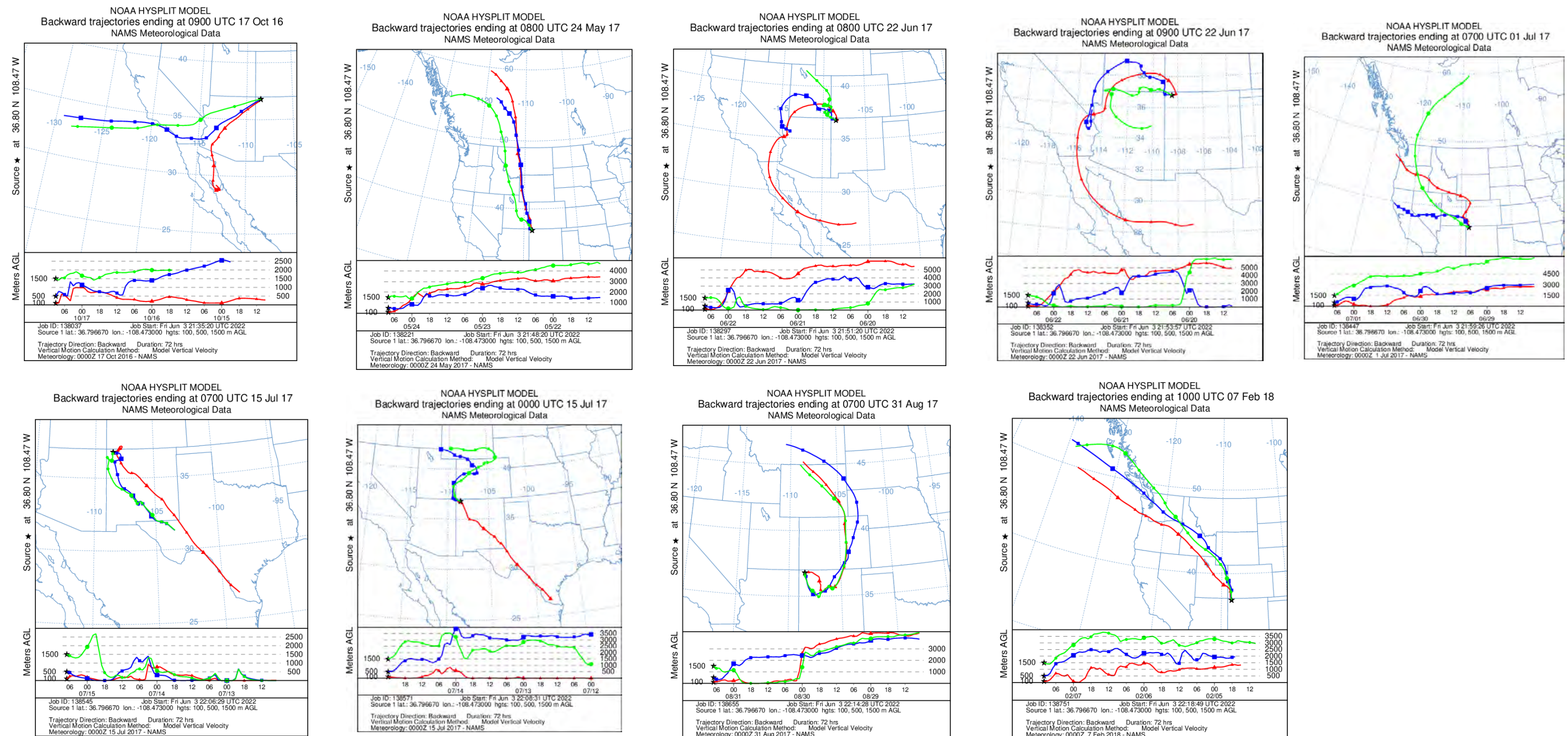
5.2   Backward Trajectories of Air Parcels at the Monitor in Shiprock, New Mexico
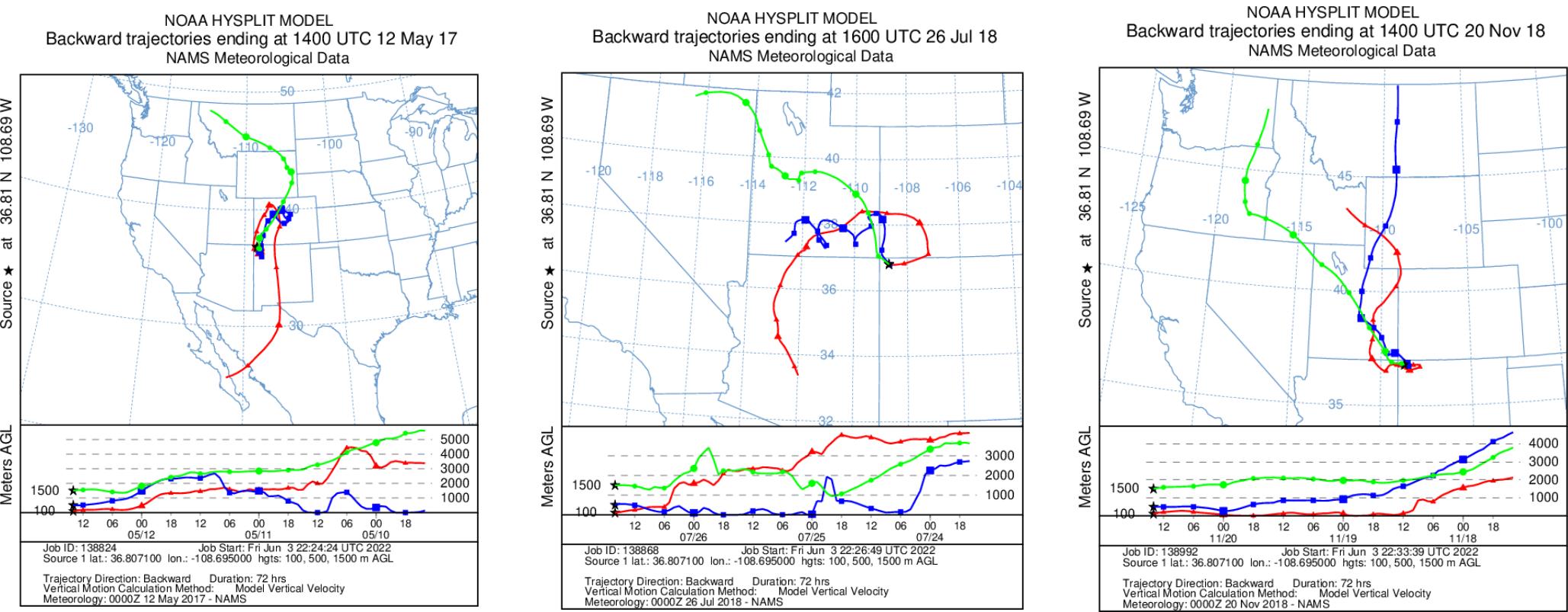
Figure 15 Backward Trajectories of Air Parcels at the Monitor in Shiprock, NM

6 SUMMARY OF AVAILABLE MODELING STUDIES AND ASSESSMENT OF LARGE FACILITIES WITHOUT MODELING

Chapter 6 builds off the emissions inventory, ambient data, and meteorological data analyses discussed in the previous chapters. Section 6.1 discusses EPA's SO_2 DRR and the facilities impacted by this rule. Section 6.2 examines the modeling studies for Arizona's two copper smelters responsible for two designated SO_2 nonattainment areas in the State. Section 6.3 summarizes modeling studies for power plants subject to the SO_2 DRR. Finally, section 6.4 assesses large facilities without modeling studies available.

6.1 The Data Requirements Rule for the 2010 1-Hour SO₂ Primary NAAQS

As mentioned in section 1.2, ADEQ identified and submitted five sources of SO_2 emissions to EPA on January 15, 2016 (See Figure 10) to satisfy the DRR.[81] Initially, ADEQ identified eight sources but was able to cull three facilities from the list after demonstrating that these facilities' emissions were expected to either maintain or achieve emissions below 2,000 tpy, thus exempting them from the scope of the DRR.[82] The five facilities Arizona submitted to EPA included the State's two primary copper smelters and three power plants. In sections 6.2 and 6.3 of this chapter, ADEQ will briefly discuss the modeling results completed for the five facilities as part of SO_2 DRR and SIP revisions.

Table 7 Arizona Facilities with 2,000 tpy or more of SO₂ Emissions	
Facility Name	2014 SO₂ (tpy) Emissions
ASARCO Hayden Smelter	17,432
Freeport Miami Smelter	4, 505
APS - Cholla Generating Station	3,806
TEP - Springerville Generating Station	6,221
AEPCO - Apache Generating Station	4,811
The data in this table was pulled directly from the *Arizona SO2 Information for the Data Requirements Rule*, Letter from Eric Massey, Director of Air Quality at the Arizona Department of Environmental Quality, to Jared Blumenfeld, Regional Administrator for the U.S. Environmental Protection Agency Region IX, January 15, 2016. The facilities listed in the table were not modeled at the time of the report but in later SO2 SIPS. ADEQ used the modeling from Arizona's Hayden and Miami SO2 SIPS to draft this supplement.	

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[81] Arizona SO2 Information for the Data Requirements Rule, Letter from Eric Massey, Director of Air Quality at the Arizona Department of Environmental Quality to Jared Blumenfeld, Regional Administrator for the U.S. Environmental Protection Agency Region IX, January 15, 2016.

[82] *Id.*

6.2   Copper Smelters

Arizona has two primary copper smelters, the Freeport Miami Copper Smelter and the Hayden Asarco Copper Smelter. ADEQ is required under the DRR to characterize the air quality around these facilities. This section will discuss the methodology ADEQ used for air quality characterization around the two smelters.

Hayden Copper Smelter

This section examines the air quality characterization at the Hayden Asarco Copper Smelter. To do this, ADEQ relied on the modeling summary previously submitted as part of *Appendix C* in the *2017 Arizona State Implementation Plan Revision for Hayden 2010 SO$_2$ Nonattainment Area.*[83] In the SIP, ADEQ used EPA's preferred regulatory dispersion model, AERMOD, to model the impacts of the Hayden smelter on the surrounding area's ambient SO$_2$ concentrations. The SIP modeling domain was defined as a 100 km square centered at the Hayden facility in the AERMOD Model.

The meteorological data used for modeling in the SIP consisted of on-site hourly surface observations that were collected from a 10-meter tower located approximately 0.35 kilometers south of the smelter building on Camera Hill and off-site meteorological data. Asarco collected and provided the raw on-site monitoring data from the tower. The off-site meteorological data was obtained from the meteorological data and processor station at the Tucson International Airport and used to model the period from August 16, 2013, through August 15, 2016.

Based on the data collected, ADEQ could determine that the 1-hour background SO$_2$ concentration in the area was 6.3 µg/m^3 (2.4 ppb). The background SO$_2$ concentration was estimated using the average concentration at five monitors in the Hayden area during the smelter shutdown period in 2009 (41 days), 2011 (25 days), and 2013 (26 days). The determined 1-hr SO$_2$ background concentration was 6.3 µg/m^3 (2.4 ppb).

The SIP's modeling analysis indicated that the 1-hr SO$_2$ emission rate of 1,518 lb/hr for the smelter's main stack produces the 4th-highest (i.e., annual 99th percentile) maximum daily 1-hr predicted concentration of SO$_2$ at 189.6 µg/m^3 (72.4 ppb) on the east side of the facility, along the fence-line. When this concentration rate is added to the background SO$_2$ concentration of 6.3 µg/m^3 (2.4 ppb), the total concentration is 195.9 µg/m^3 (74.8 ppb), below the 1-hr SO$_2$ NAAQS of 196 µg/m^3 (75 ppb). Therefore, the main stack's critical emission value (CEV) is 1518 lb/hr.

Similar to the modeling completed for the main stack, the fugitive sources were collectively modeled using AERMOD at 75.3 lb/hr. After analyzing the emission limits of different averaging periods, Asarco proposed the 14-day averaging limit of 1069.1 lb/hr for the main stack and to keep the CEV for the flash furnace fugitives, converter aisle fugitives, and anode furnace fugitives. Furthermore, the Hayden Smelter has been non-operational since mid-October 2019, and it is unknown when operations will resume. Given the facility's current operating status, it is unclear whether it can operate under the proposed CEV.

The modeling results also indicated a maximum SO$_2$ concentration of 141.19 µg/m^3 (54 ppb) at the edge of the modeling domain (50 km) on the east side, which is the side nearest to the state border. This

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[83] State Implementation Plan Revision, Sulfur Dioxide National Ambient Air Quality Standards, Hayden Nonattainment Area, Ariz. Dept. of Envtl. Quality, submitted to the U.S. Envtl. Prot. Agency on March 8, 2017.

concentration declines as the distance from the facility increases. With the nearest state border being 165 km away from the facility, the impact of the Hayden smelter beyond the State border is negligible.

The Hayden Smelter is not the only source of SO_2 in the modeling domain. Other sources of emissions include the Miami copper smelter, located about 45 km from the Hayden facility. The other facilities' emissions were minor compared to emissions from the Hayden copper smelter. When the Miami copper smelter emissions were excluded from the data, the highest emissions from the other SO_2 sources were 1,000 times less than the Hayden smelter's emissions. In the SIP analysis, the Miami copper smelter was considered a minor source of SO_2 emissions. The minor source status of the Miami smelter is due to the distance and the 7,850-foot-tall mountain separating the two facilities. The Miami copper smelter and other minor sources contribute to background concentrations at the Hayden smelter, but their emission contributions near the facility are negligible. ADEQ and Asarco could not discern such impacts from local ambient monitoring data collected during the Hayden shutdown periods. Therefore, there are no other sources with high SO_2 emissions in the modeling domain, and emissions created by the smelters' will not extend beyond the surrounding nonattainment area.

In addition, while the proposed emissions limits for the Hayden facility show SO_2 concentrations and design values close to or exceeding the 2010 SO_2 NAAQS, the facility is located 165 km west of the nearest state border. In the past, when discussing the area, EPA noted "that the state's recommended boundary contains the area violating the standard as well as areas causing or contributing to the monitored violation, as assessed using our five-factor methodology. The monitor is source-oriented and is located at the southernmost tip of Gila County. Due to constraints imposed by the complex terrain in the Hayden area (see Geography/Topography discussion above), it is expected that the extent of the area exceeding the SO_2 standard is confined to a relatively small area around the main source of SO_2 emissions, the ASARCO, LLC - Hayden smelter."[84] The distance from the border alone ensures that the emissions from the Hayden smelter will not contribute to the SO_2 NAAQS in the surrounding states. Based on the modeling results, the facility's distance from the nearest state border, the lack of other high emission sources in the modeling domain, and the area's topography, ADEQ has determined that the Hayden copper smelter will not significantly contribute to SO_2 NAAQS exceedance in the neighboring states.

Miami Copper Smelter

This section examines the air quality characterization at the Miami Copper Smelter. To do this, ADEQ relied on the modeling summary previously submitted as part of Appendix C of the *2017 Arizona State Implementation Plan Revision for Miami 2010 SO_2 Nonattainment Area*.[85] The SIP analysis was completed in collaboration with Freeport MacMoRan Inc. ADEQ used AERMOD to model the impact of the smelter on ambient SO_2 concentration in the surrounding area. The modeling domain was defined as a 100 km square centered at the Miami facility.

The meteorological data used in the modeling consists of on-site hourly surface observations collected by Freeport from the 30.5-meter Miami Smelter tower located approximately 0.32 kilometers southwest of the smelter facility. Freeport provided the raw on-site meteorological data used in the modeling to cover the period from the second quarter of 2010 through the first quarter of 2013. Simultaneous

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[84] U.S. ENVTL PROT. AGENCY. (2013). *Arizona Nonattainment Area Designations for the 2010 Sulfur Dioxide (SO2) Primary National Ambient Air Quality Standards.* Technical Support Document.

[85] Appendix C of the State Implementation Plan Revision, Sulfur Dioxide National Ambient Air Quality Standards, Hayden Nonattainment Area, Ariz. Dept. of Envtl. Quality, submitted to the U.S. ENVTL. PROT. AGENCY on March 8, 2017.

surface observations from weather stations were used to provide the parameters not collected at the Miami smelter tower, including relative humidity and cloud cover data. The two closest National Weather Service (NWS) stations with available cloud cover and surface pressure data are the Phoenix (WBAN 23183) and the Safford Airport (KSAD) stations. Although the Phoenix NWS station is slightly closer to the Miami Smelter, data from the Safford monitor was used because the location is more representative of the cloud cover and relative humidity at the Miami Smelter site. Data from the Tucson NWS site (WBAN 23160) was used for the upper air meteorology since it is the closest site capable of measuring radiosonde data.

Freeport estimated the background SO_2 concentration based on measured data collected from ambient air monitoring sites in the Miami-Claypool Arizona area. Freeport used the data measured at three monitoring sites from 2009 to 2012 to determine the area's SO_2 background concentration.[86] During those 3 years, Freeport shut down its smelter operations for 1,322 hours. While the shutdown hours represent only 3.8% of the total hours in the 3-year period, the availability of over 1,000 hours of shutdown data provides compelling evidence of background air quality conditions in the absence of the facility impacts. Freeport determined that the background air quality of SO_2 was 21.2 µg/m³ (8.1 ppb) using the ambient air measurements recorded during the smelter shutdown.

The final SIP modeling results had a predicted design concentration of 172.9 µg/m³ (66.0 ppb). This concentration added to the background concentrations discussed above results in a total concentration of 194.1 µg/m³ (74.1 ppb). Based on the dispersion model results, the facility-wide critical emissions value was determined to be 393 lb/hr. Using EPA's long-term emissions limit approach, ADEQ determined that the emissions limit based on a 30-day averaging period was 143.19 lb/hr.[87]

The modeling results also indicated an SO_2 concentration of 159.68 µg/m³ (61 ppb) at the edge of the modeling domain (50 km) on the east side, which is the side nearest to the state border. This concentration declines as the distance from the facility increases. With the nearest state border being 175 km away from the facility, the impact of the Miami smelter beyond the State border is negligible.

ADEQ completed the emission inventory for sources within the Miami area and a 50-km buffer zone based on the emissions data from 2009-2011 that extended from the boundary of the nonattainment area. Based on the available data, the primary smelting of copper ore is the most significant source category contributing to SO_2 emissions in the Miami NAA and the surrounding 50 km buffer zone. The SO_2 emissions from the Miami smelter represent more than 99.9 % of actual SO_2 emissions in the Miami nonattainment area during 2009-2011. The Hayden smelter, 46 km south of the Miami smelter, accounted for 99.9% of the actual SO_2 emissions from minor sources in the area. When the two smelters were excluded from the analysis, ADEQ determined based on the data that the remaining sources of SO_2 did not emit more than 25tpy of SO_2 during the 2009-2011 period. In addition to the lack of additional major sources in the nonattainment area, the area itself is surrounded by mountains—including a mountain separating the Miami smelter from the Hayden smelter. In addition to the area's topography limiting emissions dispersion from the facility, the Miami smelter is located 175 km west of the nearest state border (Arizona-New Mexico). In the past, EPA noted that the Miami area is "essentially surrounded by mountains in all directions. Due to the constraints imposed by the complex terrain in the

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[86] The monitoring sites were the Miami Jones Ranch (04-007-0011), Miami Townsite (04-007-0012), and Miami Ridgeline (04-007-0009).

Miami area . . . the extent of the area exceeding the SO_2 standard is expected to be confined to a relatively small area around the main source of SO_2 emissions, the . . .copper smelter."[88]

Therefore, due to the topography, distance from the nearest border, and the lack of other higher emissions sources in the modeling domain ADEQ has determined that any violations at the Hayden or Miami smelters will not be extended beyond the surrounding nonattainment area.

6.3   Power Plants

ADEQ is required under the DRR to characterize the air quality around these facilities. This section will discuss the air quality characterization and ADEQ's methodology around the three power plants.

Tucson Electric Power- Springerville

ADEQ performed air dispersion modeling using AERMOD to characterize air quality in areas proximate to Springerville Power Plant. The dispersion modeling used actual hourly emissions and meteorology for the most recent three years at the time of the analysis.[89] As mentioned in Section 2.2.7, the power plant is located 6 miles (10 km) from the New Mexico border, so when ADEQ set up the AERMOD modeling analysis, the modeling domain was centered over the power plant and extended out 50 km from the facility fence line into New Mexico. The only other major SO_2 source in the modeling domain, Coronado Generating Station, was also included in the modeling analysis.

While conducting the analysis, ADEQ discovered limitations associated with using the site-specific meteorological data. To overcome these limitations, ADEQ used the 2012-2014 NWS data collected from the monitor located in St. Johns, Arizona (KSJN), and found that the highest concentration of SO_2 occurs south of the facility, about 7 miles west of the border of New Mexico. The modeled maximum concentration of SO_2 in New Mexico attributed to the facility's emissions ranges from 60 to 80 µg/m^3. This concentration is about 31% to 41% of the NAAQS.

ADEQ determined that the facility's maximum allowable emissions resulted in an SO_2 concentration of 155.01 µg/m^3 (59.2 ppb), which means that even when the facility is emitting the maximum emissions allowed, the SO_2 concentration in the surrounding area did not exceed the 2010 SO_2 NAAQS. In addition, the closest out-of-state facility in New Mexico is the Gallup Refinery, located about 148 km northeast and only emitted 51 tons of SO_2 in 2017. Considering the relatively low SO_2 concentrations near the facility and the lack of violating monitors in the study domain, the Springerville facility will not contribute to the nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

AEPCO - Apache Generating Station

To develop the characterization of the air quality at the Apache Generating Station, ADEQ performed air dispersion modeling using AERMOD in areas proximate to the sources. The AERMOD model used actual hourly emissions and meteorology for the most recent three years at the time of the analysis. As mentioned in Section 2.2.5, the AEPCO Generating Station is in Cochise County, Arizona, near the Arizona - Mexico international border.

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[88] U.S. Envtl Prot. Agency. (2013). *Arizona Nonattainment Area Designations for the 2010 Sulfur Dioxide (SO2) Primary National Ambient Air Quality Standards.* Technical Support Document.
[89] Modeling Report for SO2 NAAQS Designation for Tucson Electric Power Co. (TEP) Springerville Generating Station, Ariz. Dept. of Envtl. Quality, January 2017.

ADEQ centered the modeling domain at the facility and extended it 50 km from the facility fence line for modeling purposes. A few facilities within the modeling domain emit small amounts of SO_2. In its analysis, ADEQ found that the SO_2 emissions from the facility represented more than 99% of actual SO_2 emissions during the 2012-2014 period.[90] Therefore, by excluding Apache generating station, ADEQ determined that no other sources in the area emitted more than 1.13 tpy of SO_2 during 2012-2014.

ADEQ modeled emissions from the generating station using meteorological data collected during 2009-2011, which represented the most recent three years (2012-2014) of meteorological conditions.[91] The predicted model concentration was around 82% of the NAAQS, with the highest concentration of 1-hour SO_2 found in the southwest portion of the modeling domain, about 9 km away from the facility.

The data used in the modeling was gathered before the facility's Unit 2 was converted from coal to natural gas in 2017, and Units 2 and 3 had emission control devices installed in 2016. Because the facility updates were not included in the modeling, the current contribution from the generating station to nearby ambient SO_2 concentrations are far lower than the concentrations estimated here. The facility now has a maximum allowable emissions threshold of 1,256 tpy.

ADEQ used AERMOD to model the impact of the current PTE using average exit velocity and temperature calculated from hourly data in the previous modeling.[92] The results indicate that the maximum allowable emissions result in SO_2 concentration at the facility of 72.05 µg/m^3 (27.5 ppb), including background concentration. Based on the concentrations modeled, the facility's highest SO_2 emissions did not contribute to the 2010 SO_2 NAAQS exceedance and, therefore, will not contribute to the nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

APS - Cholla Generating Station

To develop the characterization of the air quality at the Cholla Generating Station, ADEQ performed air dispersion modeling using AERMOD in areas proximate to the sources. The dispersion modeling used actual hourly emissions and meteorology for the most recent three years at the time of the analysis. As mentioned in section 2.2.6, the facility is located approximately 93 miles (150 km) west of New Mexico, with several SO_2 sources located within the 50 km modeling domain. The SO_2 emissions from the facility itself represent more than 99.6% of actual SO_2 emissions measured during the 2012-2014 period. [93] After excluding the facility's emissions, there are no sources that emit more than 29.5 tpy of SO_2 in the modeling domain during the 2012-2014 period.

Since the small amounts emitted by sources other than the generating station will not to contribute to a NAAQS violation in the area, ADEQ only modeled emissions from Cholla Generating Station. The modeled SO_2 concentration around the Cholla generating station was around 156.83 µg/m^3 (59.9ppb), about 80% of the NAAQS.

The Cholla generating station was granted a maximum allowable emission of 5,563 tpy after the facility's Unit 2 closed. When modeling the maximum allowable emissions at the facility, the resulting maximum SO_2 concentration (including background concentration) of 153.18 µg/m^3 (58.5 ppb) was below the 2010 SO_2 NAAQS. The facility's distance from the nearest state border means that its emissions will not cause an exceedance of the 2010 SO_2 NAAQS in neighboring states. Since the facility does not contribute to

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[90] Modeling Report for SO2 NAAQS Designation for Arizona Electric Power Cooperative (AEPCO)- Apache Generating Station, Ariz. Dept. of Envtl. Quality, January 2017.

[91] *Id.*

[92] *Id.*

[93] Modeling Report for SO2 NAAQS Designation for Arizona Public Service (APS)- Cholla Generating Station, Ariz. Dept. of Envtl. Quality, January 2017.

SO_2 nonattainment in the modeling domain, it will not contribute to the nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

6.4   Large Sources Without Modeling Data

While analyzing the sources of SO_2 that could impact areas over the Arizona border, ADEQ encountered a few facilities without previous modeling studies. These sources have a PTE above 2,000 tons of SO_2 per year but have actual emissions far below the 2,000 tpy threshold. To analyze the impact of these facilities' PTE, ADEQ considered the distance and terrain between the facility and the nearest state. For some facilities, ADEQ could determine relatively quickly that they would have a minimal impact on neighboring states. ADEQ made this determination after learning that certain facilities had been retired or that the facilities were unlikely to ever meet the conditions for emitting the maximum allowable emissions due to their current setup or because they were not economically feasible. Therefore, because the actual emissions at these facilities were significantly lower than their approved PTE, the sources were not subject to the DRR. As a result, these facilities were not modeled to estimate the air quality impacts on the surrounding areas and will not contribute to the nonattainment or interfere with the maintenance of the NAAQS in another state.

Lhoist Chemical Lime Company - Nelson Plant

The Nelson plant is located approximately 84 km southeast of Nevada on the Hualapai Indian reservation. The plant has the potential to emit 4,424 tons of SO_2 emissions per year; however, the facility's yearly emissions have been under 2,000 tpy for the last four NEI cycles. In addition, the plant is surrounded by mountainous terrain and located at a distance that, based on the modeling guidance, is far enough from the border that the facility's emissions should not impact Nevada. The facility's lack of impact on other states is supported by the absence of monitoring violations of the 2010 SO_2 NAAQS in Nevada.

Lhoist Chemical Lime Company - Douglas Plant

Lhoist's Douglas chemical lime plant is located 65 km west of the New Mexico border. The facility can potentially emit 4,535 tons of SO_2 emissions per year. As mentioned in Section 2.2.4, the facility has been idle since 2009; before that, it only emitted 1,013 tons of SO_2 in 2008. ADEQ has determined, based on the available data that the distance and terrain between the plant and the New Mexico border inhibit the facility's impact on SO_2 concentrations in New Mexico. To further support this argument, ADEQ determined that there are no monitors currently exceeding the 2010 SO_2 NAAQS standard across the border in New Mexico. Therefore, because the facility suspended its operations in 2009, the plant was exempted from ADEQ's SO_2 DRR modeling and will not contribute to the nonattainment or interfere with the maintenance of the NAAQS in another state.

APS Yucca Power Plant

The Yucca power plant is a peaking plant with the potential to emit 5,310 tons of SO_2 per year; however, the maximum actual annual SO_2 emissions from this facility since 2008 were 1.5 tons in 2018. The facility is less than one mile from the Arizona – California border, with the closest monitor located in Calexico, California, around 71 km from the power plant. The SO_2 design values concentrations measured at the Calexico monitor were below 10 ppb in the last 10 years. Based on NEI data from 2008-2017, there are no other sources in Arizona with actual SO_2 emissions greater than 2 tpy within 50km of the APS Yucca plant.

Based on the data available, a significant source of the facility's SO_2 PTE is fuel oil burning. ADEQ calculated the PTE by assuming that the facility would burn fuel oil at maximum capacity. However, the

plant runs primarily on natural gas and burns little fuel oil each year. An additional element considered by ADEQ was that if the plant ran at total capacity, year-round – on any fuel – the facility would have to change its current operational practices of running during the peak power demand hours to provide base load electricity.

Based on the emissions trends from the facility, operational and economic impacts of transitioning to PTE level operations, and low SO_2 concentrations across the border in California, the Yucca power plant will not contribute to the nonattainment or interfere with the maintenance of the NAAQS in another state.

North Loop Generating Station

The North Loop Generating Station is located about 195 km west of New Mexico, in terrain that includes Mount Lemmon, Mica Mountain, Bassett Peak, and Reiley Peak. As discussed in Section 2.2.14, the facility is a peaker plant that primarily runs on natural gas, although it can run three of its units on fuel oil. The total PTE for this facility, reflecting the use of fuel oil in the three compatible units, is 5,160 tons of SO_2 per year. However, this facility's highest actual SO_2 emissions in the past 5 years were 0.1 tpy in 2019. Because the cost of burning fuel oil is economically infeasible, it is unlikely that the facility will ever switch back to fuel oil. If the facility intended to use the legacy units that burn fuel oil for an extended period, they would likely need to be upgraded since, currently, the units are only maintained to operate in the event of an emergency. Therefore, based on current actual SO_2 emission levels, the costs associated of operating the legacy units, the surrounding terrain and distance between the facility and the border, ADEQ has concluded that the facility will not contribute to the nonattainment of another state, or interfere with the maintenance of the NAAQS in another state.

Navajo Generating Station

The Navajo Generating Station was located on the Navajo Reservation in Coconino County, Arizona, about 11 km south of the border of Arizona and Utah. With the facility permanently shutting down in November 2019, ADEQ could not obtain the facility's information about PTE. The available data shows that between 2008 and 2017, the facility's highest emissions were 5,666 tons of SO_2 per year. However, since the facility is no longer operational, ADEQ has concluded that the facility will not contribute to the SO_2 nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

Snowflake Catalyst Paper

The Snowflake Catalyst Paper was a paper recycling mill that permanently closed in 2012. Before closure, the facility emitted 2,896 tons of SO_2 in 2011. With the facility's permanent closure, ADEQ has concluded that the facility will not contribute to the SO_2 nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

Calportland - Rillito Cement Plant

The Calportland - Rillito cement plant is located about 198 km west of the nearest border of Arizona and New Mexico. The plant's terrain includes Mount Lemmon, Mica Mountain, Bassett Peak, and Reiley Peak. The facility has a PTE of 11,348 tons of SO_2 per year. However, the actual SO_2 emissions from the facility were 3.64 tons in the 2014 NEI and 5.32 tons in the 2017 NEI. Considering the terrain between the facility and New Mexico and the lack of monitor violations across the border, ADEQ has concluded that the facility will not contribute to the nonattainment or maintenance of the NAAQS in another state.

Coronado Generating Station

Coronado generating station is located approximately 21 km west of the Arizona - New Mexico border. The facility can potentially emit 3,312 tons of SO_2 emissions per year. However, after installing flue gas desulfurization systems on Unit U1B in 2012 and Unit U2B in 2013, the actual SO_2 emissions from the

facility declined to 222 tons of SO_2 per year in 2017. Emissions from Coronado generating station in the 2012-2014 period were part of the emissions inventory modeled for TEP - Springerville to comply with SO_2 DRR. The predicted highest concentration for this modeling was about 55% of the NAAQS. The modeled maximum SO_2 concentration in New Mexico ranged from 60 to 80 $\mu g/m^3$ about 31% to 41% of the NAAQS.

The modeling results indicate that emissions from TEP - Springerville combined with emissions from Coronado generating station do not lead to the 2010 SO_2 NAAQS exceedance in New Mexico or any other surrounding state. Therefore, ADEQ determined that Coronado generating station will not contribute to the nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

Tucson Electric Power Irvington

TEP Irvington generating station is located approximately 176 km west of the Arizona -New Mexico border. The facility can potentially emit 722 tons of SO_2 emissions per year. The actual emissions were 17 tons of SO_2 per year in 2017 after unit 4 switched fuel from coal to natural gas and replaced units 1 and 2 with 10 smaller new reciprocating internal combustion engines. On the facility's east side, TEP Irvington is surrounded by Mica Mountain, rising to 8,666 ft tall, and Rincon Peak, with a summit at 8,482 ft.

Considering the distance between the facility and the nearest border of Arizona - New Mexico, in addition to the terrain between the facility and the border, ADEQ determined that TEP - Irvington will not contribute to the nonattainment of another state or interfere with the maintenance of the NAAQS in another state.

7   CAA § 110(A)(2)(D)(I)(I)—PRONGS 1 & 2

Chapter 7 examines the interstate transport requirements under CAA § 110(a)(2)(D)(i)(I) and how Arizona has met the burden for each requirement. Section 7.1 provides an introduction and background on the standards required under the CAA. Section 7.2 demonstrates how Arizona has satisfied Prong 1, which ensures SO_2 emissions from Arizona do not significantly contribute to the SO_2 nonattainment of another state. Finally, section 7.3 examines how Arizona has satisfied Prong 2, which ensures SO_2 emissions from Arizona do not interfere with the maintenance of the SO_2 NAAQS in another state.

7.1   Introduction and Background

As briefly explained in section 1.1, CAA § 110(a)(2)(D)(i)(I) or the "Good Neighbor" provision contains two prongs that must be satisfied when submitting SO_2 infrastructure plans to EPA. Prong 1 requires states to include adequate provisions to ensure that any source or other emissions activity within the state does not contribute significantly to nonattainment in another state. Prong 2 requires adequate provisions to ensure that any source or other emissions activity within the state does not contribute significantly with the maintenance of the NAAQS in any other state.

7.2   Nonattainment Areas in the Surrounding States (Prong 1)

This section demonstrates, ADEQ how Arizona's SIP satisfies Prong 1 by containing adequate provisions to ensure that any source or other emissions activity originating from within the state will not contribute significantly to the nonattainment of an area in another state.[94] To do this, ADEQ conducted a two part analysis: 1) evaluating emissions from within Arizona to demonstrate that they do not significantly contribute to SO_2 nonattainment in the surrounding states; 2) assessing existing control measures, location, and typography to show the controls will prevent any future increases in SO_2 emissions from traveling over the Arizona border into the surrounding states.

7.2.1   The State's Emissions do not Significantly Contribute to SO_2 Nonattainment in the Surrounding States

This section explains how ADEQ determined that the State's emissions do not significantly contribute to SO_2 nonattainment in surrounding states. ADEQ identified and reviewed the monitoring data for the six SO_2 monitors discussed in Chapter 4 *supra*, from 1990 to 2020. The monitors examined are located close to the Arizona borders and include monitors in areas not designated as nonattainment or maintenance for the 2010 SO_2 NAAQS.[95] ADEQ's review showed that only Grant County, New Mexico, located in the southwest portion of the state, was designated as a maintenance area for SO_2 for the 1971 SO_2 NAAQS. Grant County, New Mexico, is currently in attainment for the 2010 SO_2 NAAQS.

Furthermore, ADEQ found that only the Waterflow and Shiprock monitors in New Mexico registered SO_2 concentrations greater than background concentrations (> 10 ppb). The Waterflow and Shiprock monitors were discussed in Chapters 3, 4, and 5, are both located in northwestern New Mexico.

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[94] CAA § 110(a)(2)(D)(i)(I).
[95] *See* 40 C.F.R. § 81.332.

ADEQ used HYSPLIT modeling at three different elevations to determine the back trajectory of air parcels containing elevated concentrations of SO_2. The modeling results in Figures 14 and 15, confirm the air parcels consistently passed over large sources in New Mexico (e.g., San Juan Generating Station and the Four Corners power plant). The modeling results indicate that the elevated SO_2 concentrations measured at the monitors were not from Arizona. Additionally, Arizona's significant sources of SO_2 are not located upwind of the two monitors; emissions from these Arizona sources are not expected to contribute to the elevated SO_2 concentrations measured at the Waterflow and Shiprock monitors.

At the other four monitors, SO_2 concentration data showed that measured concentration reductions tracked closely with the shutdowns of out-of-state sources.[96] As Table 4 and 5 demonstrate, ADEQ found that none of the monitors located in the design domain outside Arizona exceeded the 2010 SO_2 NAAQS despite the Arizona facilities continuously operating. This indicates the SO_2 concentrations measuring under 10 ppb are background concentrations. As a result, ADEQ concluded that the SO_2 concentrations measured at the four other monitoring sites were all from background concentrations or minor local sources outside of Arizona.

ADEQ screened out facilities that emitted less than 100 tpy after determining the emissions from such sources could not feasibly make it over the border. Subsequently, ADEQ examined the remaining facilities with current emissions above 100 tpy or with a PTE above 100 tpy. This led to the discovery of the fourteen facilities permitted by ADEQ, EPA, or local tribes discussed in Section 2.3. ADEQ determined that five of these fourteen facilities are subject to the SO_2 DRR or non-attainment area SIPs.[97] For the Arizona facilities subject to the DRR rule, ADEQ examined past dispersion modeling work and determined that the emissions from the facilities would not have a significant impact on other states.[98]

Of the nine remaining facilities, six are not subject to the SO_2 DRR or a nonattainment area SIP, Therefore, ADEQ utilized previous modeling studies, the surrounding topography, economic factors, and the facilities' PTE to determine the impact on other states.[99] The last three facilities were not discussed in the modeling section because they were either included in the modeling of other facilities or because their recent actual emissions and PTE were below 1,00 tpy.

Based on this analysis ADEQ determined that SO_2 concentrations from Arizona do not significantly contribute to SO_2 nonattainment in the surrounding states.

7.2.2 Existing Control Measures, Location, and Typography will Prevent Any Future Increases in SO₂ Emissions from Traveling Over the Arizona Border into the Surrounding States

As previously discussed, fourteen facilities in Arizona emit over 100 tpy. However, these facilities are either over 50 km from the state border or surrounded by emissions-blocking topography (e.g., mountains). These facilities are major sources and are therefore subject to SIP-approved statutory and regulatory requirements. Under Arizona's approved NSR and PSD regulatory programs, all major sources and major modifications to existing major sources in the nonattainment areas are subject to nonattainment new source review requirements, while major sources and major modifications in attainment areas are subject to the state's PSD requirements. ADEQ includes these requirements and

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[96] *See* chapters 3 and 4.
[97] *See* section 6.1 for more information about the Data Request Rule.
[98] See Appendix A.
[99] *Id.*

any other applicable requirement into air quality permits to ensure compliance. Additionally, ADEQ's controls on SO_2 also includes, but is not limited to, the following SIP-approved measures and requirements:

- Emergency power measures that authorize state actions to alleviate or prevent an emergency health risk to the public due to air pollution or likely exceedance of the NAAQS. If invoked and applied, these measures could restrict or even prohibit the source from producing SO_2 emissions if the Governor declares that the source is contributing to an emergency;[100]

- Enforcement of control measure requirements allows state and local agencies to implement control and enforcement programs for permitted sources of air contamination and those not regulated through permitting programs. If any agency or entity fails to implement a committed measure, ADEQ or the county is authorized to file an action in superior court for an injunction or any other relief provided by law. State law also establishes ADEQ and local agency authority for preconstruction review and permitting, requiring sources that emit regulated pollutants to obtain a permit before constructing, changing, replacing, or operating any equipment or process which may cause air pollution. Permits are also required if an existing facility that causes air pollution transfers ownership, relocates, or otherwise changes operations. ADEQ and county permitting agencies operate air quality permit compliance programs to ensure the implementation of emission limits and other control measures for permitted sources. Permit and SIP enforcement authority is also provided under A.R.S. §§ 49-460 through 463 and 49-510 through 513, which allows the state or county to issue orders of abatement and injunctive relief for any violations;

- Control measures and emissions limits which provide the necessary authority for state and local air quality management programs to adopt and implement control measures and plans to assure attainment and maintenance of the 2010 SO_2 air quality standards of Arizona;

- Emissions monitoring and reporting requirements for any sources of air contaminants to monitor, sample, or perform other studies to quantify emissions of air contaminants or levels of air pollution that may be reasonably attributable to that source;

- Source-specific rules, such as A.A.C. R18-2-B1302 and A.A.C. R18-2-C1302, that contain SO_2 limits for the state's copper smelters;

- Source-specific regional haze FIPs corrected deficiencies in the Arizona plan for the state's smelters and large power plants;

- Air quality modeling requirements that allow Arizona to retain the authority to perform air quality modeling for predicting the effect of emissions on ambient air quality; and

- Ambient air monitoring requirements allow Arizona to maintain its extensive monitoring network operated by state and local agencies. The network is designed to collect, compile, and analyze ambient air quality data in attainment and nonattainment areas of the state. Operating agencies track data recovery, quality control, and quality assurance parameters for all instruments operated at various network sites.

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[100] A.R.S. § 49-465 and A.A.C. R18-2-220.

The location of the facilities, the surrounding topography, as well as the state's SIP-approved statutory and regulatory requirements will prevent any future increases in SO_2 emissions from traveling over the Arizona border into the surrounding states.

Therefore, this SIP revision satisfies prong 1 of CAA § 110(a)(2)(D)(i)(I) by demonstrating through modeling that SO_2 concentrations from Arizona do not significantly contribute to SO_2 nonattainment in the surrounding states. Additionally, the state's SIP-approved statutory and regulatory requirements, the location of the facilities and the surrounding topography will prevent any future increases in SO_2 emissions from Arizona from traveling over the Arizona border into the neighboring states.

7.3 Maintenance Areas in the Surrounding States (Prong 2)

This section demonstrates how this SIP revision meets prong 2 (CAA § 110(a)(2)(D)(i)(I)), which requires states to provide adequate provisions to ensure that any source or other emissions activity within its borders does not contribute to the nonattainment and maintenance of the NAAQS in any other state.[101] Since the requirements between prongs 1 and 2 are comparable, ADEQ used methodologies similar to its prong 1 analysis. However, the focus of this analysis was to determine whether facilities in Arizona would interfere with the maintenance of the SO_2 NAAQS in other states.

ADEQ split the analysis for prong 2 into two the following sections to: 1) demonstrate the state's emissions do not interfere with the nonattainment and maintenance of the SO_2 NAAQS in other states; 2) the state's existing control measures will prevent any future increases in SO_2 emissions from interfering with the maintenance of the SO_2 NAAQS in other states.

7.3.1 The State's Emissions do not Interfere with the Maintenance of the SO_2 NAAQS in Other States

This section determines that emissions from Arizona do not interfere with the maintenance of the SO_2 NAAQS in other states. First, ADEQ examined data from the six monitors mentioned in section 7.2 and the design values presented in Figure 14 and Figure 15. Based on the data and the design values, ADEQ determined that if SO_2 emissions from Arizona were transported over the state border, the data from the six monitors would reflect higher SO_2 concentrations. However, the data showed that most of the SO_2 concentrations measured at the six monitors were within the background levels, based on previous modeling studies.[102] ADEQ determined that SO_2 concentrations under 10 ppb were background concentrations after the modeling studies revealed that background SO_2 concentrations at the facilities modeled were anywhere from 2 ppb to 8 ppb.

Additionally, ADEQ ran HYSPLIT models for the Shiprock, New Mexico, and Waterflow, New Mexico monitors to ensure the monitors were measuring background SO_2 concentrations or concentrations originating from outside of Arizona. As discussed in Chapters 4 and 5, the modeling results backtracked nearly all the SO_2 concentrations to areas outside of Arizona, with only three modeling exception coming from the Waterflow monitoring site. ADEQ determined that due to the altitude of the air plumes, the path of the airflow, and facility size the SO_2 emissions exceptions from Arizona did not impact the

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[101] *See* CAA § 110(a)(2)(D)(i)(II).
[102] *See* Appendix A.

Waterflow monitor.[103] Therefore, ADEQ determined that the SO_2 concentrations measured at monitors outside of Arizona were also the result of background concentrations.

7.3.2 Existing Control Measures Will Prevent Any Future Increases in SO_2 Emissions from Traveling Over the Border into the Surrounding States.

ADEQ took a similar approach to the one used in section 7.2.2 to demonstrate that any future increases in the state's SO_2 emissions would not travel over the border into the surrounding states. To do this, ADEQ examined the state's existing control measures.

As discussed in Chapter 2, Arizona has a number of statutory and regulatory requirements in place to ensure that SO_2 concentrations remain at or below the NAAQS and within the state. The statutory and regulatory requirements discussed in section 7.2.2 apply to prong 2.

Also, as mentioned in Chapter 2, Arizona has a number of source-specific requirements for the state's major sources of SO_2. For example, there are regional haze FIPs for the Hayden and Miami Smelters, TEP Irvington's Unit 4, Lhoist Nelson Lime Plant kilns 1 and 2, and the Calportland cement plant. Arizona incorporated the original BART FIP provisions, the state's SIP for the Cholla power plant, Apache generating station, and the Coronado generating station. In addition to FIPs provisions, Arizona has source-specific rules for the state's copper smelters. A.A.C. R18-2-B1302 and R18-2-C1302 place emission limits on the smelters.

Federal requirements also limit the emissions from major sources within the state. 40 C.F.R. Part 63, Subparts QQQ, which lists the National Emission Standards for Hazardous Air Pollutants (NESHAP) for primary copper smelters, establish requirements for compliance with all applicable emissions limitations, work practices standards, and operation and maintenance.[104] The MATS standard, which establishes NESHAP limits for coal and oil-fired electric utility steam generating units, also limits SO_2 emissions.[105] Due to the number of existing federal and state control measures in place, any future increases in the state's SO_2 emissions would not travel over the border into the surrounding states.

In conclusion, ADEQ demonstrated, through monitoring data, that the SO_2 concentrations measured in neighboring states near the Arizona border were comparable to background concentration levels. Additionally, through HYSPLIT modeling, ADEQ demonstrated that additional SO_2 emissions are attributed to out-of-state sources by backtracking the path of air parcels at the monitors during periods of measured SO_2 concentration greater than 15 ppb. Therefore, ADEQ satisfied the elements of Prong 2.

7.4 Conclusion

Based on ADEQ's analysis of prongs I and 2, this SIP revision contains adequate provisions to prevent emissions from activities in Arizona from contributing significantly to the nonattainment or interfere with maintenance of any other state with respect to the 2010 SO_2 NAAQS. ADEQ made this determination based on emissions inventory data trends, ambient monitoring data trends, previous air dispersion modeling, and the regulatory and statutory provisions in place to support existing permitting provisions.

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[103] *See* Chapter 2.
[104] *See* Table 1.
[105] *Id.*

Appendix A
Appendix Title

Air Quality Division
July 18,2022

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Exhibit AI – Modeling Reports (for reference only)

Modeling Report for SO₂ NAAQS Designation for Arizona Electric Power Cooperative (AEPCO) - Apache Generating Station

Submitted To:

Environmental Protection Agency

Region 9

Prepared By:

Arizona Department of Environmental Quality
Air Quality Department

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1.0   Introduction

On August 21, 2015, EPA finalized and promulgated the SO_2 Data Requirements Rule (DRR) (80 FR 51052), which requires the characterization of ambient SO_2 air quality around SO_2 emission sources emitting 2,000 or more tons per year of SO_2. ADEQ identified five sources that needed to be addressed for the SO_2 DRR. Those sources include two copper smelters and three coal-fired power plants. EPA has designated the two copper smelters areas (Hayden and Miami) as nonattainment areas in the first round of designations. The three coal-fired power plants include the Tucson Electric Power Springerville Generating Station (TEP-Springerville), the Arizona Public Service Cholla Generating Station (APS-Cholla), and the Arizona Electric Power Cooperatives Apache Generating Station (AEPCO-Apache). As required, ADEQ must characterize air quality in the areas impacted by the three power plants and EPA expects to use this data to designate the areas as meeting or not meeting the 2010 SO_2 standard.

This SO_2 DRR provides air agencies the flexibility to characterize air quality using either modeling of actual source emissions or using appropriately sited ambient air quality monitors. ADEQ decided to evaluate air quality using air dispersion modeling for the three coal-fired power plants. Specifically, ADEQ characterized ambient air quality in areas proximate to the three sources by using actual hourly emissions and meteorology for the most recent 3 years (2012, 2013 and 2014). As required by DRR, for source areas that an air agency decides to evaluate through air quality modeling, the air agency must provide a modeling protocol and a modeling analysis to the EPA Regional Administrator by July 1, 2016 and January 13, 2017, respectively. ADEQ submitted a modeling protocol to EPA Region 9 for review on July 1, 2016 and the protocol was approved by email on December 05, 2016. This modeling report presents the results of the modeling conducted in accordance with the approved protocol for areas around the AEPCO facility. For the other two sources, please see separate modeling reports.

As described in the approved protocol, the modeling work performed in accordance with the EPA's SO_2 NAAQS Designations Modeling Technical Assistance Document (hereafter, "EPA's Designation Modeling TAD", U.S. EPA, 2016a). The modeling report is organized as follows:

- Section 2 provides general description of AEPCO power plant including processes, topography and climate;
- Section 3 provides a discussion on the determination of the modeling domain, sources to explicitly model and the receptor grid;
- Section 4 provides a discussion on the model selection;

- Section 5 provides detailed source inputs, including source configuration, source emissions, source release parameters, and urban/rural determination;

- Section 6 provides a discussion on the selection and processing of meteorological data;

- Section 7 provides a discussion on the determination of background concentrations; and

- Section 8 provides a summary of model results.

2.0   General Description of AEPCO

The Arizona Electric Power Cooperative (AEPCO) Apache Generating Station is located approximately 3 miles south of the town of Cochise, Cochise County, Arizona. The Apache Generating Station consists of seven electric generating units: two coal/natural gas fired steam electric units (Unit 2 and Unit 3), a natural gas/fuel oil-fired steam electric, combined cycle unit (Unit 1), and four natural gas/fuel oil-fired turbines with a total generating capacity of 560 megawatts (MW).

ADEQ issued a Significant Permit Revision to Air Quality Control Permit in May 2014 to authorize AEPCO for its Apache Generating Station to change for Steam Unit 2 (ST2) from coal to combusting pipeline natural gas, and to authorize a change in air pollution control for Steam Unit 3 (ST3) to selective non-catalytic reduction (SNCR) and the use of low NOx burners. EPA approved Best Available Retrofit Technology limits for Steam Unit 2 and Unit 3 requiring that effective December 5, 2016, Steam Unit 2 and Unit 3 shall not emit SO_2 in excess of 0.15 lb/MMBtu heat input, averaged over 30 boiler operating days (79 FR 56322).

AEPCO is located in an area which is warm during summer and cold during winter. The warmest month of the year is June with an average maximum temperature of 95.5 degrees Fahrenheit, while the coldest month of the year is December with an average minimum temperature of 27.2 degrees Fahrenheit. The annual average precipitation is 13.4 Inches. The wettest month of the year is August with an average rainfall of 2.6 Inches.

There are no elevated terrain features in immediate vicinity of the AEPCO facility. Dragoon Mountains are located about 8 kilometers (km) south-west of the facility. The Dragoon Mountains are a range of mountains located in Cochise County, Arizona. The range is about 40 km long, running on an axis extending south-south east through Willcox, AZ. Mount Glenn (7,520 ft/2,292 m) is the highest point in the range. Winchester Mountains and Galiuro Mountains are located about 35 km North West of the facility, running on an axis extending south-south east. Pinaleno Mountains are located about 40 km north of the facility. The highest point of the mountains is Mount Graham at 10,720 feet (3,267 m). The mountains cover 300 square miles (780 km^2) and are part of the Coronado National Forest, Safford ranger district. The terrains within 50 km east and south of the facility are mostly flat. The topography of the local area is depicted in Figure 2-1.

Figure 2-1 Topography of the Area Surrounding AEPCO
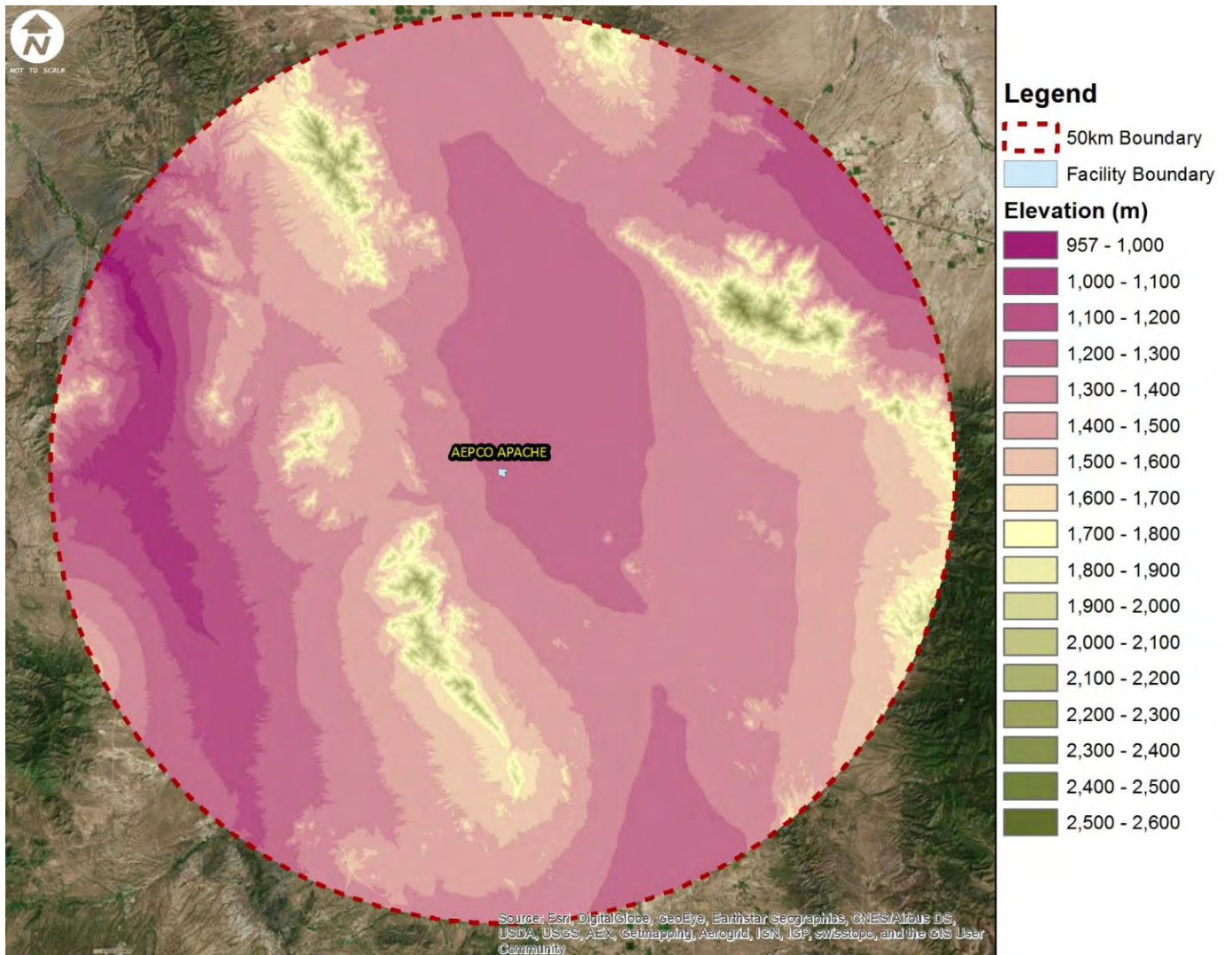
3.0   Modeling Domain

Selection of the modeling domain is dependent on the number of sources to explicitly model and size of the receptor network in order to account for the areas of impact (U.S. EPA, 2016a). The modeling domain should at a minimum include the sources that are most likely to cause or contribute to NAAQS violations in the area. In the modeling exercise, all modeled receptors should exhibit modeled attainment of the NAAQS.

In this modeling analysis, the modeling domain is centered at the facility and extended for 50 km from the facility fence line.

3.1   Determining Sources to model

Per EPA's SO$_2$ NAAQS Designations Modeling TAD (U.S. EPA, 2016a), the determination of modeling domains and number of sources to consider for modeling should begin with analyzing the spatial distributions of sources that meet or exceed the emissions threshold established in the data requirements rule. The modeling domains could be centered over these sources.

ADEQ has identified SO$_2$ sources within the 50 km modeling domain for AEPCO. Figure 3-1 is a geographical representation of these sources. Table 3-1 is an inventory of the individual sources within the 50 km modeling domain for this facility. As table 3-1 shown, the SO$_2$ emissions from AEPCO represent more than 99% of actual SO$_2$ emissions during 2012-2014. Excluding this source, there are no sources that emitted more than 1.13 tons per year of SO$_2$ in AEPCO modeling domain during 2012-2014. Due to their insignificant emissions, it is very unlikely that these minor sources could cause or contribute to a NAAQS violation in the area. Therefore, ADEQ only modeled AEPCO for this designation modeling.

Figure 3-1 Point Sources within 50 km Modeling Domain of AEPCO
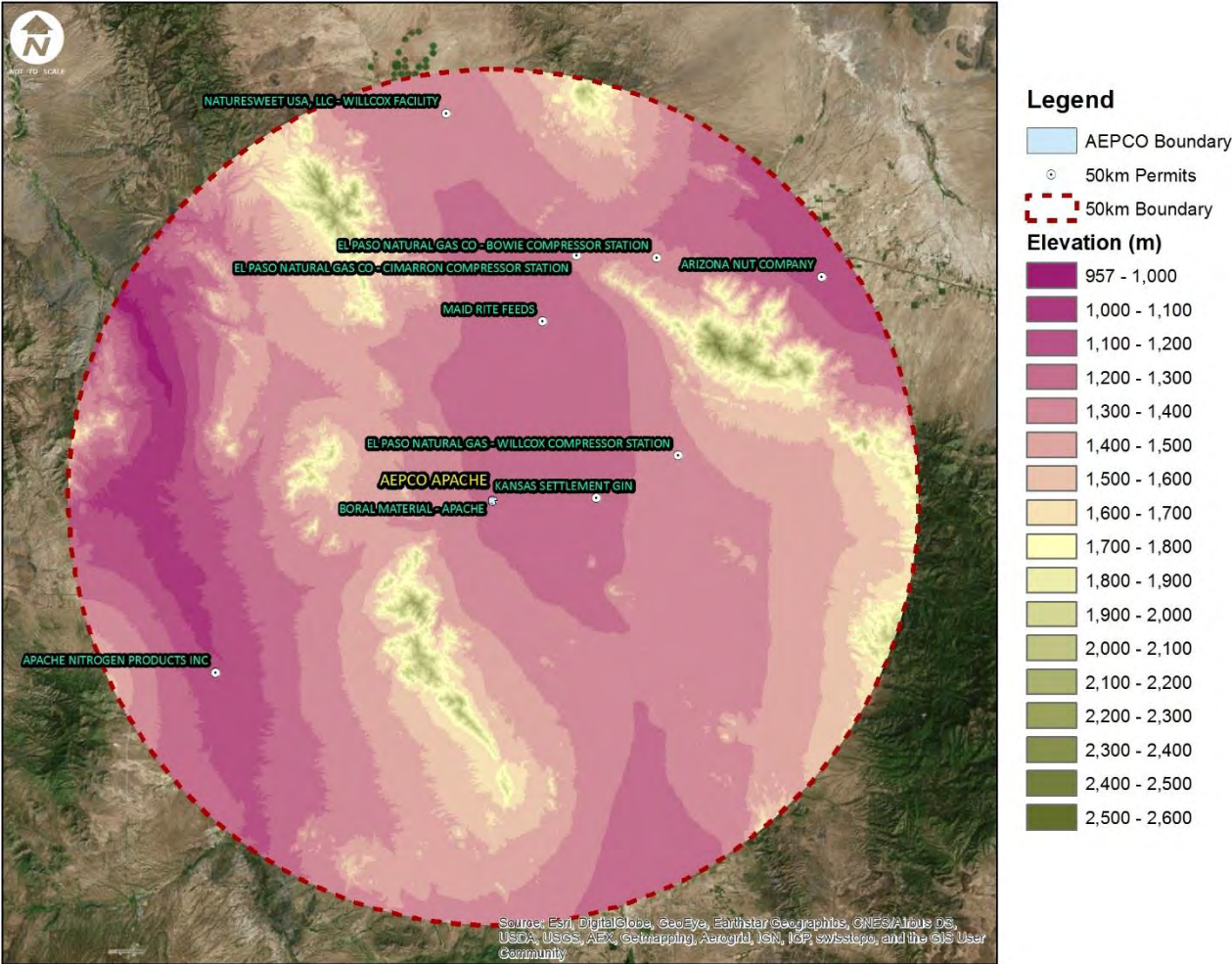
Table 3-1 Point Sources within 50 km Modeling Domain of AEPCO (Permitted Sources)

County	Site Name	Facility Type	Latitude	Longitude	2012 SO₂ (TPY)	2013 SO₂ (TPY)	2014 SO₂ (TPY)
Cochise	Boral Material- Apache	Chemicals and Allied Products	32.061	-109.894	0	0	0
Cochise	Kansas Settlement Gin	Cotton Gins Agricultural Equipment and Supplies	32.064	-109.764	0	0	0
Cochise	El Paso Natural Gas- Willcox Compressor Station	Gas Production and Distribution	32.108	-109.662	0.000063	0.585	0.821
Cochise	Apache Nitrogen Products Inc.	Manufacturer of Ammonium Nitrate-based Products	31.879	-110.238	0.141	0.139	0.154
Cochise	Apache Generating Station	Power Plant	32.064	-109.893	2090.35	3744.31	4811.87
Cochise	El Paso Natural Gas Co.-Bowie Compressor Station	Gas Production and Distribution	32.317	-109.689	0.174	0.304	0.402
Cochise	Nature Sweet USA, LLC-Willcox Facility	Hydroponic Tomatoes and Cucumbers Production	32.468	-109.951	1.13	0.659	0.239
Cochise	El Paso Natural Gas-Cimarron Compressor Station	Gas Production and Distribution	32.319	-109.789	0.256	0.558	1.007
Cochise	Arizona Nut Company	Nuts Production	32.296	-109.484	0	0	0
Cochise	Maid Rite Feeds	Farm, Ranch, and Pet Supplies	32.249	-109.831	0	0	0

3.2   Receptor Grid

ADEQ chose a modeling domain centered on AEPCO facility and extended that to 50 km from the facility fence line to make sure that the high model concentrations are captured. A total of 11505 receptors are placed in approximately 104 km by 112 km modeling domain.

ADEQ used the following receptor spacing to determine areas of maximum predicted concentrations:

- Receptors along ambient air boundary (AAB) at a spacing of 25 m;
- Receptors from AAB to 1 km at a spacing of 100 m;
- Receptors from 1 km to 5 km away from AAB at a spacing of 200-500 m;
- Receptors from 5 km to 20 km away from AAB at a spacing of 500-1,000 m;
- Receptors from 20 km to 50 km away from AAB at a spacing of 1,000-2,500 m.

ADEQ used the EPA's AERMAP software tool (version 11103; U.S. EPA, 2011b) to estimate receptor elevations and hill heights. AERMAP is the terrain preprocessor for AERMOD (discussed in Section 4) and uses the following procedure to assign elevations to a receptor:

- For each receptor, the program searches through the U.S. Geological Survey (USGS) input files to determine the two profiles (longitude or easting) that straddle this receptor;
- For each of these two profiles, the program then searches through the nodes in the USGS input files to determine which two rows (latitudes or northings) straddle the receptor;
- The program then calculates the coordinates of these four points and reads the elevations for these four points;
- A 2-dimensional distance-weighted interpolation is used to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

ADEQ used 10 meter USGS National Elevation Dataset (NED) data as inputs to AERMAP. The NED data are produced from digitized map contours or from manual or automated scanning of aerial photographs. A 1/3 arc-second NED data file consists of a regular array of elevations referenced horizontally in the UTM coordinate system, with a uniform horizontal spacing of approximately 10 meters. The NED data used for this analysis are based on the 1983 North American Datum (NAD83).The modeled receptors for AEPCO are depicted in Figure 3-2.

Figure 3-2 Modeled Receptors for AEPCO

4.0   Model Selection

In 2005, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was promulgated as the EPA's preferred near-field dispersion modeling for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation (40 CFR 51, Appendix W) (U.S. EPA, 2005). AERMOD is EPA's preferred model for area designations under the 1-hour SO_2 primary NAAQS.

ADEQ used AERMOD (version 15181; U.S. EPA, 2014a) to predict ambient concentrations in simple, complex and intermediate terrain. ADEQ is aware that EPA just released AERMOD and AERMET Models Version 16216 on December 20, 2016 (U.S. EPA, 2016b). In the new version 16126, some beta options become regulatory default options. For the example, the adjusted u-star option (ADJ_U*) when measured turbulence data are not included is no longer flagged as a beta option. As will be discussed in Section 6.2, ADEQ used the ADJ_U* option without including any turbulence data when processing the meteorological data with AERMET version 15181. Therefore, it is expected that the changes made in the new version will not affect the AEPCO designation modeling.

There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET (version 15181; U.S. EPA, 2015), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP (version 11103; U.S. EPA, 2011), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSURFACE (Version 13016; U.S. EPA, 2013), a surface characteristics preprocessor, and BPIPPRIM, a multi-building dimensions program incorporating the Good Engineering Practice technical procedures for PRIME applications (U.S. EPA, 2004).

ADEQ used the regulatory default option. This option commands AERMOD to:
- Use the elevated terrain algorithms requiring input of terrain height data for receptors and emission sources;
- Use stack tip downwash (building downwash automatically overrides);
- Use the calms processing routines;
- Use buoyancy-induced dispersion;
- Use the missing meteorological data processing routines.

5.0   Source Inputs

This section discusses source characterization to develop appropriate source inputs for dispersion modeling with AERMOD modeling system. SO$_2$ emissions are released to the atmosphere from two stacks at AEPCO power plant, which are shown in Figure 5-1.

Figure 5-1 Modeled Emission Sources in AEPCO

5.1   Source Inputs for AEPCO

5.1.1   Emission Data

In AERMOD SO_2 modeling, the real-time 2012-2014 SO_2 emissions and stack parameter data measured by continuous emission monitoring system (CEMS) are applied to obtain accurate modeling results. The hourly SO_2 emissions data being modeled are consistent with those reported from EPA Air Market database (https://ampd.epa.gov/ampd/). As discussed in EPA Designation Modeling TAD (U.S. EPA, 2016a),hourly SO_2 emissions data are input into AERMOD using the HOUREMIS keyword in the source pathway of the AERMOD control file (AERMOD.INP).

ADEQ obtained the CEMS data from AEPCO. After carefully reviewing the data, ADEQ identified some missing hours. For data substitution, ADEQ obtained the information on shutdown/maintenance periods from the facility and considered those hours as zero emission data. For the rest of missing hours, ADEQ averaged the data from immediate before and after hours and substituted the missing hours with those values.

5.1.2   Emission Release Parameters

For the purposes of modeling with actual emissions to characterize air quality, ADEQ followed the EPA recommendation and used actual stack heights, instead of calculating Good Engineering Practice (GEP) stack height. In addition, hourly emissions parameters measured by CEMS (including exhaust temperature, exit velocity and exit flow rate) were used as source inputs, which most closely represent the facility actual emission conditions.

Downwash effects were considered for AEPCO modeling by using BPIPPRM. BPIPPRM requires a digitized footprint of the facility's buildings and stacks. The source must evaluate the position and height of buildings relative to the stack position in the building wake effects analysis. The information of actual heights of existing structures were provided by the AEPCO facility. The simplified layout used in modeling for AEPCO is shown in Figures 5-2.

Figure 5-2 Simplified Facility Layout for AEPCO

ADEQ identified coordinates for the stacks by mapping the site buildings to rectified aerial photographs of the site and projected UTM coordinates of each stack to UTM Zone 12. These coordinates are based on the NAD83.

Table 5-1 presents the modeling parameters for the stacks.

Table 5-1 Modeling Parameters for AEPCO Stacks

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp. (ºK)	Exit Flow Rate
Stack 2	604324.41	3547831.47	1279.04	121.92	5.06	Variable	Variable	Variable
Stack 3	604318.68	3547828.97	1279.10	121.92	5.06	Variable	Variable	Variable

5.2   Urban/Rural Determination

Dispersion coefficients for air quality modeling were selected based on the land use classification technique suggested by Auer (Auer, 1978), which is EPA's preferred method. The classification determination involved assessing land use by Auer's categories within a 3 km radius of the proposed site. A source selected urban dispersion coefficients if greater than 50 percent of the area consists of urban land use types; otherwise, rural coefficients apply.

ADEQ classified the land use of the area using the land-use procedure set forth in EPA's "Guideline on Air Quality Models" (GAQM) (U.S. EPA, 2005). This approach requires determining the amount of specific types of land use categories within a 3 km radius circle centered on the source; if the total land use (as defined by Auer) is classified as 50% or more "urban" then the area is designated as urban; otherwise it is designated as rural.

Land use (taken from the U.S. Geological Survey (USGS) National Land Cover Data (NLCD) 1992 archives) was examined for the 3 km radius circle, and totals of each land use category were calculated. These land use categories were then correlated to the categories as established by Auer (Auer, 1978), and the amount of urban and rural land use within 3 km of each facility was calculated. The area near AEPCO that was examined is depicted in Figure 5-3, while the results of the analysis are presented in Table 5-2.

Figure 5-3 Land Use near AEPCO
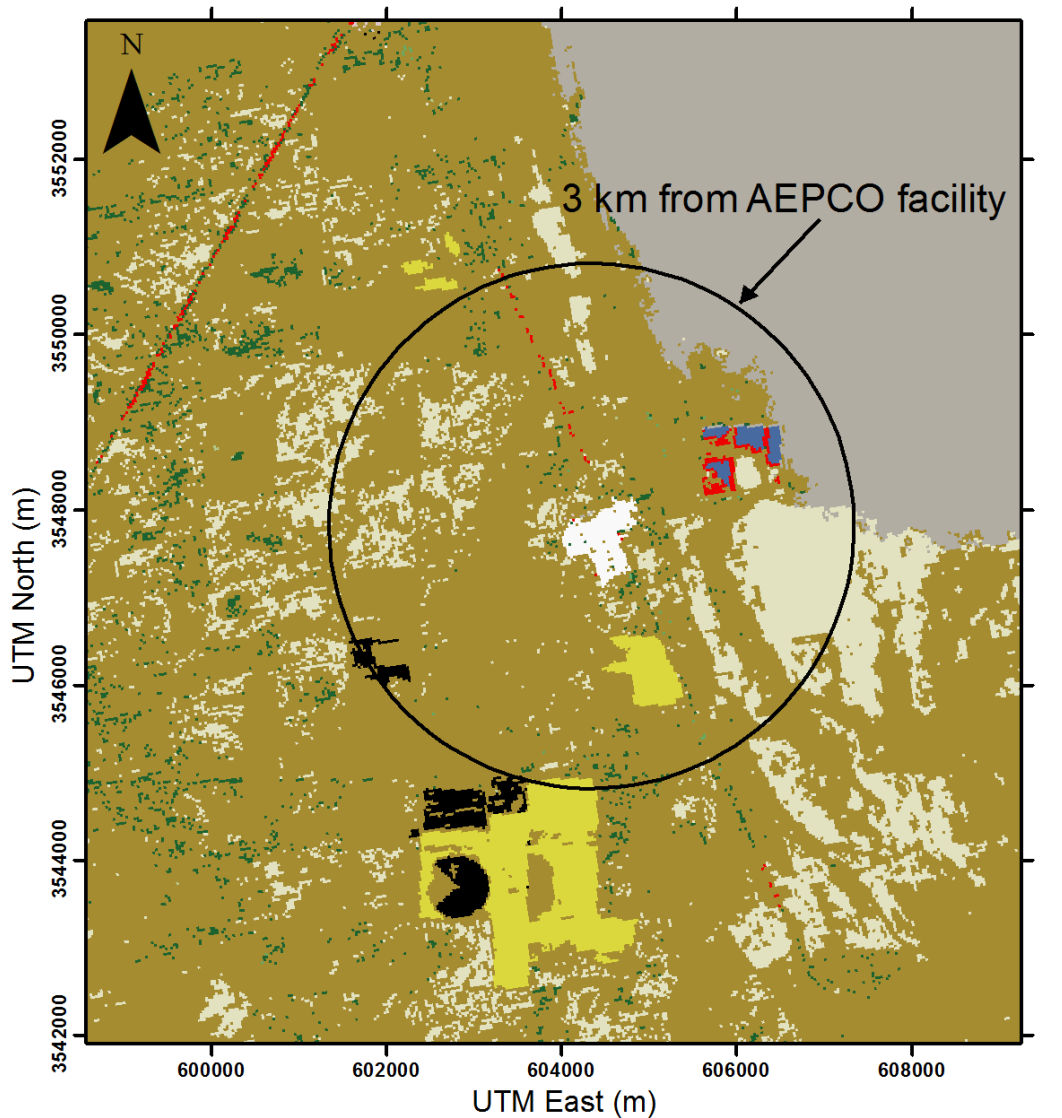
NLCD 1992 Land Cover Classification

11 Open Water	51 Shrubland
21 Low Intensity Residential	61 Orchards / Vineyards / Other
23 Commercial / Industrial / Transportation	71 Grasslands / Herbaceous
31 Bare Rock / Sand / Clay	81 Pasture / Hay
32 Quarries / Strip Mines / Gravel Pits	82 Row Crops
41 Deciduous Forest	83 Small Grains
42 Evergreen Forest	85 Urban / Recreational Grasses
43 Mixed Forest	91 Woody Wetlands

Table 5-2 Land Use Analysis within 3 km of AEPCO

1992 NLCD Land Use Category		% of Total Land Use within 3 km of AEPCO	Auer Land Use Category		
Code	Description		Code	Description	Rural/Urban
11	Open Water	0	A5	Water Surfaces	Rural
12	Perennial Ice/Snow	0	A5	Water Surfaces	Rural
21	Low Intensity Residential	1.3	R1 / R4	Common/Estate Residential	Rural
22	High Intensity Residential	0	R2 / R3	Compact Residential	Urban
23	Commercial / Industrial / Transportation	17.4	C1 / I1 / I2	Commercial/Heavy Industrial/Light-Moderate Industrial	Urban
31	Bare Rock / Sand / Clay	0.5	A	N/A	Rural
32	Quarries / Strip Mines / Gravel Pits	0	A	N/A	Rural
33	Transitional	0	A	N/A	Rural
41	Deciduous Forest	0	A4	Undeveloped Rural	Rural
42	Evergreen Forest	0	A4	Undeveloped Rural	Rural
43	Mixed Forest	0	A4	Undeveloped Rural	Rural
51	Shrubland	60.2	A3	Undeveloped	Rural
61	Orchards / Vineyards / Other	0	A2 / A3 / A4	Agricultural Rural / Undeveloped / Undeveloped Rural	Rural
71	Grasslands / Herbaceous	13.0	A3	Undeveloped	Rural
81	Pasture / Hay	0	A2	Agricultural Rural	Rural
82	Row Crops	0	A2	Agricultural Rural	Rural
83	Small Grains	0	A2	Agricultural Rural	Rural
84	Fallow	0	A2	Agricultural Rural	Rural
85	Urban / Recreational Grasses	7.6	A1	Metropolitan Natural	Rural
91	Woody Wetlands	0	A3 / A4 / A5	Undeveloped / Undeveloped Rural / Water Surfaces	Rural
92	Emergent Herbaceous Wetlands	0	A3 / A5	Undeveloped / Water Surfaces	Rural

Over 60% of the land use within 3 km of AEPCO is "shrubland" according to the NLCD92 classification scheme. Under the Auer scheme the sum of the percentage of land use categories classified as urban (R2, R3, C1, I1, and I2) is 17.4%. Accordingly, the sum of the rural categories is 82.6%. Therefore, the area around AEPCO is defined as "rural" and identified as such in the AERMOD input.

6.0   Meteorological Data

The AERMOD model used AERMET to process the meteorological data and create the data files for AERMOD.

6.1   Meteorological Data Selection

As stated in SO_2 designation modeling TAD (U.S. EPA, 2016a), for the purposes of modeling to characterize air quality for use in SO_2 designations, the EPA recommends using the most recent 3 years of meteorological data to allow the modeling to simulate what a monitor would observe.

AEPCO provided 2012-2014 site-specific meteorological data collected from a 10-m meteorological tower. However, these data have not gone through quality assurance. AEPCO provided additional 2008-2011 meteorological data collected from a 10-m meteorological tower. ADEQ's records indicate that the 2008-2011 data were subject to a quality assurance audit and met EPA Prevention of Significant Deterioration (PSD) quality assurance requirements. ADEQ reviewed the 2008-2014 data and found that the meteorological data were consistent from year to year (see Appendix A).

ADEQ also reviewed the meteorological data collected at the nearest National Weather Service (NWS) Automated Surface Observing System (ASOS) stations, Tucson International Airport and Safford Regional Airport, both of which are located about 60 miles from the AEPCO facility (Figure 6-1). ADEQ determined that neither of the two sites provides the representative meteorological data for evaluating the dispersion of emissions from the AEPCO facility due to different topography and terrain characteristics. The comparisons of the wind rose plots for Tucson, Safford and the on-site monitor clearly demonstrate that the wind patterns in the area of the project site significantly differ from those in Tucson or Safford (See Appendix A).

It is stated in EPA Designation Modeling TAD (U.S. EPA, 2016a):

> *"In some instances, representative meteorological data from the most recent three years may not be available, especially if the most representative data is older site-specific data. In such cases, it may be feasible to use older meteorological data (either site specific or NWS) that has been used in past regulatory applications for the area containing the threshold exceeding source, if these datasets are still considered representative of the most recent three years of meteorological conditions".*

ADEQ determined that the meteorological data collected during 2009-2011 were representative of the most recent three years (2012-2014) of meteorological conditions. Therefore, ADEQ decided to use the 2009-2011 site-specific data for AEPCO designation modeling.

Appendix A presents the wind rose plots for the years 2008-2014 for on-site monitor, the years 2012-2014 for Tucson NWS station, and the years 2012-2014 for Safford NWS station.

Figure 6-1 Locations of On-site Meteorological Station, Tucson NWS Station and Safford NWS Station

6.1.1 Compliance of the On-site Meteorological Station with Siting Criteria Requirements

EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications (U.S. EPA, 2000) lists criteria for siting of meteorological instruments. A listing of these criteria and the compliance status of the AEPCO 10-meter meteorological tower with such criteria are presented below:

Wind Instruments: The standard exposure height of wind instruments over level, open terrain should be 10 meters above the ground. Open terrain is defined as an area where the distance between the instrument and any obstruction is at least 10 times the height of that obstruction. As shown in Figures 6-2 and 6-3, there are no such obstructions in the immediate vicinity of the AEPCO meteorological tower.

Temperature Sensors: Ambient temperature should be measured at 2 meters and the sensor should be located over an open area of at least 9 meters in diameter, and should be located at a distance of at least 4 times the height of any nearby obstruction. The surface should be covered by short grass, or, where grass does not grow, the natural earth surface. Instruments should be protected from thermal radiation (from the earth, sun, sky, and any surrounding objects) and adequately ventilated using aspirated shields. The location of the on-site ambient and differential temperature sensors meets these criteria.

Figure 6-2 Picture of the AEPCO 10-m Meteorological Tower

Figure 6-3 Aerial View of AEPCO 10-m Meteorological Tower Location

6.1.2 Compliance with Quality Assurance and Completeness Requirements

The monitoring program met the quality assurance audit requirements for 2008-2011 (see Table 6-1) as described in EPA's "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), 1987" and "Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Version 2.0 Final, March 2008". Independent audits were conducted every 6 months during 2008-2011 by Meteorological Solutions Inc.

Table 6-1 Recommended System Accuracies and Resolutions

Meteorological Variable	System Accuracy	Measurement Resolution
Wind Speed (Horizontal and vertical)	± (0.2 m/s + 5% of observed)	0.1 m/s
Wind Direction (azimuth and elevation)	± 5 degrees	1.0 degree
Ambient Temperature	± 0.5 ^{o}C	0.1 ^{o}C
Vertical Temperature Difference	± 0.1 ^{o}C	0.02 ^{o}C
Dew Point Temperature	± 1.5 ^{o}C or ± 7% RH	0.1 ^{o}C
Precipitation	± 10% of observed or± 0.5 mm	0.3mm
Pressure	± 3 mb (0.3 kPa)	0.5 mb
Solar Radiation	± 5% of observed	10 W/m2

6.1.3 Processed Data Completeness

According to EPA-454/R-99-005, "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (U.S. EPA, 2000), meteorological data must be 90 percent complete in order to be acceptable for usage in regulatory dispersion modeling. The 2009-2011 site-specific data were evaluated quarter by quarter to assess compliance with the 90 percent completeness criteria. No data substitution was employed. The results are shown in Table 6-2. As shown in the table, the data meet the 90 percent requirement for each monitored parameter for each quarter.

Table 6-2 AEPCO On-site Data Completeness

Year	Quarter	Wind Speed	Wind Direction	Temp (10 m)
2009	Q1	99%	99%	99%
	Q2	99.8%	99.8%	99.8%
	Q3	100%	100%	100%
	Q4	100%	100%	100%
2010	Q1	91.8%	91.8%	91.8%
	Q2	100%	100%	100%
	Q3	99.7%	99.7%	99.7%
	Q4	100%	100%	100%
2011	Q1	100%	100%	100%
	Q2	100%	100%	100%
	Q3	100%	100%	100%
	Q4	99.9%	99.9%	99.9%

6.2   Meteorological Data Processing with AERMET

ADEQ used the EPA's AERMET tool (version 15181; U.S. EPA, 2014b) to process meteorological data for use with AERMOD. AERMET merges site-specific meteorological data and NWS surface observations with NWS upper air observation and performs calculation of boundary layer parameters required by AERMOD. In addition to the meteorological observations, AERMET further requires the inclusion of the characteristics of land use surfaces (routinely calculated using EPA's AERSURFACE tool).

EPA has proposed to designate some beta options as the default regulatory formulation in the proposed revisions to the Guideline on Air Quality Models (Proposed Rule, U.S. EPA, 2015). In the AEPCO SO$_2$ DRR modeling protocol submitted to EPA Region 9, ADEQ proposed to use the beta alternative formulation of surface friction velocity (u*) non regulatory default option (ADJ_U*) in AERMET version 15181 to process meteorological data for modeling with AERMOD (see Appendix B for detailed discussions). On December 20, 2016, EPA finalized the revisions to the Guideline on Air Quality Models and released AERMOD and AERMET Models Version 16216 (Final Rule, U.S. EPA, 2016b), in which the ADJ_U* option when site-specific turbulence data (sigma-theta and/or sigma-w) are not included is no longer flagged as a beta option. As stated in the Final Rule, using the ADJ_U* option is appropriate when standard National

Weather Service (NWS) airport meteorological data, site-specific meteorological data without turbulence parameters, or prognostic meteorological input data are used for the regulatory application (U.S.EPA, 2016b). EPA also determined that the ADJ_U* option should not be used in AERMET in combination with use of measured site-specific turbulence data since it may introduce a bias toward under-prediction of modeled concentrations (U.S. EPA, 2016b).

To process the site-specific meteorological data for AEPCO with the ADJ_U* option, ADEQ did not use any turbulence parameters. The ADEQ's records (the audit reports for AEPCO's meteorological monitoring station) did not explicitly indicate that AEPCO had measured site-specific turbulence data (sigma-theta and/or sigma-w). The raw meteorological data sets AEPCO submitted to ADEQ did not include any site-specific turbulence data as well. ADEQ is also aware that, for some cases that had site-specific turbulence data available, the EPA's Model Clearinghouse (MCH) approved the use of the ADJ_U* option when the site-specific turbulence data were excluded in the meteorological data processing (U.S.EPA, 2016c). For AEPCO, ADEQ used site-specific meteorological data without turbulence parameters in accordance with the requirements of the final rule (U.S. EPA, 2016b). For the above reasons, ADEQ believes that it is appropriate to use the ADJ_U* option for AEPCO.

It should be noted that using the previous default regulatory options (without using the ADJ_U* option) for this project shows maximum impact locations in the rugged terrain of the mountains located about 8-10 km from the facility. Installation of a monitor in the current maximum impact location is unreasonable due to accessibility issues associated with the location. Also, the maximum impact location is not populated and, would thus, not provide an adequate representation of impact on public health. This situation is very similar to a case in Utah, where the maximum model concentrations were observed in an unpopulated, mountainous area. In that case, EPA agreed (via email) that monitoring was not an option. Other similar documented case studies are described in Appendix B.

Additionally, the controls that will be implemented by AEPCO by the end of 2017, will result in SO_2 emissions lower than 2000 tons per year threshold identified by EPA for source consideration of either modeling or monitoring.

6.2.1   Surface Data

As discussed in Section 6.1, ADEQ used the 2009-2011 site-specific meteorological data for AEPCO designation modeling. Since hourly emissions for most recent three years (2012-2014) were modeled, the dates of the meteorological datasets were adjusted. Based on SO_2 designation modeling TAD (U.S. EPA, 2016a), ADEQ modified the years of the meteorological datasets to match the most recent three years of emissions (i.e., change 2009 to 2012, 2010 to 2013, and 2011 to 2014). Months, days, and hours remained unchanged. Since the year of 2012 contains emissions for February 29 but the meteorological data does not cover leap years, ADEQ substituted meteorological data collected on February 28 for February 29.

6.2.2   Upper Air Observations

Given the proximity of location, topography and climate as AEPCO power plant, ADEQ used the upper air data obtained from Tucson, AZ (Station ID:23160, Latitude/Longitude: 32.23 N/110.96 W), which is 101 km northwest away from AEPCO facility (see Figure 6-4).

Figure 6-4 Location of Tucson Upper Air Station and AEPCO Power Plant

6.2.3 AERSURFACE

ADEQ used EPA's AERSURFACE tool to calculate the surface roughness length, albedo and Bowen ratio inputs required by AERMET. EPA developed AERSURFACE to identify these parameters within a defined radius from a specified point. In this case, ADEQ inputted the UTM coordinates of the on-site meteorological station to AERSURFACE along with a 1 km radius per EPA guidance. ADEQ used 1992 USGS National Land Cover Data (NLCD) for the state of Arizona as inputs to AERSURFACE. ADEQ calculated the parameters for twelve compass sectors of 30 degrees each, and by month. Considering the climate characteristics in the AEPCO area, ADEQ assigned the seasonal categories for AEPCO as follows:

- Late autumn after frost and harvest, or winter with no snow: January, February, March, December;

- Winter with continuous snow on the ground: none;

- Transitional spring (partial green coverage, short annuals): April, May, June;

- Midsummer with lush vegetation: July, August, September;

- Autumn with un-harvested cropland: October, November.

The surface moisture condition were determined by comparing precipitation for the period of data to be processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th-percentile, "dry" conditions if precipitation is in the lower 30th-percentile, and "average" conditions if precipitation is in the middle 40th-percentile.ADEQ choose "average" conditions for AEPCO case.

7.0   Background Air Quality

EPA requires background air quality estimates be added to modeling results for comparison to the NAAQS.

There are limited SO_2 monitoring sites in Arizona and the monitoring sites are located in the Phoenix/Tucson metropolitan area or close to copper smelters. ADEQ used the ambient monitoring data collected from Central Phoenix (1645 E Roosevelt St, ID: 40133002, Figure 7-1) as 1-hour SO_2 background concentration. This site is located in an urban area and surrounded by various anthropogenic sources. The AEPCO power plant is located in a rural area without significant human activities. Therefore, the monitoring concentration at central Phoenix monitor is expected to be higher than the background concentration in the AEPCO modeling domain. Thus this method is considered conservative.

The 99th percentile SO_2 1-hour concentrations at the Central Phoenix Monitoring Site was calculated for each year in the 2010-2014 dataset, which were retrieved from U.S. EPA's Air Quality System (https://www3.epa.gov/airdata/). The 3 year (2012-2014) design values were 8ppb, 8ppb and 7ppb, respectively. Following the EPA Designation Modeling TSD, the SO_2 background concentration for the AEPCO power plant was determined to be 7.7 ppb (20.18 µg/m3) as the average of 3-year 99th percentile SO_2 1-hour concentrations.

Figure 7-1 Location of Central Phoenix SO₂ Monitor
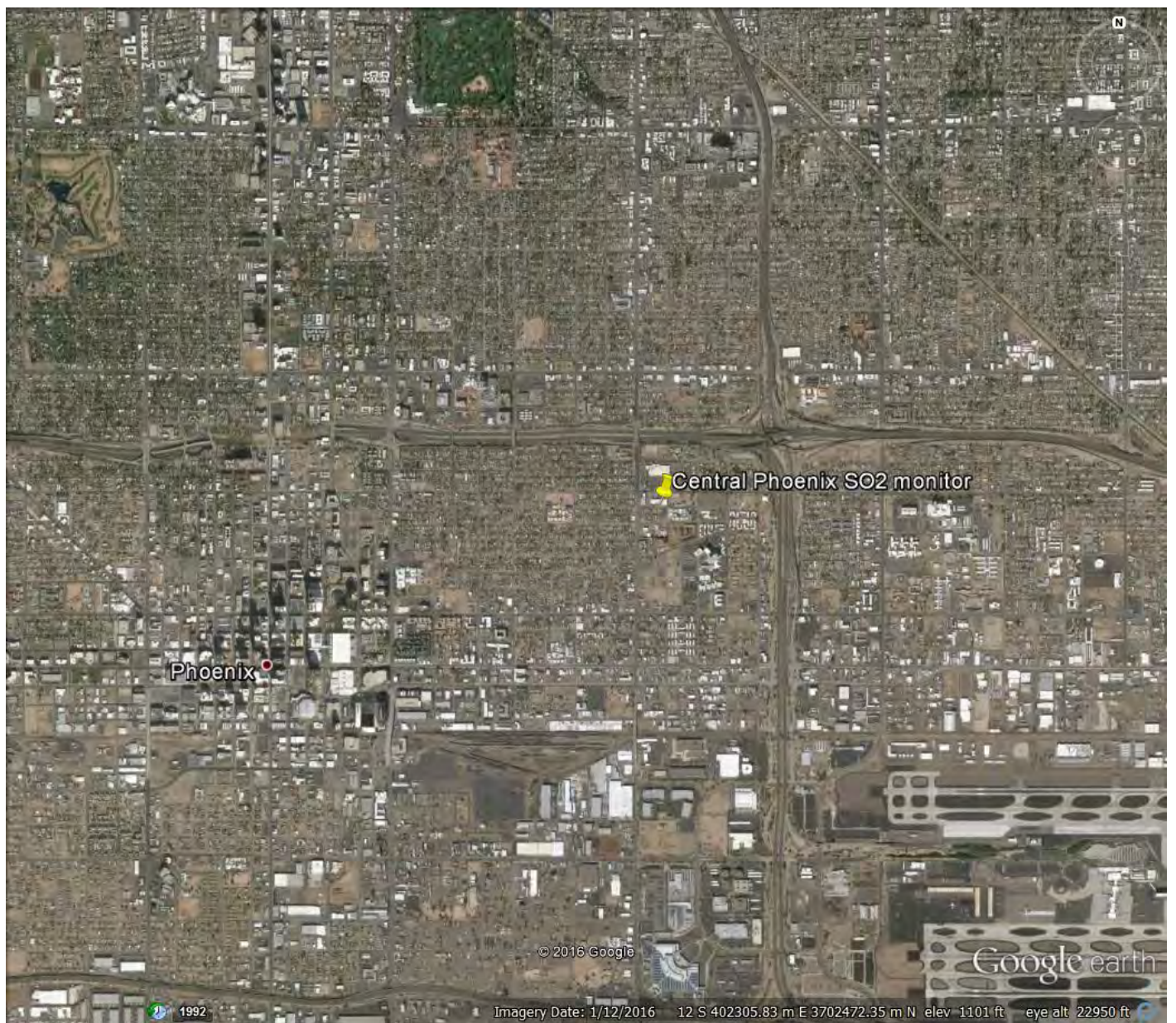
8.0 Modeling Results and Discussions

Demonstration of protection of the NAAQS was accomplished by comparison of the modeled design value to the applicable standard. The modeled design value for 1-hour SO_2 is defined as the sum of the 4th highest modeled hourly concentration and the 99th percentile background concentration. The results for AEPCO power plant are discussed in this section.

The predicted highest 4th high 1-hour SO_2 concentrations using the site-specific meteorological data with the ADJ_U* Beta option was 140.91 µg/m³. This predicted concentration was added to the 1-hour SO_2 background concentration of 20.18 µg/m³ and provided the ambient concentration of 161.09 µg/m³. This concentration is less than the applicable 1-hour SO_2 NAAQS of 196 µg/m³. Table 8-1 summarizes the modeling results.

Table 8-1: Summary of Modeling Results

Model Predicted Concentration (Highest 4th High) µg/m³	Background Concentration (99th Percentile) µg/m³	Total Concentration µg/m³	NAAQS µg/m³
140.91	20.18	161.09	196
4th highest maximum daily 1-hour SO_2 concentration predicted to occur at 597300.00m E and 3542700.00m N			

Based on the spatial concentration of contour plot (Figure 8-1), the highest concentrations of 1-hour SO_2 around AEPCO power plant were located in the southwest area, which is about 8.6 km away from the facility.

ADEQ submitted all applicable electronic modeling files including model input files, model output files, building downwash files, terrain files, and meteorological data files along with this modeling report.

Figure 8-1 Spatial distributions of SO₂ concentration modeled by AERMOD near APECO
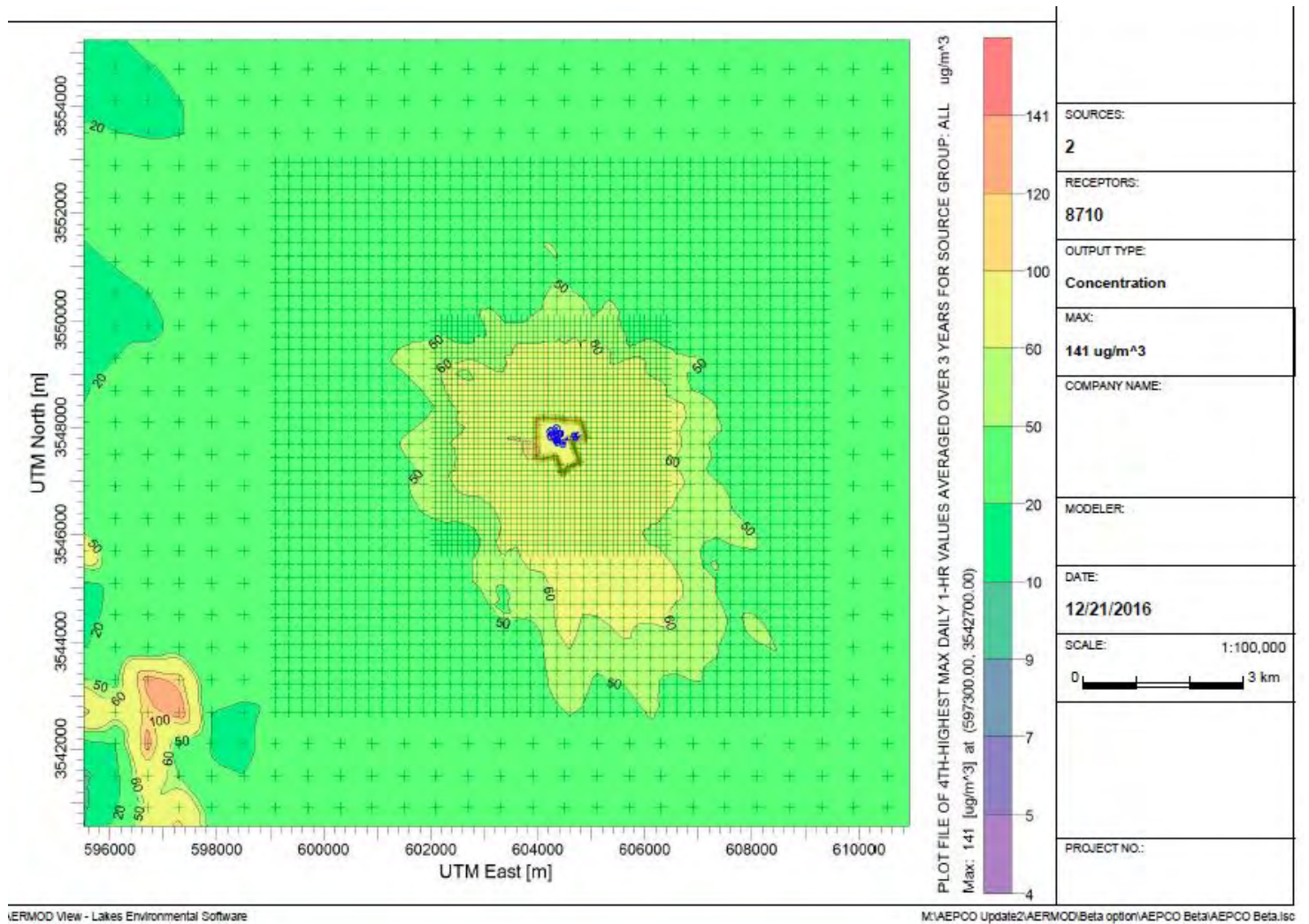
9.0 References

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Appendix A: Wind Rose Plots for AEPCO On-site Meteorological Monitor, Tucson NWS Station and Safford NWS Station

Table A-1 The information of meteorological site location

Meteorological Data Sources	Sampling Period	Latitude	Longitude
On-site 10-m meteorological tower	2012-2014	32.068 N	109.926 W
Tucson International Airport	2012-2014	32.133 N	110.933 W
Safford Regional Airport	2012-2014	32.855 N	109.630 W

2008-2014 Year to Year Analysis

Figure A-1 2008 On-site MET Data
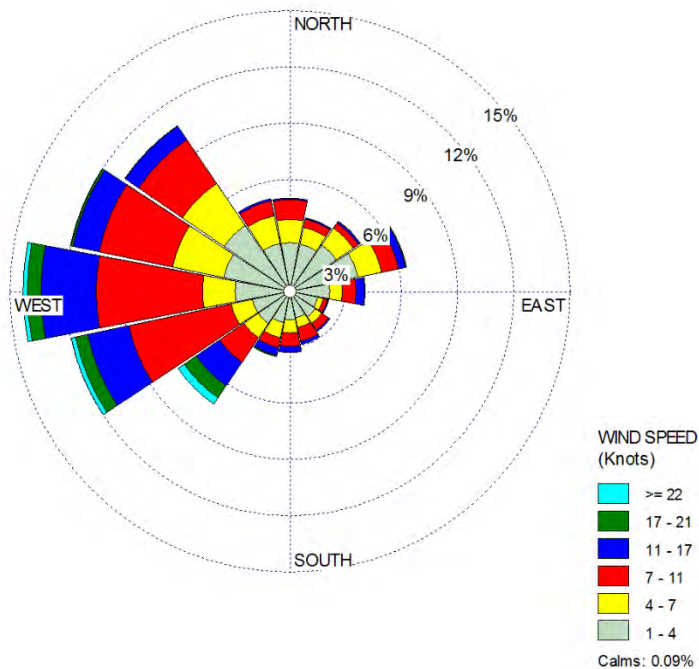
Figure A-2 2009 On-site MET Data
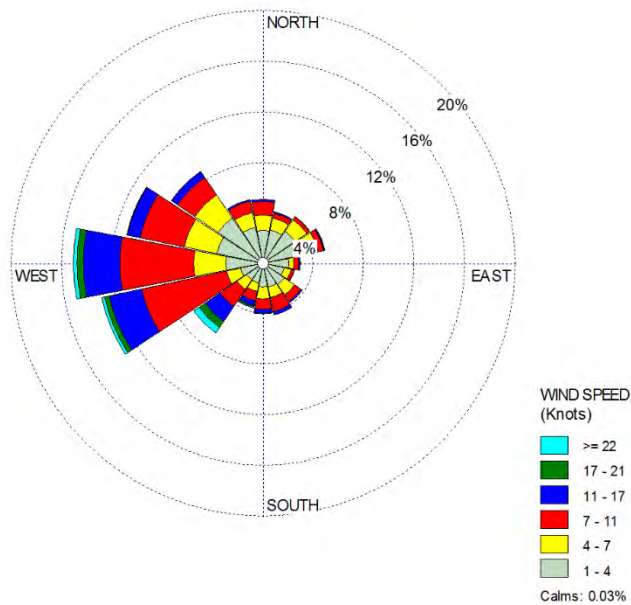
Figure A-3 2010 On-site MET Data
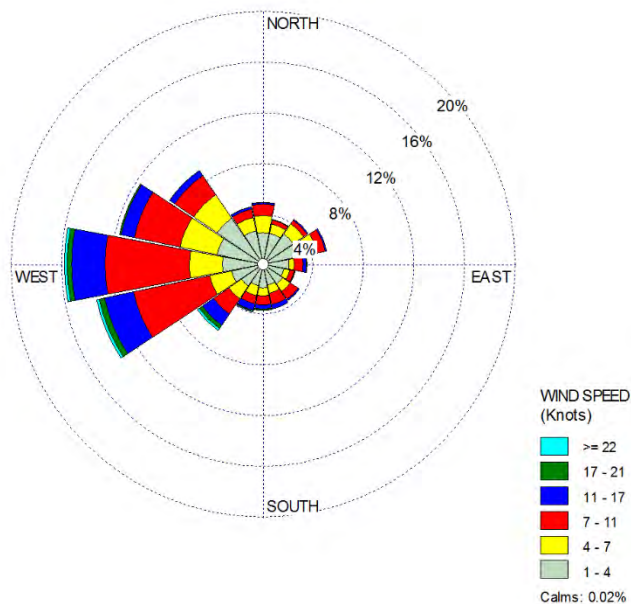
Figure A-4 2011 On-site MET Data
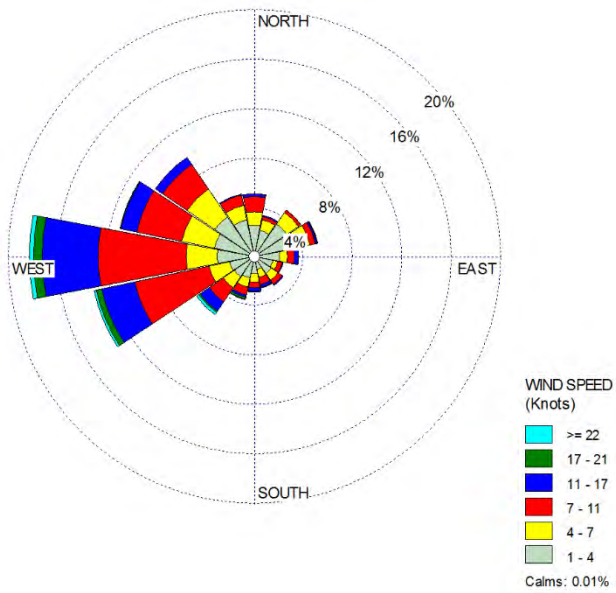
Figure A-5 2012 On-site MET Data
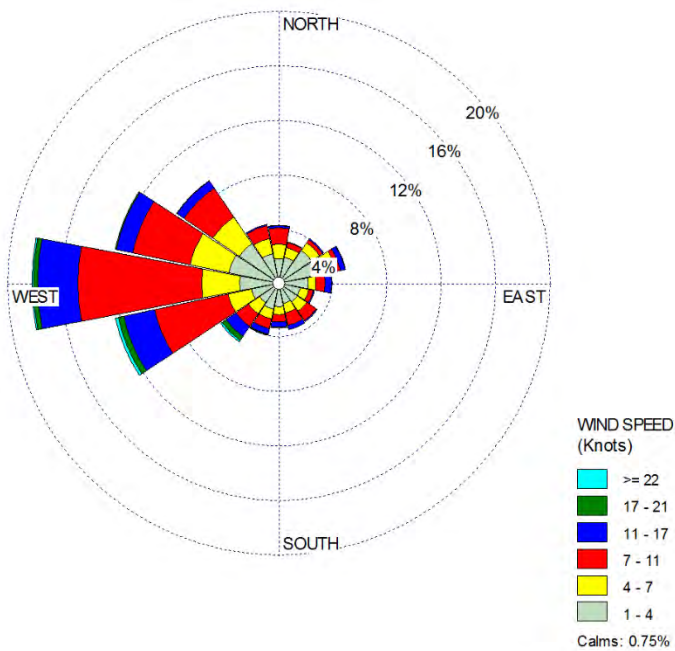
Figure A-6 2013 On-site MET Data
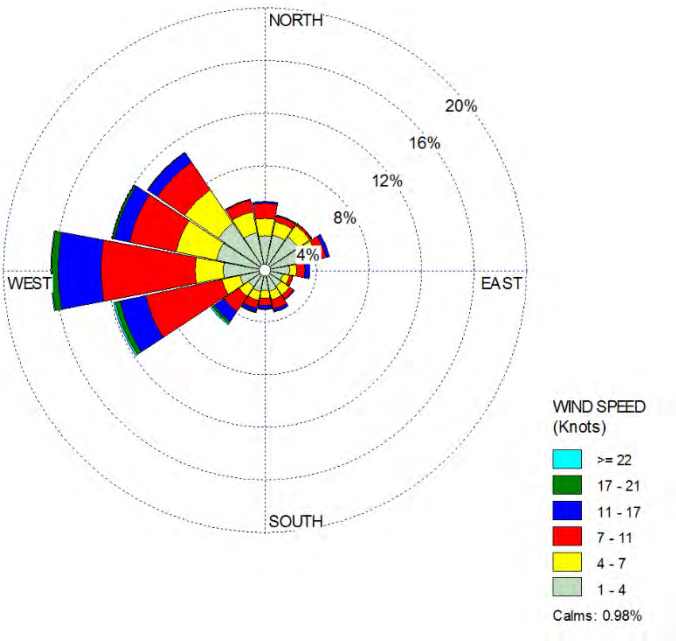
Figure A-7 2014 On-site MET Data
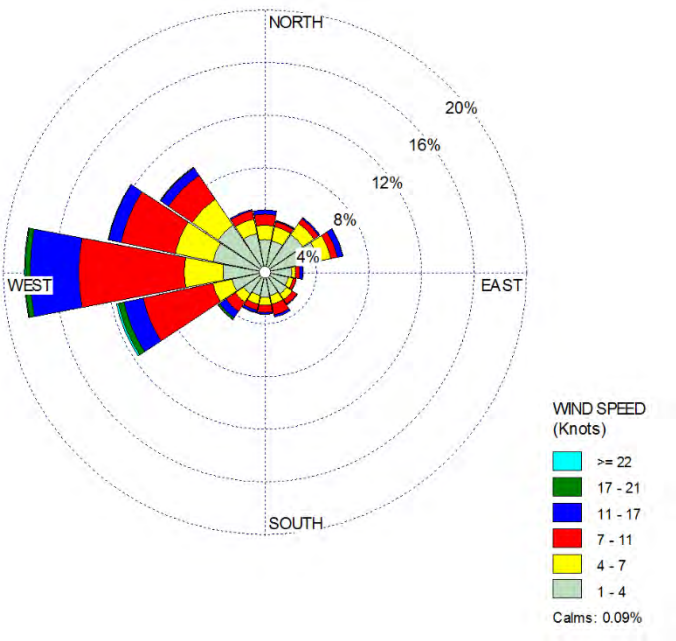
2012-2014 On-site and Airport Data

Figure A-8 2012-2014 On-site MET Data
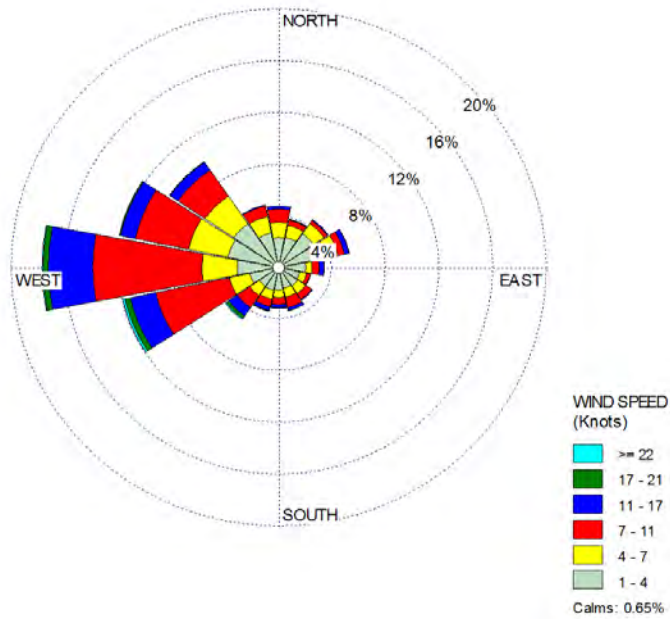
Figure A-9 2012-2014 Tucson Airport Data
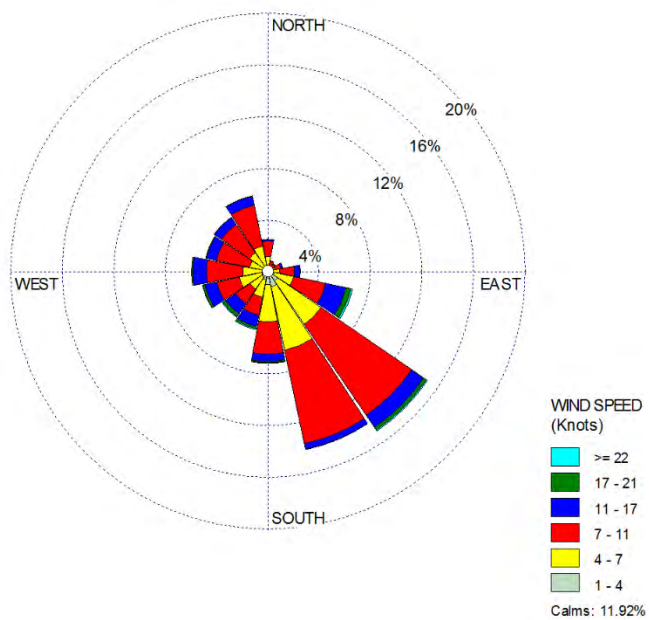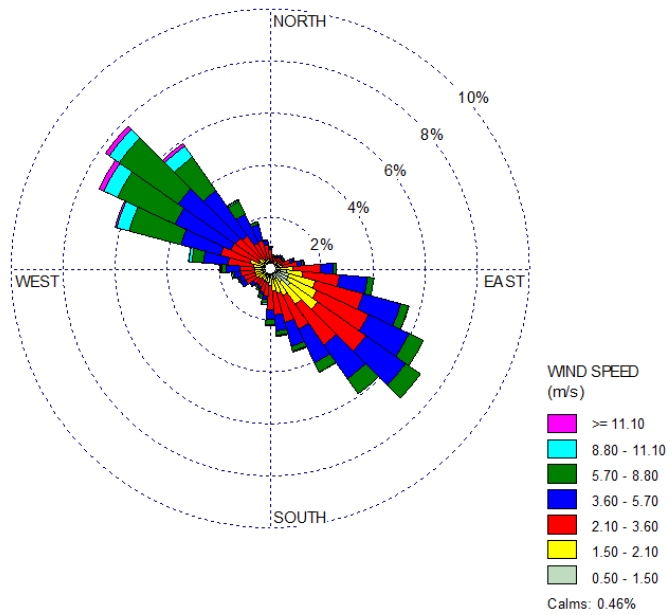
Appendix B: Using the ADJ_U* Option Formulation for Meteorological Data Processing for AEPCO

B.1 Introduction

The Arizona Department of Environmental Quality (ADEQ) is proposing the use of the beta adjusted surface friction velocity (ADJ_U*) modeling technique in the AERMET meteorological preprocessor (version 15181) in dispersion modeling of Apache Generating Station in Cochise, Arizona, owned and operated by Arizona Electric Power Cooperative (AEPCO). The modeling intends to demonstrate compliance with the 2010 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standards (NAAQS) for the Apache Generating Station under the 2010 1-hour NAAQS SO_2 Data Requirements Rule (DRR).

This technical report provides justification for the use of the ADJ_U* option in AERMET. Section 2 provide a brief description of the AEPCO Apache Generating Station. Section 3 reviews background of the development of the ADJ_U* option as well as the regulatory requirements of the application of this non-regulatory beta option. Section 4 performs a comprehensive review on published performance evaluations that compare the results of AERMOD with AERMET run with default options versus with the ADJ_U* option. Specifically, the review focuses on the circumstances associated with tall stacks with buoyant releases in complex terrain, which is an accurate emissions characterization of the Apache Generating Station. Section 5 presents a site-specific analysis for the Apache Generating Station, comparing the results of AERMOD with AERMET run with default options versus with the ADJ_U* option. ADEQ may further conduct additional analysis based on the EPA's comments and suggestions.

B.2 Source Overview

The Apache Generating Station is located approximately 3 miles south of the town of Cochise, Cochise County, Arizona. The Apache Generating Station consists of seven electric generating units: two coal/natural gas fired steam electric units (Unit 2 and Unit 3), a natural gas/fuel oil-fired steam electric, combined cycle unit (Unit 1), and four natural gas/fuel oil-fired turbines with a total generating capacity of 560 megawatts (MW). The Apache Generating Station has two tall stacks with a height of 122 m at a base elevation of 1279 m (the stack top height is around 1400 m).

Terrain within 8-10 km surrounding the facility is simple with flat or gently rolling features. Beyond this distance, the complex terrain (i.e., features with elevations above the height of the stack) begin. The Dragoon Mountains are located about 8 km south-west of the facility in Cochise County, Arizona. The range is about 40 km long, running on an axis extending south-south-east through Willcox, Arizona. Winchester Mountains and Galiuro Mountains are located about 35 km northwest of the facility, running on an axis extending south-south-east. Pinaleno Mountains are located about 40 km north of the facility, which cover 300 square miles (780 km^2) and are part of the Coronado National Forest, Safford ranger district. The terrains within 50 km east and south of the facility are mostly flat. The topography of the local area is depicted in Figure B-1.

The nearest complex terrain features are the Dragoon Mountains located about 8 km south-west of the facility and Gunnison Hills located about 10 km west of the facility. The two terrain features are of great interests to ADEQ, as preliminary AERMOD modeling with AERMET default options indicated that the controlling concentrations occurred in these areas. Figure B-2 illustrates the elevation profile from Gunnison Hills/Dragoon Mountains to the facility. As discussed, the setting of the Apache Generating Station can be characterized as tall stacks with buoyant releases in complex terrain.

Figure B-1 Terrain within 50 km of AEPCO Facility
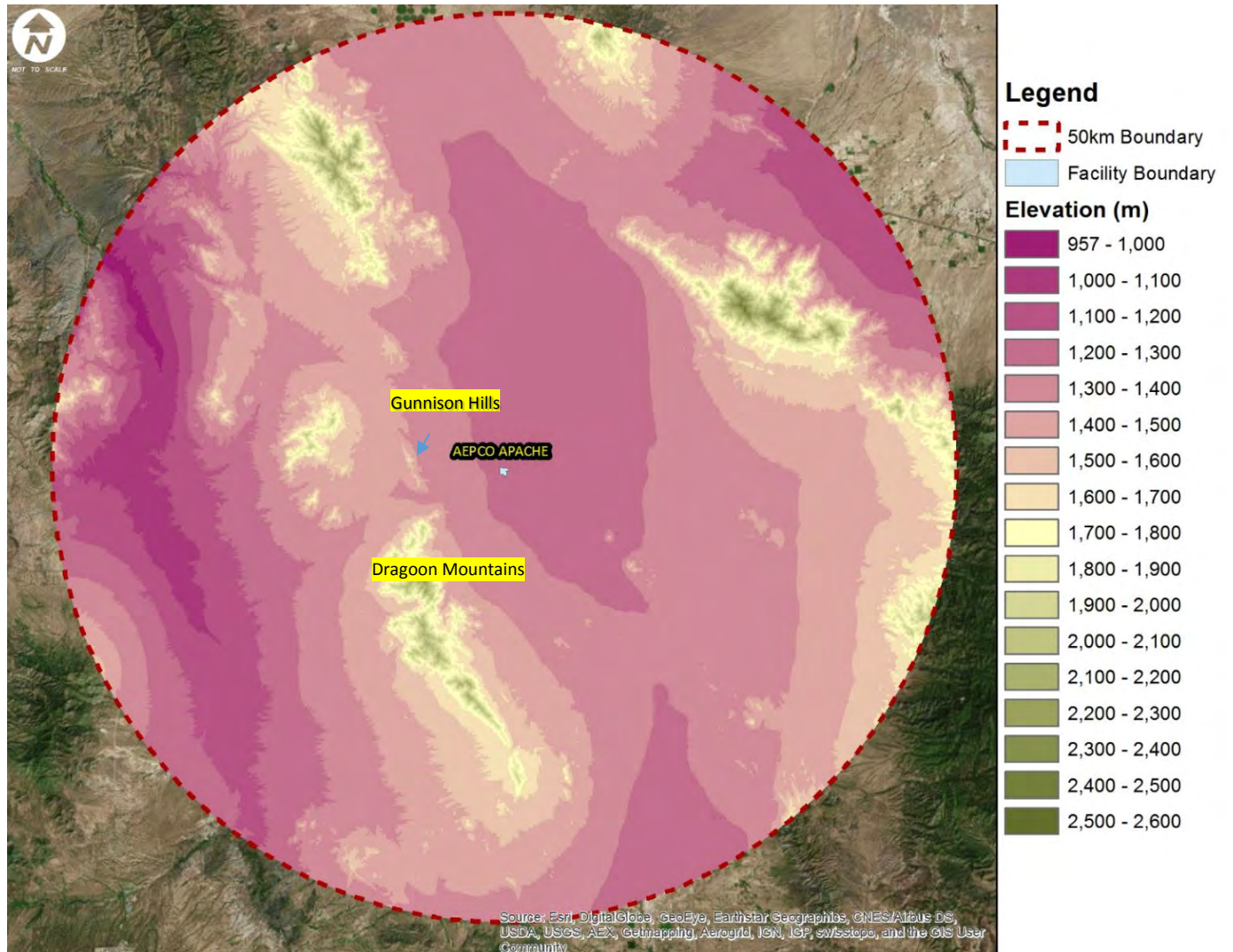
Figure B-2a Elevation Profile from Gunnison Hills Hill to AEPCO
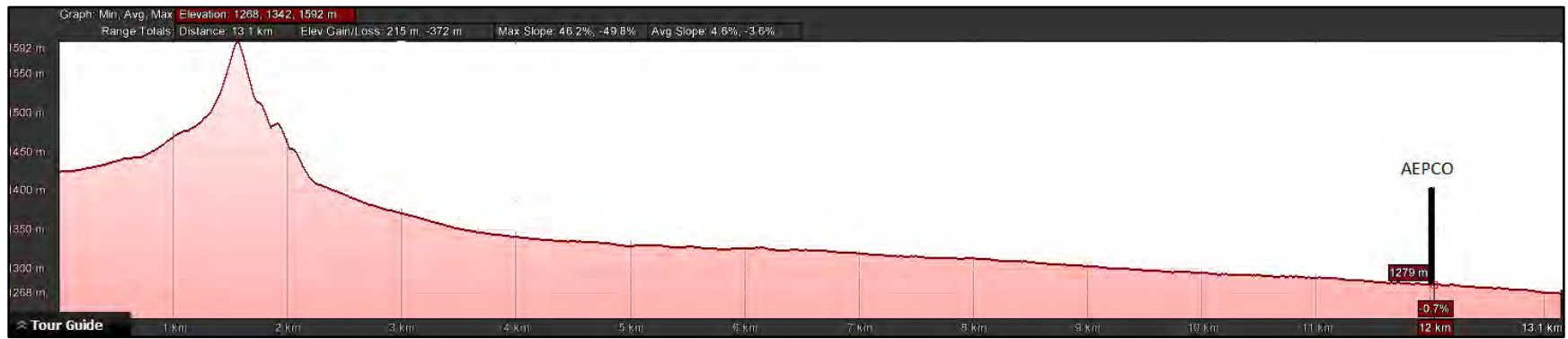
Figure B-2b Elevation Profile from Dragoon Mountains to AEPCO
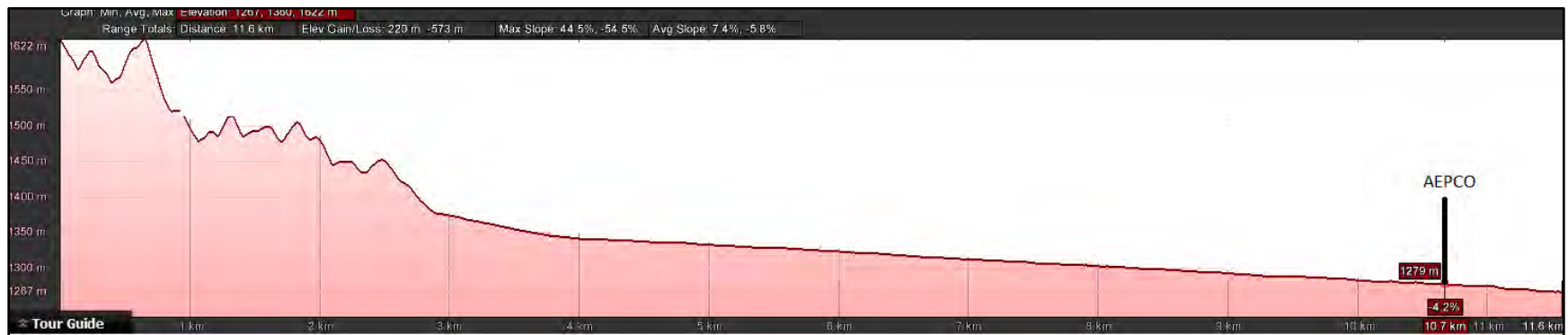
B.3 Regulatory Background of the ADJ_U* Option

EPA has long known that AERMOD intended to over-predict ambient concentrations during stable boundary layer conditions under low wind speeds (Robinson and Brode, 2007). This over-prediction tendency has partially resulted from the underestimation of surface friction velocity (u*) in the AERMET meteorological processor. Several studies have demonstrated that AERMET with default options tend to significantly underestimate surface friction velocity (u*) for low wind speed conditions (Luhar and Rayner, 2009; Qian and Venkatram, 2010; Paine et al., 2015). For example, Luhar and Rayner (2009) compared u* estimates by AERMOD/AERMET with boundary-layer observations during field experiments and found that at very low wind speeds, u* was being underestimated by AERMET by as much as a factor of 2. As u* is a key parameter being used to estimate wind profiles, turbulence, and mixing depths, the underestimation of u* results in the underestimation of turbulence and mixing height in AERMOD for stable conditions. This underestimation reduces dispersion and leads to over-predicted concentrations (Hanna and Chowdhury, 2013).

In an effort to address AERMOD's propensity to overestimate concentration estimates during low wind speed stable conditions, EPA has introduced a beta adjust u* option (ADJ_U*) in Version 12345 of the AERMET meteorological processor (U.S. EPA, 2012), based on peer-reviewed work by Qian and Venkatram (2011) and Luhar and Rayner (2009). This option was subsequently updated in Versions 13350(U.S. EPA, 2013), 14134 (U.S. EPA, 2014a) and 15181 (U.S. EPA, 2015a).

EPA has conducted model performance evaluations of the ADJ_U* option and the current regulatory default AERMOD system (U.S. EPA, 2015b). The evaluations were performed against results from monitoring field studies to investigate diffusion under low wind speed conditions, and against results from a field study with a tall stack in complex terrain where stable and low wind speed conditions can also be important. The results of these evaluations indicated significant over-prediction using the regulatory default AERMET/AERMOD, and better performance - though still somewhat over-predicting - using the ADJ_U* option. Based in part on the results of these evaluations, EPA has proposed to designate the ADJ_U* option as the default regulatory formulation in AERMET for estimating u* under stable conditions with low wind speeds in the proposed revision to Appendix W (U.S. EPA, 2015c)

While it is very clear that EPA intends to incorporate the ADJ_U* option in AERMET into the regulatory version of the model, the ADJ_U* option is still a non-regulatory beta option at this stage. In December 2015, EPA issued a

memorandum that clarified the approval process for non-regulatory beta options in AERMOD that have been proposed as regulatory options in the proposed revision to Appendix W (U.S. EPA, 2015d). This memorandum confirmed that the use of all non-default beta options, including the ADJ_U* option, in regulatory modeling requires formal approval from EPA Regional Office and is subject to the requirements of Section 3.2 of the current 2005 version of Appendix W.

Appendix W Section 3.2.2 provides three different conditions for which an alternative model is approvable (U.S. EPA, 2005). These three conditions are briefly summarized as:

- The alternative and preferred model provide equivalent estimates (Condition 1);
- The alternative model outperforms the preferred model when comparing the results to actual air quality data (Condition 2); or
- The preferred model is less appropriate or there is no preferred model for the given scenario (Condition 3).

ADEQ relies on Condition 2 for the basis of this alternative model approval. As will be presented in the following sections, field studies using measured air quality data have clearly demonstrated that the current regulatory default AERMOD system significantly over-predicts ambient concentrations during stable boundary layer conditions under low wind speeds. Comparatively, the use of AERMET version 15181 with the ADJ_U* option improves model performance for AERMOD.

B.4 Performance Evaluations on the ADJ_U* Option vs. Default Option

In the past several years, there has been increased study on the performance of AERMOD low wind beta options (including the ADJ_U* option) for low-wind stable conditions. The available studies include:

EPA's evaluations on the ADJ_U* option:
- Oak Ridge (low-level, non-buoyant release, complex terrain) (U.S. EPA, 2015b);
- Idaho Falls (low-level, non-buoyant release, complex terrain) (U.S. EPA, 2015b);
- Lovett (tall stacks, complex terrain) (U.S. EPA, 2015b); and
- Cordero Rojo (low-level, non-buoyant fugitive release, simple terrain) (U.S. EPA, 2014b).

Peer-reviewed work on the ADJ_U* option by Paine et al., 2015:
- Mercer County, North Dakota (tall stacks, both simple and complex terrain); and

- Gibson (tall stacks, simple terrain).

EPA's Model Clearinghouse concurrence memorandum regarding the use of the ADJ_U* option as an alternative model:

- DGLLC, EPA Region 10 (low-level, non-buoyant fugitive release/tall stacks, complex terrain) (U.S. EPA, 2016a);
- Schiller, EPA Region 1 (tall stacks, complex terrain) (U.S. EPA, 2016b);
- Wagner, EPA Region 3 (tall stacks, complex terrain) (U.S. EPA, 2016c); and
- Heskett, EPA Region 8 (tall stacks, complex terrain) (U.S. EPA, 2016d)

The Oak Ridge, Idaho Falls, and Cordero Rojo studies are less directly applicable to AEPCO because the release heights from those studies are low-level, whereas AEPCO release buoyant plumes from tall stacks. The Gibson study is also limited in relevance to AEPCO because of the simple terrain of the area around Gibson. Although the DGLLC project includes tall stacks, its primary ambient air impact issues are related to particulate concentrations from low-release fugitive emission sources, which are irrelevant to AEPCO.

The remaining studies (Lovett, Mercer County, Schiller, Wagner, and Heskett) are directly relevant to AEPCO due to similarities in terrain (complex) and emission characteristics (tall stacks with buoyant releases). Therefore, the following review focuses on these three studies.

B.4.1 Lovett Database

The Lovett database consists of 2,595 hours of ambient SO_2 monitoring data from 12 monitors near the Lovett Power Plant, located in a rural area with mountainous terrain along the Hudson River in New York. Most of the monitors had elevations above the release height of Lovett's 145 m stack, and at distances from the source of 1-3 km (Figure B-3). The Lovett database also includes a 100m meteorological tower with wind speed, wind direction, sigma-theta and temperature collected at the 10m, 50m, and 100m levels. In addition, sigma-w was also collected at the 10m and 100m levels.

Figure B-3 Monitoring Network Used for the Lovett Complex Terrain Model Evaluation Study (U.S. EPA, 2015b)
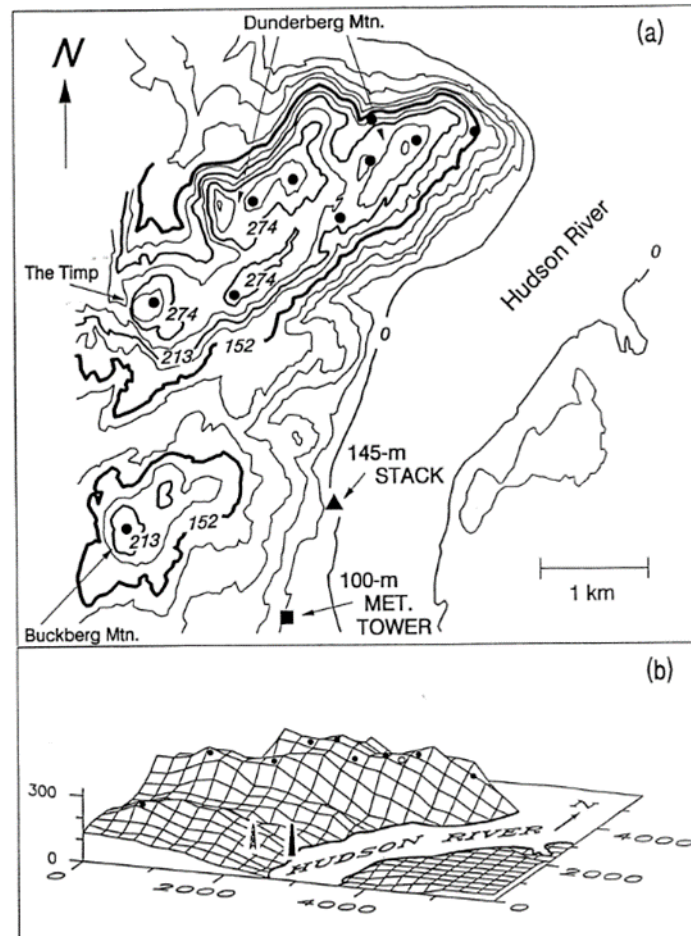
EPA conducted model performance evaluations of the ADJ_U* option and the current regulatory default AERMOD system with three different meteorological datasets (U.S. EPA, 2015b):

- Full site-specific meteorological data;
- Site-specific meteorological data without the temperature profile; and
- Site-specific meteorological data without the temperature profile and turbulence data.

EPA found that including the ADJ_U* option with full onsite meteorological data shows a slight improvement in model performance. In fact, the modeled concentrations with the ADJ_U* option are slightly higher than those with the regulatory default options. Therefore, it is likely that the modeled impacts at near-by elevated receptors (within a distance of several kilometers) would be higher using the ADJ_U* option.

Using site-specific meteorological data without the temperature profile /turbulence data, EPA found that the model with default options over-predicted ambient concentrations. The use of the ADJ_U* option significantly reduced the over-prediction bias resulted from the default options.

B.4.2 Mercer County, North Dakota Database

The Mercer County ND database consists of 4-years of hourly emission data from 13 tall stacks (> 60 m) as well as monitoring data from 5 monitors in the vicinity of the Dakota Gasification Company plant and the Antelope Valley Station power plant in an area of both simple and elevated terrain (Figure B-4). The elevation of the four monitors (DGC 12, DGC 14, DGC 16 and Beulah) ranges from 590 m to 630 m while the elevation of DGC 17 is as high as 710 m. Among the 13 tall stacks, 12 stacks have a stack top height above 650 m. In general, DGC17 is located in an elevated complex terrain setting while the other four monitors are located in a relatively flat and simple terrain setting.

Figure B-5 presents the results of the model performance evaluation for Mercer County ND database. As indicated in Figure B-2, AERMOD over-predicted the ambient impacts regardless of whether the AERMET default options or the ADJ_U* option was used. In particular, AERMOD with AERMET default options significantly over-predicted the ambient impacts at DGC-17, as the modeled 99th percentile 1-hour monitoring concentration of 184.48 $\mu g/m^3$ is significantly higher than the observation concentration of 83.76 $\mu g/m^3$ by a factor of 2.2. The use of the ADJ_U* option in AERMET significantly improved model performance, while still remaining conservative, and reduced the over-prediction to a factor of 1.53 with a predicted concentration of 127.93 $\mu g/m^3$. In contrast, for the monitors in simple terrain (DGC 12, DGC 14, DGC 16 and Beulah), the modeled results with the ADJ_U* option were identical to those obtained from AERMET default options, indicating that the incorporation of the ADJ_U* in AERMET has virtually no effect on the predicted concentrations for receptors with lower elevations.

Figure B-5 Modeled vs. Monitoring Concentrations in Mercer County ND Model Performance Study (Adapted from Paine et al., 2015)
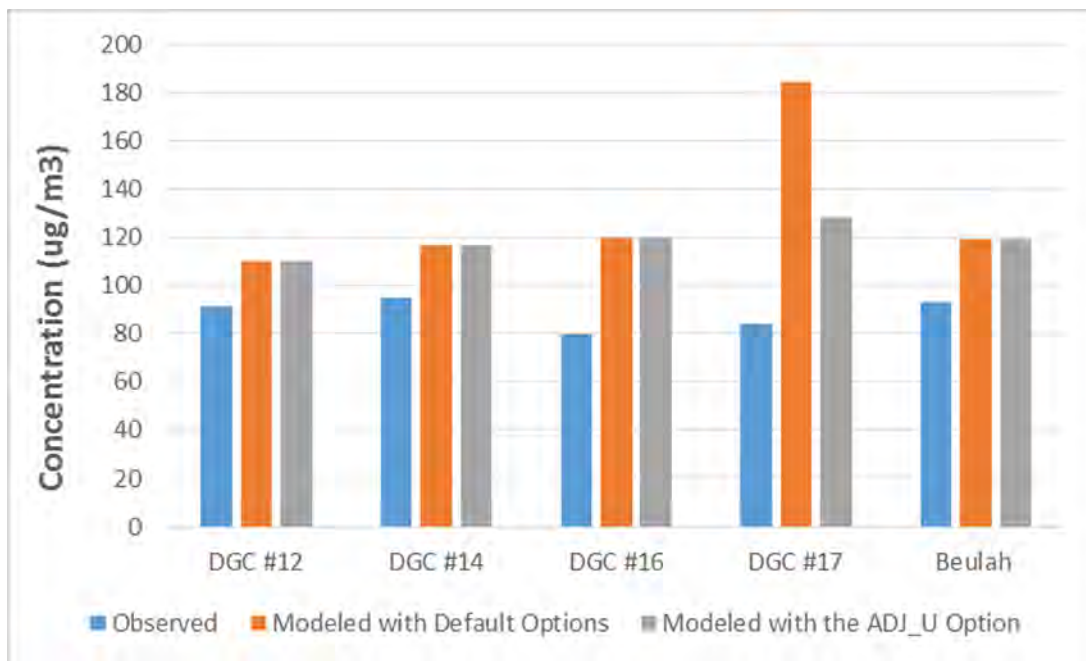
Paine et al. (2015) also found that the majority of peak modeled concentrations at DGC-17 with AERMET default options occurred during stable, light wind conditions. However, with the incorporation of the ADJ_U* option in AERMET, the majority of peak modeled concentrations were found to occur during daytime with light to moderate winds, which were more consistent with the meteorological conditions for actual peak observations.

B.4.3 Schiller Study

On April 29, 2016, the EPA's Model Clearinghouse approved a request from EPA Region 1 for use of the ADJ_U* option in AERMET for modeling for the 2010 1-hour sulfur dioxide standard at Schiller Station in Portsmouth, New Hampshire (U.S. EPA, 2016b).

Schiller has three tall stacks ranging approximately 68-70 m in height at elevations of 6.4-7.3 m. Terrain within around 10 km around Schiller is simple with flat or gently rolling features; however, terrain becomes increasingly complex as an isolated terrain feature (Mt. Agamenticas), with a peak elevation about 200 m above the stack base, is located about 15km north-northeast from the Schiller Station (Figure B-6).

As reported in the model sensitivity analysis for Schiller (U.S. EPA R1, 2016e), using AERMOD with AERMET default options led to the controlling concentrations associated with receptors at a distance, in complex terrain. Specifically, the top ten 5-year average 4th highest maximum daily 1-hour impacts (herein, "top 10 impacts") were predicted to occur near the peak of Mt. Agamenticus, at locations with elevations ranging from 129 m to 147 m. These top 10 impacts, located within distant terrain, were found to occur during low wind, stable conditions. The five-year average u* values corresponding to these top 10 impacts were substantially low, ranging from 0.057 m/s to 0.069 m/s. When the ADJ_U* option was used in AERMET, these u* values significantly increased by 62-96% (0.104-0.114 m/s). As a result of the increase in u* from the use of the ADJ_U*option, the 5-year average 4th highest maximum daily 1-hour impacts at these receptors on Mount Agamenticus dropped by 57-64%.

Figure B-6 Terrain Features Surrounding Shiller Generating Station (Adapted from U.S.EPA R1, 2016e)

S:\gisuser\yl1\AEPCO\Beta option
Date: 06/23/2016
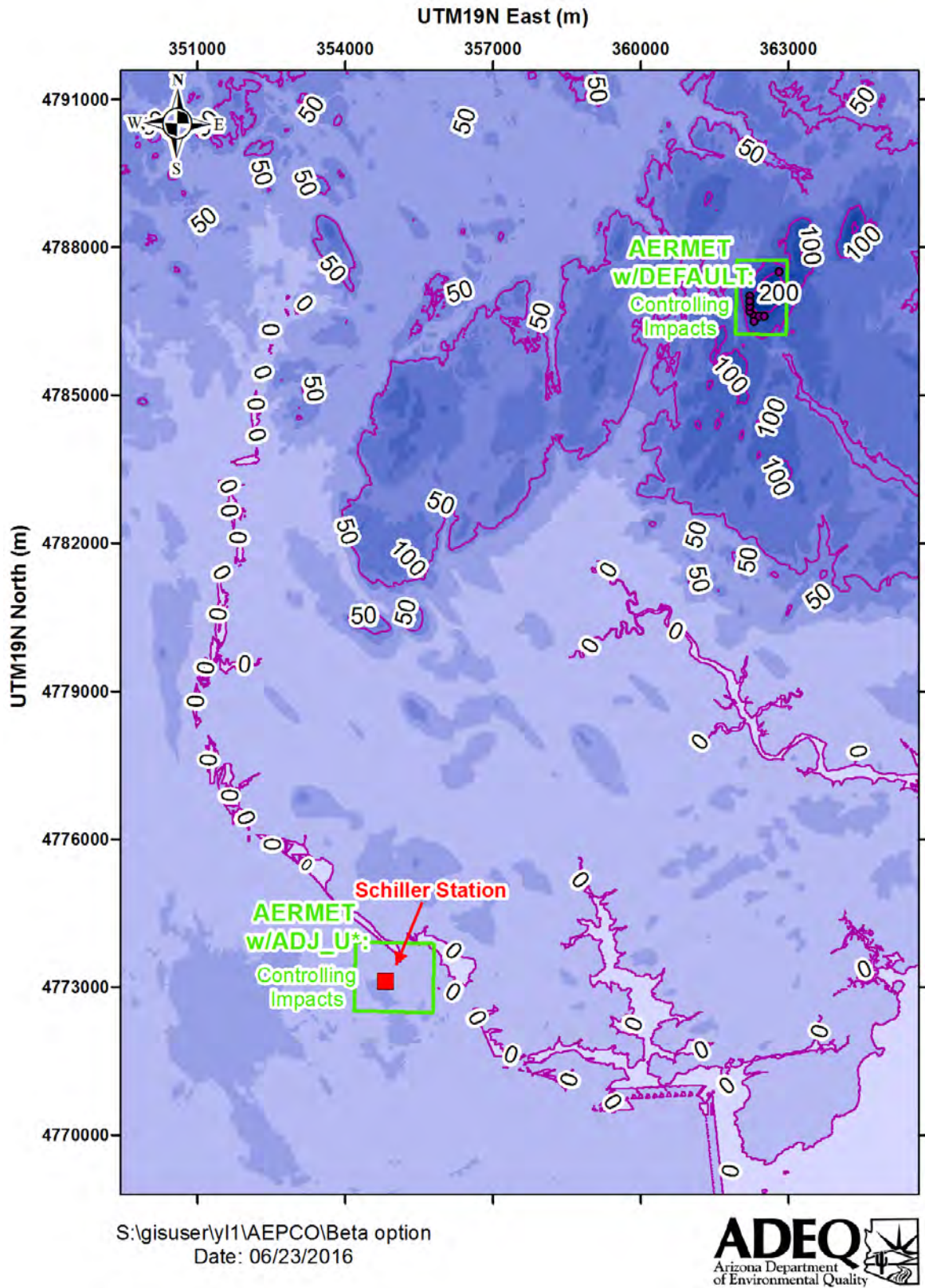
Moreover, the application of the ADJ_U* option in AERMET shifted the controlling impact areas from remote Mt. Agamenticus to Eliot, Maine that is located within 1 km of Schiller. For the nearby controlling receptors, the top 10 impacts occurred at hours of relatively higher u* and these values were unchanged with the use of ADJ_U* option compared to AERMET run with default options.

The sensitivity analysis further revealed that the ADJ_U* option only had a significant impact on the model concentrations at receptors with elevations at or above the height of release (≥ 85 m), mainly due to the fact that stable conditions with low wind speeds were the controlling meteorological conditions for these receptors. In contrast, the use of ADJ_U* option had virtually no effect on the model concentrations at receptors below 85 m, indicating that stable conditions with low wind speeds are not controlling meteorological conditions at elevations below the release height.

The sensitivity analysis also compared predicted concentrations vs. monitoring concentrations at two nearby SO_2 monitor that are located in simple terrain within 5 km of Schiller. However, due to the lack of monitoring data in complex terrain, this analysis did not provide direct evidence to demonstrate that AERMOD with AERMET default options over-predicts the ambient impacts at complex terrain and the use of the ADJ_U* option improves the model performance. Instead, the Schiller study still heavily relied upon the Lovett study (U.S. EPA, 2015b) as well as the Mercer County ND study (Paine et al., 2015) regarding the model performance for complex terrain.

B.4.4 Wagner Study

On June 20, 2016, the EPA's Model Clearinghouse approved a request from EPA Region 3 for use of the ADJ_U* option in AERMET for modeling of the 2010 1-hour sulfur dioxide standard at the Herbert A. Wagner Generating Station (Wagner) located near the City of Baltimore (U.S. EPA, 2016c).

Wagner is located in northern Ann Arundel County, just outside Baltimore, Maryland. The sources in the Wager modeling analysis include four steam electric generating units (EGUs) at Wagner as well as other nearby EGUs. All modeled sources lie on the Atlantic Coastal Plane physiographic region and are less than 10 meters above mean sea level (AMSL). Stack heights for all sources are relatively tall ranging from 87 to 122 meters; the lowest effective stack elevation (stack + base height) is 93 meters. Distant terrain features are located at around 20 km and between 34 and 37 km northwest of the Wagner facility with a peak elevation approximately 200 meters above the stack base, with relatively flat or gradually sloping terrain between the source and those terrain features (Figure B-7).
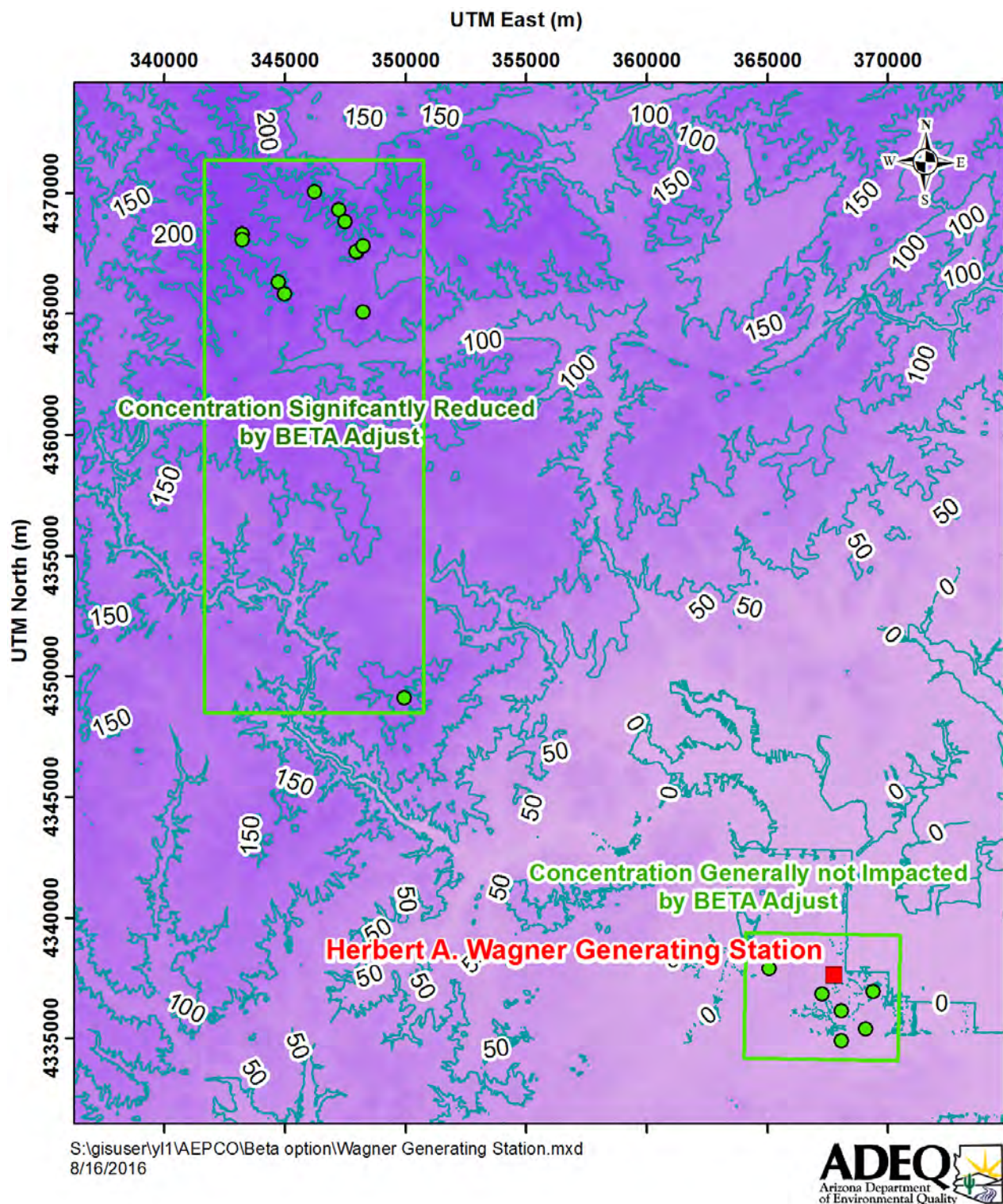
As reported in the model sensitivity analysis for Wager (U.S. EPA R3, 2016f), utilizing AERMOD with AERMET default options, violating receptor locations occurred in the immediate vicinity of Wagner and in several portions of Baltimore County west and northwest of the City of Baltimore. The nearby violating receptors are located in the areas within 5 km of Wagner at elevations between 0 and 10 m AMSL. For these nearby receptors, the highest concentrations occurred during daylight hours with unstable conditions. In contrast, the far-off violating receptors are generally located in terrain above the lowest effective stack height (93 m) and at distances ranging from approximately 20 km to 37 km from Wagner. For these far-off receptors, the highest model concentrations occurred during the overnight hours (with low wind speed, stable conditions).

The application of the ADJ_U* option eliminated all far-off violating receptors but nearby violating receptors were retained. When the ADJ_U* option was used in AERMET, the u* values associated with stable conditions for the far-off receptors significantly increased by 2-3 times (from 0.026-0.081 m/s to 0.094-0.150 m/s). Therefore, the modeled concentrations for these far-off receptors significantly dropped. In contrast, the use of the ADJ_U* option had virtually no effect on the u* values associated with unstable conditions. As a result, peak model concentrations for the nearby receptors were identical between the default and the ADJ_U* runs.

There is no evaluation database analysis for Wagner. Instead, the Wagner study heavily relied upon the Lovett study (U.S. EPA, 2015b) regarding the model performance for tall stacks in complex terrain.

B.4.5 Heskett Study

On August 1, 2016, the EPA's Model Clearinghouse approved a request from EPA Region 8 for use of the ADJ_U* option in AERMET for modeling of the 2010 1-hour sulfur dioxide standard at the Montana-Dakota Utilities Company's R.M. Heskett Station (Heskett), which is located about 10 km northwest of Bismarck, North Dakota (U.S. EPA, 2016d).

Heskett has two tall stacks with a height of 91 m at an elevation of 505 m. Heskett is situated along the west bank of the Missouri River where the topography is dominated by the Missouri Plateau. In general, the Missouri Plateau consists of rolling to hilly plains (Figure B-8). However, there is a prominent bluff approximately 15 km west-northwest of Heskett. The bluff, known as Crown Butte, peaks at approximately 707 m AMSL.
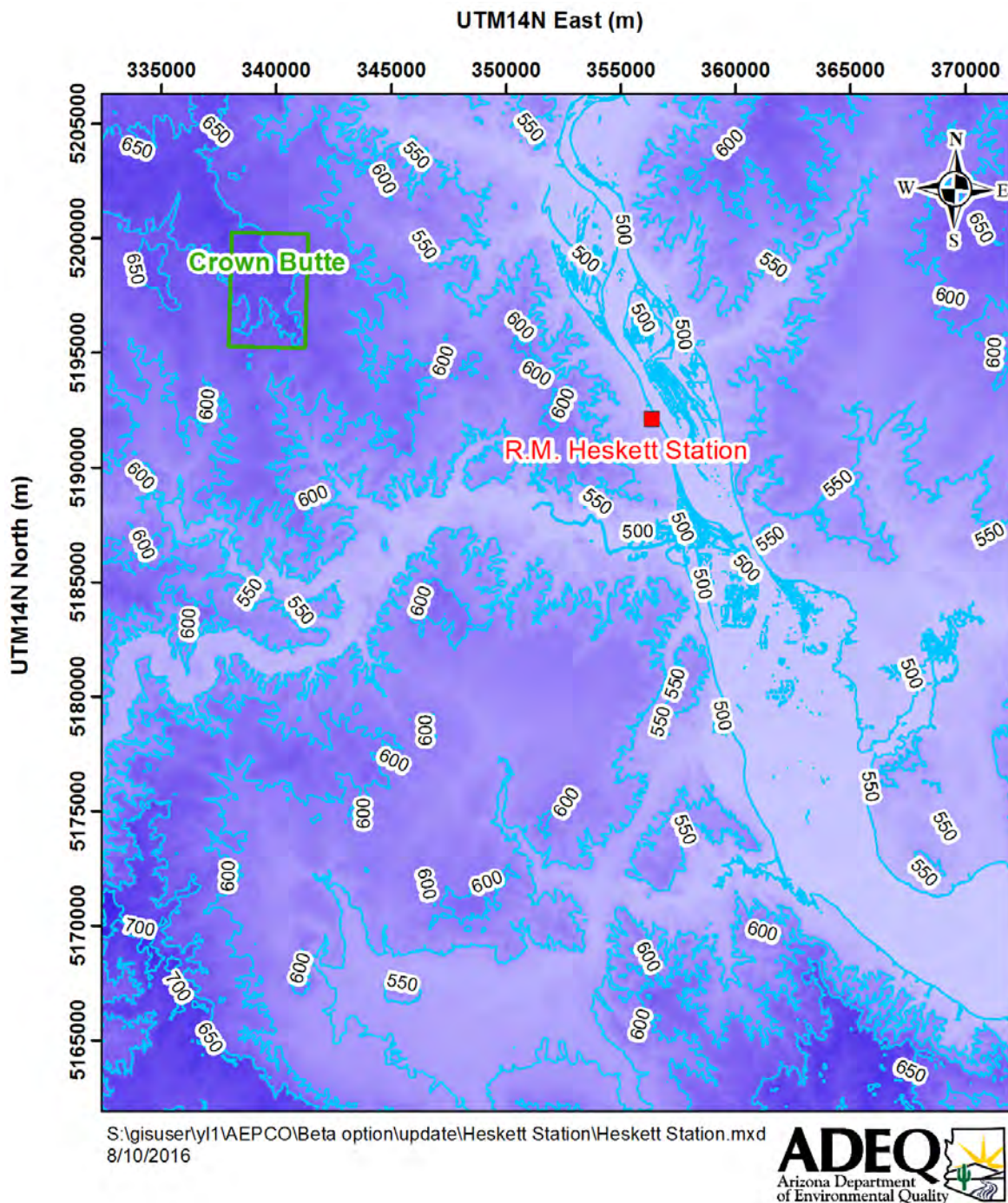
As reported in the model sensitivity analysis for Heskett (U.S. EPA, 2016g), using AERMOD with AERMET default options led to the controlling concentrations associated with receptors at a distance of approximately 15 km, in complex terrain. Specifically, the top ten 3-year average 4th highest maximum daily 1-hour impacts were

predicted to occur at Crown Butte. These top 10 modeled impacts, located within distant terrain, were found to occur during low wind speed, stable conditions. The three-year average u* values corresponding to these top 10 impacts were substantially small, ranging from 0.029 m/s to 0.050 m/s. When the ADJ_U* option was used in AERMET, these u* values significantly increased with values ranging from 0.074 m/s to 0.105 m/s. As a result, the 3-year average 4th highest maximum daily 1-hour impacts at these receptors at Crown Butte dropped by 47-61%.

Using the AERMET ADJ_U* option and AERMOD default options, the locations of the receptors corresponding to the top 10 modeled impacts were split between those at Crown Butte (4 receptors) and within less than 1 km of Heskett (6 receptors). The four highest modeled impacts, occurring at Crown Butte, were still associated with low wind speed, stable conditions. In contrast, the six highest modeled impacts, occurring near Heskett, were associated with daylight hours with relatively higher u* (0.21-0.34 m/s). The design concentration across the modeling domain for Heskett still occurred at distant complex terrain but the design concentration significantly dropped compared to the default AERMET option.

The sensitivity analysis further revealed that the ADJ_U* option only had a significant impact on the model concentrations at receptors in complex terrain while it had virtually no effect on the model concentrations at receptors in flat terrain. These findings were consistent with those of the Schiller study.

There is no evaluation database analysis for Heskett. Instead, the Heskett study focused on the comparison with Mercer County, North Dakota evaluation database since significant similarities existed between the surrounding terrain of the Heskett facility and the Mercer County North Dakota evaluation study.

B.5 Model Sensitivity Analysis for AEPCO Apache Generating Station

To further demonstrate the appropriateness and applicability of the ADJ_U* option for the AEPCO case, ADEQ performed a model sensitivity analysis for AEPCO, similar to what the Schiller study and the Heskett study have done before.

B.5.1 Sensitivity of Model Controlling Concentrations to the ADJ_U* Option

Top 10 Model Impacts under AERMET Default Option

Using AERMOD with AERMET default options, ADEQ found that the controlling concentrations occurred on receptors within distant terrain. Specifically, the top ten 3-year average 4th highest maximum daily 1-hour impacts were predicted to occur at the receptors at Gunnison Hills and the Dragoon Mountains, around 8-10 km west or

southwest of the facility (Figure B-9). The elevation of the top 10 receptors ranged from 1470 m to 1504 m, all above the stack top height of 1400 m at the Apache Generating Station. These top 10 model impacts within distant terrain were found to occur during low wind, stable conditions (Table B-1). As shown in Table 1, the u^* values corresponding to these top 10 model impacts were extremely low, ranging from 0.023 m/s to 0.079 m/s. When the ADJ_U* option instead of default options was used in AERMET, the three-year average u^* values corresponding the top 10 model impacts (under AERMET Default Options) significantly increased from 0.041-0.069 to 0.100-0.208 m/s (Table B-2). As a result of the increase in u^* from the use of the ADJ_U*option, the three-year average 4th highest maximum daily 1-hour impacts at these distant receptors dropped by 58-75%.

Figure B-9 Locations of Top Ten Predicted 3-year Average 4th Highest Maximum Daily 1-hour Concentrations Using AERMOD V15181 and AERMET V15181 with Default Options
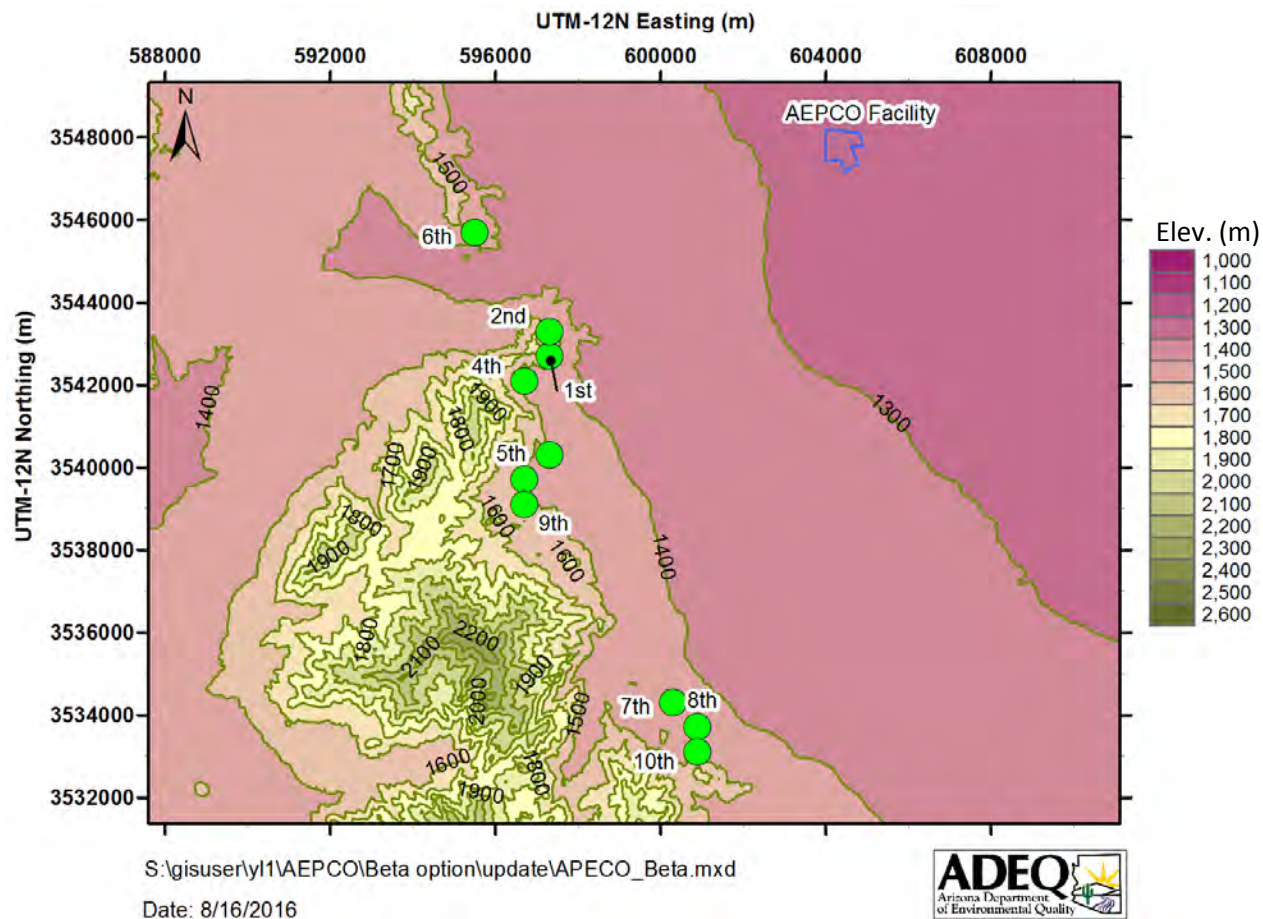
Table B-1 Top 10 Predicted 3-year Average 4th Highest Maximum Daily 1-hour SO₂ Concentrations Using AERMOD v15181 and AERMET v15181 Default Options

Rank	UTM-EAST (m)	UTM-North (m)	Year	4th Highest Max Daily 1-hour SO₂ Conc. (μg/m³)	u* (m/s)	Hour Of Day	Wind Speed (m/s)	Monin-Obukhov length (m)
1st Highest	597300	3542700	2012*	145.12	0.044	17	1.1	5.8
			2013*	425.61	0.023	6	0.5	2.2
			2014*	522.73	0.055	6	1.2	5.4
2nd Highest	597300	3543300	2012*	203.33	0.032	2	0.7	3.3
			2013*	370.42	0.055	18	1.3	5.2
			2014*	479.33	0.055	19	1.2	5.5
3rd Highest	596700	3539700	2012*	118.36	0.036	17	0.9	4.8
			2013*	407.07	0.051	3	1.1	5.0
			2014*	448.06	0.040	5	1	3.5
4th Highest	596700	3542100	2012*	128.43	0.065	20	1.4	6.5
			2013*	311.61	0.079	19	1.7	7.7
			2014*	502.78	0.035	5	0.8	3.4
5th Highest	597300	3540300	2012*	144.03	0.065	23	1.4	6.3
			2013*	368.79	0.068	20	1.7	6.1
			2014*	419.77	0.075	1	1.9	6.7
6th Highest	595500	3545700	2012*	156.54	0.059	24	1.4	5.5
			2013*	352.34	0.056	1	1.2	5.5
			2014*	385.71	0.047	7	1	4.5
7th Highest	600300	3534300	2012*	89.51	0.045	5	1	4.4
			2013*	347.77	0.041	5	0.9	4.0
			2014*	444.92	0.036	6	0.8	3.5
8th Highest	600900	3533700	2012*	88.59	0.039	20	1.1	3.3
			2013*	367.55	0.042	6	1	4
			2014*	408.94	0.045	20	1	4.4
9th Highest	596700	3539100	2012*	87.89	0.051	5	1.1	5.0
			2013*	415.23	0.055	20	1.2	5.4
			2014*	353.80	0.042	4	0.9	4.0
10th Highest	600900	3533100	2012*	85.51	0.057	6	1.6	4.7
			2013*	363.63	0.042	6	1	4.0
			2014*	403.62	0.041	6	0.9	4.0

Note: As stated in Section 6.1.3, the meteorological data in 2012*, 2013* and 2014* were actually from 2009, 2010 and 2011, respectively.

Table B-2 Comparison of Predicted Concentrations with Default Options vs. ADJ_U* at Receptors with Top ten 3-year Average 4th Highest Maximum Daily 1-hour SO$_2$ Concentrations (Top 10 Concentrations were Based on Model Runs with AERMOD/AERMET Default Options)

Rank	UTM-EAST (m)	UTM-North (m)	Elev. (m)	3-Year Ave. Conc. AERMET W/Default (µg/m³)	3-Year Ave. Conc. AERMET W/ADJ_u* (µg/m³)	Decrease in Conc. (%)	3-year average u* AERMET w/ Default Options	3-year average u* AERMET w/ ADJ_u*
1st Highest	597300	3542700	1504	364.487	140.91	-61	0.041	0.121
2nd Highest	597300	3543300	1475	351.027	112.63	-68	0.047	0.109
3rd Highest	596700	3539700	1489	324.497	107.03	-67	0.042	0.115
4th Highest	596700	3542100	1486	314.273	132.89	-58	0.060	0.208
5th Highest	597300	3540300	1470	310.863	116.78	-62	0.069	0.122
6th Highest	595500	3545700	1474	298.197	92.85	-69	0.054	0.108
7th Highest	600300	3534300	1494	294.067	75.89	-74	0.041	0.111
8th Highest	600900	3533700	1481	288.360	71.73	-75	0.042	0.100
9th Highest	596700	3539100	1490	285.640	98.04	-66	0.049	0.112
10th Highest	600900	3533100	1480	284.253	69.69	-75	0.047	0.125

Top 10 Model Impacts under the ADJ_U* Option

Using the ADJ_U* option, ADEQ found that the top ten 3-year average of the 4th highest maximum daily 1-hour SO$_2$ impacts occurred at eight receptors at Dragoon Mountains and two receptors in the vicinity of the Apache Generating Station (Figure B-10 and Table B-3). ADEQ further investigated the locations of the top 50 receptors and found that 39 receptors among the top 50 receptors were located in the vicinity of the Apache Generating Station. This indicates that, with the ADJ_U* option, the locations of highest model impacts tend to shift from distant complex terrain to areas near the facility. This finding was consistent with the Schiller and Heskett studies discussed in section B 4.3 and B4.5, respectively.

For the eight receptors at Dragoon Mountains with the elevation of 1470-1564 m, the critical modeled impacts were still associated with low wind speed, stable conditions. On the contrary, for the two receptors in the vicinity of the source with an elevation of around 1285 m, the critical impacts occurred during daytime with light to moderate winds. Relatively higher u* values (0.21-0.24) corresponding to these hours indicated that stable conditions with low wind speeds are not controlling meteorological conditions for the nearby receptors that are not associated with the distant terrain features. As expected, the application of the ADJ_U* option resulted in significant increases in the u* values for receptors at Dragoon Mountains but had no effect on the u* values for receptors in close proximity to the facility (Table B-3).

Figure B-10 Locations of Top ten Predicted 3-year Average 4th Highest Maximum Daily 1-hour Concentration Using AERMOD V15181 and AERMET V15181 with ADJ_U*
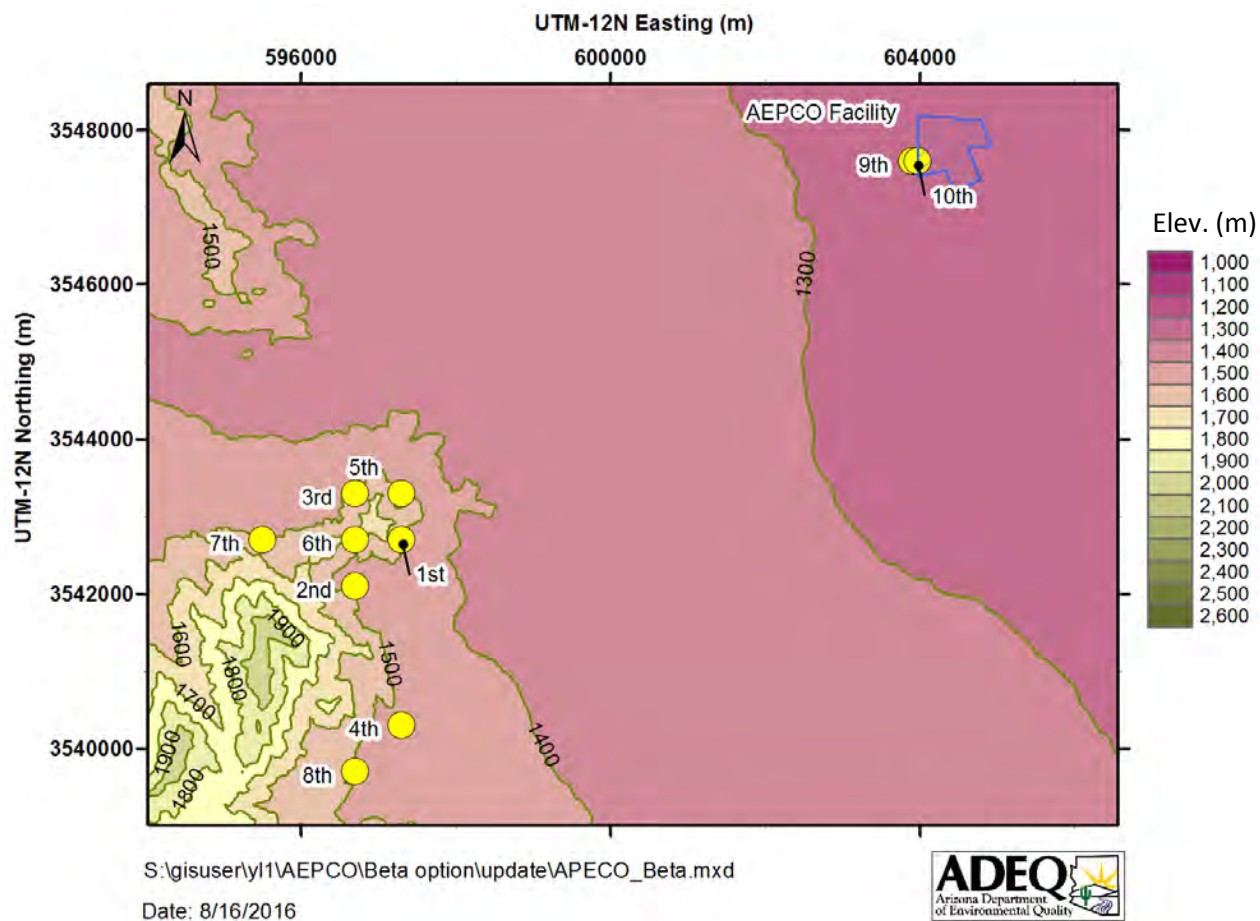
Table B-3 Comparison of Predicted Concentrations with Default Options vs. ADJ_U* at Receptors with Top Ten 3-year Average 4th Highest Maximum Daily 1-hour SO$_2$ Concentrations (Top Ten Concentrations were Based on Model Runs with AERMOD/AERMET ADJ_U* Option)

Rank	UTM-EAST (m)	UTM-North (m)	Elev. (m)	3-Year Ave. Conc. AERMET W/ADJ_U* (μg/m³)	3-year Ave. u* AERMET w/Default	3-year Ave. u* AERMET W/ADJ_u*
1st Highest	597300	3542700	1504	140.91	0.041	0.121
2nd Highest	596700	3542100	1486	132.89	0.06	0.125
3rd Highest	596700	3543300	1521	130.15	0.037	0.103
4th Highest	597300	3540300	1470	116.78	0.069	0.122
5th Highest	597300	3543300	1475	112.63	0.047	0.109
6th Highest	596700	3542700	1564	110.43	0.069	0.101
7th Highest	595500	3542700	1509	109.48	0.048	0.101
8th Highest	596700	3539700	1489	107.03	0.042	0.115
9th Highest	603900	3547600	1285	105.69	0.217	0.217
10thHighest	603977.52	3547599.05	1284	104.84	0.235	0.235

B.5.2 Sensitivity of Modeled Concentrations to Receptor Elevations with the Use of the ADJ_U* Option

ADEQ further investigated how the modeled concentrations at receptors with varied elevations responded to the use of ADJ_U* option. The receptors were simply classified into two groups: receptors with elevations above stack top height (> 1400 m) and receptors with elevations below stack top height (< 1400 m).

Figure B-11 compares the 3-year average 4th highest maximum predicted 1-hour concentrations with AERMET default options vs. with the ADJ_U* option for the two groups of receptors. As shown in Figure B-11, for receptors with elevations below stack top height, the modeled results with the ADJ_U* option were nearly identical to those obtained from AERMET default options (the plot is approximately a straight line with a slope of 1). In contrast, the use of the ADJ_U* option had a significant effect on the modeled concentrations at receptors with elevations above stack top height. Overall, the use of the ADJ_U* option reduced the modeled concentrations at these receptors by approximately a factor of two.

ADEQ also found that stable conditions with low wind speeds were the controlling meteorological conditions for the receptors located in a complex terrain under the AERMET default options. The use of the ADJ_U* option in AERMET reduced the underestimation bias of u*, resulting in lower modeled concentrations at these receptors.

Figure B-11 Comparison of Modeled Concentrations with Default Options vs. with ADJ_U* Option for Receptors with Elevations below 1400 m(green) and Receptors with Elevations above 1400 m (blue)
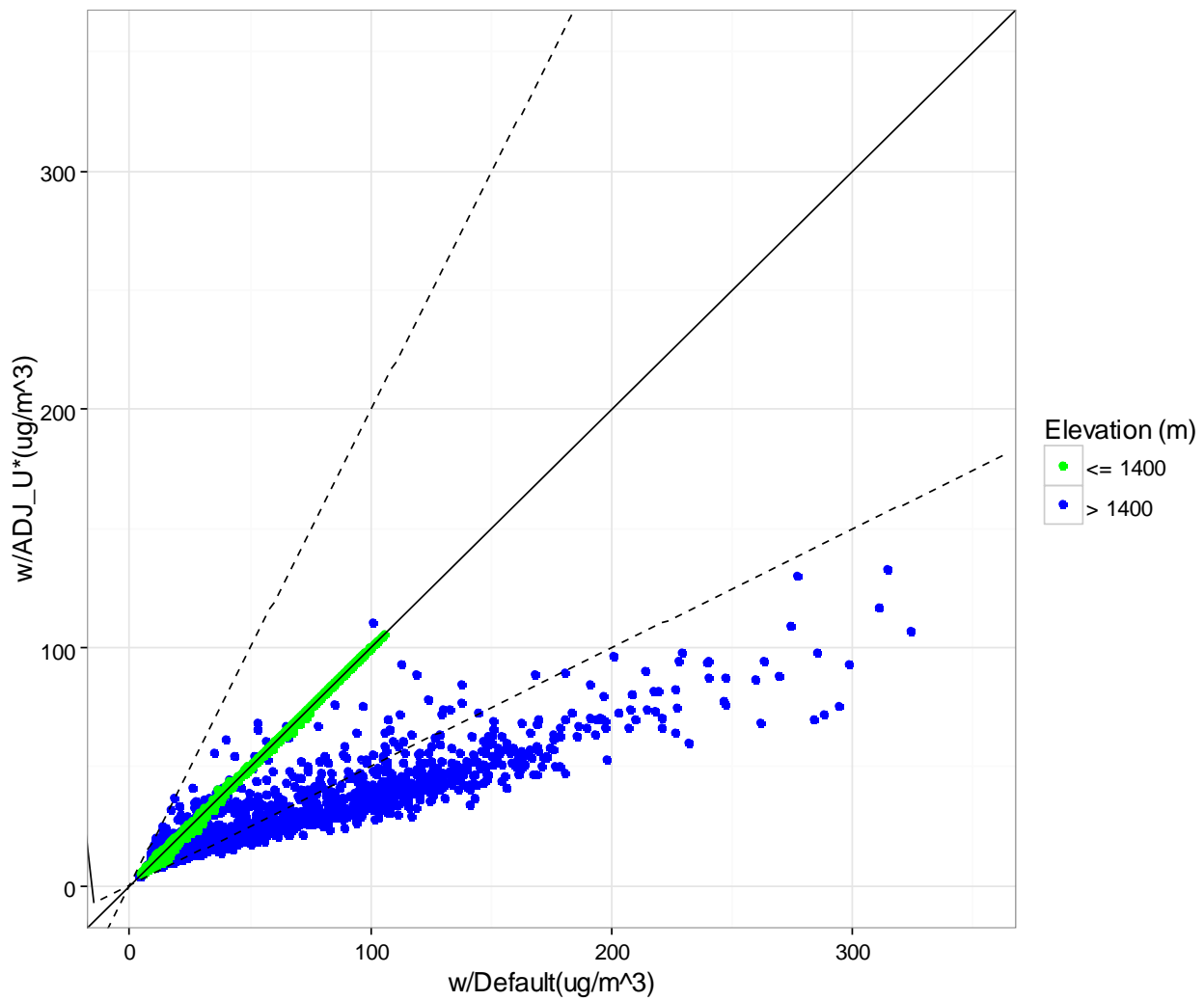
B.5.3 Sensitivity of Surface Friction Velocity Values (u*) to the Use of the ADJ_U* Option

ADEQ finally compared all u* values from AERMET default options against those from AERMET with the ADJ_U* option over the full three-year modeling period. The results are shown in Table B-4 and Figure B-12. Using the ADJ_U* option, the number of hours with extremely small u* values between 0.0-0.1 m/s dropped from 5805 (22.1%) to 896 (3.4%). As previously discussed, extremely low u* values results in the underestimation of turbulence and mixing height in AERMOD for stable conditions, leading to over-predicted concentrations. The use of the ADJ_U* option in AERMET raises the u* values and thus provides more realistic predicted concentrations for stable conditions.

Table B-4 Comparison of u* Values from AERMET Default Options vs. AERMET with the ADJ_U* Option over Three Model Years

u* (m/s)	# of Hours AERMET w/Default	# of Hours AERMET w/ADJ_U*	% Hours AERMET w/Default	% Hours AERMET w/ ADJ_U*
0-0.1	5805	896	22.09	3.41
0.1-0.2	4799	7758	18.26	29.52
0.2-0.3	5330	6601	20.28	25.12
0.3-0.4	3758	4107	14.30	15.63
0.4-0.5	2415	2625	9.19	9.99
0.5-0.6	1831	1878	6.97	7.15
0.6-0.7	1042	1086	3.97	4.13
0.7-0.8	625	644	2.38	2.45
0.8-0.9	322	327	1.23	1.24
0.9-1.0	191	188	0.73	0.72
1.0-1.1	94	98	0.36	0.37
1.1-1.2	40	43	0.15	0.16
1.2-1.3	15	15	0.06	0.06
1.3-1.4	11	12	0.04	0.05
1.4-1.5	1	1	0.004	0.004

Figure B-12 Histogram of u* Values from AERMET Default Options and AERMET with the ADJ_U* Option
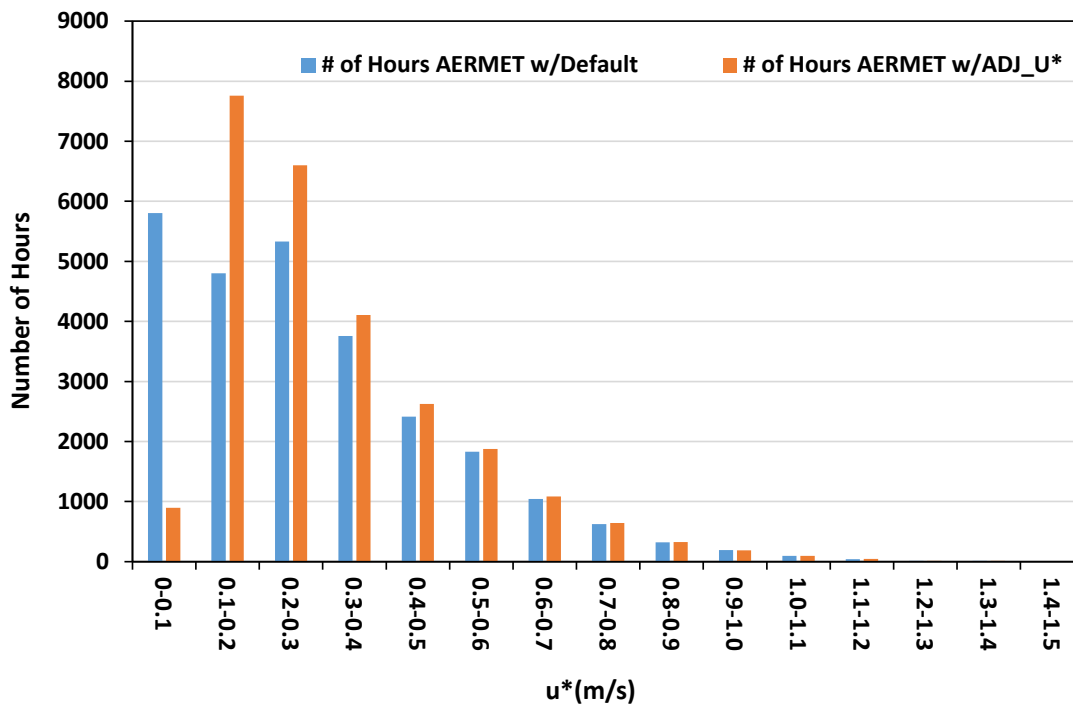
B.6 Discussions

Both the Lovett study and the Mercer County ND study have clearly demonstrated that the use of AERMET version 15181 with the ADJ_U* option improves model performance for AERMOD modeling of tall stacks with buoyant releases in complex terrain.

In the Lovett study, elevated complex terrain features/elevated monitors are in proximity to the source, slightly differing from the AEPCO circumstances in which elevated complex terrain features are around 8-10 km away from the source. Comparatively, in the Mercer County ND study, the monitor located in an elevated complex terrain (DGC-17) is around 7.5 km away from the source, which matches the characteristics of the AEPCO case. Therefore, the Mercer County ND study provides a sufficient basis to evaluate the AEPCO case. The DGC-17 data have clearly demonstrated that AERMOD with AERMET default options significantly over-predict the ambient impacts at elevated complex terrain, and the use of the ADJ_U* option in AERMET significantly improves model performance. Moreover, the DGC-17 data have revealed that, although the use of the ADJ_U* option in AERMET reduces modeled concentrations at receptors in elevated complex terrain, the predicted modeled concentrations are still conservative when compared to the actual monitoring data. Based on the Mercer County ND study, ADEQ believes that the use of the ADJ_U* option in AERMET will provide more realistic, but still conservative, estimations of the impacts at Gunnison Hills/Dragoon Mountains in the AEPCO case.

ADEQ performed a model sensitivity analysis for AEPCO using the same approaches as presented in the studies for Schiller, Wagner and Heskett. ADEQ found that the findings resulted from the AEPCO study are very similar to those from these three studies. Peak modeled concentrations at receptors in complex terrain with AERMET default options occurred during stable, light wind conditions. The use of the ADJ_U* option in AERMET resulted in increases in the u* values, leading to lower modeled concentrations at these receptors. For the nearby controlling receptors not associated with the distant terrain features, peak modeled concentration occurred at times of much higher u* values, and these u* values were unchanged with the use of the ADJ_U* Beta option. Overall, the use of the ADJ_U* option in AERMET only had a significant impact on the model concentrations at receptors in complex terrain, while having virtually no effect on the model concentrations at receptors in simple terrain.

As discussed, circumstances (tall stacks in complex terrain) and model responses with the use of the ADJ_U* option for AEPCO, Schiller, Wagner and Heskett are nearly identical. Because the EPA model clearinghouse

concurred with the use of the ADJ_U* Beta option for the Schiller, Wagner and Heskett demonstrations, ADEQ believes that it is also appropriate for the ADJ_U* Beta option in AERMET to be considered for the regulatory modeling demonstration at AEPCO.

B.7 Conclusions

Based on the EPA's model performance studies, peer-reviewed articles, as well as the AEPCO model sensitivity analysis, ADEQ believes that the use of the beta ADJ_U* option in AERMET for the AEPCO modeling under the Data Requirements Rule satisfies condition 2 of Appendix W, Section 3.2.2.b. Specifically ADEQ feels that "the alternative model performs better for the given application than a comparable model in Appendix A". Therefore, ADEQ is seeking the EPA's concurrence on the proposed use of the ADJ_ U* Beta option in AERMET for the AEPCO DRR modeling.

B.8 References

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EPA. 2016b. Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Schiller Station Modeling Demonstration. April 29, 2016.

EPA. 2016c. Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Herbert A. Wagner Generating Station Modeling Demonstration. June 20, 2016.

EPA. 2016d. Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Montana-Dakota Utility Company's R.M. Heskett Station Modeling Demonstration. August 1, 2016.

EPA. R1. 2016e. Request to Approve the Use of the Beta Alternative Formulation of Surface Friction velocity (u*) Non-Regulatory Default Option in AERMET Version 15181 for the Schiller Station Alternative Refined Model Demonstration. April 7, 2016.

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EPA. 2012. AERMOD Model Change Bulletin #8 - Version Date 12345.

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Modeling Report for SO$_2$ NAAQS Designation for Arizona Public Service (APS)-Cholla Generating Station

Submitted To:

Environmental Protection Agency

Region 9

Prepared By:

Arizona Department of Environmental Quality
Air Quality Department

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1.0   Introduction

On August 21, 2015, U.S. Environmental Protection Agency (EPA) finalized and promulgated the sulfur dioxide (SO_2) Data Requirements Rule (DRR) (80 FR 51052), which requires the characterization of ambient SO_2 air quality around SO_2 emission sources emitting 2,000 or more tons per year of SO_2. ADEQ identified five sources that needed to be addressed for the SO_2 DRR. Those sources include two copper smelters and three coal-fired power plants. EPA has designated the two copper smelters areas (Hayden and Miami) as nonattainment areas in the first round of designations. The three coal-fired power plants include the Tucson Electric Power Springerville Generating Station (TEP-Springerville), the Arizona Public Service Cholla Generating Station (APS-Cholla), and Arizona Electric Power Cooperatives Apache Generating Station (AEPCO-Apache). As required, ADEQ must characterize air quality in the areas impacted by the three power plants and EPA expects to use this data to designate the areas as meeting or not meeting the 2010 SO_2 standard.

This SO_2 DRR provides air agencies the flexibility to characterize air quality using either modeling of actual source emissions or using appropriately sited ambient air quality monitors. ADEQ decided to evaluate air quality using air dispersion modeling for the three coal-fired power plants. Specifically, ADEQ has characterized ambient air quality in areas proximate to the three sources by using actual hourly emissions and meteorology for the most recent 3 years (2012, 2013 and 2014). As required by DRR, for source areas that an air agency decides to evaluate through air quality modeling, the air agency must provide a modeling protocol and a modeling analysis to the EPA Regional Administrator by July 1, 2016 and January 13, 2017, respectively. ADEQ have submitted a modeling protocol on July 1, 2016 and the protocol was approved by email on December 05, 2016. This modeling report presents the methodology that ADEQ followed to complete the ambient air quality analysis in areas around the APS-Cholla facility followed by modeling results and discussion. For the other two sources, please see separate modeling reports.

As described in the approved protocol, the modeling was performed in accordance with the EPA's SO_2 NAAQS Designations Modeling Technical Assistance Document (hereafter, "EPA's Designation Modeling TAD", U.S. EPA, 2016a). This report is organized as follows:

- Section 2 provides general description of APS-Cholla power plant including processes, topography and climate;
- Section 3 provides a discussion on the determination of the modeling domain, sources to explicitly model and the receptor grid;
- Section 4 provides a discussion on the model selection;
- Section 5 provides detailed source inputs, including source configuration, source emissions, source release parameters, and urban/rural determination;

- Section 6 provides a discussion on the selection and processing of meteorological data;
- Section 7 provides a discussion on the determination of background concentrations; and
- Section 8 provides the modeling results and discussion.

2.0   General Description of APS-Cholla Power Plant

The Arizona Public Service Cholla Generating Station (APS-Cholla) is located approximately two miles east of Joseph City along Interstate 40 in Navajo County, Arizona. Cholla consists of four primarily coal-fired EGUs with a total plant-wide generating capacity of 1,180 gross megawatts (MW). Unit 1 is a 126 gross MW tangentially-fired, dry-bottom boiler. Units 2, 3, and 4 have capacities of 272, 272, and 410 gross MW, respectively, and are tangentially-fired, dry-bottom boilers. Units 1, 2, and 3 are owned and operated by APS, and Unit 4 is owned by PacifiCorp and operated by APS. Unit 1 was completed in 1962, Units 2 and 3 were completed in 1978 and 1980, and Unit 4 was placed in commercial operation in 1981.

The area has a semi-arid climate with cold to cool winters and hot summers. The warmest month of the year is July with an average maximum temperature of 92.2 degrees Fahrenheit, while the coldest months of the year are January and December with an average minimum temperature of 20.9 degrees Fahrenheit. Although the mean snowfall is 6.30 inches, the median is zero, so the majority of winters do not have measurable snow. The wettest month of the year is August with an average rainfall of 1.51 inches.

The Cholla facility is located in a flat area. There are no elevated or complex terrain features within 20-25 km distance from the facility. The topography of the local area is depicted in Figure 2-1.

Figure 2-1: Topography of the Area Surrounding APS-Cholla
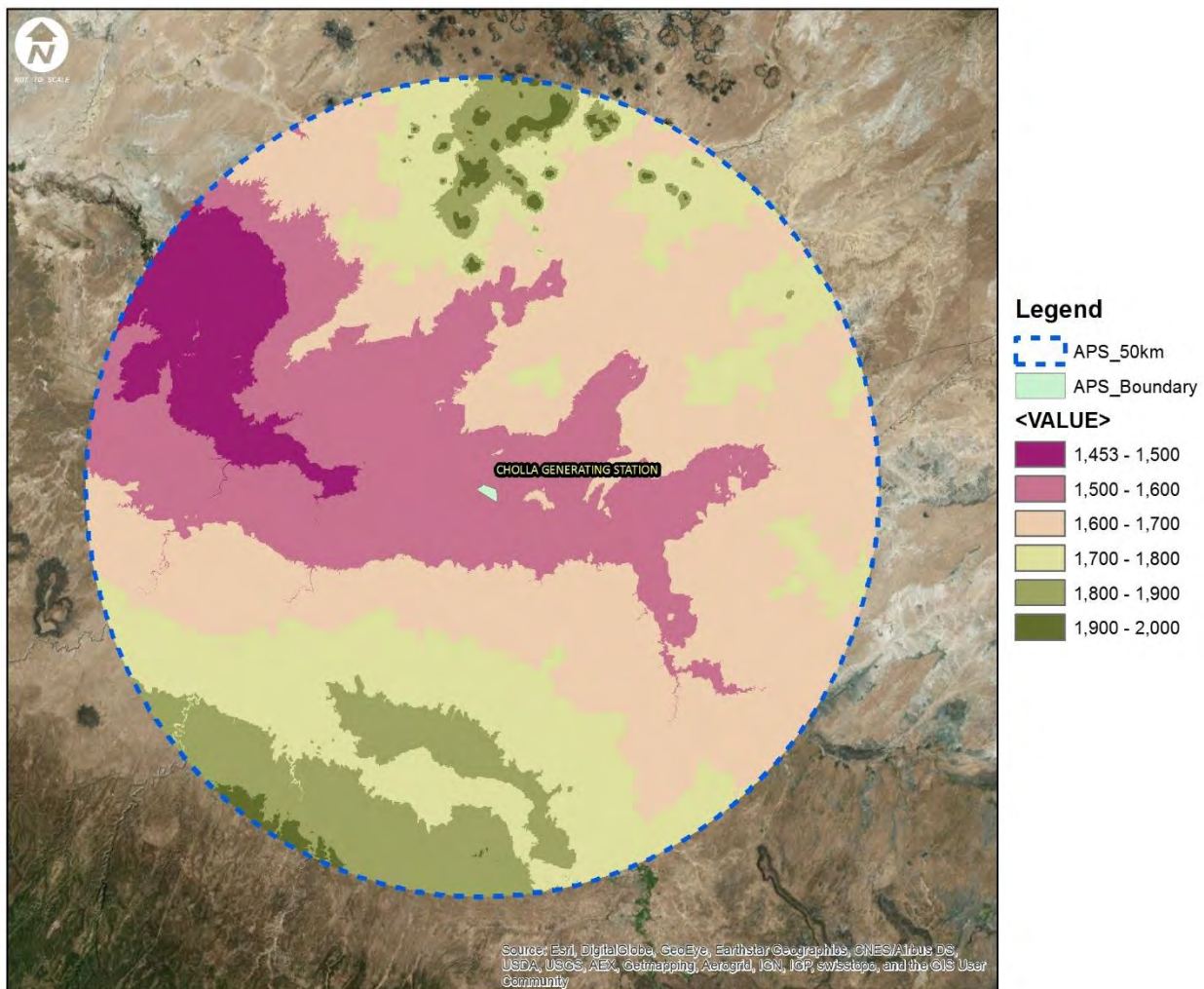
3.0   Modeling Domain

Selection of the modeling domain is dependent on the number of sources to explicitly model and size of the receptor network in order to account for the areas of impact (U.S EPA, 2016). The modeling domain should at a minimum include the sources that are most likely to cause or contribute to NAAQS violations in the area. In the modeling exercise, all modeled receptors should exhibit modeled attainment of the NAAQS.

In this modeling analysis, the modeling domain is centered at the facility and extended for 50 kilometers from the facility fence line.

3.1   Determining Sources to Model

Per EPA's SO_2 NAAQS Designations Modeling TAD, the determination of modeling domains and number of sources to consider for modeling should begin with analyzing the spatial distributions of sources that meet or exceed the emissions threshold established in the data requirements rule. The modeling domains could be centered over these sources.

ADEQ has identified SO_2 sources within the 50-km modeling domain for the Cholla power plant. Figures 3-1 is a geographical representation of these sources. Table 3-1 is an inventory of the individual sources within the 50-km modeling domain for Cholla.

As table 3-1 shows, the SO_2 emissions from APS-Cholla represent more than 99.6% of actual SO_2 emissions during 2012-2014. Excluding this source, there are no sources that emitted more than 29.5 tons per year of SO_2 in the Cholla modeling domain during 2012-2014. Due to their insignificant emissions, it is very unlikely that these minor sources could cause or contribute to a NAAQS violation in the area. Therefore, ADEQ only modeled Cholla for this designation modeling.

Figure 3-1: Point Sources within 50-km Modeling Domain of APS-Cholla
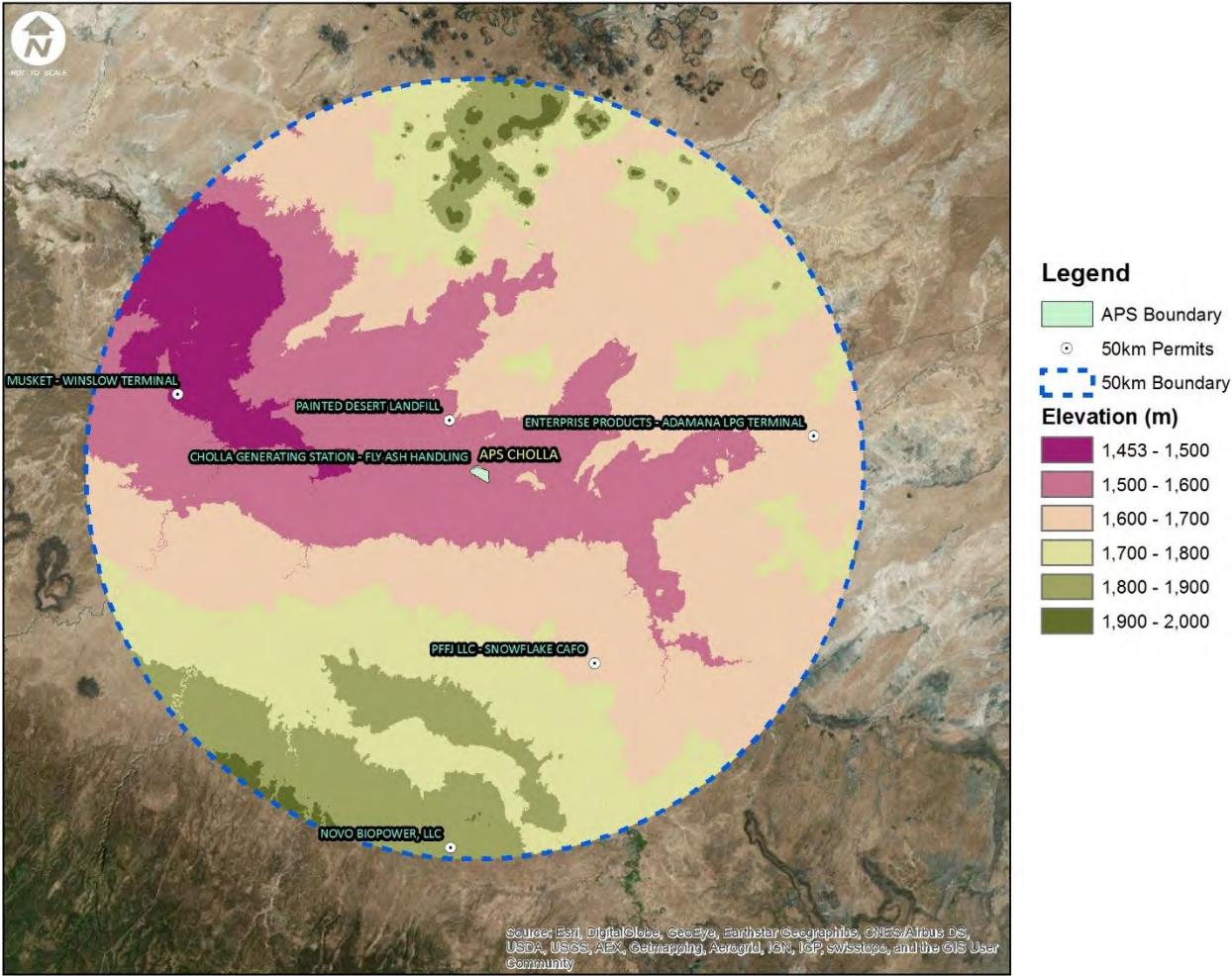
Table 3-1: Point Sources within 50-km Modeling Domain of APS-Cholla (Permitted Sources)

County	Site Name	Facility Type	Latitude	Longitude	2012 SO$_2$ (TPY)	2013 SO$_2$ (TPY)	2014 SO$_2$ (TPY)
Navajo	Cholla Generating Station	Power Plant	34.941	-110.301	6174.1	5065.3	3806.6
Navajo	Painted Desert Landfill	Landfill	34.998	-110.337	0.0671	0.0671	0.0521
Navajo	Cholla Generating Station- Fly Ash Handling	Fly Ash Handling	34.940	-110.296	0	0	0
Navajo	Musket- Winslow Terminal	Petroleum Distribution Terminals	35.028	-110.719	0	0	0
Navajo	Novo Bio-power, LLC	Biomass Power Generation Utilizing Wood Waste	34.504	-110.335	29.494	8.768	20.358
Navajo	PFFJ LLC- Snowflake CAFO	Farm Operations	34.718	-110.132	0	0	0
Apache	Enterprise Products- Adamana LPG Terminal	LPG Storage and Terminal	34.980	-109.824	0	0	0

3.2   Receptor Grid

ADEQ defined a modeling domain centered on the Cholla power plant and extended that to 50 kilometers from the facility fence line to make sure that the high model concentrations are captured. A total of 12483 receptors were placed in approximately 101km by 103km modeling domain.

- ADEQ used the following receptor spacing to determine areas of maximum predicted concentrations:
- Receptors along ambient air boundary (AAB) at a spacing of 25 m;
- Receptors from AAB to 1 km at a spacing of 100 m;
- Receptors from 1 km to 5 km away from AAB at a spacing of 200-500 m;
- Receptors from 5 km to 20 km away from AAB at a spacing of 500-1,000 m;
- Receptors from 20 km to 50 km away from AAB at a spacing of 1,000-2,500 m.

ADEQ used the EPA's AERMAP software tool (version 11103; U.S. EPA, 2011) to estimate receptor elevations and hill heights. AERMAP is the terrain preprocessor for AERMOD (discussed in Section 4) and uses the following procedure to assign elevations to a receptor:

- For each receptor, the program searches through the U.S. Geological Survey (USGS) input files to determine the two profiles (longitude or easting) that straddle this receptor;
- For each of these two profiles, the program then searches through the nodes in the USGS input files to determine which two rows (latitudes or northings) straddle the receptor;
- The program then calculates the coordinates of these four points and reads the elevations for these four points;
- A 2-dimensional distance-weighted interpolation is used to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

ADEQ used ten (10) meter USGS National Elevation Dataset (NED) data as inputs to AERMAP. The NED data are produced from digitized map contours or from manual or automated scanning of aerial photographs. A 1/3 arc-second NED data file consists of a regular array of elevations referenced horizontally in the UTM coordinate system, with a uniform horizontal spacing of approximately 10 meters. The NED data used for this analysis are based on the 1983 North American Datum (NAD83). The modeled receptors for APS-Cholla are depicted in Figure 3-2.

Figure 3-2: Modeled Receptors, APS-Cholla

4.0 Model Selection

In 2005, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was promulgated as the EPA's preferred near-field dispersion modeling for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation (40 CFR 51, Appendix W) (U.S. EPA, 2005) . AERMOD is EPA's preferred model for area designations under the 1-hour SO_2 primary NAAQS.

ADEQ used AERMOD (version 15181; U.S. EPA, 2014a) to predict ambient concentrations in simple, complex and intermediate terrain. ADEQ is aware that EPA just released AERMOD and AERMET Models Version 16216 on December 20, 2016 (U.S. EPA, 2016b). However, it is unlikely that the changes made in the new version will affect the APS-Cholla designation modeling.

There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET (version 15181; U.S. EPA, 2015), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP (version 11103; U.S. EPA, 2011), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSURFACE (Version 13016; U.S. EPA, 2013), a surface characteristics preprocessor, and BPIPPRIM, a multi-building dimensions program incorporating the Good Engineering Practice technical procedures for PRIME applications (U.S. EPA, 2004).

ADEQ used the regulatory default option. This option commands AERMOD to:

- Use the elevated terrain algorithms requiring input of terrain height data for receptors and emission sources;
- Use stack tip downwash (building downwash automatically overrides);
- Use the calms processing routines;
- Use buoyancy-induced dispersion;
- Use the missing meteorological data processing routines.

5.0   Source Inputs

This section discusses source characterization to develop appropriate source inputs for dispersion modeling with AERMOD modeling system. SO_2 emissions are released to the atmosphere from four stacks at the Cholla power plant as shown in Figure 5-1.

Figure 5-1 Modeled Emission Sources in APS-Cholla Power Plant

5.1 Source Inputs for APS-Cholla

5.1.1 Emission Data

For AERMOD SO_2 modeling the real-time 2012-2014 SO_2 emissions and stack parameter data measured by continuous emission monitoring system (CEMS) are applied to obtain accurate modeling results. The hourly SO_2 emissions data being modeled are consistent with those reported from EPA Air Market database (https://ampd.epa.gov/ampd/). As discussed in EPA Designation Modeling TAD (U.S. EPA, 2016), hourly SO_2 emissions data are input into AERMOD using the HOUREMIS keyword in the source pathway of the AERMOD control file (AERMOD.INP).

ADEQ obtained the CEMS data from Cholla facility. After carefully reviewing the data, ADEQ did not identify any case of missing hours and therefore no data substitution was done for missing hours in the modeling input.

5.1.2 Emission Release Parameters

For the purposes of modeling with actual emissions to characterize air quality, ADEQ followed the EPA recommendation and used actual stack heights, instead of calculating Good Engineering Practice (GEP) stack height. In addition, hourly emissions parameters measured by CEMS (including exhaust temperature, exit velocity and exit flow rate) were used as source inputs, which will most closely represent the facility actual emission conditions.

Downwash effects were considered for APS-Cholla modeling by using BPIPPRM. BPIPPRM requires a digitized footprint of the facility's buildings and stacks. The source must evaluate the position and height of buildings relative to the stack position in the building wake effects analysis. The information of actual heights of existing structures were provided by the Cholla facility. The simplified layout used in modeling for APS-Cholla is shown in Figures 5-2.

Figure 5-2: Simplified Facility Layout for APS-Cholla
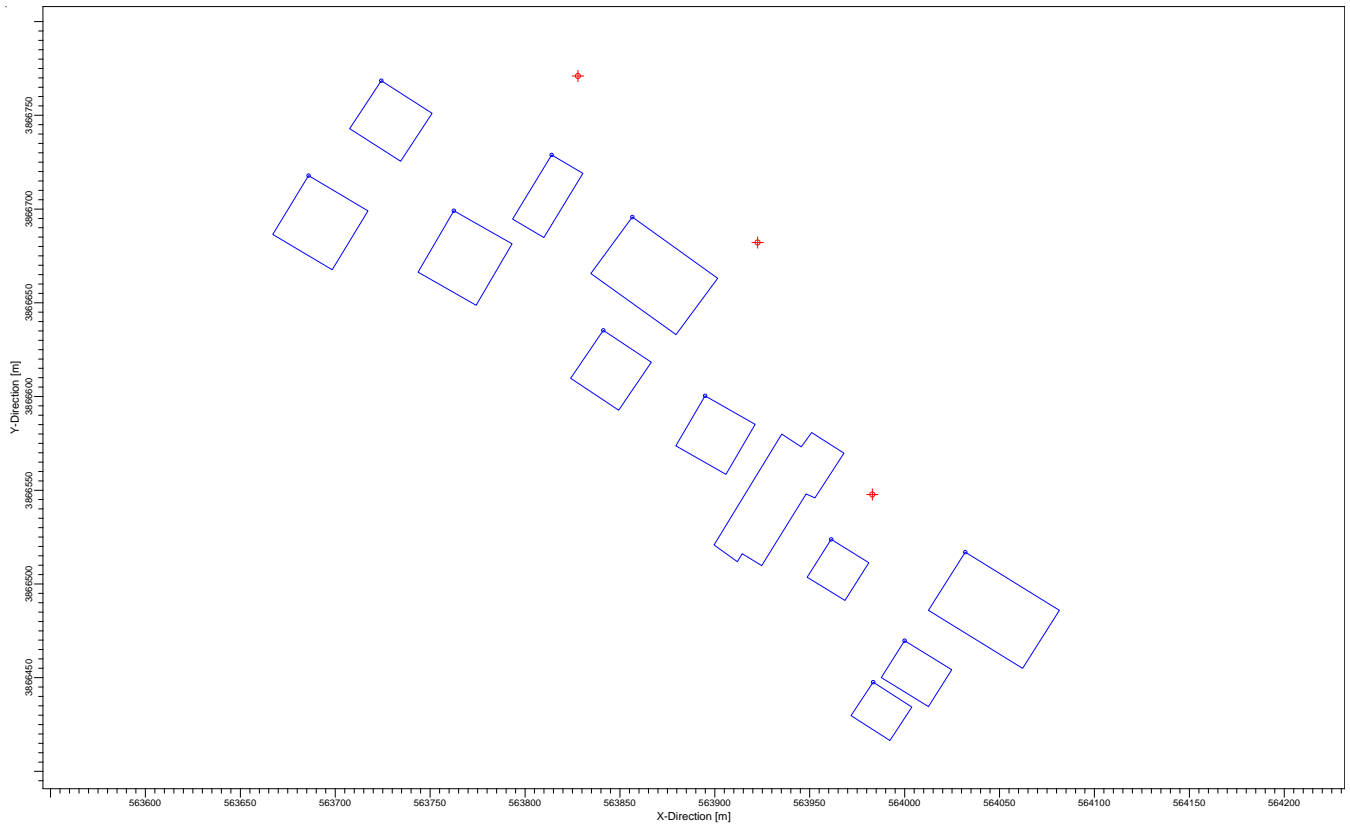
ADEQ identified coordinates for the stacks by mapping the site buildings to rectified aerial photographs of the site and projected UTM coordinates of each stack to UTM Zone 12. These coordinates are based on the NAD83.

Table 5-1 presents the modeling parameters for the stacks.

Table 5-1: Modeling Parameters for APS-Cholla Stacks

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp. (ºK)	Exit Flow Rate
Stack 1	563983.04	3866547.68	1531.48	76.2	3.43	Variable	Variable	Variable
Stack 2&3	563922.60	3866682.10	1531.52	167.6	6.88	Variable	Variable	Variable
Stack 4	563827.93	3866771.00	1531.48	167.6	5.85	Variable	Variable	Variable

Please note that unit 2 and 3 flue exhaust into a common stack, which is called Stack 2&3 in this document. The equivalent stack diameter for Stack 2&3 was obtained from the facility and the equivalent stack temperature and exit velocity were calculated for the 2012-2014 hourly emissions based on CEMS data, which were used in the model.

5.2   Urban/Rural Determination

Dispersion coefficients for air quality modeling are selected based on the land use classification technique suggested by Auer (Auer, 1978), which is EPA's preferred method. The classification determination involves assessing land use by Auer's categories within a 3-kilometer radius of the proposed site. A source should select urban dispersion coefficients if greater than 50 percent of the area consists of urban land use types; otherwise, rural coefficients apply.

Following the 2016 EPA Designation Modeling TAD (U.S. EPA, 2016a), ADEQ classified the land use of the area using the land-use procedure set forth in EPA's "Guideline on Air Quality Models" (GAQM). This approach requires determining the amount of specific types of land use categories within a 3-km radius circle centered on the source; if the total land use (as defined by Auer6) is classified as 50% or more "urban" then the area is designated as urban; otherwise it is designated as rural.

Land use (taken from the U.S. Geological Survey (USGS) National Land Cover Data (NLCD) 1992 archives) was examined for the 3-km radius circle, and the totals of each land use category were calculated. These land use categories were then correlated to the categories as established by Auer, and the amount of urban and rural land use within 3 km of each facility was calculated.

The area near APS-Cholla that was examined is depicted in Figure 5-3, while the results of the analysis are presented in Table 5-2.

Figure 5-3: Land Use near APS-Cholla

NLCD 1992 LAND Cover Classification

11 Open Water	51 Shrubland
21 Low Intensity Residential	71 Grasslands / Herbaceous
23 Commercial / Industrial / Transportation	81 Pasture / Hay
31 Bare Rock / Sand / Clay	82 Row Crops
32 Quarries / Strip Mines / Gravel Pits	83 Small Grains
41 Deciduous Forest	85 Urban / Recreational Grasses
42 Evergreen Forest	91 Woody Wetlands
43 Mixed Forest	92 Emergent Herbaceous Wetlands

Table 5-2: Land Use Analysis within 3 km of APS-Cholla Facility

1992 NLCD Land Use Category		% of Total Land Use within 3 km of Asarco	Auer Land Use Category		
Code	Description		Code	Description	Rural/Urban
11	Open Water	8.3	A5	Water Surfaces	Rural
12	Perennial Ice/Snow	0	A5	Water Surfaces	Rural
21	Low Intensity Residential	0	R1 / R4	Common/Estate Residential	Rural
22	High Intensity Residential	0	R2 / R3	Compact Residential	Urban
23	Commercial / Industrial / Transportation	1.7	C1 / I1 / I2	Commercial/Heavy Industrial/Light-Moderate Industrial	Urban
31	Bare Rock / Sand / Clay	9.4	A	N/A	Rural
32	Quarries / Strip Mines / Gravel Pits	0	A	N/A	Rural
33	Transitional	0	A	N/A	Rural
41	Deciduous Forest	0	A4	Undeveloped Rural	Rural
42	Evergreen Forest	0.4	A4	Undeveloped Rural	Rural
43	Mixed Forest	0	A4	Undeveloped Rural	Rural
51	Shrubland	71.9	A3	Undeveloped	Rural
61	Orchards / Vineyards / Other	0	A2 / A3 / A4	Agricultural Rural / Undeveloped / Undeveloped Rural	Rural
71	Grasslands / Herbaceous	8.3	A3	Undeveloped	Rural
81	Pasture / Hay	0	A2	Agricultural Rural	Rural
82	Row Crops	0	A2	Agricultural Rural	Rural
83	Small Grains	0	A2	Agricultural Rural	Rural
84	Fallow	0	A2	Agricultural Rural	Rural
85	Urban / Recreational Grasses	0	A1	Metropolitan Natural	Rural
91	Woody Wetlands	0	A3 / A4 / A5	Undeveloped / Undeveloped Rural / Water Surfaces	Rural
92	Emergent Herbaceous Wetlands	0	A3 / A5	Undeveloped / Water Surfaces	Rural

About 72% of the land use within 3 km of APS-Cholla is "shrubland" according to the NLCD92 classification scheme. Under the Auer scheme the sum of the percentage of land use categories classified as urban (R2, R3, C1, I1, and I2) is only 1.7%. Accordingly, the sum of the rural categories is 98.3%. Therefore, the area around APS-Cholla is defined as "rural" and identified as such in the AERMOD input.

6.0 Meteorological Data

AERMOD requires the use of AERMET to process the meteorological data and create the data files for AERMOD.

6.1 Meteorological Data Selection

As stated in SO$_2$ designation modeling TAD (U.S.EPA, 2016), for the purposes of modeling to characterize air quality for use in SO$_2$ designations, the EPA recommends using the most recent 3 years of meteorological data to allow the modeling to simulate what a monitor would observe.

The APS-Cholla power plant provided the 2012-2014 site-specific meteorological data collected from a 10-m meteorological tower. However, the data for 2012-2014 from the tower has not gone through quality assurance. ADEQ also found an older site-specific meteorological dataset (2005-2006) obtained from a meteorological tower at different heights from 10 m to 400 m, which were used for previous regulatory applications. Although the EPA Designation Modeling TAD indicates that older meteorological data may be used under some circumstances (U.S. EPA, 2016), the use of this one-year meteorological dataset has some limitations. If this dataset is used, it must be duplicated twice to model three-year emissions, which would be inappropriate. In addition, the meteorological data was collected more than 10-years ago. The EPA Designation Modeling TSD cautions the use of older meteorological data with recent emissions, "especially for those emissions that are meteorological dependent, such as demand in hot or cold weather for EGUs."

Due to the limitations associated with the use of site-specific meteorological data, ADEQ used the 2012-2014 National Weather Service (NWS) data collected from Winslow-Lindbergh ASOS station in Winslow, Arizona. The following section discusses why the Winslow NWS data are representative of transport and dispersion conditions within the modeling domain.

Criteria for Representativeness

For a better evaluation of using Winslow airport data for Cholla, ADEQ referred to Section 8.3 of 40 CFR 51 Appendix W, which states that the representativeness of meteorological data is dependent upon (a) the proximity of the meteorological monitoring site to the area under consideration; (b) the complexity of the topography of the area; (c) the exposure of the meteorological sensors; and (d) the period of time during which the data are collected.

As discussed in Appendix W section 8.3, the spatial representativeness of the data can be adversely affected by large distances between the source and receptors of interest and the complex topographic characteristics of the area. Significant cautions must be taken to select a meteorological station if the meteorological conditions vary drastically in the modeling domain and/or the areas of concern have complex terrain.

Spatial representativeness for off-site data should also be assessed by comparing the surface characteristics (albedo, Bowen ratio, and surface roughness) of the meteorological monitoring site and the analysis area.

Winslow airport MET data are examined below for these criteria.

Evaluation of Representativeness of Winslow Airport Data

As shown in Figure 6.1 and Table 6.1, Winslow airport is located about 24 miles from the Cholla power plant. Because of their proximity, both sites share the same climate characteristics. The area has a semi-arid climate with cold to cool winters and hot summers.

Table 6-1: Information of Meteorological Site Location

Meteorological Data Sources	Sampling Period	Latitude	Longitude
Winslow-Lindbergh Regional Airport	2012-2014	35.022	-110.723
10-m on-site meteorological tower	2012-2014	34.9086	-110.2838

Figure 6-1: Meteorological Stations near APS-Cholla Facility

Both locations are at approximately the same elevation (1526 m versus 1490 m) and have similar topography surrounding each location. Also, the Winslow airport and APS-Cholla are located roughly about the same distance and in the same orientation to the significant terrain features in the region that influence wind flow patterns. These terrain features are part of the same large scale terrain features in the area that are oriented in a northeast-southwest direction. There are no specific terrain features in the Cholla area or in Winslow that would cause directional steering of locally generated winds or would influence the predominant meteorology in the area. Therefore, the same mesoscale and localized geographic and topographic features that influence wind flow patterns at the airport site also influence the wind flow patterns at the Cholla site

The wind roses at the site (both 10-m and multi-height measurement towers) show the similar wind patterns to the Winslow airport site, indicating the winds from west, south west and south east prevail in the modeling domain (Figures 6.2 to 6.6).

Figure 6-2: 2012-2014 Winslow Airport Meteorological Data
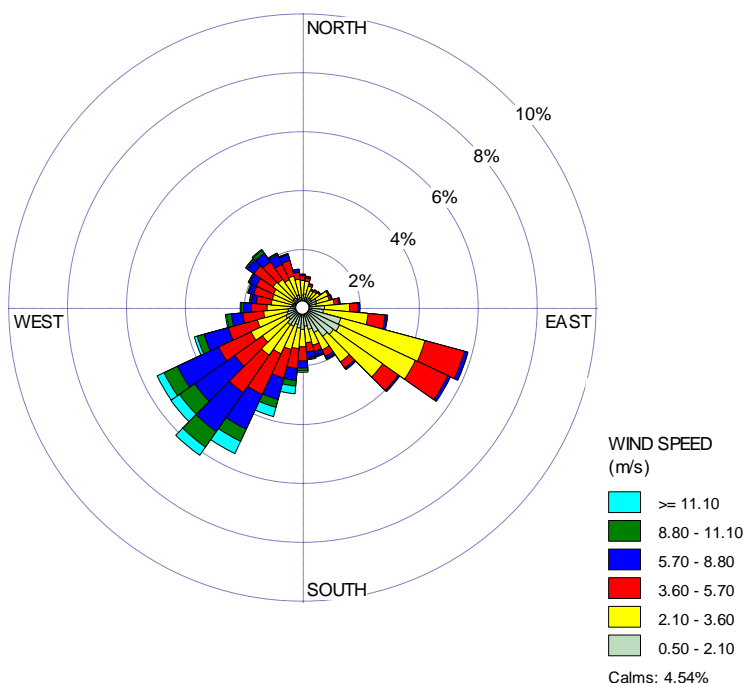
Figure 6-3: 2012-2014 On-site Meteorological Data Collected at 10-m Tower
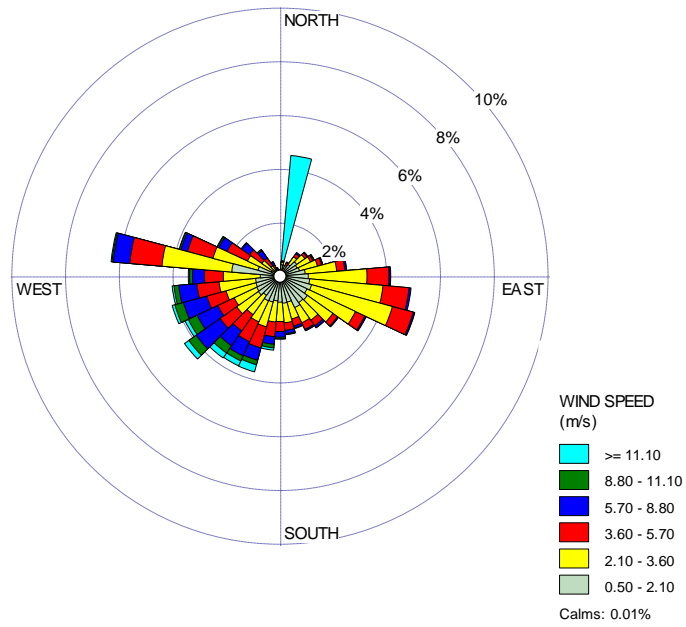
Figure 6-4: 2005-2006 On-site Meteorological Data Collected at 10-m
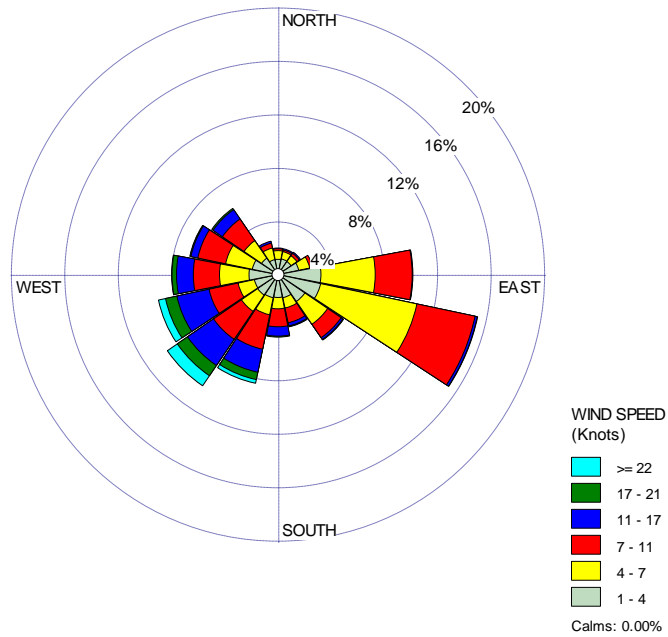
Figure 6-5: 2005-2006 On-site Meteorological Data Collected at 50-m
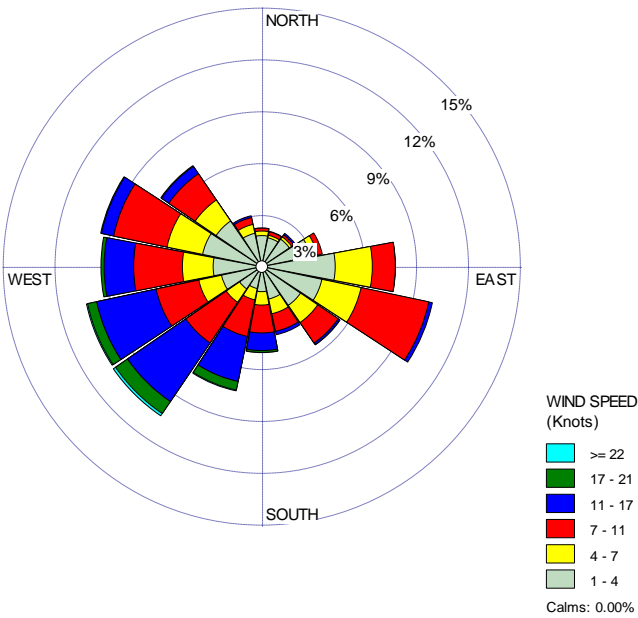
Figure 6-6: 2005-2006 On-site Meteorological Data Collected at 150-m
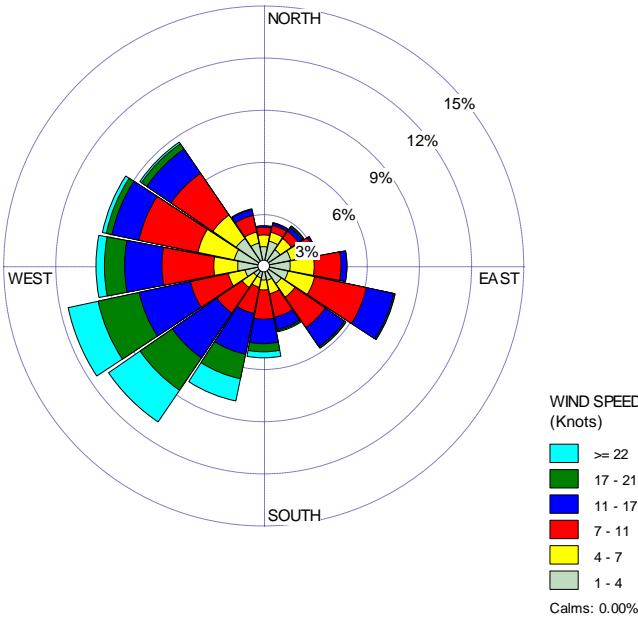
Meteorological data from Winslow station was obtained through the Automated Surface Observing System (ASOS) network. The siting requirements of an ASOS station (including exposure conditions of the meteorological sensors) are consistent with those necessary for use in an air dispersion modeling analysis. For the years 2012, 2013 and 2014, the surface data collected from the Winslow airport meets the data completeness requirements of Section 5.3.2 of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (U.S. EPA, 2000). Additionally, the ASOS station can utilize AERMINUTE to significantly reduce calm or missing hours, which is critical for modeling 1-hour standards (U.S. EPA, 2013).

Additionally, monthly surface characteristics were determined with AERSURFACE using Land Use/Land Cover (LULC) data in accordance with EPA guidance documents ("AERMOD Implementation Guide" and "AERSURFACE User's Guide") as described below. AERSURFACE uses U.S. Geological Survey (USGS) National Land Cover Data 1992 archives (NLCD92) to determine the midday albedo, daytime Bowen ratio, and surface roughness length representative of the surface meteorological station and project site.

Running AERSURFACE at both the meteorological monitoring and proposed site locations produced similar results for Bowen ratio, albedo and roughness lengths. Also, based on the Auer land use classifications, which was described in section 5.3, both locations are classified as rural, and there is good correlation of the rural characteristic land types between the two locations. Table 6-1 and 6-2 present the AERSURFACE input/outputs assigned to the processing of the AERMET data.

For the reasons discussed above, the Winslow NWS data meets all representativeness criteria listed in section 8.3 of 40 CFR 51 Appendix W. Therefore ADEQ believes that the Winslow NWS data is appropriate for use in this modeling analysis.

Table 6-2: Winslow AERSURFACE Inputs/Outputs for Use in AERMET

Month	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Seasonal Assumptions for Surface Roughness (meters) and Albedo												
Season	Winter	Winter	Winter	Spring	Spring	Spring	Summer	Summer	Autumn	Autumn	Winter	Winter
Surface Roughness, meters	0.073	0.073	0.073	0.091	0.091	0.091	0.101	0.101	0.099	0.099	0.073	0.073
Albedo	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.24	0.24
Bowen Ratio	4.29	4.29	4.29	2.22	2.22	2.22	2.99	2.99	4.29	4.29	4.29	4.29

Table 6-3: On-site AERSURFACE Inputs/Outputs for Use in AERMET

Month	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Seasonal Assumptions for Surface Roughness (meters) and Albedo												
Season	Winter	Winter	Winter	Spring	Spring	Spring	Summer	Summer	Autumn	Autumn	Winter	Winter
Surface Roughness, meters	0.069	0.069	0.069	0.070	0.070	0.070	0.071	0.071	0.071	0.071	0.069	0.069
Albedo	0.024	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Bowen Ratio	4.66	4.66	4.66	2.36	2.36	2.36	3.18	3.18	4.66	4.66	4.66	4.66

6.2   Meteorological Data Processing with AERMET

ADEQ used EPA's AERMET tool (version 15181; U.S. EPA, 2014b) to process meteorological data for use with AERMOD. AERMET merges NWS surface observations with NWS upper air observation and performs calculation of boundary layer parameters required by AERMOD. In addition to the meteorological observations, AERMET further requires the inclusion of the characteristics of land use surfaces (routinely calculated using EPA's AERSURFACE tool). Although EPA has proposed to designate some beta options as the default regulatory formulation in AERMET (U.S. EPA, 2015) and recently finalized the ADJ_U* option as the default option (U.S. EPA, 2016b), ADEQ did not use the ADJ_U* option and all previous default options in AERMET were used for this case.

6.2.1   Surface Observation

As discussed in Section 6.1, ADEQ used the 2012-2014 NWS data collected at Winslow airport for this project. To reduce the number of calms and missing winds associated with the NWS meteorological data, ADEQ used AERMINUTE to supplement the standard ASOS data with hourly-averaged wind speed and direction to support AERMOD dispersion modeling (U.S. EPA, 2013b). ADEQ also used a minimum wind speed threshold of 0.5 m/s to the hourly averaged wind speeds provided by AERMINUTE.

6.2.2   Upper Air Observation

Given the proximity of Location, topography and climate at the APS-Cholla power plant, ADEQ used the upper air data obtained from Flagstaff, AZ (Station ID:53103,Latitude/Longitude: 35.23 N/111.82 W),which is 144 km northwest away from APS-Cholla.

Figure 6-7: Location of Upper Air Station and APS-Cholla Power Plant

6.2.3 AERSURFACE

ADEQ used EPA's AERSURFACE tool to calculate the surface roughness length, albedo and Bowen ratio inputs required by AERMET. EPA developed AERSURFACE to identify these parameters within a defined radius from a specified point. In this case, ADEQ input the UTM coordinates of the NWS meteorological station to AERSURFACE along with a 1-kilometer radius per EPA guidance. ADEQ used 1992 USGS National Land Cover Data (NLCD) for the state of Arizona as inputs to AERSURFACE. ADEQ calculated the parameters for twelve compass sectors of 30° each, and by month. Considering the climate characteristics in the Winslow area, ADEQ assigned the seasonal categories for APS-Cholla as follows:

- Late autumn after frost and harvest, or winter with no snow: November, December, January, February, March;

- Winter with continuous snow on the ground: none;

- Transitional spring (partial green coverage, short annuals): April, May, June;

- Midsummer with lush vegetation: July, August; and

- Autumn with un-harvested cropland: September, October.

The surface moisture condition can be determined by comparing precipitation for the period of data to be processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th-percentile, "dry" conditions if precipitation is in the lower 30th-percentile, and "average" conditions if precipitation is in the middle 40th-percentile.

7.0   Background Air Quality

EPA requires background air quality estimates be added to modeling results for comparison to the NAAQS.

There are limited SO_2 monitoring sites in Arizona and the monitoring sites are located in the Phoenix/Tucson metropolitan area or close to copper smelters. ADEQ used the ambient monitoring data collected from Central Phoenix (1645 E Roosevelt St, ID: 40133002, Figure 7-1) as 1-hour SO_2 background concentration. This site is located in an urban area and surrounded by various anthropological sources. The APS-Cholla power plant is located in a rural area without significant human activities. Therefore, the monitoring concentration at central Phoenix is expected to be higher than the background concentration in the APS-Cholla modeling domain. Thus this method is considered a conservative approach to calculate the background concentration.

The 99th percentile SO_2 1-hour concentrations at the Central Phoenix Monitoring Site was calculated for each year in the 2010-2014 dataset, which were retrieved from U.S. EPA's Air Quality System (https://www3.epa.gov/airdata). The 3 year (2012-2014) design values were 8ppb, 8ppb and 7ppb, respectively. Following the EPA Designation Modeling TAD, the SO_2 background concentration for the Cholla power plant was determined to be 7.7 ppb (20.18 µg/m3) as the average of 3-year 99th percentile SO_2 1-hour concentrations.

Figure 7-1: The Location of Central Phoenix SO₂ Monitor
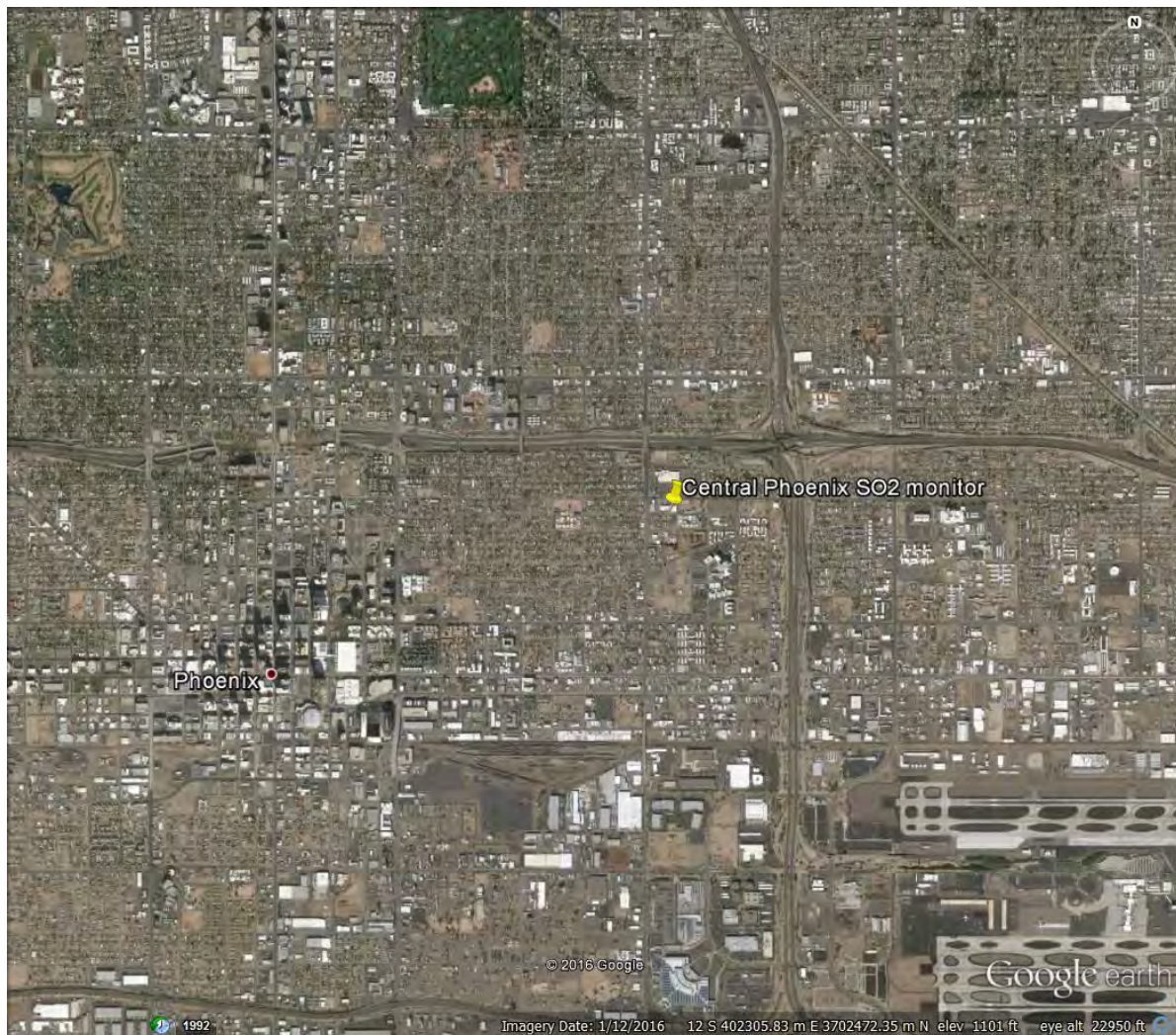
8.0   Modeling Results and Discussions

Demonstration of protection of the NAAQS was accomplished by comparison of the maximum modeled SO_2 design value to the NAAQS. The maximum design value for 1-hour SO_2 is defined as the sum of the 4th highest modeled hourly concentrations and the background concentration. The results for APS-Cholla are discussed in this section.

The predicted 4th highest maximum daily 1-hour SO_2 concentrations using the Winslow NWS metrological data was 136.65 µg/m^3. Adding a background concentration of 20.18 µg/m^3 to the modeled concentration, resulted in an ambient concentration of 156.83 µg/m^3. This concentration is less than the applicable 1-hour SO_2 NAAQS of 196 µg/m^3. In conclusion, the SO_2 concentrations around the APS-Cholla power plant complies with 1-hour SO_2 NAAQS. Table 8-1 summarizes the modeling results.

Table 8-1 APS-Cholla 1-Hour SO_2 Modeling Results

Model Predicted Impact (Highest 4th High) Concentration µg/m^3	Background Concentration (99th Percentile) µg/m^3	Total Concentration µg/m^3	NAAQS µg/m^3
136.65	20.18	156.83	196
4th highest maximum daily 1-hour SO_2 concentration predicted to occur at 562900 mN and 3866800 mE			

As Figure 8-1 shows, the highest concentrations of 1-hour SO_2 around APS-Cholla power plant were located in the west of the facility near the facility fence line.

ADEQ will submit all applicable electronic modeling files including model input files, model output files, building downwash files, terrain files, and meteorological data files along with this modeling report.

Figure 8-1: Isopleths of Predicted Design Value SO₂ Concentrations
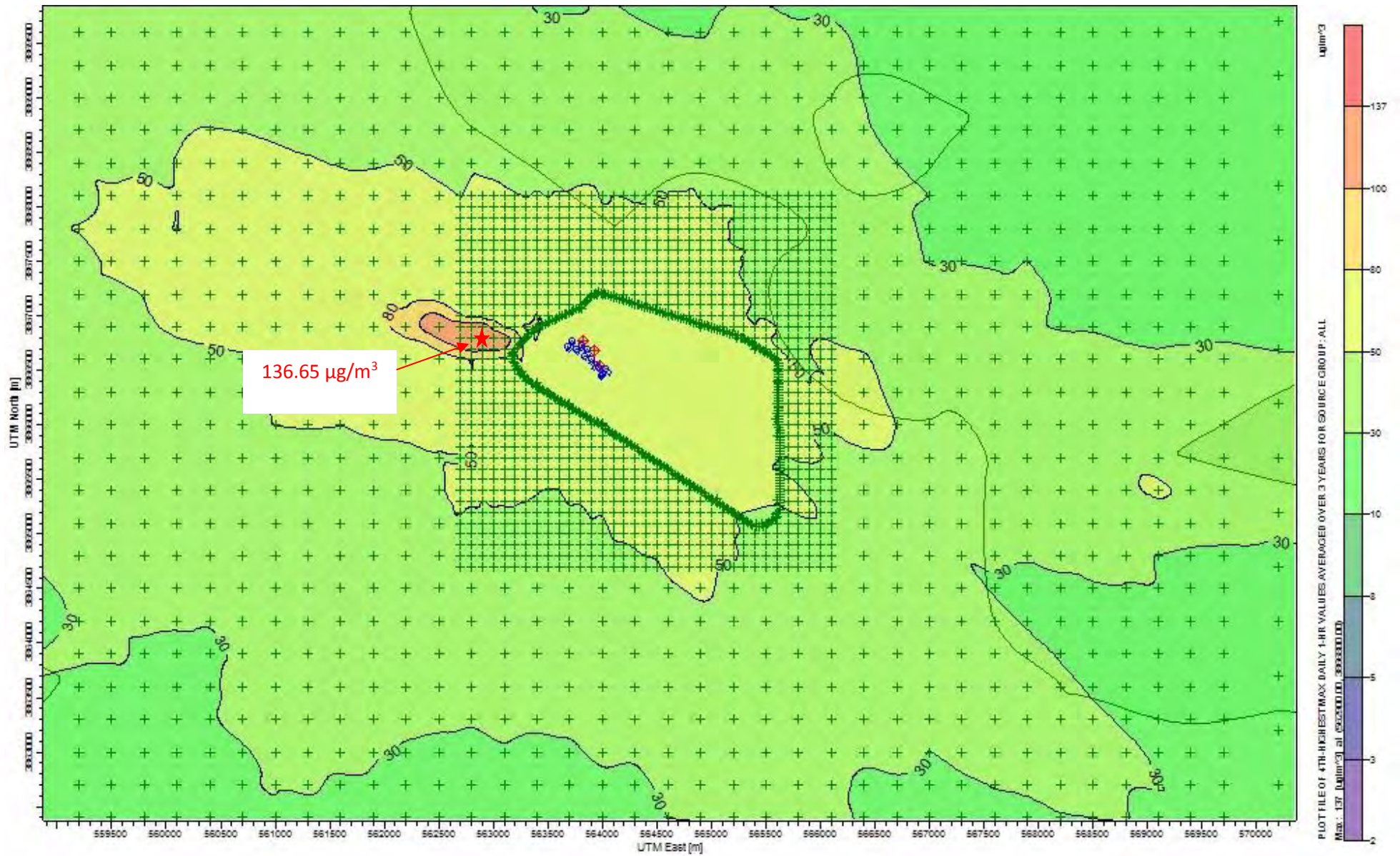
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Modeling Report for SO₂ NAAQS Designation for Tucson Electric Power Co. (TEP)- Springerville Generating Station

Submitted To:

Environmental Protection Agency

Region 9

Prepared By:

Arizona Department of Environmental Quality
Air Quality Department

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1.0   Introduction

On August 21, 2015, U.S. Environmental Protection Agency (EPA) finalized and promulgated the sulfur dioxide (SO$_2$) Data Requirements Rule (DRR) (80 FR 51052), which requires the characterization of ambient SO$_2$ air quality around SO$_2$ emission sources emitting 2,000 or more tons per year of SO$_2$. The Arizona Department of Environmental Quality (ADEQ) identified five sources that needed to be addressed for the SO$_2$ DRR. Those sources include two copper smelters and three coal-fired power plants. EPA has designated the two copper smelters areas (Hayden and Miami) as nonattainment areas in the first round of designations. The three coal-fired power plants include the Tucson Electric Power Springerville Generating Station (TEP-Springerville), the Arizona Public Service Cholla Generating Station (APS-Cholla), and Arizona Electric Power Cooperatives Apache Generating Station (AEPCO-Apache). As required, ADEQ must characterize air quality in the areas impacted by the three power plants and EPA expects to use this data to designate the areas as meeting or not meeting the 2010 SO$_2$ standard.

This SO$_2$ DRR provides air agencies the flexibility to characterize air quality using either modeling of actual source emissions or using appropriately sited ambient air quality monitors. ADEQ decided to evaluate air quality using air dispersion modeling for the three coal-fired power plants. Specifically, ADEQ characterized ambient air quality in areas proximate to the three sources by using actual hourly emissions and meteorology for the most recent 3 years (2012, 2013 and 2014). As required by DRR, for source areas that an air agency decides to evaluate through air quality modeling, the air agency must provide a modeling protocol and a modeling analysis to the EPA Regional Administrator by July 1, 2016 and January 13, 2017, respectively. ADEQ submitted a modeling protocol to EPA Region 9 for review on July 1, 2016 and the protocol was approved by email on December 05, 2016. This modeling report presents the results of the modeling conducted in accordance with the approved modeling protocol for areas around the TEP-Springerville facility. For the other two sources, please see separate modeling report.

As described in the approved protocol, the modeling work performed in accordance with the Draft EPA's SO$_2$ NAAQS Designations Modeling Technical Assistance Document (hereafter, "EPA Designation Modeling TAD" (U.S. EPA, 2016a). This report is organized as follows:
- Section 2 provides general description of TEP-Springerville power plant including processes, topography and climate;
- Section 3 provides a discussion on the determination of the modeling domain, sources to explicitly model and the receptor grids;
- Section 4 provides a discussion on the model selection;

- Section 5 provides detailed source inputs, including source configuration, source emissions, source release parameters, and urban/rural determination;
- Section 6 provides a discussion on the selection and processing of meteorological data;
- Section 7 provides a discussion on the determination of background concentrations; and
- Section 8 provides a summary of model results.

2.0   General Description of Sources

Tucson Electric Power Company (TEP)-Springerville Generating Station, is located in Apache County, approximately 15 miles north of Springerville, Arizona. TEP-Springerville is a steam electric generating station. The Standard Industrial Classification (SIC) is 4911. The station consists of four coal-fired generating units designated as Unit 1, Unit 2, Unit 3 and Unit 4. All four units burn coal during normal operations except the period of start-up and flame stabilization for which fuel oil including bio-diesel is fired. Under normal full load operating conditions, the net megawatts (MW) ratings at the units are 387 MW, 390 MW, 417 MW, and 415 MW, respectively. TEP-Springerville supplies electric power for sale to customers. Unit 1 and Unit 2 boilers are tangentially-fired units and burn coal. Unit 3 and Unit 4 boilers are dry bottom wall-fired units and are primarily fired with coal.

The climate is hot during summer and very cold and dry during winter. The warmest month of the year is July with an average maximum temperature of 82.40 degrees Fahrenheit, while the coldest month of the year is December with an average minimum temperature of 15.40 degrees Fahrenheit. The annual average precipitation in the area is 11.99 inches. The wettest month of the year is August with an average rainfall of 3.11 inches.

The terrain features within 50 km from the facility are mostly flat. Escudilla Mountains are located about 40 km south of the facility. Escudilla Peak is Arizona's third highest mountain, at 10,912 feet (3326 m) above sea level. The topography of the local area is depicted in Figure 2-1.

Figure 2-1 Topography of the Area Surrounding TEP-Springerville
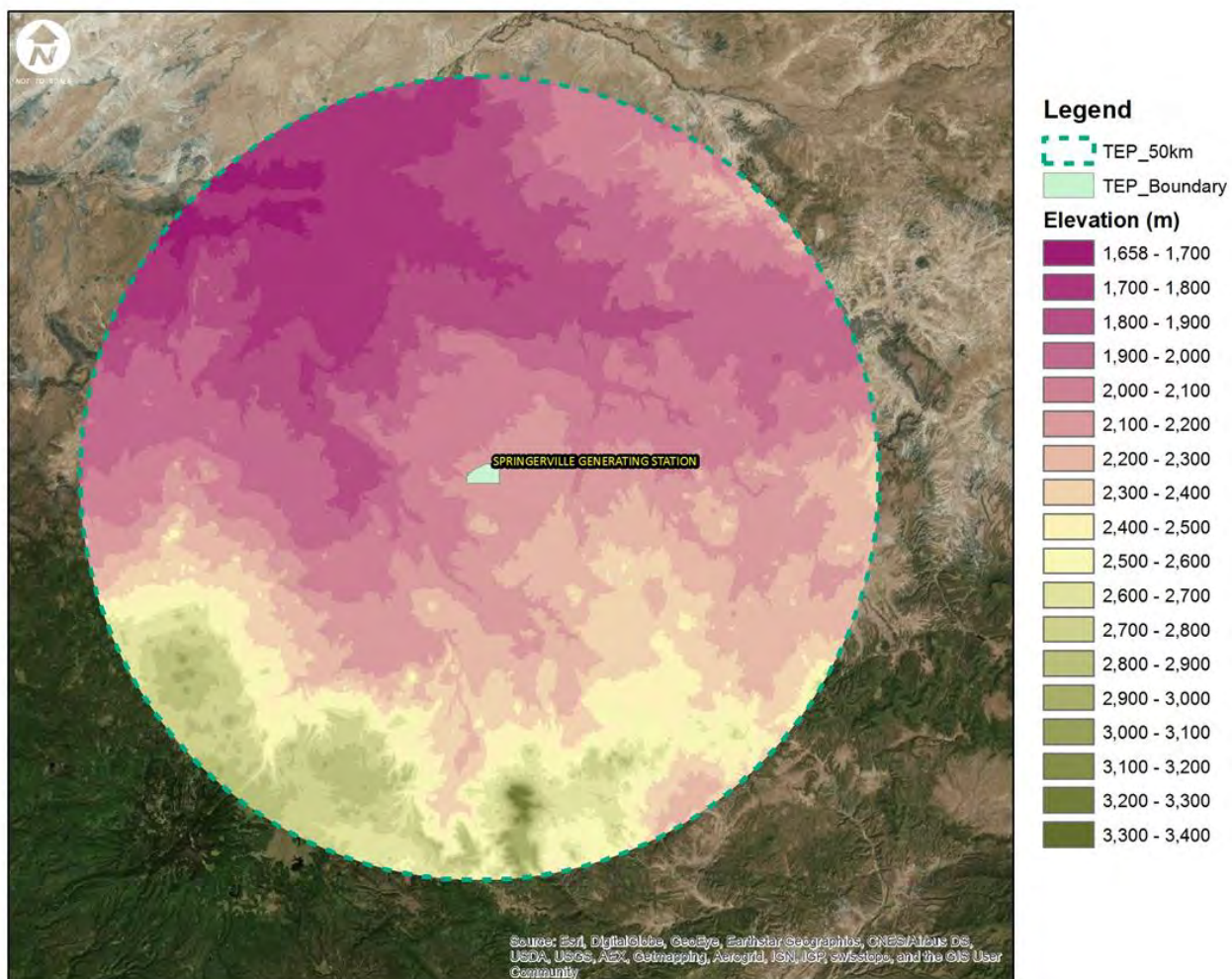
3.0   Modeling Domain

Selection of the modeling domain is dependent on the number of sources to explicitly model and size of the receptor network in order to account for the areas of impact (U.S. EPA, 2016a). The modeling domain should at a minimum include the sources that are most likely to cause or contribute to NAAQS violations in the area. In the modeling exercise, all modeled receptors should exhibit modeled attainment of the NAAQS.

In this modeling analysis, the modeling domain is centered at the TEP-Springerville power plant and extended for 50 kilometers (km) from the facility fence line.

3.1   Determining Sources to Model

Per EPA's SO$_2$ NAAQS Designations Modeling TAD (U.S. EPA, 2016a), the determination of modeling domains and number of sources to consider for modeling should begin with analyzing the spatial distributions of sources that meet or exceed the emissions threshold established in the data requirements rule. The modeling domains should be centered over these sources.

ADEQ has identified SO$_2$ sources within the 50-km modeling domain for the TEP-Springerville power plant. Figure 3-1 is a geographical representation of these sources. Table 3-1 is an inventory of the individual sources within the 50-km modeling domain for TEP-Springerville. As shown in Table 3-1, Salt River Project Coronado Generating Station (SRP-CGS) is the only major source near TEP-Springerville. SRP-CGS consists of two pulverized coal-fired, electric utility steam boilers (Units 1 and 2). 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.

As discussed in the EPA's Designations Modeling TAD (U.S. EPA, 2016a), the determination of specific sources (those sources that are below the emissions threshold) to explicitly model should consider emissions, source parameters, and proximity to the target source are items for consideration. SRP-CGS, consisting of two tall stacks of 122 m, is located around 18 miles northwest of TEP-Springerville (Figure 3-1). Although ADEQ does not expect that SRP-CGS will cause significant concentration gradients in the vicinity of TEP-Sringerville, it is not clear whether the cumulative impacts from SRP-CGS and TEP-Springerville would cause a NAAQS violation in some areas between the two sources. Moreover, the background concentration as proposed in Section 7 may not sufficiently reflect the impacts from major SO$_2$ sources such as SRP-CGS. Therefore, to be safe, ADEQ incorporated SRP-CGS

into the TEP-Springerville designation modeling. The modeling parameters for SRP-CGS will be discussed later in Section 5.

Figure 3-1 Point Sources within 50-km Modeling Domain of TEP-Springerville
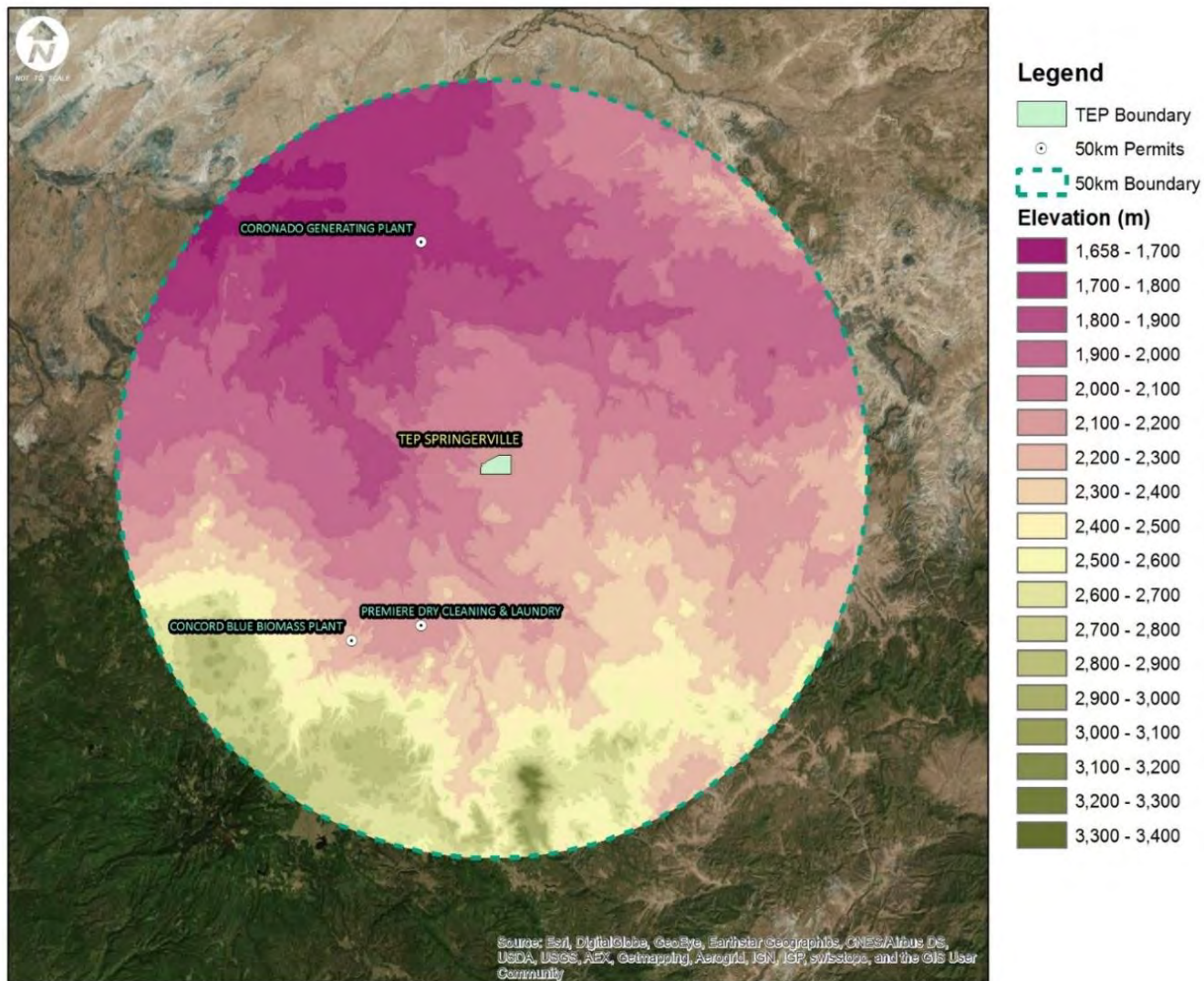
Table 3-1 Point Sources within 50 km Modeling Domain of TEP-Springerville (Permitted Sources)

County	Site Name	Facility Type	Latitude	Longitude	2012 SO$_2$ (TPY)	2013 SO$_2$ (TPY)	2014 SO$_2$ (TPY)
Apache	Springerville Generating Station	Power Plant	34.312	-109.172	6160.36	7944.67	6221.04
Apache	Coronado Generating Station	Power Plant	34.576	-109.275	1219.31	843.43	908.12
Apache	Premier Dry Cleaning & Laundry	Dry Cleaning and Laundry	34.132	-109.275	0	0	0
Apache	Concord Blue Biomass Plant	Electrical Energy Production from Biomass	34.115	-109.375	0	0	0

3.2   Receptor Grid

ADEQ chose a modeling domain centered on TEP-Springerville facility and extended that to 50 km from facility fence line to make sure that the high model concentrations are captured. In this case, a total of 27,700 receptors are placed in the approximately 108 km by 106 km modeling domain for TEP-Springville power plant facility.

ADEQ used the following receptor spacing:

- Receptors along ambient air boundary (AAB) at a spacing of 25 m;
- Receptors from AAB to 1 km at a spacing of 100 m;
- Receptors from 1 km to 5 km away from AAB at a spacing of 200-500 m;
- Receptors from 5 km to 20 km away from AAB at a spacing of 500-1,000 m;
- Receptors from 20 km to 50 km away from AAB at a spacing of 1,000-2,500 m.

ADEQ used EPA's AERMAP software tool (version 11103; U.S. EPA, 2011) to estimate receptor elevations and hill heights. AERMAP is a terrain preprocessor for AERMOD and uses the following procedure to assign elevations to each receptor:

- For each receptor, the program searches through the U.S. Geological Survey (USGS) input files to determine the two profiles (longitude or easting) that straddle this receptor;
- For each of these two profiles, the program then searches through the nodes in the USGS input files to determine which two rows (latitudes or northings) straddle the receptor;
- The program then calculates the coordinates of these four points and reads the elevations for these four points;
- A 2-dimensional distance-weighted interpolation is used to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

ADEQ used 10 meter USGS National Elevation Dataset (NED) data as inputs to AERMAP. The NED data are produced from digitized map contours or from manual or automated scanning of aerial photographs. A 1/3 arc-second NED data file consists of a regular array of elevations referenced horizontally in the UTM (Universal Transverse Mercator) coordinate system, with a uniform horizontal spacing of approximately 10 meters. The NED data used for this analysis are based on the 1983 North American Datum (NAD83). The modeled receptors for TEP-Springerville are depicted in Figure 3-2.

Figure 3-2 Modeled Receptors for TEP-Springerville in 50km

4.0   Model Selection

In 2005, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was promulgated as the EPA's preferred near-field dispersion modeling for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation(40 CFR 51, Appendix W) (U.S. EPA, 2005). AERMOD is EPA's preferred model for area designations under the 1-hour SO_2 primary NAAQS.

ADEQ used AERMOD (version 15181; U.S. EPA, 2014a) to predict ambient concentrations in simple, complex and intermediate terrain. ADEQ is aware that EPA just released AERMOD and AERMET Models Version 16216 on December 20, 2016 (U.S. EPA, 2016b). However, it is unlikely that the changes made in the new version will affect the TEP-Springerville designation modeling.

There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET (version 15181; U.S. EPA, 2014b), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP (version 11103; U.S. EPA, 2011), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSURFACE (Version 13016; U.S. EPA, 2013a), a surface characteristics preprocessor, and BPIPPRIM, a multi-building dimensions program incorporating the Good Engineering Practice technical procedures for PRIME applications (U.S. EPA, 2004).

ADEQ used the regulatory default option. This option commands AERMOD to:
- Use the elevated terrain algorithms requiring input of terrain height data for receptors and emission sources;
- Use stack tip downwash (building downwash automatically overrides);
- Use the calms processing routines;
- Use buoyancy-induced dispersion;
- Use the missing meteorological data processing routines.

5.0   Source Inputs

This section discusses source characterization to develop appropriate source inputs for dispersion modeling with AERMOD modeling system. SO_2 emissions are released to the atmosphere from four stacks at TEP power plant as shown in Figure 5-1.

Figure 5-1 Modeled Emission Sources in TEP-Springerville Power Plant
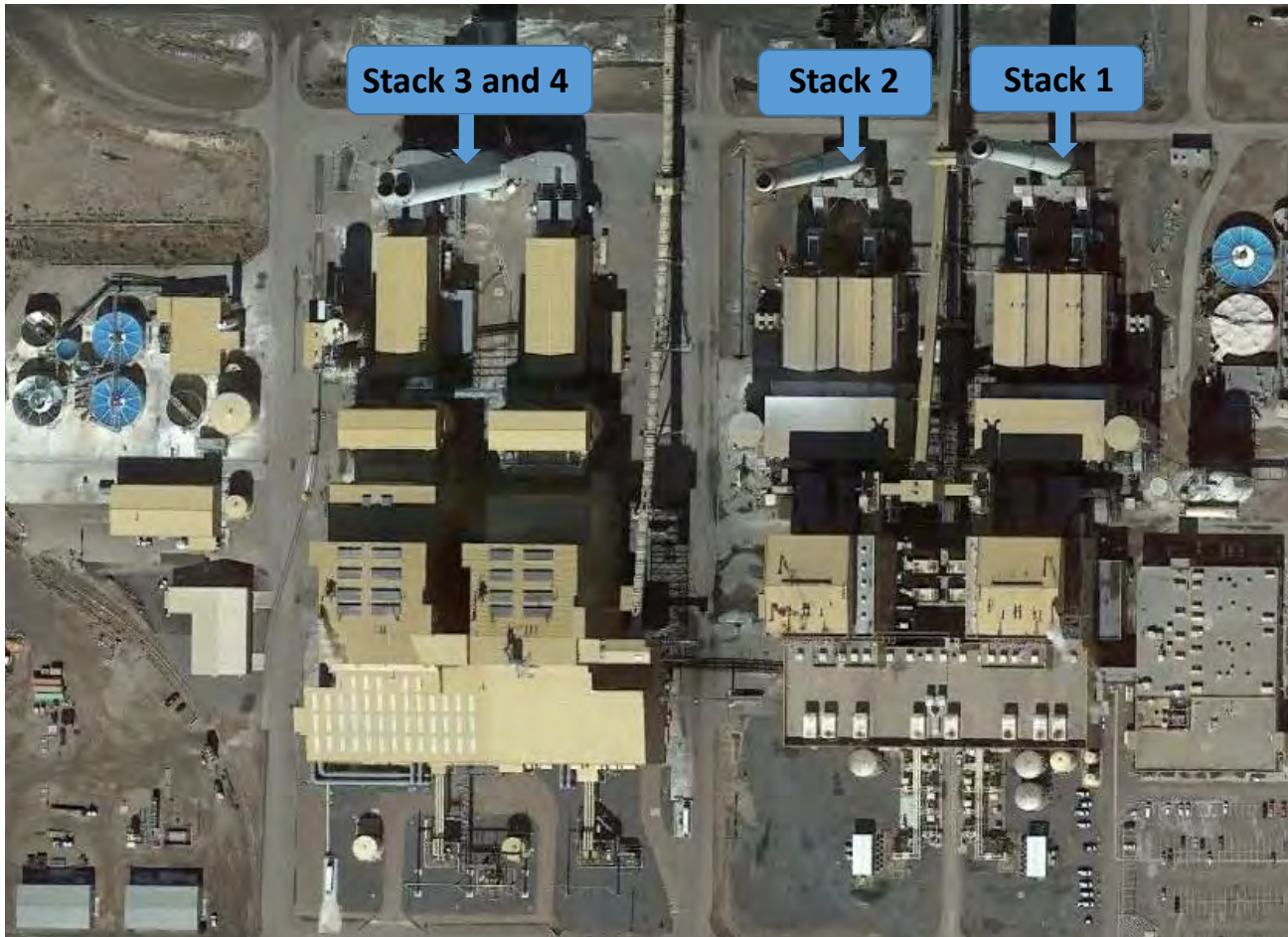
5.1 Source Inputs for TEP-Springerville

5.1.1 Emission Data

In SO_2 designation modeling with AERMOD, the real-time 2012-2014 SO_2 emissions and stack parameter data measured by continuous emission monitoring system (CEMS) are applied to obtain accurate modeling results. The hourly SO_2 emissions data being modeled are consistent with those reported from EPA Air Market database (https://ampd.epa.gov/ampd/). As discussed in EPA Designation Modeling TAD (U.S. EPA, 2016a), hourly SO_2 emissions data are input into AERMOD using the HOUREMIS keyword in the source pathway of the AERMOD control file (AERMOD.INP).

ADEQ obtained the CEMS data from TEP. After carefully reviewing the data, ADEQ did not identify any missing hours and therefore no data substitution is necessary in the TEP modeling inputs.

5.1.2 Emission Release Parameters

For the purposes of modeling with actual emissions to characterize air quality, ADEQ followed the EPA's recommendation and used actual stack heights, instead of calculating Good Engineering Practice (GEP) stack height. In addition, hourly emissions parameters measured by CEMS (including exhaust temperature, exit velocity and exit flow rate) were used as source inputs, which is most closely represent the facility actual emission conditions.

Downwash effects were considered for TEP-Springerville modeling by using BPIPPRM. BPIPPRM requires a digitized footprint of the facility's buildings and stacks. The source must evaluate the position and height of buildings relative to the stack position in the building wake effects analysis. ADEQ obtained the information of actual heights of existing structures from TEP. The simplified layout used in modeling for TEP-Springerville is shown in Figures 5-2.

Figure 5-2 Simplified Facility Layout for TEP-Springerville
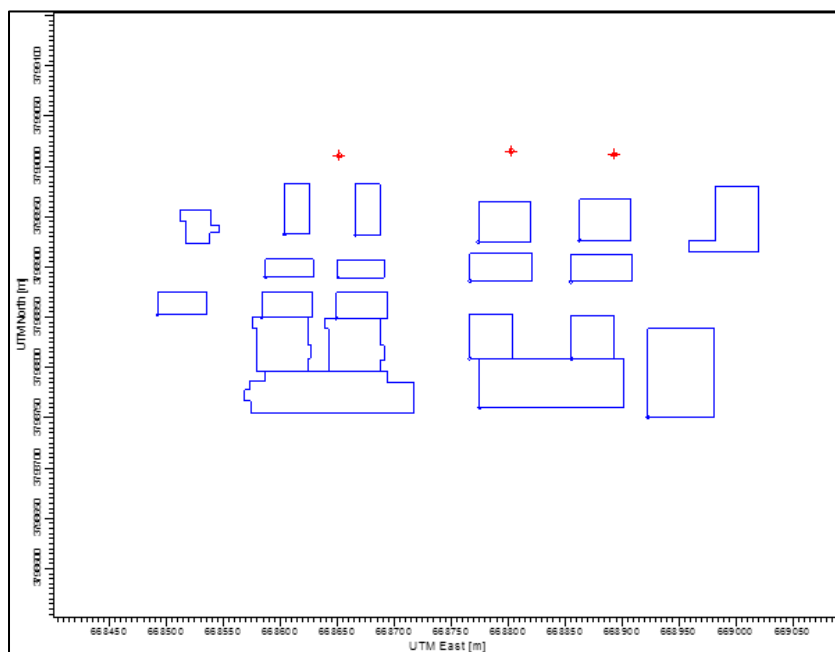
ADEQ identified coordinates for the stacks by mapping the site buildings to rectified aerial photographs of the site and projected UTM coordinates of each stack to UTM Zone 12. These coordinates are based on the NAD83.

In summary, Table 5-1 presents the parameters modeled for the four stacks at TEP-Springerville.

Table 5-1 Modeling Parameters for TEP Stacks

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp. (ºK)	Exit Flow Rate
Stack 1	668893.00	3799012.00	2127.35	152.4	6.096	CEMS	CEMS	CEMS
Stack 2	668803.06	3799015.28	2127.52	152.4	6.096	CEMS	CEMS	CEMS
Stack 3	668651.60	3799010.72	2125.71	152.4	6.096	CEMS	CEMS	CEMS
Stack 4	668651.60	3799010.72	2125.71	152.4	6.096	CEMS	CEMS	CEMS

5.2   Source Inputs for SRP-CGS

ADEQ adopted conservative modeling approaches to evaluate the maximum impacts of CGS emissions in the vicinity of TEP-Springville site. The emission parameters of CGS were set to "fixed" values as shown in Table 5-2.

Those modeled emission parameters were determined based on enforceable emission limits that were established through best available retrofit technology (BART) under Arizona's regional haze State Implementation Plan (SIP).

Table 5-2 Modeling Parameters for CGS Impact Evaluation

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Emission Rate (g/s)	Gas Exit Temp. (ºK)	Gas Exit Flow Rate (m³/s)	Gas Exit Velocity (m/s)
Unit 1	658427.44	3827741.06	1765.89	121.9	7.388	47.262	329.261	772.3026	18.014
Unit 2	658437.80	3827408.07	1767.50	121.9	7.401	44.792	329.261	774.8535	18.014

5.3   Urban/Rural Determination

Dispersion coefficients for air quality modeling were selected based on the land use classification technique suggested by Auer (Auer, 1978), which is EPA's preferred method. The classification determination involved assessing land use by Auer's categories within a 3-km radius of the proposed site. A source selected urban dispersion coefficients if greater than 50 percent of the area consists of urban land use types; otherwise, rural coefficients apply.

Following the 2016 EPA Designation Modeling TAD (U.S. EPA, 2016a), ADEQ classified the land use of the area using the land-use procedure set forth in EPA's "Guideline on Air Quality Models" (GAQM) (U.S. EPA, 2005). This approach requires determining the amount of specific types of land use categories within a 3-km radius circle centered on the source; if the total land use (as defined by Auer) is classified as 50% or more "urban" then the area is designated as urban; otherwise it is designated as rural.

Land use (taken from the U.S. Geological Survey (USGS) National Land Cover Data (NLCD) 1992 archives) was examined for the 3-km radius circle, and total of each land use category were calculated. These land use categories were then correlated to the categories as established by Auer (Auer, 1978), and the amount of urban and rural land use within 3 km of TEP-Springerville were calculated. The area near TEP-Springerville that was examined is depicted in Figure 5-3, while the detailed results of the analysis are presented in Table 5-2.

Figure 5-3 Land Use near TEP-Springerville

NLCD 1992 Land Cover Classification

11 Open Water		51 Shrubland	
21 Low Intensity Residential		71 Grasslands / Herbaceous	
23 Commercial / Industrial / Transportation		81 Pasture / Hay	
31 Bare Rock / Sand / Clay		82 Row Crops	
32 Quarries / Strip Mines / Gravel Pits		83 Small Grains	
41 Deciduous Forest		85 Urban / Recreational Grasses	
42 Evergreen Forest		91 Woody Wetlands	
43 Mixed Forest		92 Emergent Herbaceous Wetlands	

Table 5-3 Land Use Analysis within 3 km of TEP-Springerville Facility

1992 NLCD Land Use Category		% of Total Land Use within 3 km of Asarco	Auer Land Use Category		
Code	Description		Code	Description	Rural/Urban
11	Open Water	1.3	A5	Water Surfaces	Rural
12	Perennial Ice/Snow	0	A5	Water Surfaces	Rural
21	Low Intensity Residential	0	R1 / R4	Common/Estate Residential	Rural
22	High Intensity Residential	0	R2 / R3	Compact Residential	Urban
23	Commercial / Industrial / Transportation	0.7	C1 / I1 / I2	Commercial/Heavy Industrial/Light-Moderate Industrial	Urban
31	Bare Rock / Sand / Clay	0.3	A	N/A	Rural
32	Quarries / Strip Mines / Gravel Pits	7.2	A	N/A	Rural
33	Transitional	0	A	N/A	Rural
41	Deciduous Forest	0	A4	Undeveloped Rural	Rural
42	Evergreen Forest	1.7	A4	Undeveloped Rural	Rural
43	Mixed Forest	0	A4	Undeveloped Rural	Rural
51	Shrubland	83.9	A3	Undeveloped	Rural
61	Orchards / Vineyards / Other	0	A2 / A3 / A4	Agricultural Rural / Undeveloped / Undeveloped Rural	Rural
71	Grasslands / Herbaceous	4.9	A3	Undeveloped	Rural
81	Pasture / Hay	0	A2	Agricultural Rural	Rural
82	Row Crops	0	A2	Agricultural Rural	Rural
83	Small Grains	0	A2	Agricultural Rural	Rural
84	Fallow	0	A2	Agricultural Rural	Rural
85	Urban / Recreational Grasses	0	A1	Metropolitan Natural	Rural
91	Woody Wetlands	0	A3 / A4 / A5	Undeveloped / Undeveloped Rural / Water Surfaces	Rural
92	Emergent Herbaceous Wetlands	0	A3 / A5	Undeveloped / Water Surfaces	Rural

Over 80% of the land use within 3 km of TEP-Springerville is "shrubland" according to the NLCD92 classification scheme. Under the Auer's scheme, the sum of the percentage of land use categories classified as urban (R2, R3, C1, I1, and I2) is only 0.7%. Accordingly, the sum of the rural categories is 99.3%. Therefore, the area around TEP-Springerville is defined as "rural" and identified as such in the AERMOD input.

6.0   Meteorological Data

The AERMOD model used AERMET to process the meteorological data and create the data files for AERMOD.

6.1   Meteorological Data Selection

As stated in SO_2 designation modeling TAD (U.S. EPA, 2016a), for the purposes of modeling to characterize air quality for use in SO_2 designations, EPA recommends using the most recent 3 years of meteorological data to allow the modeling to simulate what a monitor would observe.

The TEP-Springerville power plant provided 2012-2014 site-specific meteorological data collected from a 10-m meteorological tower. However, these data have not gone through quality assurance. ADEQ also found an older site-specific meteorological dataset obtained from a 60-m meteorological tower which was previously used for a Prevention of Significant Deterioration (PSD) modeling analysis for TEP-Springerville generating station. Although the EPA Designation Modeling TAD indicates that older site-specific meteorological data may be used under some circumstances (U.S. EPA, 2016a), the use of this one-year meteorological dataset is encountering some limitations. If this dataset is used, it must be duplicated twice to model three-year emissions, which appears to be inappropriate. Moreover, the meteorological data were collected as early as in 1993, more than 20-years ago. The EPA Designation Modeling TAD cautions the use of older meteorological data with recent emissions, "especially for those emissions that are meteorological dependent, such as demand in hot or cold weather for EGUs."

Due to the limitations associated with the use of site-specific meteorological data, ADEQ used the 2012-2014 National Weather Service (NWS) data collected from St. Johns Industrial Air Park, St. Johns, Arizona. The following section discusses why the St. Johns NWS data are representative of transport and dispersion conditions within the modeling domain.

Criteria for Representativeness

The section 8.3 of 40 CFR 51 Appendix W (U.S. EPA, 2005) stipulates that the representativeness of meteorological data is dependent upon four criteria:

- Spatial proximity of the meteorological monitoring site to the facility;
- Complexity of the topography of the area;
- Exposure of the meteorological sensors; and

- Period of time during which the data are collected.

As discussed in Appendix W section 8.3, the spatial representativeness of the data can be adversely affected by large distances between the source and receptors of interest and the complex topographic characteristics of the area. Significant cautions must be taken to select a meteorological station if the meteorological conditions vary drastically in the modeling domain and/or the areas of concern have complex terrain.

Spatial representativeness for off-site data were also assessed by comparing the surface characteristics (albedo, Bowen ratio, and surface roughness) of the meteorological monitoring site and the analysis area.

Evaluation of Representativeness of St. Johns Airport Data

As shown in Figure 6.1 and Table 1, St. Johns Industrial Air Park is located around 18 miles away from TEP-Springerville and 7 miles from SRP-CGS (the other source being included in this modeling analysis as we mentioned in Section 3.1). Because of their proximity, the three sites share the same climatic characteristics. The climate is cold semi-arid with cold, dry winters and hot summers with relatively greater precipitation via erratic thunderstorms.

Table 6-1 Information of Meteorological Site Location

Meteorological Data Sources	Sampling Period	Latitude	Longtitude
St. Johns Industrial Air Park	2012-2014	34.518 N	109.379 W
10-m meteorological tower	2012-2014	34.308 N	109.146 W
60-m meteorological tower	1993	34.320 N	109.160 W

Figure 6-1 Meteorological Stations near TEP-Springerville Facility

The St. Johns Industrial Air Park site and the TEP-Springerville site have similar surrounding topography. Terrain between St. Johns Airport and TEP-Springerville is simple with gently rolling features. There are no specific terrain features that would cause directional steering of locally generated winds or would influence the predominant meteorology in the modeling domain. The wind roses at the project site (both 10-m and 60-m meteorological tower) show the similar wind patterns to the St. Johns Industrial Air Park site, indicating the winds from west, southwest and south prevail in the modeling domain (Figure 6.2 to 6.4).

Figure 6-2 2012-2014 St. Johns Airport Meteorological Data
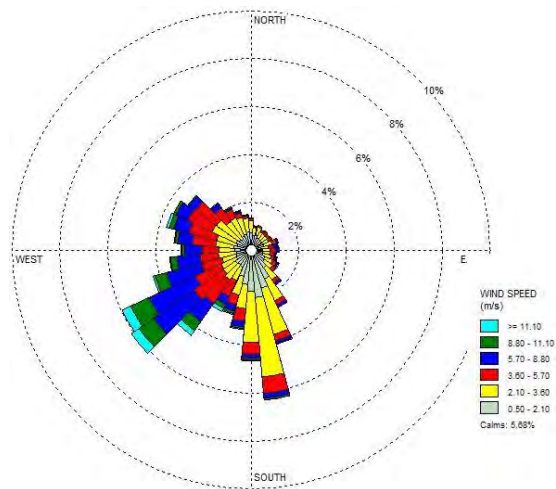
Figure 6-3 2012-2014 On-site Meteorological Data Collected at 10-m Tower
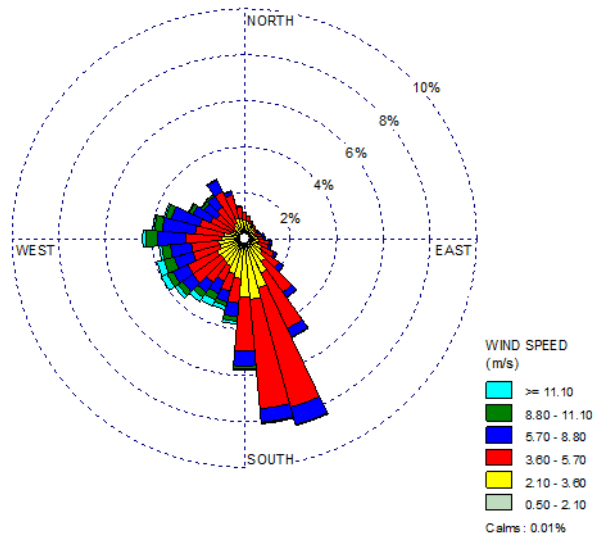
Figure 6-4 1993 On-site Meteorological Data Collected at 60-m Tower
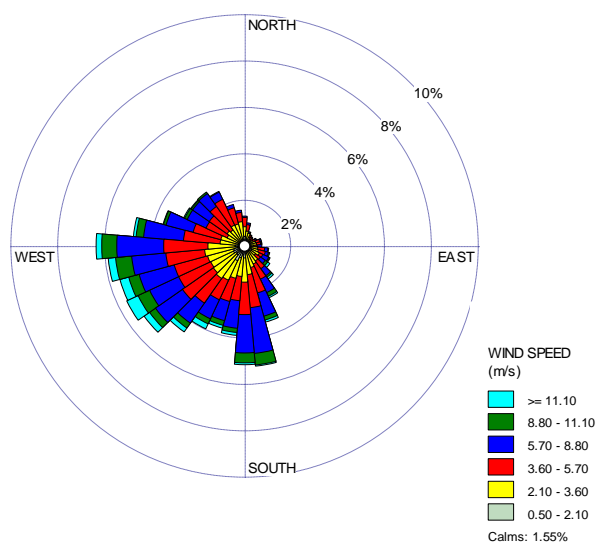
Meteorological data from St. Johns were obtained through the Automated Surface Observing System (ASOS) network. The siting requirements of an ASOS station (including exposure conditions of the meteorological sensors) are consistent with those necessary for use in an air dispersion modeling analysis. Moreover, for the years 2012, 2013 and 2014, the surface data collected from the St. Johns Industrial Air Park meet the data completeness requirements of Section 5.3.2 of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (U.S. EPA, 2000). Especially, the ASOS station can utilize AERMINUTE to significantly reduce calm or missing hours, which is critical for modeling 1-hour standards (U.S. EPA, 2013a).

ADEQ also used AERSURFACE to compare the surface characteristics within 1 km/10 km of the St. Johns Industrial Air Park site and the project site, specifically the albedo, Bowen ratio, and the surface roughness length (Table 6-2 and Table 6-3). As shown in Table 6-2 and Table 6-3, the albedo and the surface roughness length of the two sites are nearly identical. The Bowen ratio between the two sites show some differences, mainly due to the Pasture/Hay and Low Intensity Residential land use near the St. Johns Industrial Air Park site. In general, AERMOD is not sensitive to changes in Bowen ratio. Overall, shrubland dominates the land cover near both sites. Therefore, the surface characteristics of the two sites are very similar.

As discussed above, the St Johns NWS data meet all representativeness criteria listed in section 8.3 of 40 CFR 51 Appendix W. Therefore, used St Johns NWS data were used in this modeling analysis by ADEQ.

Table 6-2 St. Johns Industrial Air Park AERSURFACE Inputs/Outputs for Use in AERMET

Month	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Albedo	0.23	0.22	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23
Bowen Ratio	3.66	1.82	1.82	1.82	1.82	1.82	2.49	2.49	2.49	2.49	3.66	3.66
Surface Roughness	0.146	0.145	0.145	0.145	0.145	0.145	0.146	0.146	0.146	0.146	0.146	0.146

Table 6-3 TEP-Springerville AERSURFACE Inputs/Outputs for Use in AERMET

Month	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Albedo	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Bowen Ratio	5.07	5.07	5.07	5.07	2.6	2.6	3.37	3.37	3.37	3.37	5.07	5.07
Surface Roughness	0.14	0.14	0.14	0.14	0.146	0.146	0.148	0.148	0.148	0.148	0.148	0.148

6.2   Meteorological Data Processing with AERMET

ADEQ used the EPA's AERMET tool (version 15181; U.S. EPA, 2014b) to process meteorological data for using with AERMOD. AERMET merges NWS surface observations with NWS upper air observation and performs calculation of boundary layer parameters required by AERMOD. In addition to the meteorological observations, AERMET further requires the inclusion of the characteristics of land use surfaces (routinely calculated using EPA's AERSURFACE tool). Although EPA has proposed to designate some beta options as the default regulatory formulation in AERMET (U.S. EPA, 2015) and recently finalized the ADJ_U* option as the default option (U.S. EPA, 2016b), ADEQ did not use the ADJ_U* option and all previous default options in AERMET were used for this case.

6.2.1   Surface Observation

As discussed in Section 6.1, ADEQ used the 2012-2014 NWS data collected at St. Johns Industrial Air Park site for this project. To reduce the number of calms and missing winds associated with the NWS meteorological data, ADEQused AERMINUTE to supplement the standard ASOS data with hourly-averaged wind speed and direction to support AERMOD dispersion modeling (U.S. EPA, 2013b). ADEQ also used a minimum wind speed threshold of 0.5 m/s to the hourly averaged wind speeds provided by AERMINUTE.

6.2.2 Upper Air Observation

Given the proximity of location, topography and climate at the TEP-Springerville power plant, ADEQ used the upper air data obtained from Albuquerque, NM (Station ID:23050,Latitude/Longitude: 35.05 N/106.62 W),which is 240 km northeast away from TEP-Springerville.

Figure 6-5 Location of Upper Air Station and TEP-Springerville Power Plant
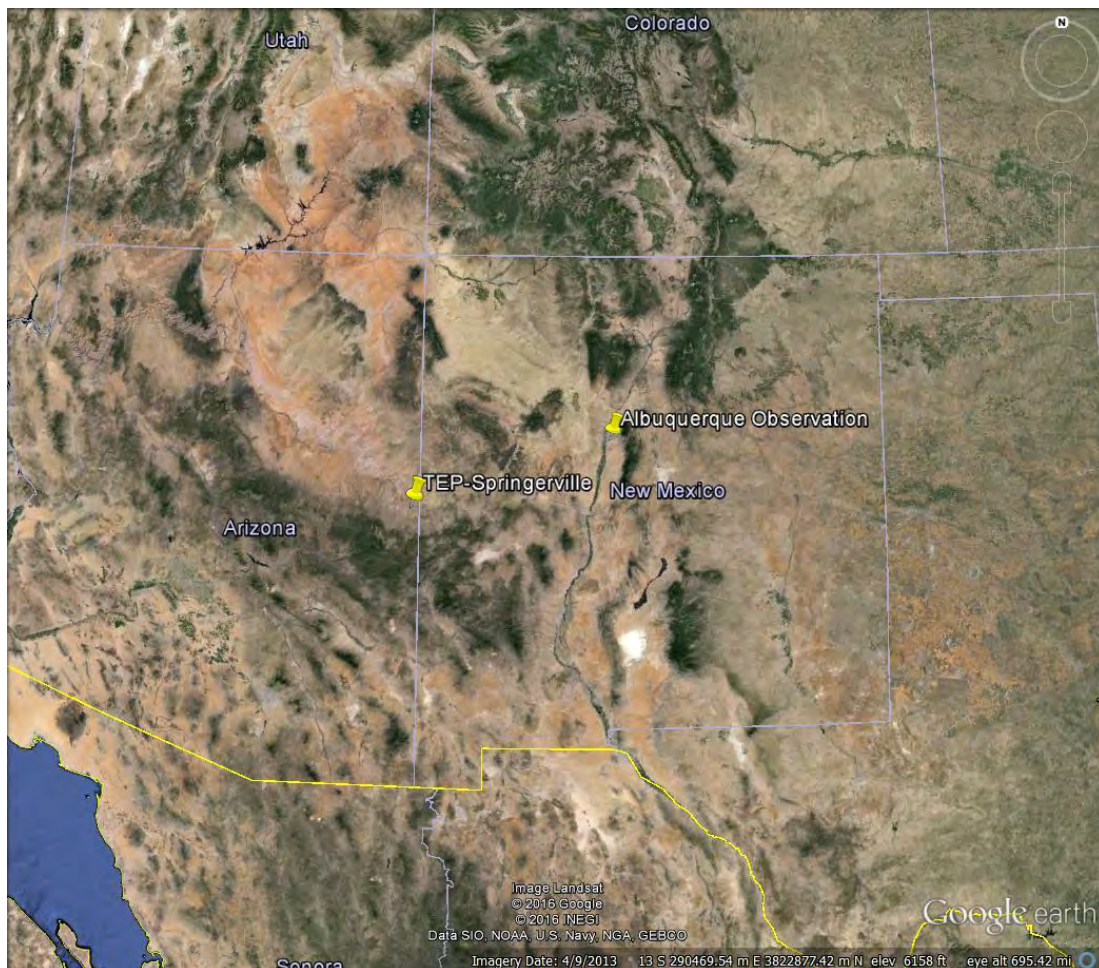
6.2.3 AERSURFACE

ADEQ used EPA's AERSURFACE tool to calculate the surface characteristic parameters (surface roughness length, albedo and Bowen ratio) based on the 1992 USGS National Land Cover Data (NLCD). EPA developed AERSURFACE to identify these parameters within a defined radius from a specified point. In this case, ADEQ inputted the UTM coordinates of the NWS meteorological station to AERSURFACE along with a default 1-km radius. ADEQ calculated

the parameters for twelve compass sectors of 30° each, and by month. Considering the climate characteristics in the St. Johns area, ADEQ assigned the seasonal categories for TEP-Springerville as follows:

- Late autumn after frost and harvest, or winter with no snow: none;

- Transitional spring (partial green coverage, short annuals): February, March, April, May, June;

- Midsummer with lush vegetation: July, August, September, October;

- Autumn with unharvested cropland: January, November, December.

The surface moisture condition were determined by comparing precipitation for the period of data to be processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th-percentile, "dry" conditions if precipitation is in the lower 30th-percentile, and "average" conditions if precipitation is in the middle 40th-percentile. "Average" condition was set for TEP-Springerville case.

7.0   Background Air Quality

EPA requires background air quality estimates be added to modeling results for comparison to the NAAQS.

There are limited SO_2 monitoring sites in Arizona and the monitoring sites are located in the Phoenix/Tucson metropolitan area or close to copper smelters. ADEQ used the ambient monitoring data collected from Central Phoenix (1645 E Roosevelt St, ID: 40133002, Figure 7-1) as 1-hour SO_2 background concentration. This site is located in an urban area and surrounded by various anthropogenic sources. The TEP-Springerville power plant is located in a rural area without significant human activities. Since the source contribution from SRP-CGS had been taken into account in the modeled concentration, the monitoring concentration at central Phoenix is expected to be higher than the background concentration in the TEP-Spingerville modeling domain. Thus this method is considered as conservative.

The 99th percentile SO_2 1-hour concentrations at the Central Phoenix Monitoring Site was calculated for each year in the 2010-2014 dataset which were retrieved from EPA's Air Quality System (https://www3.epa.gov/airdata/). The 3 year (2012-2014) design values were 8ppb, 8ppb and 7ppb, respectively. Following EPA Designation Modeling TAD, the SO_2 background concentration for the TEP-Springerville power plant was determined to be 7.7 ppb (20.18 μg/m^3) as the average of 3-year 99th percentile SO_2 1-hour concentrations.

Figure 7-1 Location of Central Phoenix SO₂ Monitor
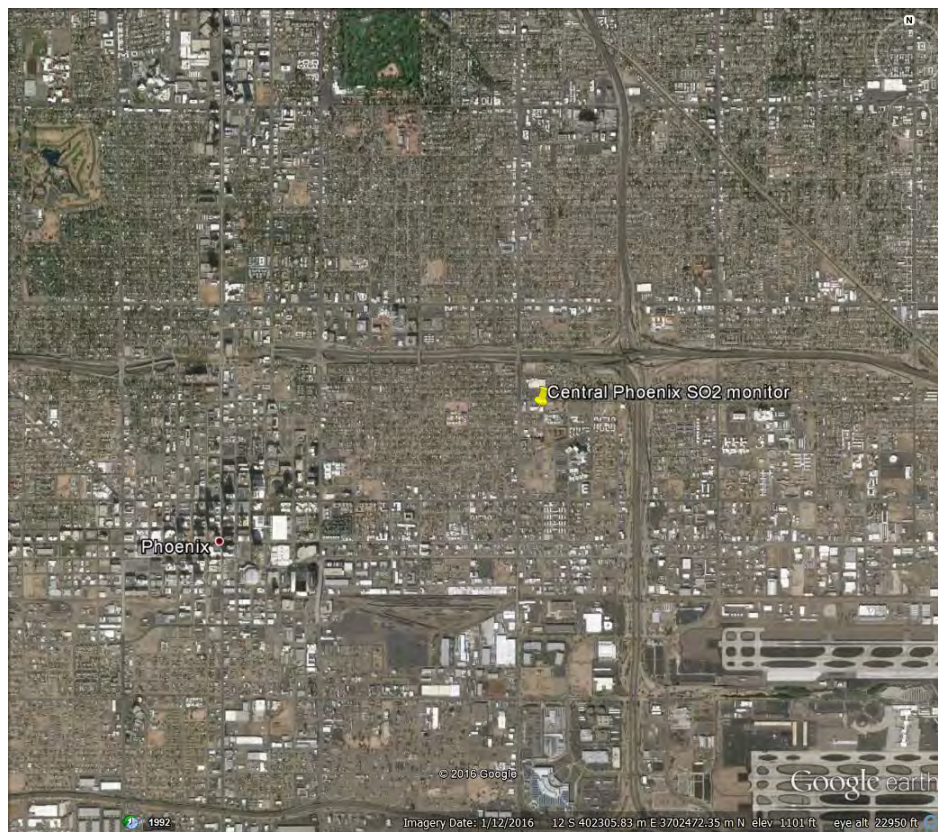
8.0 Modeling Results and Discussions

Demonstration of protection of the NAAQS was accomplished by comparison of the modeled design value to the applicable standard. The modeled design value for 1-hour SO_2 is defined as the sum of the 4th highest modeled hourly concentration and the 99th percentile background concentration. The results for TEP-Springerville are discussed in this section.

The predicted highest 4th high 1-hour SO_2 concentrations using the St Johns NWS meteorological data was 87.51 $\mu g/m^3$.This predicted concentration added to the 1-hour SO_2 background concentration of 20.18 $\mu g/m^3$ yields the ambient concentration of 107.69$\mu g/m^3$. This concentration is less than the applicable 1-hour SO_2 NAAQS of 196 $\mu g/m^3$. In conclusion, the SO_2 concentrations around the TEP-Springerville power plant complies with 1-hour SO_2 NAAQS. Table 8-1 summarizes the modeling results.

Table 8-1 Results of TEP-Sprinerville Designation Modeling

Model Predicted Impact(Highest 4th High) $\mu g/m^3$	Background Concentration(99th Percentile) $\mu g/m^3$	Total Concentration $\mu g/m^3$	NAAQS $\mu g/m^3$
87.51	20.18	107.69	196
4th highest maximum daily 1-hour SO_2 concentration predicted to occur at 668392.81 mN and 3797791.82 mE			

Based on the spatial concentration of contour plot (Figure 8-1), the highest concentrations of 1-hour SO_2 around TEP-Springerville Power Plant were located to the south of the facility. The modeling analysis also revealed that the inclusion of SRP-CGS emissions did not affect the design concentration of the TEP-Springerville designation modeling (Please check TEP-CGS folder in SO_2 Technical Assistance Document for more details).

ADEQ is submitting all applicable electronic modeling files including model input files, model output files, building downwash files, terrain files, and meteorological data files along with this modeling report.

Figure 8-1 Spatial distributions of SO₂ concentration modeled by AERMOD near TEP-Springerville
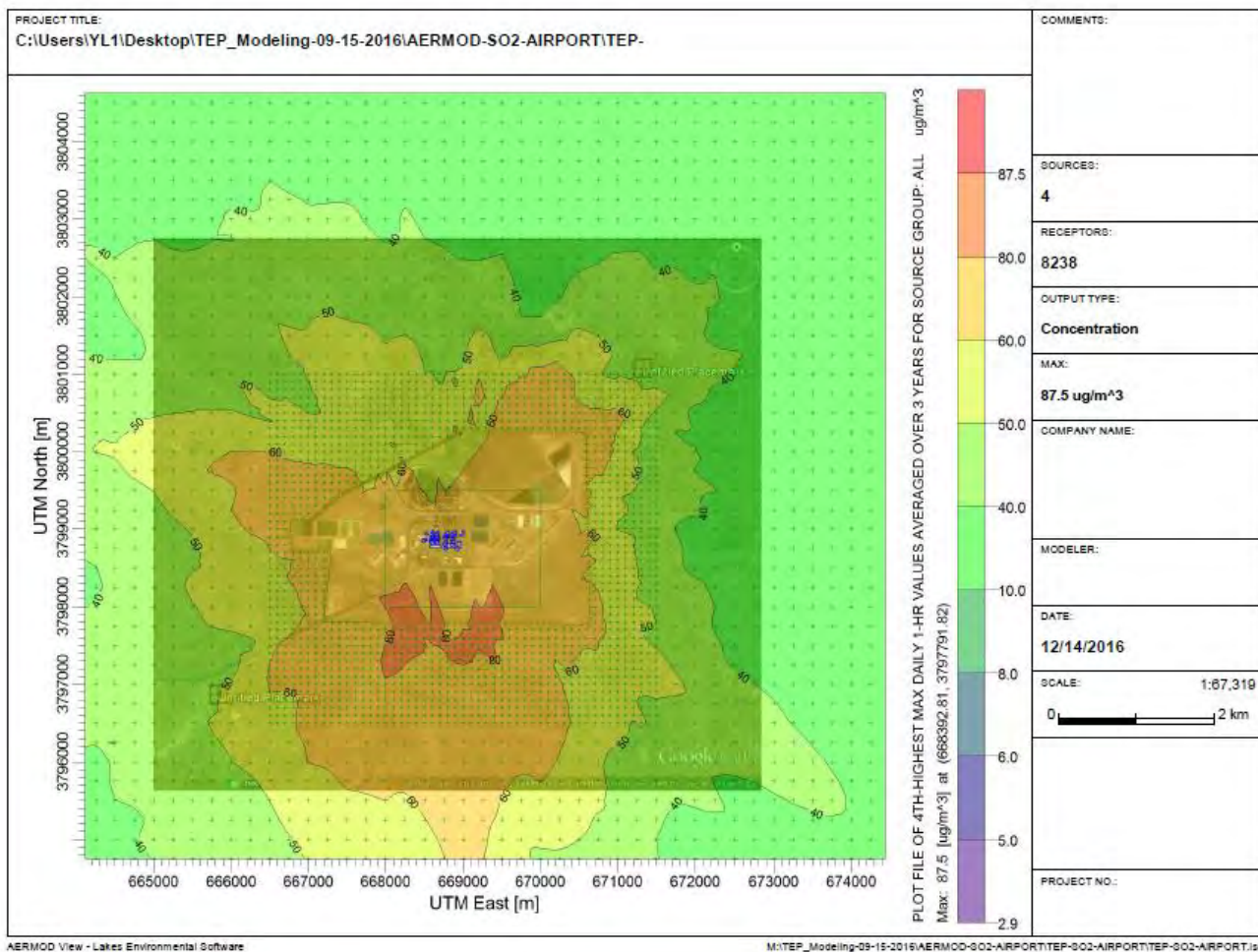
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Exhibit AII – Data Requirement Rule Materials

ARIZONA DEPARTMENT
OF
ENVIRONMENTAL QUALITY

Douglas A. Ducey
Governor

Misael Cabrera
Director

January 15, 2016

Mr. Jared Blumenfeld, Regional Administrator
U.S. Environmental Protection Agency, Region IX
Mail Code ORA-1
75 Hawthrone Street
San Francisco, CA 94105

Re: Arizona SO2 Information for the Data Requirements Rule

Dear Mr. Blumenfeld:

On August 10, 2015, the U.S. Environmental Protection Agency finalized requirements for air agencies to monitor or model ambient sulfur dioxide (SO_2) levels in areas with large sources of SO_2 emissions to help implement the 1-hour SO_2 National Air Ambient Quality Standard (NAAQS).

This final rule establishes that, at a minimum, air agencies must characterize air quality around sources that emit 2,000 tons per year (tpy) or more of SO_2. An air agency may avoid the requirement for air quality characterization near a source by adopting enforceable emission limits that ensure the source will not emit more than 2,000 tpy of SO_2.

The Arizona Department of Environmental Quality (ADEQ) has identified five sources that will need to be addressed for the data requirements rule. Those sources include two copper smelters and three coal-fired power plants. The names of the sources along with information regarding SO_2 emissions and upcoming controls are presented in the table below.

Lhoist North America-Nelson Lime Plant, TEP Irvington, and Salt River Project - Coronado Generating Station were included in EPA's 2011 NEI as sources that generate near or over 2,000 tpy of SO_2. However, these sources are not included in the table below for the following reasons:
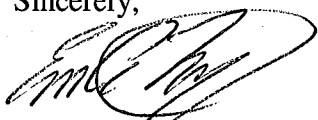
- Lhoist North America-Nelson Lime Plant generated 1,997 tons of SO_2 in 2014 and is expected to generate emissions well below the limit when the EPA regional haze FIP is implemented, which will require them to shift to lower sulfur content fuels.

- TEP Irvington generated 1,084 tons of SO_2 in 2014. Due to the regional haze issues, they are shifting to lower sulfur content fuels, which will result in lower SO_2 emissions.

- Salt River Project - Coronado Generating Station generated 908 tons of SO_2 in 2014, which is well below the 2,000 tpy limit, and no further change in emissions is anticipated.

Main Office
1110 W. Washington Street • Phoenix, AZ 85007
(602) 771-2300

Southern Regional Office
400 W. Congress Street • Suite 433 • Tucson, AZ 85701
(520) 628-6733

www.azdeq.gov
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Arizona Facilities with 2,000 tpy or more of SO_2 Emissions

FACILITY NAME	2014 SO_2 (TONS)	UPCOMING CONTROLS	EMISSIONS AFTER NEW CONTROLS
Asarco Hayden Smelter	17,432	3 new converters, improved primary and secondary capture system, new tertiary capture system	On implementation of proposed changes, emissions will reduce to about 3,500 tpy
Freeport Miami Smelter	4,505	Replace Isa furnace with bigger one, reconfigure roofline to capture fugitive emissions and capture/route these emissions to aisle caustic scrubber	On implementation of proposed changes, emissions will reduce to 552 tpy
APS - Cholla	3,806	Unit 2 expected to shut down in April 2016. Units 1, 3 and 4 conversion to natural gas in 2025	Unit 2 will permanently shut down in April 2016 resulting in emissions reduction by about 1,000 tpy. Facility-wide SO_2 emissions likely to drop to below 10 tpy after natural gas switch in 2025
Tucson Electric Power Co.- Springerville Generating Station	6,221	No changes are planned at the facility	No change in emissions is anticipated
Arizona Electric Power Cooperative - Apache Generating Station	4,811	As part of the BART process the following changes will occur: Unit 2 will switch from coal to natural gas. Unit 2 will install SNCR control technology.	Based on AEPCO's BART analysis, the changes being made to Unit 2 and Unit 3 will result in SO_2 emission reductions of approximately 1,000 tpy facility-wide. Expected installation in May 2017.

If you should have any questions regarding this letter, please contact me at (602) 771-2308.

Sincerely,

Eric C. Massey, Director
Air Quality Division
Arizona Department of Environmental Quality

Exhibit AIII – Source Specific Technical Materials

Modeling Technical Support Document
for the Miami
Sulfur Dioxide (SO₂) Nonattainment Area

Submitted To:

Environmental Protection Agency

Region 9

Prepared By:

Arizona Department of Environmental Quality
Air Quality Division

&

Freeport-McMoRan Inc.

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1.0   Introduction

The United States Environmental Protection Agency (EPA) established a new 1-hour National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) of 75 parts per billion (ppb) on June 2, 2010. EPA designated the Miami area of Gila County as a Non-attainment Area (NAA) for the 2010 SO_2 Primary NAAQS on August 5, 2013, effective as of October 4, 2013. Because of this designation, the Arizona Department of Environmental Quality (ADEQ) must develop a State Implementation Plan (SIP) revision to demonstrate future attainment of the NAAQS within five years of the effective date of designation. An attainment demonstration using an EPA approved air quality dispersion model is a core component of state SO_2 NAA SIP submittals.

As described in this Attainment Demonstration Technical Support Document (TSD), the modeling will be performed in accordance with the EPA's *Guideline on Air Quality Models (GAQM)* (40 CFR 51, Appendix W) (U.S. EPA, 2005) and *Guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions - Appendix A Modeling Guidance for Nonattainment Areas* (U.S. EPA, 2014a). Additionally, ADEQ will employ *Additional Clarification Regarding Application of Appendix W from Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard* (U.S. EPA, 2011a)[1].

This TSD presents the modeling methodologies ADEQ followed in completing the ambient air quality analysis of the Miami planning area. ADEQ appointed FMMI's lead modeler, Amec Foster Wheeler, to perform the attainment demonstration, while ADEQ used its expertise in an oversight and review capacity. The TSD is organized as follows:

- Section 2 provides an overview of the general regional characteristics of the Miami NAA, including topography, land use, and climate;
- Section 3 provides a discussion on the determination of the modeling domain, sources to explicitly model and the receptor grid;
- Section 4 provides a discussion on the model selection, addressing a hybrid modeling approach, and model performance evaluation for the hybrid approach;
- Section 5 provides detailed source inputs, including current and future source configuration, source emissions, source release parameters, Good Engineering Practice (GEP) stack height, and urban/rural determination;
- Section 6 provides a discussion on the selection and processing of meteorological data;
- Section 7 provides a discussion on the determination of background concentrations;
- Section 8 provides proposed emission limits and attainment demonstration results and discussion.

To help EPA's review, ADEQ is addressing all modeling components, following the structure of EPA's Modeling Guidance for Non-Attainment Areas (U.S. EPA, 2014a). Along with the TSD, ADEQ has also provided an enclosed CD-ROM, including files associated with modified BLP code, assignment of terrain elevations to receptors, and preparation of a sequential 3-year meteorological data set for use in the modeling. A list of the materials in the CD-ROM is provided in Appendix A of this document.

---

[1] Although this guidance is for NO_2 modeling, the common 1-hour averaging time and form of both the NO_2 and SO_2 standards makes this modeling guidance applicable to the 1-hour SO_2 NAAQS.

2.0   Overview of Miami Nonattainment Area (NAA) for 1-hour SO$_2$

The towns of Miami, Claypool and most of Globe lie within the Miami SO$_2$ NAA. The Miami SO$_2$ NAA is comprised of the portions of Gila County bound by the townships and ranges as presented in Figure 2-1. Figure 3-1 contains the location of the Miami Smelter. FMMI's proposed changes will occur at the existing Miami Smelter located in Claypool, Arizona. The Miami Smelter is located on a hill to the north of the communities of Claypool and Miami.

2.1   Population

The Arizona Department of Administration (ADOA) estimates the year 2011 population of Gila County at 53,577 persons. ADOA estimates 14,457 persons resided within the bounds of the Miami SO$_2$ NAA during 2011. The Miami SO$_2$ NAA represents approximately 27 percent of the population of Gila County.

2.2   Land use

The Miami NAA encompasses some 2,286 square miles within the bounds of Gila County. The majority of the land within the NAA is owned by the United States Forest Service; followed by privately held lands, the U.S. Bureau of Land Management (BLM) managed land, and Arizona State Trust land. The San Carlos Indian Reservation owns none of the land within the Miami NAA. Overall, the area has minimal commercial development.

Industrial sources within the Miami NAA are provided in Section 3.1.1 of this TSD. Further discussion of land use, as it pertains to dispersion modeling and meteorological processing inputs, is provided in Sections 5.6 and 6.1.3 of this TSD.

2.3   Topography

Miami is at roughly 3,500 feet above mean sea level (AMSL), located in the southwest-northeast tending river valley of the Bloody Tanks Wash. The Miami Smelter project site sits about 3,600 feet AMSL on a hill above US Route 60. To the northeast, this valley joins the Pinal Wash at a right angle; the Wash then tends northwest and merges with the Pinal Creek Valley. Northeast beyond this juncture, the Apache Peaks rise to 4,300 feet, and to 6,200 feet a bit outside of the nonattainment area. To the northwest, Webster Mountain rises to 5,000 feet, the Pinal and other mountain ranges to the south and southwest rise to 6,500 feet.

The highest terrain feature in the vicinity, but outside of the nonattainment area, is Pinal Peak with an elevation of 7,850 feet and located 15.1 kilometers south of the facility. Another prominent terrain feature 44.4 kilometers to the north of the facility is Aztec Mountain with an elevation of 7,748 feet.

Further discussion of topography, as it pertains to dispersion modeling inputs, is provided in Section 3.2 of this TSD.

2.4   Climate

One can find both desert terrain and mountain ranges in the region and as such, one can find both warm desert and cool alpine climates near the Miami SO$_2$ NAA. In Miami, the hottest month of the year is July, when the average daily maximum temperature is 96.4 ˚F. January is the coolest month with an average daily minimum temperature of 33.6 ˚F.

Precipitation generally occurs in two seasons. The wettest month in Miami is August when monsoonal thunderstorms produce an average monthly total of 2.7 inches (") of rain. Pacific winter storms moving across the area from December through March produce monthly averages of 2.0" to 2.2" of precipitation in the form of rain or snow. The driest month is June, with an average of 0.3" of rain. The average yearly precipitation is 19.5".

The local terrain heavily influences winds in the Miami planning area. The valley is oriented on a southwesterly-northeasterly axis, and wind directions tend to follow that orientation. The elevated terrain in the region also contributes to diurnal downslope and upslope winds, which FMMI expects to be more pronounced near the higher peaks such as Pinal Peak.

Further discussion of meteorology, as it pertains to dispersion modeling and meteorological processing inputs, is provided in Section 6 of this TSD.

2.5   Summary of Attainment Status for Criteria Pollutants

Gila County is designated as "unclassified" or in "attainment" for the 8-hour ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM) with a diameter less than 2.5 microns ($PM_{2.5}$), and lead (Pb) NAAQS.

EPA designated a portion of Gila County as "nonattainment" for the particulate matter with a diameter less than 10 microns (PM_{10}) NAAQS, specifically the Miami and Hayden planning areas. The Miami Smelter is located in the Miami planning area. In July 2006, ADEQ requested EPA split the Hayden/Miami PM_{10} NAA into separate nonattainment areas. EPA concurred with this request in January 2007. In addition, EPA also issued a clean data finding for the Miami PM_{10} NAA in the same decision. In July 2008, ADEQ submitted to the EPA the *Miami Moderate Area PM_{10} Limited Maintenance Plan and Request for Re-designation to Attainment*. EPA has yet to publish formal approval of this submittal.

EPA recently designated the Miami planning area as nonattainment for the 2010 SO_2 NAAQS, effective October 4, 2013. The Miami Planning Area remains designated as attainment for the historic 3-hour, 24-hour and annual SO_2 NAAQS but is classified as a "maintenance area" for the historic NAAQS due to the area's former nonattainment status.

Figure 2-1 Miami Nonattainment Area Townships and Ranges
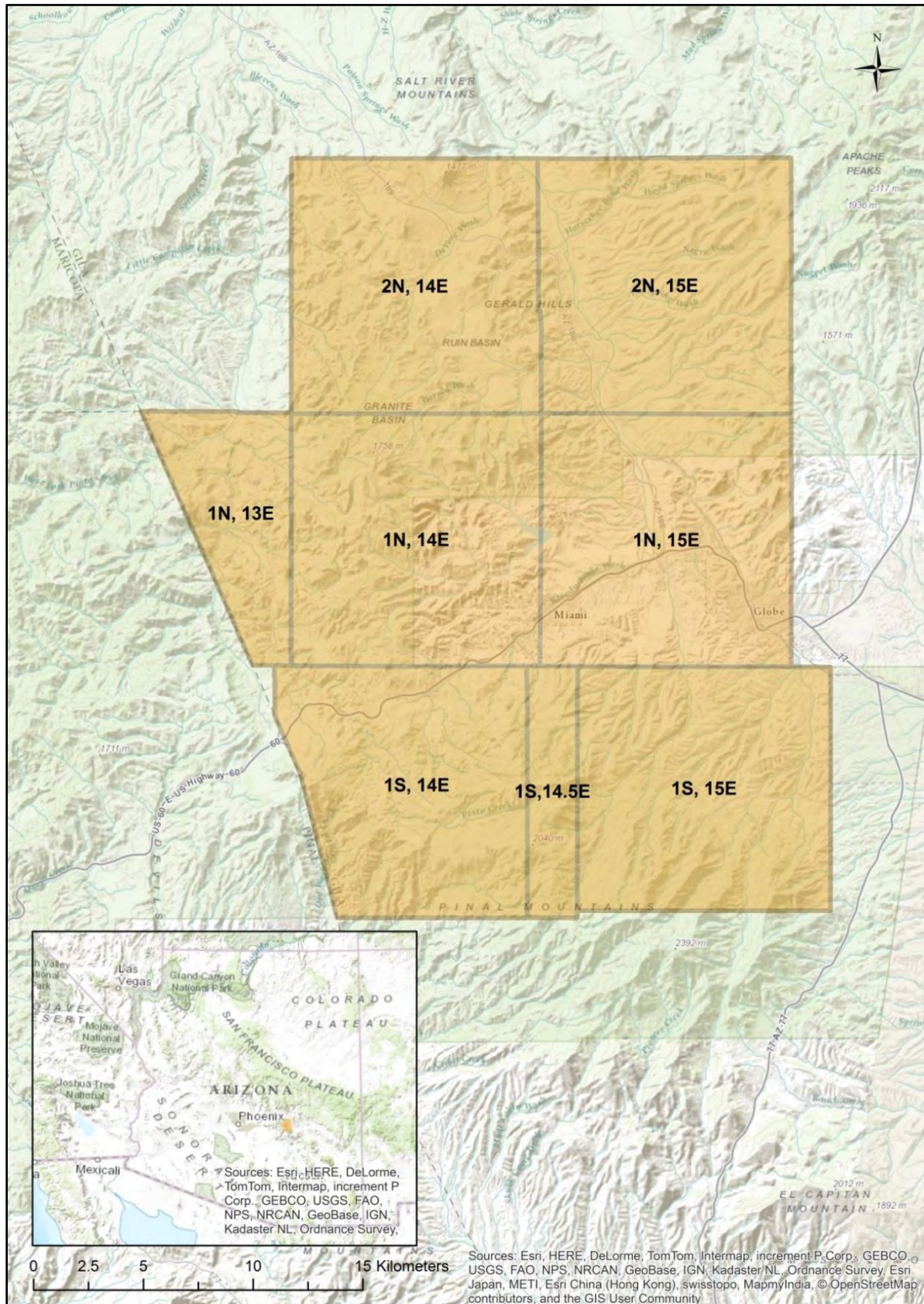
3.0   Modeling Domain

The first step of the SIP modeling exercise is to determine the area of the modeling domain—which is dependent on the number of sources to explicitly model and the size of the receptor network—in order to account for the areas of impact (U.S. EPA, 2014a). The modeling domain should, at a minimum, encompass the nonattainment area and include the sources thought most likely to cause or contribute to violations of the Primary SO_2 NAAQS in and around the nonattainment area. In the modeling exercise, all modeled receptors should exhibit modeled attainment of the NAAQS.

3.1   Determining Sources to explicitly model

ADEQ classifies the Miami Smelter as a major source pursuant to A.A.C. R18-2-101.75. The potential emission rates of the following pollutants are greater than major source thresholds: (i) particulate matter with an aerodynamic diameter less than 10 microns, (ii) sulfur dioxide, (iii) nitrogen oxides, (iv) carbon monoxide and (v) hazardous air pollutants.

Per EPA's guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions, Appendix A, there are two key criteria for the determination of sources to explicitly model: whether sources could cause or contribute to a NAAQS violation, and whether the background concentrations include the ambient impacts from sources other than the Smelter in and around the Miami NAA (U.S. EPA, 2014a).

3.1.1   Sources that Could Cause or Contribute to a NAAQS Violation in the Miami NAA

ADEQ has completed the emission inventory for sources within the Miami NAA and a 50-km buffer zone extending from the boundaries of the NAA based on data from 2009-2011. Figure 3-1 is a geographical representation of these sources. Table 3-3 lists the facility names that correspond to the numerical identifiers in figure 3-1. Tables 3-1 and 3-2 are an inventory of the annual emissions for the point sources within the Miami NAA and point sources within the 50-km buffer zone surrounding the Miami NAA, respectively. As shown in Tables 3-1 and 3-2, the primary smelting of copper ore has proven to be the most significant source category in contributing to SO_2 emissions in the Miami NAA and the surrounding 50 km buffer zone. The SO_2 emissions from the FMMI Miami Smelter represent more than 99.9 % of actual SO_2 emissions in the Miami NAA during 2009-2011. Similarly, the Asarco LLC Hayden Smelter accounted for 99.9% of actual SO_2 emissions in the Miami NAA 50 km buffer zone during 2009-2011. Excluding the two smelters, there are no sources that emitted more than 25 tons per year (TPY) of SO_2 during 2009-2011. Due to their insignificant emissions, it is very unlikely that sources other than the smelters could cause or contribute to a NAAQS violation in the Miami NAA.

A preliminary question is whether the Asarco LLC Hayden Smelter could cause or contribute to a NAAQS violation in the Miami NAA. As mountains surround Miami in all directions, ADEQ does not expect sources outside the Miami NAA to contribute to exceedances at monitors in the Miami planning area. ADEQ expects the Asarco LLC Hayden Smelter, located around 46 km south of the Miami Smelter, to have negligible ambient impacts on Miami NAA because of the following facts:

- The 7,850-foot Pinal Mountain topographically separates the Hayden Smelter from the Miami NAA;

- Preliminary analysis of air quality and meteorological data indicate that exceedances of the 1-hour SO_2 standard generally occur under light winds. These lights winds would typically follow mountain / valley drainage wind patterns and since the Hayden and Miami Smelters are located in two different air sheds, the influence of one on the other would likely be minimal;

- ADEQ modeled the Asarco's 1000-ft main stack with the existing emissions and determined that the modeled impact from Asarco on the FMMI's monitors is negligible;

- Asarco is proposing a Converter Retrofit Project (CRP), which is an integral part of Asarco's proposed plan to attain the 1-hour SO_2 Primary NAAQS. The CRP will result in a substantial reduction of SO_2 emissions from the Asarco's smelter operation, which further supports the fact Asarco will have negligible ambient impacts on the SO_2 State or Local Air Monitoring Stations (SLAMS) located in the Miami Planning Area in the future.

ADEQ proposed two separate 1-hour SO_2 nonattainment areas for Miami and Hayden and concluded that the Miami and Hayden smelters are the sources causing the violation in their respective nonattainment areas. EPA concurred with the ADEQ's proposal and conclusions. In the *Draft Technical Arizona Area Designations for the 2010 SO_2 Primary National Ambient Air Quality Standard* (U.S. EPA, 2013a), EPA concludes:

"The Freeport-McMoRan Miami Inc. (FMMI) copper smelter located less than 1,400 meters (less than 0.86 mile) away from the violating monitor is expected to be the source of the emissions causing the violation. Miami is essentially surrounded by mountains in all directions. Due to the constraints imposed by the complex terrain in the Miami area, the extent of the area exceeding the SO_2 standard is expected to be confined to a relatively small area around the main source of SO_2 emissions, the FMMI copper smelter. For the same reason, locations outside the particular valley containing Miami are not expected to contribute to Miami monitor's exceedances".

Table 3-1: 2011 Miami SO₂ Nonattainment Area Point Source Emission Inventory

Source	Longitude	Latitude	2009 Emissions (tons)	2010 Emissions (tons)	2011 Emissions (tons)	Facility PTE[2] (TPY)
Primary Metal Production						
Freeport-McMoRan Miami Smelter	-110.8565	33.412655	3401	3082	2545.06[3]	10600[4]
Mineral Products						
Freeport-McMoRan Miami Mine	-110.88677	33.399399	0.0670	2.063	7.053	7.412
BHP Copper-Pinto Valley Operations-Miami Unit	-110.8706	33.408741	0.01	0.01	0.004	0.03
BHP Copper- Pinto Valley Operations-PV Mine	-110.98421	33.417445	0.1907	0.035	0.073	14.062
Carlota Copper Co-Pinto Valley Mine	-110.98956	33.384777	19.6887	6.3241	3.3	3.41
Total Emissions			**3420.956**	**3090.432**	**2555.49**	**10624.9**

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[2] Facility equipment list PTE at 100% load capacity or federally enforceable permit limit in TPY as of December 31, 2011.

[3] Estimate based on FMMI sulfur balance methodology outlined in section 4.3 and attached as an appendix in section 10.3

[4] Maximum allowable emissions as reported in: A.A.C. R18-2-715(H)

Table 3-2: 2011 Miami SO$_2$ Nonattainment Area 50 km Buffer Zone Point Source Emission Inventory

Source	Longitude	Latitude	2009 Emissions (tons)	2010 Emissions (tons)	2011 Emissions (tons)	Facility PTE[5] (TPY)
Primary Metal Production						
Asarco LLC Hayden Concentrator	-110.77632	33.003378	0.0006	0.0019	0.002	0.03[6]
Asarco LLC Hayden Smelter	-110.77795	33.001796	23659.5	24187	21747	31435
Mineral Products						
Asarco Ray Mine Complex	-110.978	33.156	21.238	24.385	24.191	115.60
Omya Calcium Carbonate Quarry	-111.121	33.288	0.004	0.004	0.005	1.0643
Omya Arizona Limestone Quarry	-111.068	33.343	TS[7]	TS	TS	1.10375
Queen Creek Plant	-111.416	33.251	0.202	0.357	0.529	4.00375
Winkleman Plant #546	-110.691	32.876	1.02	1.34	1.35	2.40375
Industrial Equipment						
ACI Florence	-111.374	33.027	1.140	0.001	0.005	1.0327
Apache Junction Landfill	-111.529	33.37	0.020	0.060	0.080	27.44
Eyman Prison Complex	-111.338	33.033	0.090	0.080	0.090	2.65375
Florence Correctional Center	-111.371	33.043	0.058	0.405	0.075	1.934
Industrial Equipment: Airports and Helipads						
SRP-Stewart Mountain Dam	-111.549	33.5523			0.00131	0.0015[8]
Horse Mesa Dam NR2	-111.344	33.5906			0.00131	
Horse Mesa NR1	-111.357	33.5825			0.00131	
Mormon Flat Dam	-111.445	33.5534			0.00131	
Roosevelt Dam	-111.162	33.6079			0.00131	
Tonto Ranger Station	-111.124	33.6664			0.00131	
San Carlos Apache	-110.66736	33.35315			0.00131	
San Carlos	-110.4618	33.3778			0.00047	
Total Emissions			**23683.47**	**24213.68**	**21773.43**	**31592.2**

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[5] Facility equipment list PTE at 100% load capacity or federally enforceable permit limit in TPY as of December 31, 2011. Some sources have no established SO$_2$ emission limit listed in their respective permit so ADEQ calculated a PTE for these sources based on 100% load capacity of equipment plus de minimis for small equipment not listed in the permit (where applicable). Sources without permitted equipment with the potential to emit SO$_2$ emissions were excluded from the point source inventory. Permits and PTE calculations are available for all point sources included in this inventory.

[6] Current Permit M070399P1-99 expired on 5/30/2006. PTE was determined based on the PTE calculations workbook maintained on ADEQ servers and located in the directory with the aforementioned permit. The facility submitted an application for renewal of this permit (LTF No. 38459), but ADEQ denied this permit application as the Asarco mine and Smelter should have a single permit since they are adjacent to each other. For this reason, the Asarco smelter and concentrator are listed as separate entities.

[7] TS indicates the facility is still permitted, but Temporarily Shutdown

[8] In surveys completed by PCAQCD, PDEQ and MCAQD, only the SRP Stewart Mountain Dam facility had a permitted limit for SO$_2$ emissions. The other airport and heliport sources voluntarily reported SO$_2$ Emissions to their respective permitting agency in their annual emission inventory questionnaire.
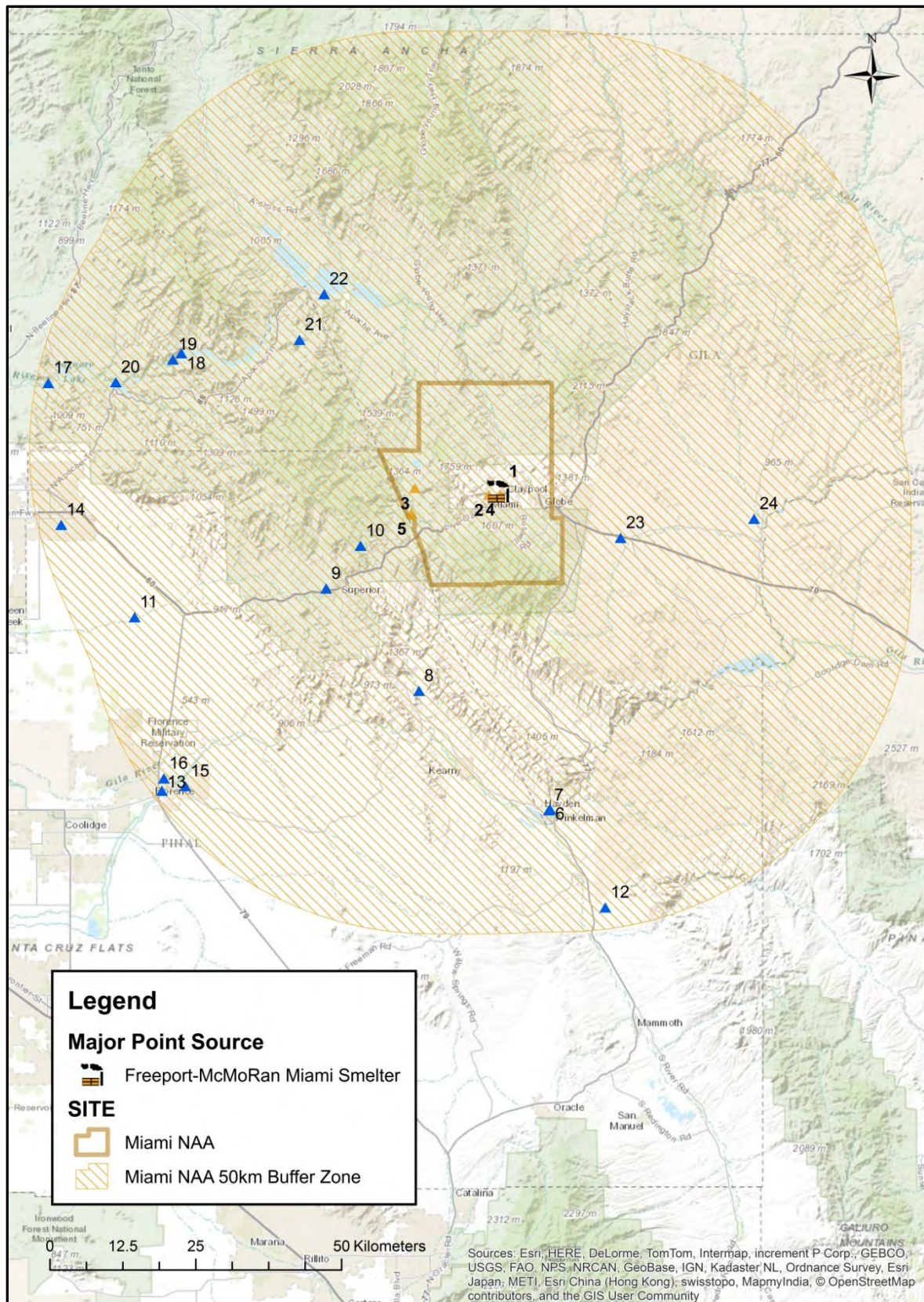
Table 3-3: Miami Nonattainment Area and 50-km Buffer Zone Point Source Map Identification Table

ID	Facility Name	ID	Facility Name
1	Freeport-McMoRan Miami Smelter	13	ACI Florence
2	Freeport-McMoRan Miami Mine	14	Apache Junction Landfill
3	BHP-Copper Valley Operations-Miami Unit	15	Eyman Prison Complex
4	Capstone Copper, Pinto Valley Unit	16	Florence Correctional Center
5	KGHM Copper Company	17	SRP-Stewart Mountain Dam
6	Asarco LLC Hayden Concentrator	18	Horse Mesa Dam NR2
7	Asarco LLC Hayden Smelter	19	Horse Mesa NR1
8	Asarco Ray Mine Complex	20	Mormon Flat Dam
9	Omya Calcium Carbonate Quarry	21	Roosevelt Dam
10	Omya Arizona Limestone Quarry	22	Tonto Ranger Station
11	Queen Creek Plant	23	San Carlos Apache
12	Winkleman Plan #546	24	San Carlos

3.1.2 Sources Impacts that Could Be Represented via Background Concentrations

Per Appendix W (U.S. EPA, 2005), background air quality includes pollutant concentrations due to: (i) natural sources; (ii) nearby sources other than the one(s) currently under consideration; and (iii) unidentified sources. As previously discussed, the Miami Smelter is the sole source that contributes to a NAAQS violation in the Miami NAA. In addition, sources that may have a potential contribution to ambient air quality in the immediate vicinity of the Miami Smelter include: emissions due to the low traffic levels and residential heating during the heating season; nearby industrial facilities; and regional sources.

To calculate the background concentration of SO_2 for the SIP modeling, ADEQ proposes using the monitoring data collected from source-oriented monitors located near FMMI Miami Smelter during the shutdown of the smelter operations.

Four point sources are located in the Miami vicinity, and while they contribute to background concentrations, the contributions of these point sources to background air quality in the immediate vicinity of the Miami Smelter are negligible because such impacts cannot be discerned from local ambient monitoring data collected during FMMI shutdown periods. These sources, all "minor sources" with respect to permitting, are:

- Capstone Copper, Pinto Valley Unit (formerly BHP Copper Pinto Valley Operations PV-Unit);
- BHP Copper, Miami Unit;
- KGHM Copper Company (formerly Carlota Copper Company-Pinto Valley Mine); and
- FMMI Mine Operations

The ASARCO copper smelter in Hayden is a "major source" located 46 km south of FMMI's operations. As discussed previously, given the distance and topography, this source is expected to be a minor contributor to background air quality. An analysis of ambient SO_2 concentrations measured at the three monitoring stations located near the Miami Smelter confirms that the Hayden Smelter is not a significant contributor to concentrations measured in the Miami NAA. Further evaluation of background air quality measured at the FMMI's monitor during periods of Miami Smelter shutdowns demonstrates that there is no distinguishable difference in background concentration with respect to wind direction, as shown in Figure 3-2.

Accordingly, ADEQ believes the background value during FMMI shutdown periods should reflect the ambient impacts from other regional/local sources on the Miami NAA (if any); in other words, the ambient impacts from these sources will be represented via background concentrations.

Based on the above discussions, the Miami Smelter facility is the only source of concern. ADEQ proposes modeling the Miami Smelter exclusively and taking the impacts from other sources into account with a representative background concentration.

3.2   Receptor Grid

FMMI has developed a modeling domain with a total coverage of approximately 24.6 kilometers by 28.7 kilometers, centered on the Miami Smelter facility and covering the Miami nonattainment area. The modeling domain covers portions of Gila County and encompasses the Miami NAA. Figure 3-3 presents the entire modeling domain on a map of the area. Figure 3-4 presents the receptors within 10 km of the facility.

FMMI placed 8,917 receptors in five nested Cartesian grids in the modeling domain, including 2,575 fence line receptors in the grid and spaced these at intervals of no more than 25 meters and two fine grids around high impact receptor locations. Receptor spacing is as follows for each of the five grids, with each centered on the Miami Smelter:

- Two fine grids = 25 meters, covering areas where the 4th highest 1-Hour (H4H) predicted concentration is greatest
- Inner grid = 100 meters, covering an area of 4,700 meters by 4,640 meters
- Second grid = 200 meters, covering an area of 11,500 meters by 11,440 meters
- Third grid = 500 meters, covering an area of 16,700 meters by 16,640 meters
- Fourth grid = 1,000 meters, covering an approximate area of 24,600 meters by 28,700 meters

The 2,575 fence line receptors follow the facility's Ambient Air Boundary (AAB), which is shown in Figure 3-3. The AAB is defined by either a physical fence or a slope greater than or equal to 3 Horizontal (H):1 Vertical (V). The majority of the facility is delineated by a fence, the exceptions include areas along the southern border of the facility (highlighted in green in Figure 3-3). These four segments are areas where the existing gradient (≥3H:1V) would preclude the public from accessing the facility.

FMMI moved receptors immediately outside of the Miami NAA to the planning area boundary to ensure the receptor grid represented the full NAA domain. FMMI also placed additional receptors at the locations of learning centers (such as schools) and existing ambient air monitoring equipment.

FMMI used EPA's AERMAP software tool (version 11103; U.S. EPA, 2011b) to estimate receptor elevations and hill heights. AERMAP is the terrain preprocessor for AERMOD (discussed in Section 4) and uses the following procedure to assign elevations to a receptor:

- For each receptor, the program searches through the U.S. Geological Survey (USGS) input files to determine the two profiles (longitude or easting) that straddle this receptor;
- For each of these two profiles, the program then searches through the nodes in the USGS input files to determine which two rows (latitudes or northings) straddle the receptor;
- The program then calculates the coordinates of these four points and reads the elevations for these four points;
- The AERMAP preprocessor uses a 2-dimensional distance-weighted interpolation to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

FMMI used 10-meter USGS National Elevation Dataset (NED) data as inputs to AERMAP. The USGS produced NED data from digitized map contours or from manual or automated scanning of aerial photographs. A 10-meter NED data file consists of a regular array of elevations referenced horizontally in

the UTM coordinate system, with a uniform horizontal spacing of 10 meters. The 1983 North American Datum (NAD83) was the basis of the NED data used for this analysis. ADEQ will provide AERMAP input and output files on CD-ROM per the nomenclature described in Appendix A.

Figure 3-2: Ambient SO₂ Concentrations with Respect to Wind Direction during FMMI Shutdown Periods
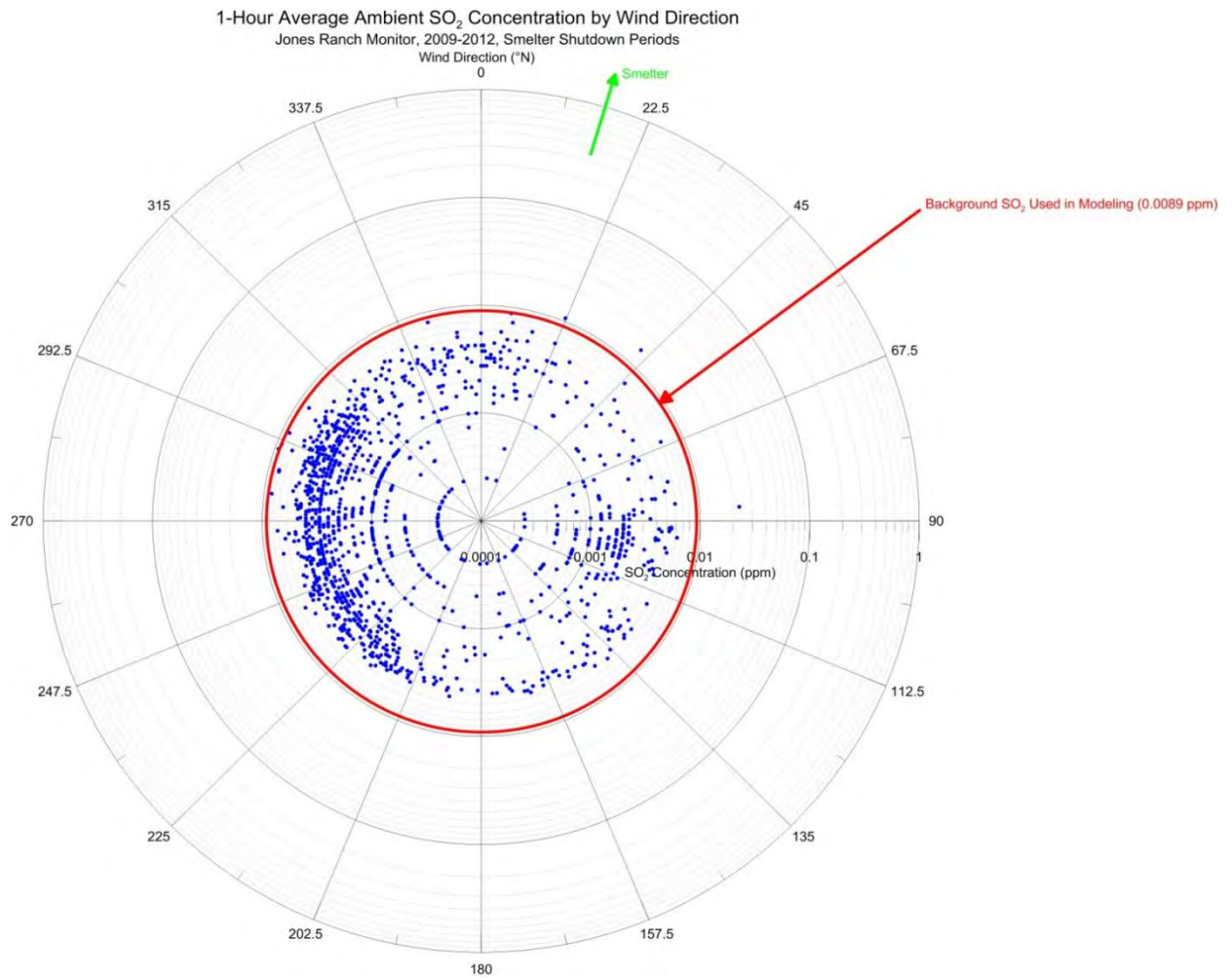
Figure 3-3: FMMI's Ambient Air Boundary

On Wednesday, February 22rd Arizona Department of Environmental Quality (ADEQ) personnel performed an on-site tour of the ambient air boundary (AAB) used for the Miami SO₂ nonattainment plan. During this tour ADEQ personnel traveled and documented the portions of the AAB that were reasonably accessible.

In general, upon visiting the site and inspecting the AAB perimeter, ADEQ has determined the boundary represents a practical ability to preclude public access. This conclusion is a result of the observations and discussions outlined in Appendix M of this modeling TSD.

Figure 3-4 Full Receptor Grid

Figure 3-4 Full Receptor Grid
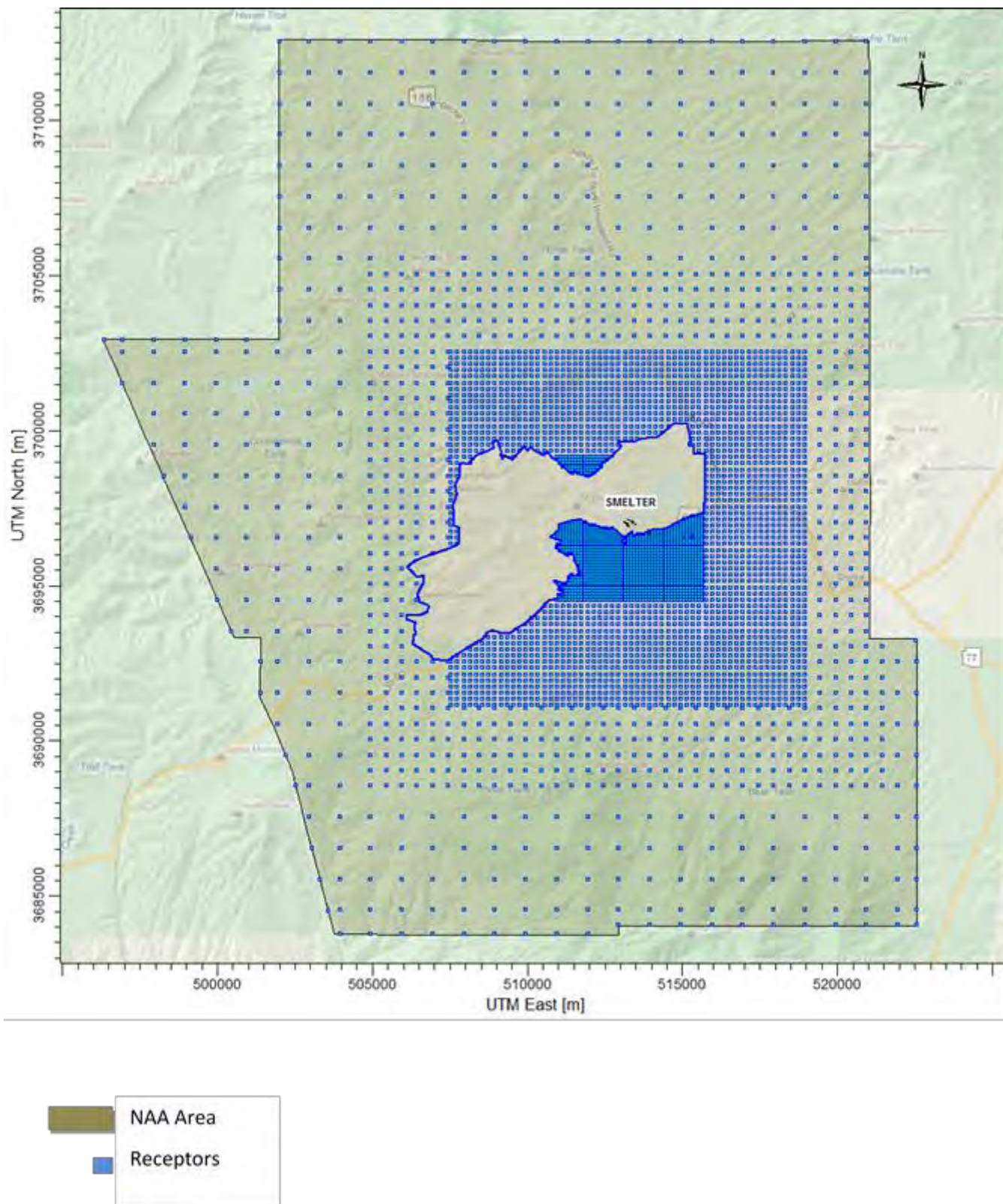
Figure 3-5: Fine Receptor Grid
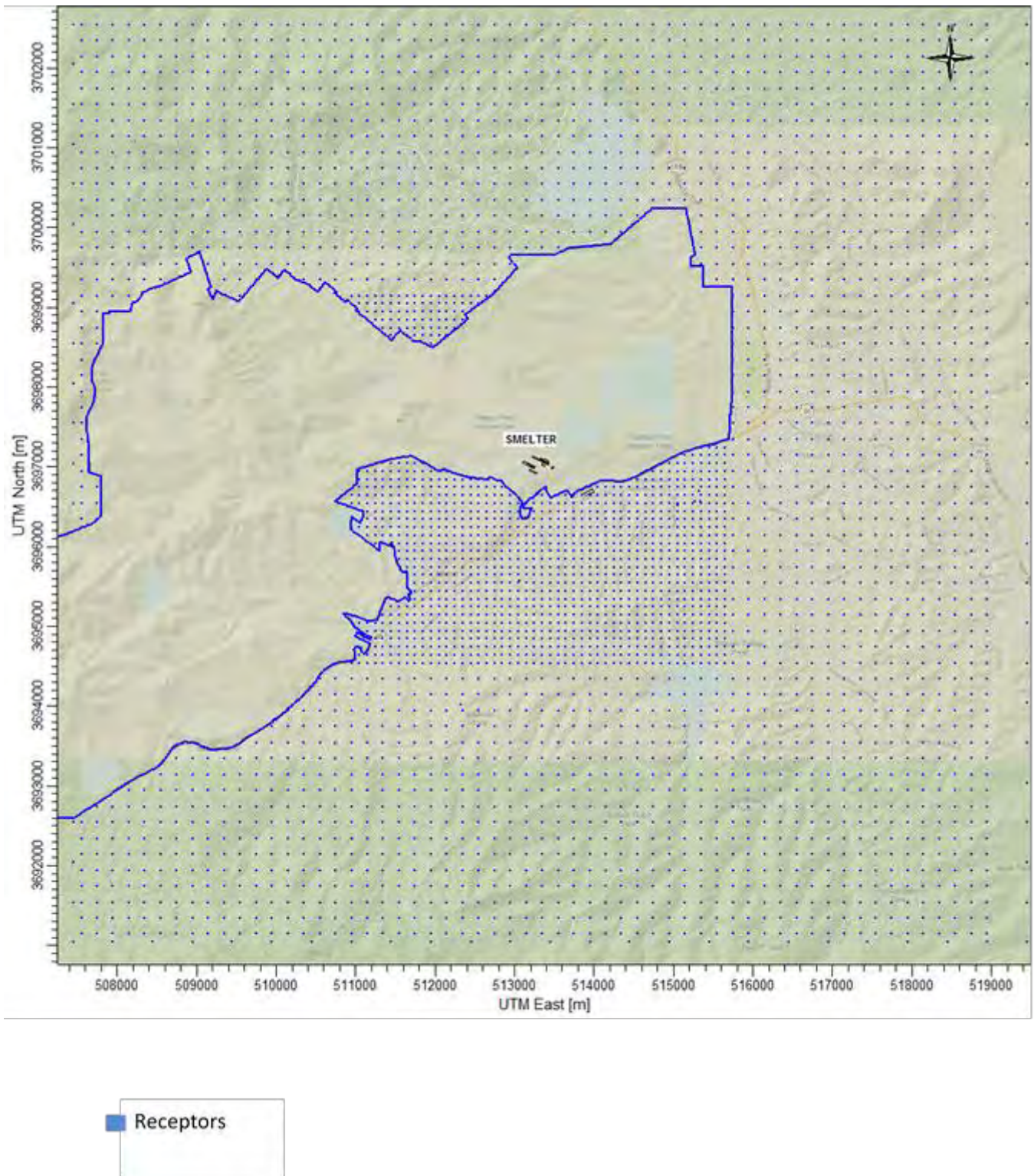
4.0   Model Selection

As outlined in the EPA's Modeling Guidance for Nonattainment Areas (U.S. EPA, 2014a), for SIP development under the 2010 primary SO₂ NAAQS, American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) or one of the other preferred models in Appendix W should be used for near-field dispersion modeling unless use of an alternative model can be justified. EPA anticipates that AERMOD will be the model of choice for most applications but there may be particular applications where other preferred models, such as Buoyant Line and Point Source (BLP) model would be used.

4.1   AERMOD

FMMI used American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (version 14134; U.S. EPA, 2014b) to predict ambient concentrations in simple, complex and intermediate terrain. AERMOD is the recommended sequential model in EPA's Guideline on Air Quality Models (GAQM) (40 CFR Pt. 51, Appendix W) (U.S. EPA, 2005) for near-field analysis.

There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET (version 14134; U.S. EPA, 2014c), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP (version 11103; U.S. EPA, 2011b), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include AERSURFACE (Version 13016; U.S. EPA, 2013b), a surface characteristics preprocessor; and BPIPPRIME, a multi-building dimensions program incorporating the Good Engineering Practice technical procedures for PRIME applications (U.S. EPA, 2004a). FMMI used the regulatory default option. This option commands AERMOD to:

- Use the elevated terrain algorithms requiring input of terrain height data for receptors and emission sources;
- Use stack tip downwash (building downwash automatically overrides);
- Use the calms processing routines;
- Use buoyancy-induced dispersion;
- Use the missing meteorological data processing routines.

4.2   BLP

The fugitive emissions from the roofline are one of primary sources of SO₂ emissions at the Miami Smelter. Almost half of the SO₂ emissions from the Miami Smelter are emitted from roof vents. FMMI characterizes the roofline fugitive emissions as stationary buoyant line sources as these roof vents provide for the ventilation of various smelter operations, and the temperature of the roof vent exhaust is characteristically high due to the heat of those operations. Per the GAQM (US EPA, 2005), BLP (version 99176; Schulman and Scire, 1980) is EPA's recommended sequential dispersion model for emissions from buoyant line sources such as roof vents[9]. Therefore, FMMI considered the buoyant line source technique in the modeling approach. The features of the BLP model include:
- Enhanced plume rise of buoyant line sources compared to point sources (less entrainment of ambient air);
- Plume enhancement due to multiple line sources;

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[9] EPA has proposed changes to the Guideline on Air Quality Models (80 FR 45340) that would replace BLP with AERMOD as the preferred model for addressing buoyant line sources.

- Line source rise dependency on wind direction, line length, the number of parallel lines, and their spacing the number of parallel lines, and their spacing;
- Effect of vertical wind shear on plume rise; and
- Incorporation of building downwash in both plume rise and dispersion calculations.

4.3 Hybrid Modeling Approach

As noted previously, BLP is EPA's recommended sequential dispersion model for emissions from buoyant line sources such as roof vents as noted in the GAQM. Because the project includes roof vents, the buoyant line source technique was considered in the modeling approach. Although the most recent version of AERMOD (v15181) is equipped with a buoyant line source algorithm, this version was not used for modeling the roof vents in this project because:

- Version 14134 of AERMOD was the latest version available when modeling began in support of the SIP. Version 14134 is not equipped with a buoyant line source algorithm. The BLP/AERMOD hybrid approach was conducted for this reason. (see Section 4.4);
- The hybrid approach is appropriate for the Miami Smelter based on the results from the model performance study; and
- While EPA's recently proposed changes to the GAQM include replacing the BLP model with AERMOD (80 FR 45340), BLP remains the preferred model for addressing buoyant line sources and the performance of the buoyant line source algorithms in AERMOD is still under review and testing.

While AERMOD version 14134 allows for line source inputs, the line source type is neither the buoyant line source type addressed by BLP nor subject to building downwash. AERMOD directly addresses building downwash only for point source releases. For these reasons, BLP remains EPA's preferred dispersion model for emissions from buoyant line sources and was evaluated for use in the Miami Smelter modeling.

However, BLP has several limitations that may affect the accuracy of the impacts from FMMI's roof vents. For instance, BLP cannot adequately address complex terrain, presenting a major hurdle for the direct application of BLP in the FMMI case. The GAQM recommends using BLP for simple terrain (U.S. EPA, 2005) while the terrain surrounding the FMMI facility has complex features. Moreover, BLP assumes all buildings are equally long and are equally separated. BLP assumes the roof vents are aligned parallel to each other and have identical buoyancies. BLP also uses the old MPRM/RAMMET meteorological files that use the old Pasquill-Gifford (P-G) stability class procedure and BLP does not have a calms processing routine.

To handle such unique modeling problems associated with the roofline fugitive emissions, FMMI proposed a two-step hybrid approach to couple the BLP model with AERMOD:

- Use the BLP model to estimate hourly line source final plume rise and sigma-z from the Smelter roof vents based on line source buoyancy parameter(s), physical dimensions, source orientation as well as hourly meteorological conditions;
- Apply the BLP-predicted final plume heights and sigma-z in AERMOD with hourly volume source approach.

Detailed methodologies for estimating final plume heights and sigma-z are contained in Section 5.2.3.2. ADEQ determined that the hybrid approach, while resource intensive (particularly for meteorological data processing), is the best approach to address both buoyant line source characteristics and the effects of complex terrain.

This Hybrid Approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, relying instead on AERMOD's implementation of complex terrain and meteorology, and

incorporates EPA's preferred plume rise and building downwash calculations for buoyant line sources for which AERMOD version 14134 is not equipped to perform. The hybrid approach of BLP/AERMOD will be applied for modeling roofline fugitive emissions. AERMOD will be used for modeling all other sources, including main stacks as well as other industrial sources. Figure 4-1 presents the flowchart of proposed modeling system framework for the SIP attainment demonstration.

EPA applied a similar hybrid approach in its Residual Risk Assessment for Coke Oven National Emission Standards for Hazardous Air Pollutants (EPA, 2004b). In that assessment, EPA coupled the BLP model with the Industrial Source Complex Short Term (ISCST3) model to evaluate the fate and transport of hazardous air pollutants (HAPs) from coke oven batteries. EPA used the BLP model to estimate the plume height and then used that value as an input to the ISCST3 model. Because AERMOD has replaced ISCST3 as EPA's preferred regulatory model for near-field application, the hybrid approach ADEQ proposes is consistent with the approach EPA previously used. In addition, EPA's own assessment of AERMOD's shortcomings had led the Agency to propose the inclusion of a buoyant line algorithm for use in AERMOD (80 FR 45340) that is conceptually similar to the modeling approach that ADEQ has determined to be most appropriate in this case.

To demonstrate that the hybrid AERMOD/BLP modeling approach is the best performing model for the unique conditions present at the Miami Smelter, FMMI conducted a performance evaluation, which is provided in Section 4.4 and Appendix C. ADEQ reviewed FMMI's performance evaluation and determined that the hybrid model is a better performing model than either AERMOD or BLP alone. As a result, ADEQ concluded that the use of the hybrid model as an alternative model is appropriate for the Miami NAA.

Figure 4-1: Flowchart of Proposed Modeling System Framwork for SIP Demonstration
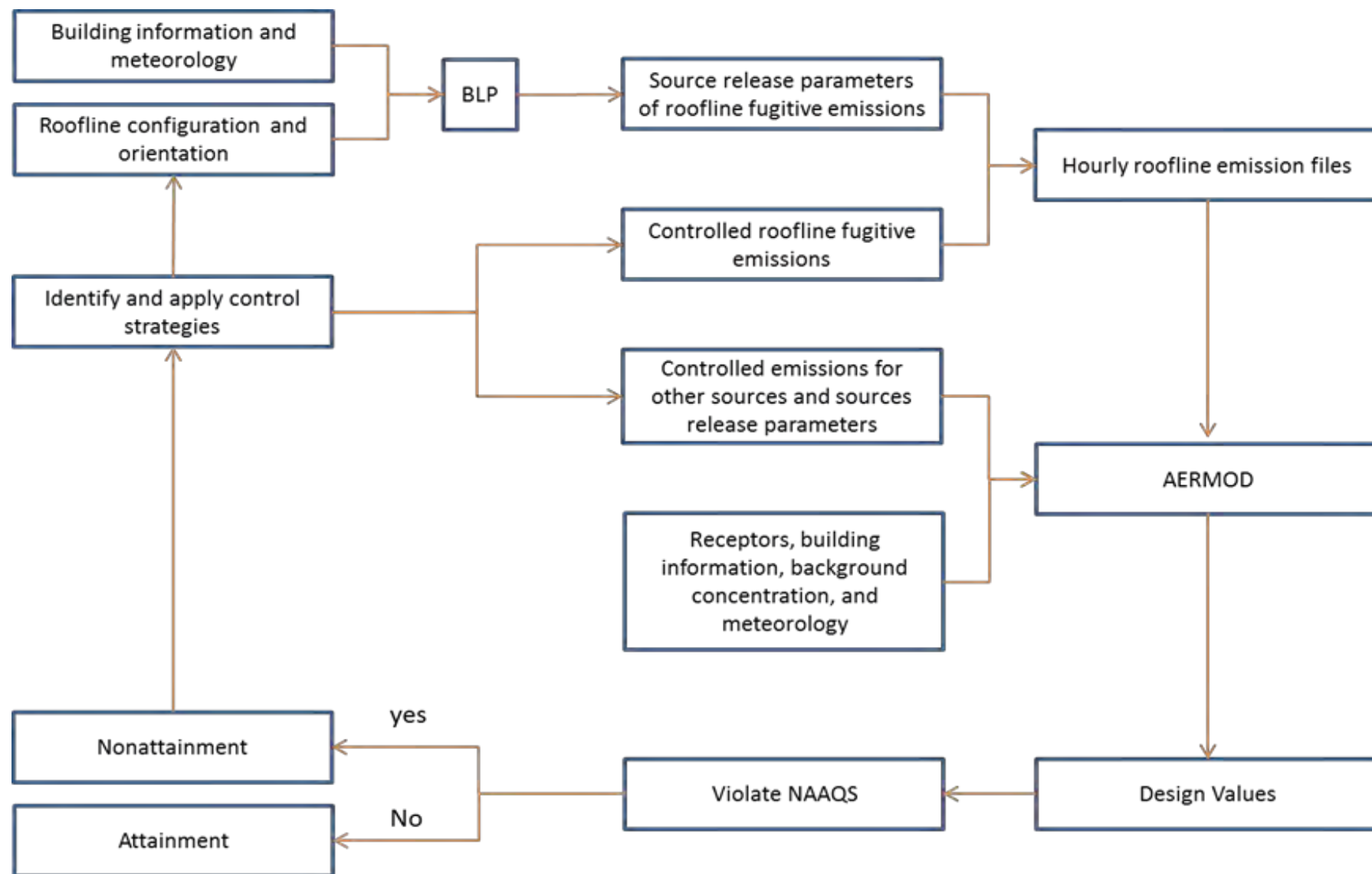
4.4 Performance Evaluation of the Hybrid BLP/AERMOD Approach

As discussed above, due to the physical configuration of the Smelter (i.e., the roof vents that are buoyant line sources) and the proximity of complex terrain to the Smelter, an alternative model that employs relevant and appropriate features of EPA's preferred models is expected to perform better for this facility than EPA's preferred dispersion models alone. To demonstrate that the Hybrid Approach is a better performing alternative model within the meaning of section 3.2.2 of the GAQM, FMMI executed a performance evaluation to compare predicted ambient concentrations measured at the three ambient monitoring sites listed in Table 4- 1 and shown in Figure 6-1.

Table 4-1: Coordinates for Ambient SO₂ Monitoring Sites

Monitor	UTM Easting (m)	UTM Northing (m)
Jones Ranch	512,328.4	3,694,022.4
Ridgeline	513,066.1	3,695,568.2
Miami	511,674.8	3,695,370.6

Section 3.2.2 of the GAQM provides recommendations for determining acceptability of an alternative method in lieu of a preferred method. Specifically, the GAQM identifies the following three conditions under which an alternative model may be used:

1. A demonstration that the alternative model produces concentration estimates equivalent to the estimates obtained using a preferred model;
2. A statistical performance evaluation using measured air quality data that demonstrates the alternative model performs better for the given application than a comparable preferred model; or
3. The preferred model is less appropriate for the specific application, or there is no preferred model for the specific application.

FMMI conducted a performance evaluation under the second condition, for situations where an alternative model performs better than a comparable preferred model, whereby model-predicted concentrations are compared to relevant measured air quality data. The following five modeling approaches were evaluated based on implementation of EPA's preferred BLP and AERMOD dispersion models, both of which have features relevant to modeling the Smelter:

- Additive BLP/AERMOD, Multi-Vent BLP Plume Rise
- Additive BLP/AERMOD, Single-Vent BLP Plume Rise
- Hybrid BLP/AERMOD
- AERMOD, Roof Vents with Downwash
- AERMOD, Roof Vents without Downwash

The results showed that the Hybrid BLP/AERMOD approach performed the best at the worst-case monitoring location (Jones Ranch). Accordingly, the performance evaluation demonstrates that the alternative hybrid approach is more appropriate than a preferred model alone.

A detailed discussion on the model performance evaluation methodology and results including quantile-quantile plots (q-q plots) is included in a technical memorandum provided in Appendix C.

5.0   Source Inputs

This section discusses source characterization to develop appropriate source inputs for dispersion modeling with the AERMOD/BLP modeling system.

- Section 5.1 provides an overview of Miami Smelter operations and proposed Smelter upgrade project;
- Section 5.2 provides details on current and future source configuration, source types and source release parameters;
- Section 5.3 discusses Good Engineering Practice (GEP) stack heights;
- Section 5.4 provides details on urban/rural determination of the sources.

5.1   FMMI Smelter Operations and Proposed Smelter Upgrade Project

The Miami Smelter in Claypool, AZ, operated by FMMI, currently consists of five roof vents that account for a significant proportion of the Smelter's current sulfur dioxide (SO_2) emissions (approximately 44% of Smelter SO_2 emissions during the period from May 2013 through April 2014). The roof vents are located above the IsaSmelt® (Isa) vessel, the Electric Furnace (ELF), the converter aisle (2 vents), and the anode aisle. The three vents over the converter aisle and anode aisle are aligned along the length of the Smelter building. The shorter vents over the Isa and ELF are oriented perpendicular to the converter aisle and anode aisle vents. In addition to the roof vents, three stacks (Acid Plant Tail Gas Stack, Vent Fume Stack, and Bypass Stack) are located at the Smelter. The locations of the existing vents and stacks are shown in Figure 5-1.

On July 3, 2013, FMMI submitted a Class I Significant Permit Revision to ADEQ, proposing upgrades to enhance emission capture and control systems as well as the increase of operational efficiency and capacity at its Miami Smelter facility (hereafter referred to as the "Smelter Upgrade Project"). The Smelter Upgrade Project will increase the capture of process gasses and fugitive emissions. The Smelter will process the captured emissions in its upgraded acid plant or treat them using standard control methods (e.g., enhanced scrubbing, sorbent injection followed by filtration).

The Smelter's air quality permit authorizes operation with a maximum throughput of 1,000,000 tons per year of copper concentrate and the implementation of the following process and capture/control improvements:

- Upgrade the bedding plant conveyor belts and Isa furnace feed paddle mixers;
- Replace the existing Isa;
- Upgrade the Isa furnace cooling and emissions control system (i.e., lance seal, feed port hood, and tapping hood controls);
- Upgrade the converter emissions control system (i.e., reconfiguring the roofline to capture emissions and route them to a new Aisle Scrubber including stack);
- Upgrade the electric furnace emissions control system (i.e., tapping hood controls);

Figure 5-1: Miami Smelter Stacks and Roof Vents

Figure 5-1: Miami Smelter Stacks and Roof Vents
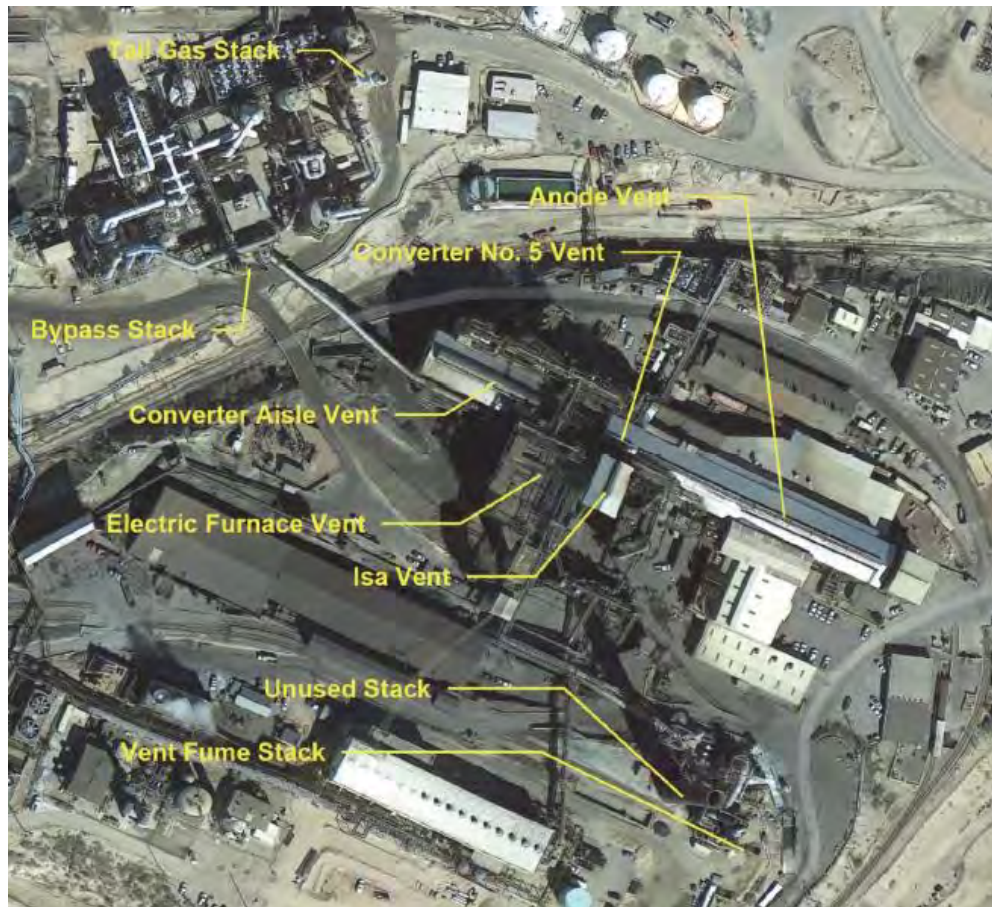
- Upgrade the anode furnaces and utility vessel (also known as the mold barrel) emissions control system (i.e., process gas collection system, mouth covers, replacement of utility vessel, new baghouse ducted to the new Aisle Scrubber, new hydrated lime silo, and new baghouse dust return system to the electric furnace);

- Increase operational flexibility via authorization of 1,000,000 dry tons per year of New Metal Bearing Material (NMBM) throughput capacity;

- Increase Acid Plant capacity to accommodate the authorized concentrate throughput capacity (i.e., upgraded cooling system, new converter bed, new blower, and new SO_3 cooler);

- Upgrade the Vent Fume Scrubber and Acid Plant Tail Gas Scrubber to caustic use;

- Add three new Wet Electrostatic Precipitator (WESP) modules at the vent fume control system;

- Enclose the temporary on-site concentrate storage piles with an enclosed structure;

- Increase the height of the Vent Fume Stack and Tail Gas Stack; and

- Other support facility changes.

On July 21, 2014, ADEQ issued a Class I Significant Permit Revisions (No. 58409) to FMMI authorizing the Smelter Upgrade Project. FMMI has since committed to an additional modification that will direct Acid

Plant Bypass emissions to the proposed Aisle Scrubber for treatment. Thus, the Bypass Stack in the future would only be used during extraordinary emergency situations.

The future Smelter configuration will consist of four roof vents and three stacks. The roof vent located above Converters 2 through 5 will be reconfigured as part of a collection system for fugitive emissions. In addition, the anode and mold vessels will be modified to collect emissions generated during the refining of blister copper. The collected emissions from the converter roofline and anode vessel capture systems will be routed to the new Aisle Scrubber to treat the captured SO_2 emissions. The roofline above the non-functional Inspiration Converter and the Anode Aisle will still vent to the atmosphere. Additionally, Acid Plant Bypass emissions will be routed to the Aisle Scrubber for treatment prior to discharge to atmosphere.

5.2   Source Configuration, Types and Release Parameters

5.2.1   Existing Stacks (Point Sources)

Table 5-1 presents the stack and exhaust parameters modeled for existing stacks located at the facility. FMMI identified coordinates for the stacks by mapping the site plan to rectified aerial photographs of the site. FMMI projected the UTM coordinates of each stack to UTM Zone 12, NAD83. Figure 5-2 shows the location of each existing stack associated with the Smelter and the acid plant. Figure 5-3 shows the location of each existing stack in the rod plant. Figure 5-4 shows the locations for other existing stacks.

5.2.2   Existing Line Sources

Table 5-2 presents the source parameters modeled for the existing line source located at the Rod Plant. FMMI identified coordinates for the sources by mapping the site plan to rectified aerial photographs of the site. FMMI projected the UTM coordinates of each source to UTM Zone 12, NAD83. Figure 5-5 shows the line source location on the simplified plot plan.

Table 5-1: Stack and Exhaust Parameters, Existing Stacks

Source ID	Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp. (ºK)
TAILSTK	Tail Stack	513194.6	3697246	1081.99	60.96	1.83	24.08	323.0
VENTSTK	Vent Fume Stack	513354.5	3696918	1099.74	48.8	3.048	20.85	amb
APPREHT	Acid Plant Preheater	513175.7	3697200	1085.00	2.1	0.5	1.0	361.0
ISAAUXBLR	Isa Auxiliary Boiler	513352.3	3697058	1085.00	32.55	0.61	6.39	571.0
CHRMWTH	Change Room Water Heater	513467.6	3696975	1080.24	4.67	0.203	4.01	533.0
RPTB	Rod Plant Thermal Breaker	513933.2	3696689	1021.00	3.05	0.01	0.01	298.0
RPSFS	Rod Plant Shaft Furnace	513879.2	3696663	1021.00	19.81	1.77	7.68	644.0
CMPRS1	Diesel Compressor	513278.4	3696934	1099.46	5.0	0.3048	6.096	478.0
CMPRS2	Diesel Compressor	513414.9	3697101	1080.50	5.0	0.3048	6.096	478.0
SLAG	Slag Storage Area	512838.8	3697516	1089.70	0.0	13.3	1.45	1333
SCRNENG	Screening Engine	512620.4	3697457	1099.43	1.372	0.076	6.096	478.0
ISA_EGEN	Isa Emer. Gen.	513393.7	3697032	1085.53	3.048	0.238	6.096	477.6
SMLTEGEN	Converter Emer. Gen.	513293.6	3697165	1085.98	6.492	0.3048	6.096	477.6
EPUMP	Emergency Water Pump	513358.4	3697161	1086.32	1.372	0.128	6.096	477.6
MS_EGEN	Server Room Emer. Gen.	511771.8	3697718	1165.58	1.372	0.128	6.096	477.6
MH_EGEN	Moonshine Hill Emer. Gen.	511544.2	3697586	1221.75	1.372	0.128	6.096	477.6
CO_EGEN	Communications Emer. Gen.	514628.7	3697005	1012.00	1.372	0.128	6.096	477.6
RT_EGEN	Radio Tower Emer. Gen.	511549.2	3697592	1221.79	1.372	0.128	6.096	477.6
SGH_EGEN	Guardhouse Emer. Gen.	513744.2	3696758	1021.00	1.372	0.128	6.096	477.6
CPUMP	Hood Emer. Pump	513363.3	3697054	1086.32	1.372	0.128	6.096	477.6
BYPASS	Bypass Stack	513139.0	3697165	1084.6	60.96	2.286	12.10	-322.5[10]

Table 5-2: Source Parameters, Existing Line Sources

Source ID	Line Source	Starting UTM Easting (m)	Starting UTM Northing (m)	Ending UTM Easting (m)	Ending UTM Northing (m)	Base Elevation (m)	Release Height (m)
RPRFVENT	Rod Plant Roof Vent	513878.3	3696657	513947.6	3696687	1021	12.2

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[10] Negative temperature indicates temperature above ambient, zero temperature indicates ambient temperature

Figure 5-2: Smelter Point and Acid Plant Sources and Buildings
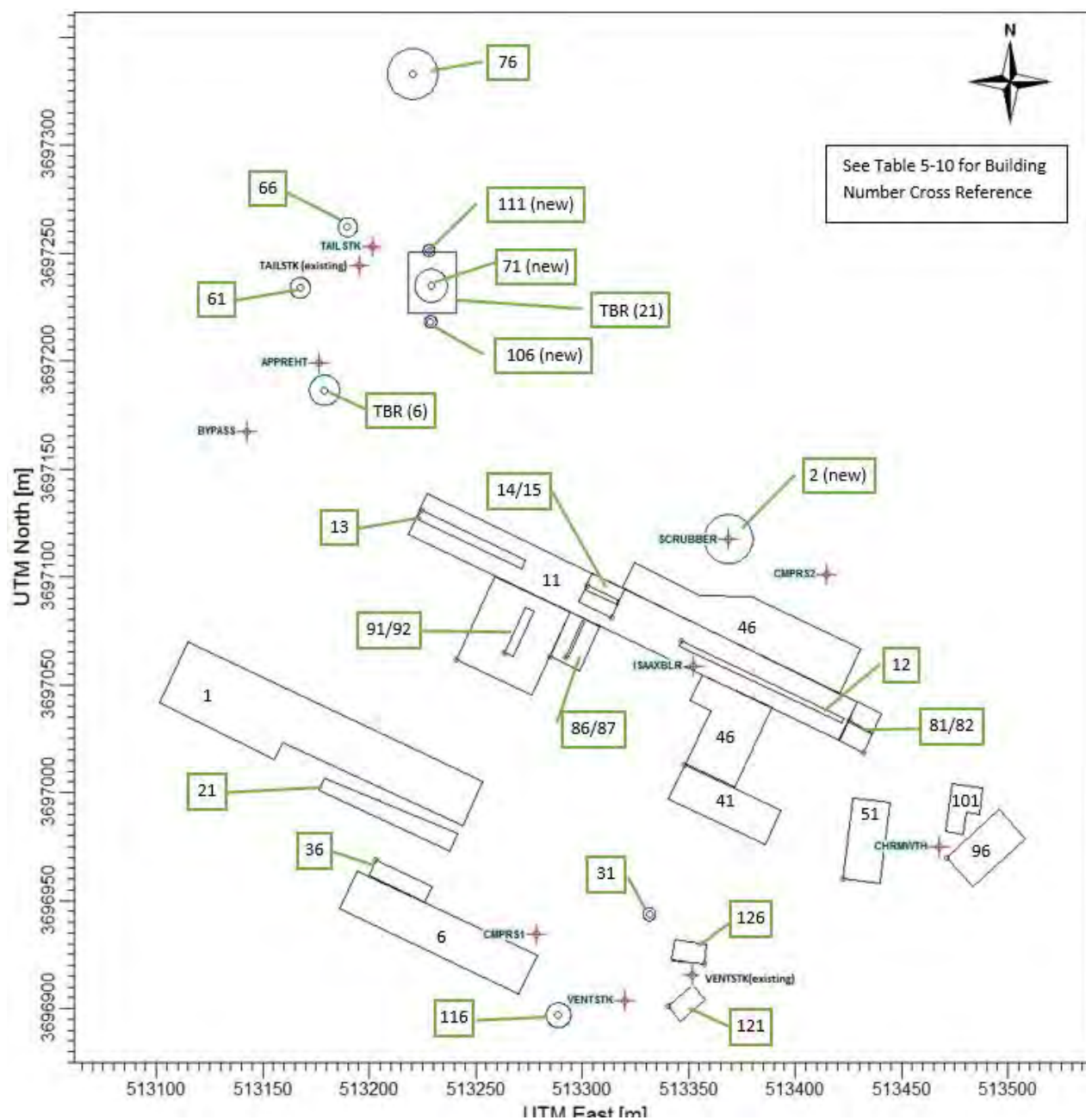
TBR = To be removed (index corresponds to performance runs)

Figure 5-3: Rod Plant Point Sources and Buildings

See Table 5-11 for Building Number Cross Reference

N

RPTB

RPRFVENT

RPSFS

UTM North [m]

UTM East [m]

Figure 5-4: Locations of Other Existing Stacks
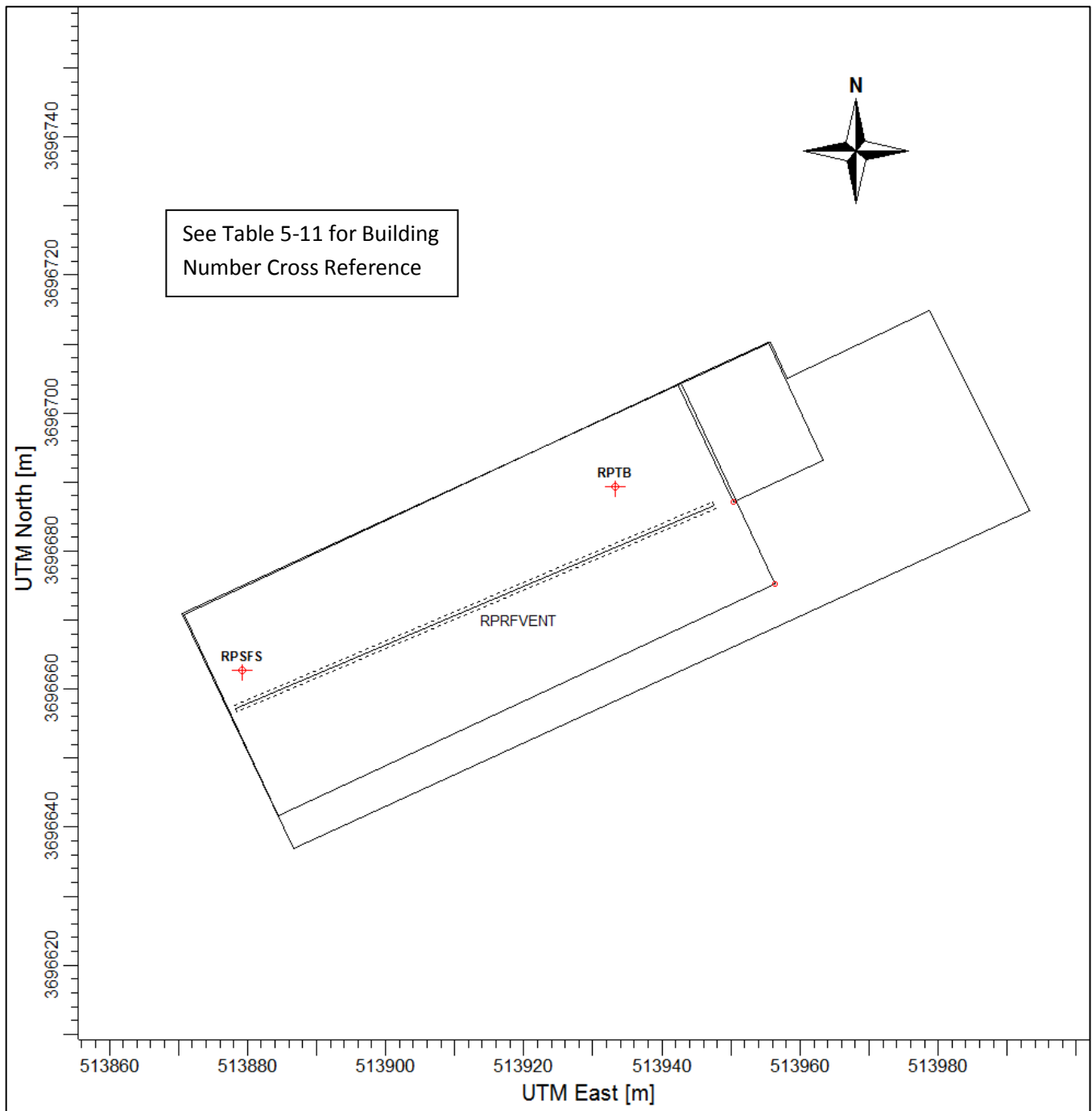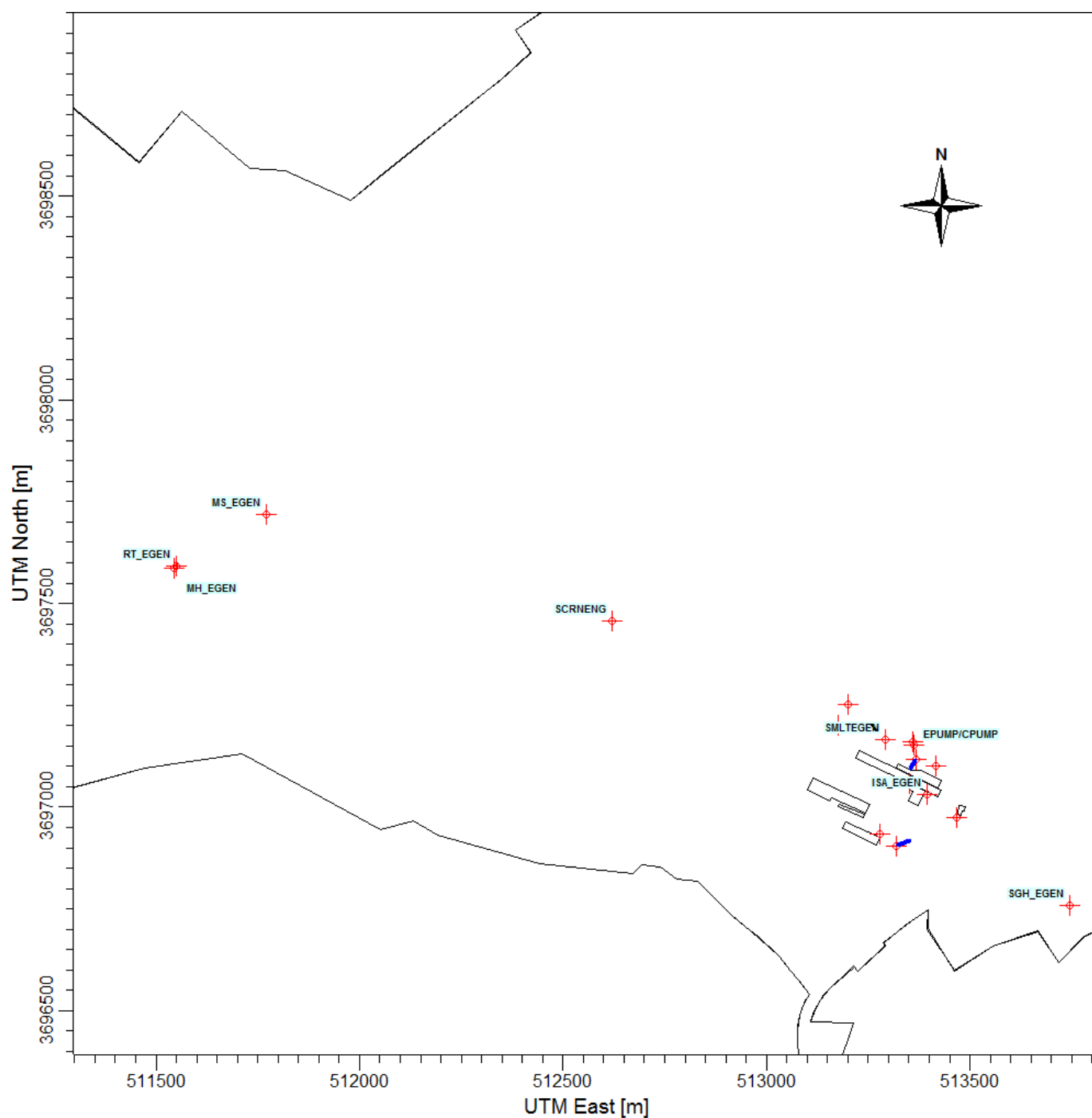
Figure 5-4: Locations of Other Existing Stacks

5.2.3 Existing Roof Vents (Buoyant Line Sources)

5.2.3.1 Roof Vents Configuration

FMMI identified coordinates for the roof vents by mapping the site plan to rectified aerial photographs of the site and adjusting the building footprint to site Computer Assisted Drafting (CAD) drawings. FMMI projected the Universal Transverse Mercator (UTM) coordinates of each vent to UTM Zone 12, 1983 North American Datum (NAD83). Figure 5-5 shows each vent location on the simplified plot plan and the representative volume source used in AERMOD. Table 5-3 lists the coordinates of each vent. Table 5-4 provides vent-specific parameters for the proposed configuration of the roof vents.

Table 5-3: Vent Coordinates for Roof Vents

Ridge Vent	Endpoint A		Endpoint B	
	UTM Easting (m)	UTM Northing (m)	UTM Easting (m)	UTM Northing (m)
Anode	513,347	3,697,069	513,423	3,697,032
Converter	513,224	3,697,129	513,273	3,697,106
Converter 5	513,301	3,697,094	513,316	3,697,088
Isa	513,293	3,697,063	513,300.5	3,697,079
ELF	513,265	3,697,064	513,275	3,697,085

Table 5-4: Vent-Specific Parameters for Roof Vents

Ridge Vent	Vent Length (m)	Vent Width (m)	Vent Height Above Ground (m)	Vent Velocity (m/s)	Vent Temperature (K)
Anode	84.53	1.42	32.55	2.508	361.3
Converter	54.13	3.66	32.70	2.352	339.9
Converter 5	16.16	3.66	37.50	2.198	339.9
Isa	17.67	0.76	53.04	11.297	313.7
ELF	23.26	3.35	40.45	1.391	320.6

Figure 5-5: Roof Line Vents and Pseudo Volume Sources
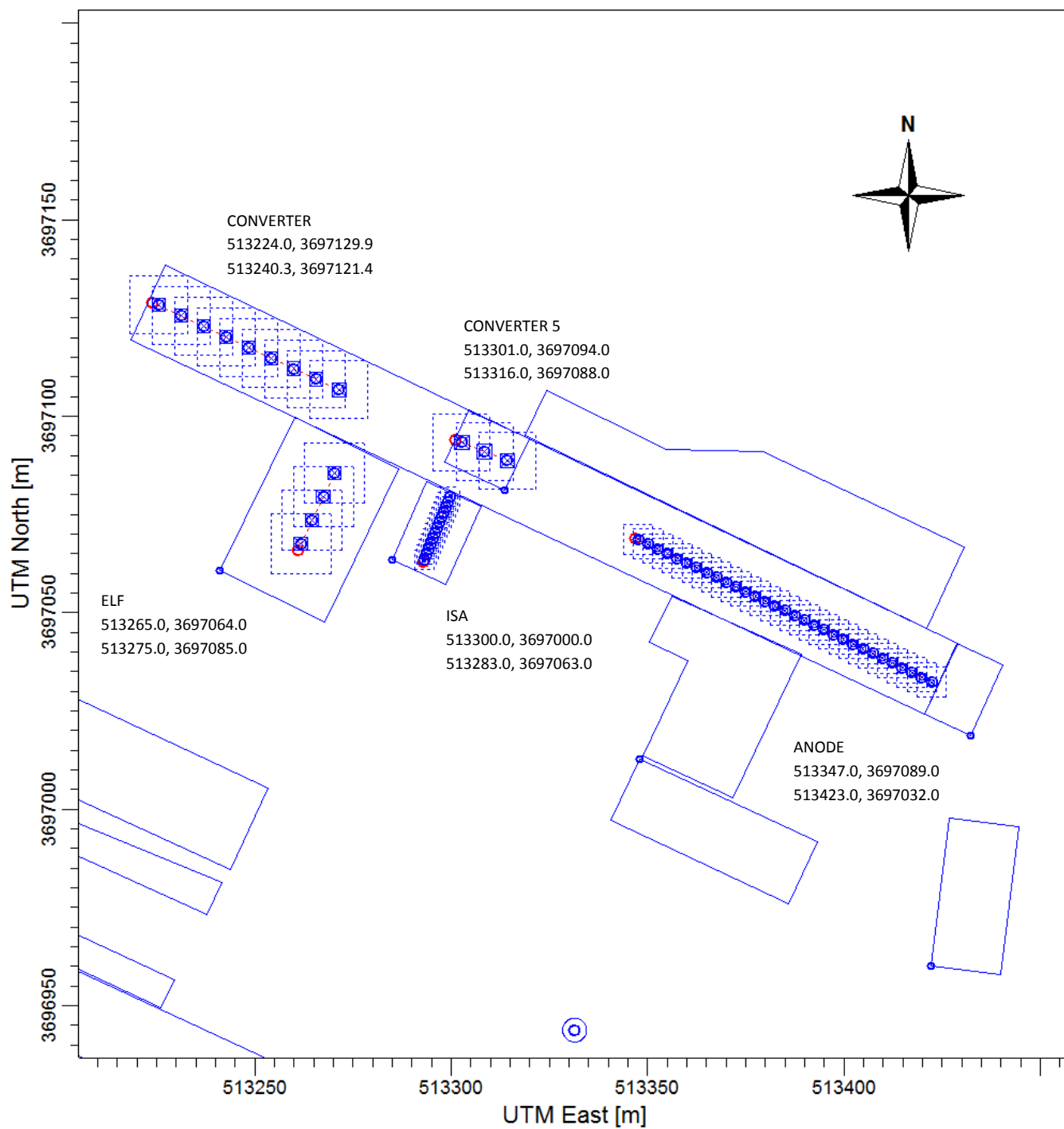
5.2.3.2   Determination of Source Release Parameters for Roof Vents

As discussed in Section 4, the roof vents located on the Smelter building were modeled using a hybrid approach with AERMOD and BLP models. BLP was used to determine the hourly ridge line final plume height and initial vertical dimension (sigma-z, σ_z) values and then the hourly emission file option in AERMOD was used to model the roof vents as elevated volume sources, using the hourly BLP-calculated final plume height as the hourly volume source release height in AERMOD. FMMI also modeled multiple volume sources for each vent, with the number of volume sources determined by the length of the vent. This approach allows for an approximation of each vent's initial lateral dimension (sigma-y, σ_y) by wind direction. Although this approach does not completely address the issues of implementing buoyant line source plume rise and dispersion in AERMOD, it does allow the use of updated dispersion algorithms in AERMOD and the calms processing algorithm. Detailed discussions are as follows:

Final Plume Rise

In BLP, the following parameters for each roof vent are required to determine plume rise for buoyant line sources:

- Coordinates of the ridge vent end points;
- Average roof vent width;
- Roof vent height;
- Average building length (same orientation as the ridge vent);
- Average building width (perpendicular orientation to ridge vent);
- Average building height;
- Average spacing between buildings that have roof vents;
- Average buoyancy parameter, which requires the following additional parameters:
    - Roof vent exit velocity,
    - Roof vent exit temperature,
    - Ambient air temperature.

As noted in the BLP User's Guide, plumes from buoyant line sources tend to rise higher when the wind aligns along the long axis of the line source than when the wind is perpendicular to the line. Plume rise from buoyant line sources also exhibits relationships with buoyancy, wind speed and distance differently than stack releases.

A key issue in calculating the plume rise for buoyant line sources is determining what roof vents to model together in the BLP model run. BLP cannot adequately address perpendicular roof vents and the code prevents FMMI from running all four vents simultaneously. Not being able to account for all vents in a single run limits BLP's computation of plume rise enhancement due to mixing of the buoyant plumes and therefore FMMI expect the calculated plume rise for each vent to be conservatively low. To resolve this issue, FMMI performed two BLP runs:

- Model the Anode and Converter Vents together in a single BLP run; and
- Model the Isa, ELF and Converter Vents together in a separate BLP run.

The AERMOD volume source height selected for the Converter Vent was taken from the BLP run that included the Anode Vent. The Converter Vent was also included in the BLP run with the Isa and ELF Vents to allow the Isa and ELF Vents to be subject to enhanced plume rise. This approach is justified on the basis that full credit for enhanced plume rise is not being taken because BLP cannot run all vents simultaneously. Therefore, FMMI expects even the highest calculated plume height to be a conservatively low estimate compared to modeling all four vents together.

One of the critical modeled inputs for BLP is the average line-source buoyancy parameter, which depends on physical dimensions (length and width), the gas temperature, and the exit velocity of roof vents as well as the ambient air temperature. To calculate the average line source buoyancy parameter, FMMI reviewed and validated the 2013 Roofline Study data, and modified the physical dimensions to reflect the actual dimensions after the Smelter Upgrade Project. Table 5-5 provides the calculated averaged parameters.

Table 5-5: Averaged Parameters for Roof Vents

Vent Width (m)	Building Length (m)	Building Width (m)	Building Height (m)	Building Separation (m)*	Buoyancy Parameter (m⁴/s³)
2.57	56.6	21.0	37.65	0.0/9.0	284.91

*The building separation between the anode and converter is zero and the building separation between the Isa and ELF is 9 meters.

FMMI also used a polar receptor grid with receptors placed every 10 degrees and 1-kilometer from the Smelter to calculate the final plume heights. FMMI selected the 1-kilometer distance to ensure that final plume heights (rather than gradual or transitional plume rise) are calculated.

Sigma-z

The hourly emission file created for input to AERMOD requires the sigma-z parameter for volume sources. As noted previously, FMMI used BLP to calculate hourly sigma-z values. FMMI used a polar grid with receptors placed every five degrees and 250 meters from the Smelter center. The 250-meter distance is representative minimum distance for receptors to clear the Smelter building and not overlay with a vent. This approach also ensures that the sigma-z values are properly accounting for plume interaction and downwash.

Sigma-y

The hourly emission file created for input to AERMOD also requires the initial sigma-y parameter for volume sources. As noted previously, FMMI modeled each ridge vent using multiple volume sources that represent the orientation and length of the vent. The purpose is to simulate the effective initial sigma-y of each vent. The series of volume sources follows the AERMOD guidance (U.S. EPA, 2014b) and FMMI separated them by two times the volume source width, which will be set to the width of the vent. FMMI provided the number of volume sources used to represent each vent in Table 5-6 based on the aforementioned approach. The initial sigma-y for each individual volume source was determined by dividing the center-to-center separation length of the volume sources by 2.13.

Table 5-6: Number of Volume Sources Used To Simulate Each Ridge Vent

Vent	Number of Volumes	Initial σ_Y (m)
Anode Vent	30	1.32
Converter Vent	9	3.40
Converter 5 Vent	3	3.40
Isa Vent	12	0.71
ELF Vent	4	3.12

BLP Plume Rise and Sigma-z Analysis

EPA requested an evaluation of receptor distances used in BLP to identify final plume height and initial sigma-z. FMMI analyzed the final plume heights from receptor distances of 250 meters (m), 1 kilometer (km), 1.5 km, 2 km, 3 km, 4 km, and 5 km. These distances were evaluated for several compass directions, specifically 110 degrees (ESE), 150 degrees (SSE), 180 degrees (South), 210 degrees (SSW), and 260 degrees (WSW), from the North. These directions were selected because they align with the closest fence line receptors to the Smelter.

The BLP model was run with building downwash and normalized emission rates for each of the future vents to determine how the vent plume dynamics and terrain affected the near field results.

EPA identified several hours where the Miami Townsite monitor recorded elevated 1-hour SO_2 concentrations during the first quarter of 2014 and 2015. Two evaluations were performed to identify if building downwash or inversion breakup fumigation potentially contributed to the elevated measurements. Figures 5-6 through 5-8 provide evidence that the elevated concentrations measured at the Miami Townsite monitor are due to inversion breakup fumigation (Appendix L provides a more detailed discussion).

First, the BLP model was run with building downwash and normalized emission rates for each of the future vents to determine how the vent plume dynamics and terrain affected the near field results. As expected, BLP predicted lower plume heights when the downwash flag was turned on in BLP. However, a comparison of predicted concentrations at receptors along the FMMI fenceline did not show any differences between the downwash and non-downwash cases in BLP. This indicates that if there are any plume impacts at ground level due to downwash, the impacts occur within the fenceline or do not occur at all. The BLP model downwash comparison runs are included in the modeling DVD.

The plume height analysis results showed that the use of BLP-predicted plume heights at a 1 km receptor distance is adequate for the volume source release height input in the AERMOD model. Gradual plume rise does not need to be considered for near-field receptors because the maximum predicted 1-hour design value concentrations are located in the area where final plume rise has been achieved.

EPA also requested further information on how the sigma-y value was derived for the Hybrid Approach. BLP calculates sigma-z at each receptor point. To determine sigma-z values near the release points, a 250 meter

polar grid measured from the Smelter center was used to capture sigma-z values. The 250 meter distance places the receptors beyond the northern and southern ends of the Smelter building, which is expected to allow building interactions and roof vent plume mixing to be included in the sigma-z calculation. The 250 meter distance also uses a uniform receptor grid for each source and prevents receptors from overlapping with the source, which is not allowed in BLP. Other BLP/AERMOD approaches have used sigma-z values based on the final plume rise, which likely overestimates the sigma-z value and dilutes the plume in the near field. The 250 meter distance is necessary to allow the plume and building dynamics to be addressed without diluting the plume.

The results of the sigma-z analysis showed that the use of the BLP-calculated values from the proposed 250 meter receptor grid were adequate for the volume source sigma-z input in the AERMOD model. Sensitivity analysis of the sigma-z value showed the expected range of sigma-z values had negligible effects on the predicted off-site concentrations. The details on the approach and results of the plume rise and sigma-z analysis are presented in Appendix D.

The second analysis utilized the AERSCREEN model in fumigation mode to individually evaluate each major stack and ridge vent to assess the potential contribution of inversion breakup fumigation to the elevated measurements. The analysis is provided in Appendix L and shows inversion breakup fumigation is a potential contributor to the elevated readings and that the major stack sources are the most likely source of SO_2 during these fumigation events (whereas the roof vents are not). Another potential cause of the elevated reading is the use of the Miami Fire Department's diesel-fired equipment, which is located directly across the street from the monitor. The fire department's equipment is exercised at variable frequencies, but as frequently as every other day. The level of impact from the fire department would be affected by the federal requirements on sulfur content of diesel fuel.

Measured 1-Hour Average Ambient SO₂ Concentration by Hour of Day
Jones Ranch Monitor
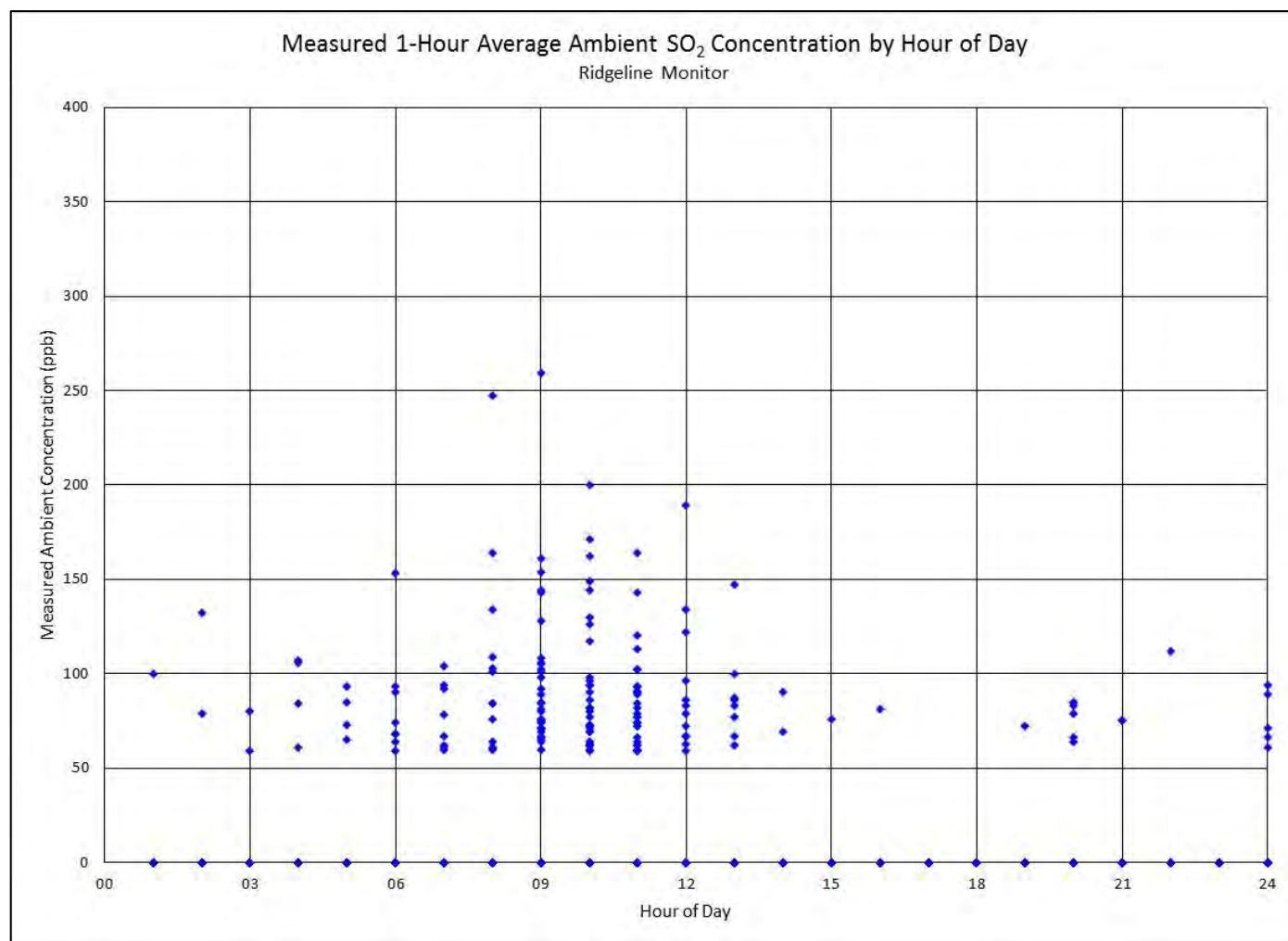
Because BLP output files do not provide the estimations of hourly line source final plume rise and sigma-z, FMMI had to modify the BLP code to suit the hybrid approach application. However, these changes do not affect the dispersion algorithms within BLP and thus the preferred status. As stated in the GAQM Section 3.1.2 b (U.S. EPA, 2005):

> *"If changes are made to a preferred model without affecting the concentration estimates, the preferred status of the model is unchanged."*

ADEQ will provide modified BLP code on CD-ROM per the nomenclature described in Appendix A.

5.2.4   Fugitive Sources

Two fugitive sources of SO_2 emissions are included in the modeling effort:

- Smelter building leaks
- Slag dumping

Smelter building leaks are emissions not captured and vented through stacks or the roof vents. Rather, these emissions escape from windows, doors, and other openings in the walls of the Smelter building. While the buoyant draft of the building results in these openings serving primarily as air intakes, these openings may occasionally serve as indoor air release points. The Smelter expansion project includes a reduction in size and number of such openings, as well as the addition of emissions capture systems in the converter and anode aisles—all of which will reduce fugitive emissions considerably and further enhance the function of these openings as supplying make-up air to the working environment within the Smelter building.

The Smelter building leaks are modeled as a set of volume sources in AERMOD. FMMI identified the locations of potential building leaks, with the volume sources placed in those locations. The release height of the volume source(s) was also identified. The initial sigma-y and sigma-z parameters were assigned in accordance with EPA's AERMOD guidance.

Slag dumping is the activity of pouring molten slag from a ladle onto the slag pile located northwest of the Acid Plant. The slag pours will occur approximately 60 times per day in the post expansion scenario, with each pour taking no more than one minute to complete. The molten slag spreads across the top of the slag pile and crusts over within a minute of the pouring operation being completed, with the total time taking from two to three minutes between commencement of the slag pouring and crust formation. Fugitive SO_2 emissions are released from the molten slag during this time.

5.2.4.1   *Slag Pouring Emissions Estimation*

Slag pouring emissions were modeled as a pseudo point source with a stack height of zero meters. The stack diameter is the average spread area of the slag pouring, with stack placement within an area generally representative of worst-case slag emissions. The average slag temperature was used as the stack temperature inputs, with the exit velocity and plume rise inputs calculated based on differences between slag and ambient temperatures.

A smelter fugitive emission rate of 4.0 lb/ton ore concentrate, from AP-42 table 12.3-11, was used as the emissions calculation basis. While this table gives a smelter fugitive emissions factor of 4.0 lb/ton of concentrate, it indicates the factor for non-reverberatory furnaces, such as the Isa furnace at the Miami Smelter, may be lower. According to AP-42, total SO_2 emissions from the smelting furnace are distributed

90% to matte tapping and 10% to slag skimming. The slag skimming emissions are allocated 75% to the furnace area and 25% to the dumping site.

Equation 5-1: Slag Pouring Emission Calculation

$$E = Slag\ Pouring\ Emissions = E_1 \cdot E_2 \cdot FT_1 \cdot FT_2 \cdot FT_3$$

Where:

E_1= 4 lb SO$_2$/ton concentrate was set equal to the value identified in Table 12.3-11 of AP-42 Section 12.3 for smelting furnaces.

E_2= *Maximum tons ore concentrate processed per year (1 million post project tons NMBM)*

FT_1=*Ratio of slag SO$_2$/ton anode produced.* The value of FT$_1$ (0.1) was set equal to the value identified in footnote b of Table 12.3-11 of AP-42 Section 12.3, which states *"90% of total SO$_2$ emissions are from matte tapping operations, with remainder from slag skimming."* ASARCO used the same value in their analysis of slag pouring emissions *(Compare E$_1$, which is based on reverberatory process, to lbs/ton concentrate from Isa process)*

FT_2=*Slag skimming fraction of total smelting furnace SO$_2$ emissions (10% or 0.10)*

FT_3=*Pouring fraction of total slag skimming emissions (25% or 0.25)*

For the purposes of calculating the hourly SO$_2$ emission rate of 3.75 lb/hr, a 1-hour New Metal Bearing Material (NMBM) maximum throughput rate of 125 tons per hour was assumed based on the annual allowable NMBM throughput limit of 1 million tons. That is, the hourly throughput rate was derived by dividing the annual allowable NMBM throughput of 1 million tons by 8,760 hours, and conservatively adding a 10% margin of safety to account for throughput variability. The Asarco El Paso Smelting facility in Texas has used this methodology to estimate slag-pouring emissions for their SIP. This methodology is analogous to the flare modeling method in ADEQ's Air Dispersion Modeling Guideline Section 3.3.6. Table 5-7 provides the modeled parameters for slag pouring:

Table 5-7: Slag Pouring Model Parameters

Parameter	Modeled Value
Stack Height (m)	0.0
Exit Diameter (m)	13.3
Exit Temperature (K)	1,333
Exit Velocity (m/s)	1.45
SO$_2$ Emission Rate (g/s)	0.4725

5.2.4.2   *Uncaptured and Unmonitored Building Leak Emissions Estimation*

The leakage through unmonitored openings was estimated at 4.5% of the future Smelter roofline fugitive emissions. These roofline fugitive emissions were calculated through Roofline Monitoring System connected to a continuous monitoring device. Expressed as a portion of total SO_2 from stacks and building fugitives, the percentages are even lower. The methodology used to determine uncaptured and unmonitored fugitive emissions from the Smelter building is based on an engineering analysis performed by Hatch for FMMI. The calculation methodology examines building leakage and building envelope surface area to determine a ratio of the above grade surface area and openings to the roof vents to determine a ratio of monitored to unmonitored emissions. Figure 5-6 illustrates the volume sources representative of building fugitive emissions. The Hatch Memo is included as Appendix B in this modeling TSD and is based on the following information:

a.   A leakage factor of 32 cubic meters per hour of air leakage per square meter of building surface area, exerted at a pressure of 75 Pa (0.011 psi) was identified in Emmerich and Persily.[11]

b.   Using Bernoulli's equation (v = $[2g \times \Delta p / \rho]^{0.5}$), where g is the gravitational constant, p is the exerted pressure (75 Pa), and ρ is the density of air (0.066 lb/ft^3 at Smelter elevation), an air leakage velocity of 39 ft/sec (11.9 m/sec) was derived.

c.   The fraction of the building surface area available for leakage was obtained by dividing the referenced leakage factor by the air leakage velocity. The resulting percentage of the building surface available for leakage was 0.07% (i.e., [32 m^3/hr/m^2] / [11.9 m/sec] / [3600 sec/hr]), which was rounded up to 0.1%.

d.   The total surface area of the Smelter building was determined to be 205,000 ft^2. Applying the calculated fraction of building surface area available for leakage, the resulting surface area available for leakage was 205 ft^2 (i.e., 205,000 ft^2 × 0.1%).

e.   After reconfiguration of the Smelter building, the roof vent area will have an opening of approximately 4,500 ft^2. The ratio of building surface area available for leakage to the roof vent area is 4.5% (i.e., 205 ft^2 / 4,500 ft^2). The SO_2 concentration in the building leakage is assumed to be the same as that vented through the roofline. Therefore, SO_2 emissions from building leakage are assumed to be equal to 4.5% of the roof vent emissions.

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[11] S. Emmerich and A. Persily, "*Airtightness of Commercial Buildings in the U.S.*", Building and Fire Research Laboratory, National Institute of Standards and Technology.

Figure 5-9: Defined Volume Sources for Building Fugitive Emissions

Figure 5-9: Defined Volume Sources for Building Fugitive Emissions
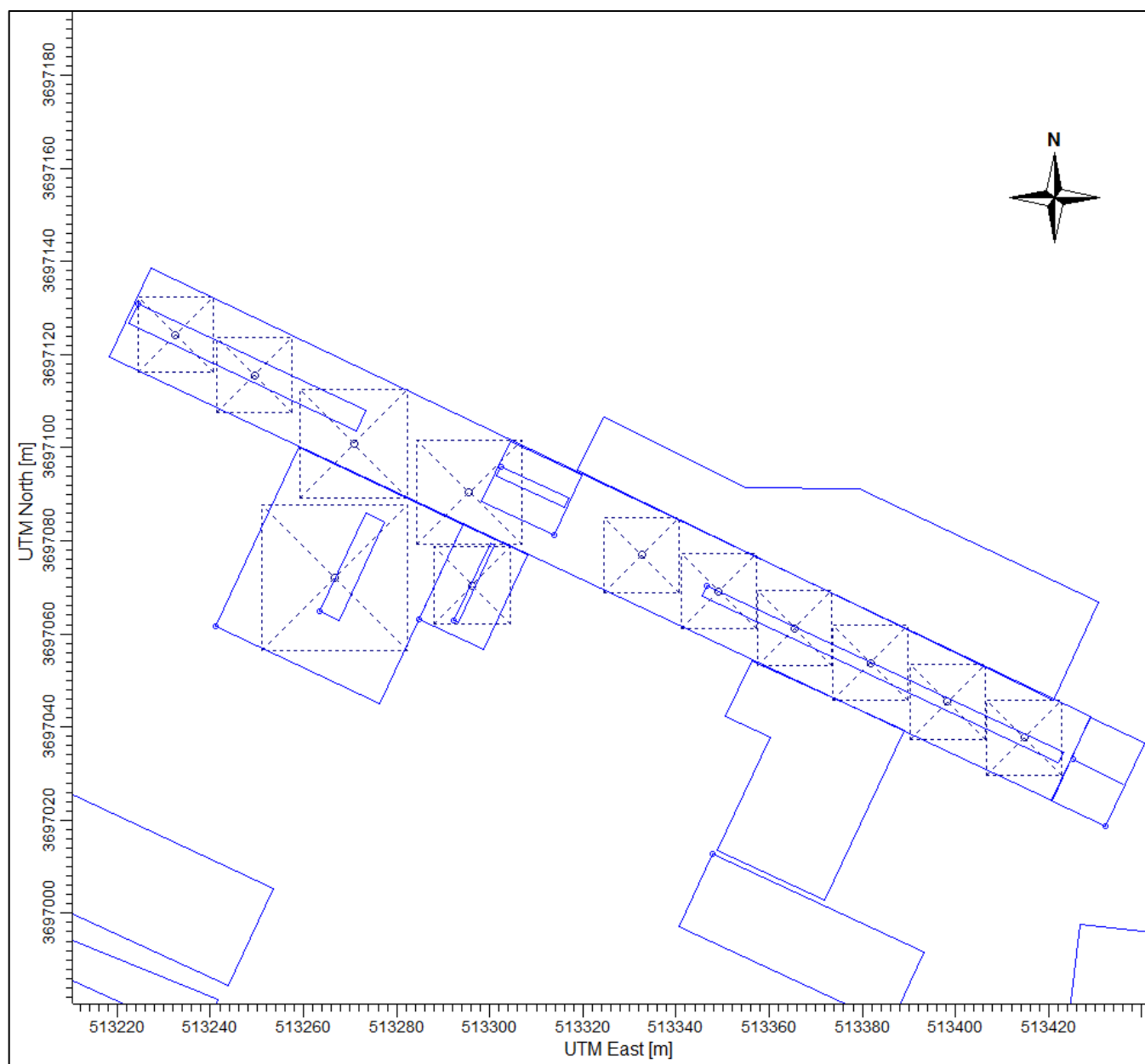
5.2.5 Future Source Parameters

As discussed in Section 5-1, ADEQ issued a permit revision (Significant Revision 53592) on July 21, 2014 for the Miami Smelter to increase allowable production; install and upgrade control equipment; and make physical changes to the facility. Tables 5-8 and 5-9 show the new stack locations and vent parameters and figure 5-7 shows the new vent configurations.

Table 5-8: Stack and Exhaust Parameters, Project Stacks and Vents

Source ID	Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity[12] (m/s)	Exhaust Temp.[13] (ºK)
TAILSTK	Tail Stack	513194.6	3697246	1081.99	65.00	2.300	19.5	298.0
VENTSTK	Vent Fume Stack	513319.8	3696904	1098.02	65.00	2.900	18.5	varying
SCRUBBER	Aisle Scrubber Stack (Normal)	513368.5	3697117	1079.67	57.00	7.300	16.4	varying
	Aisle Scrubber Stack (Bypass)	513368.5	3697117	1079.67	57.00	7.300	18.53	-17.2

The exhaust temperature of the Vent Fume Stack was based on CEMS data from 2010 through 2013. The stack temperature data was averaged by hour and month to develop stack temperature inputs for the AERMOD hourly emission file. An engineering study by Hatch developed anticipated stack temperature profiles for the future aisle scrubber stack under normal operating conditions. These values were incorporated into the AERMOD hourly emission file.

Ridge Vent	Endpoint A		Endpoint B	
	UTM Easting (m)	UTM Northing (m)	UTM Easting (m)	UTM Northing (m)
Anode	513,347	3,697,069	513,423	3,697,032
Converter (future)	513,224	3,697,129	513,240.3	3,697,121.4
Isa	513,293	3,697,063	513,300.5	3,697,079
ELF	513,265	3,697,064	513,275	3,697,085

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[12] Average exhaust flow design values.

[13] Negative temperature indicates temperature above ambient, zero temperature indicates ambient temperature. Varying values based on actual CEMS data and engineering analysis.

Table 5-9: Vent-Specific Parameters for Roof Vents

Ridge Vent	Vent Length (m)	Vent Width (m)	Vent Height Above Ground (m)	Vent Velocity (m/s)	Vent Temperature (K)
Anode	84.53	1.42	32.55	2.508	361.3
Converter (revised)	18.04	3.66	32.70	2.352	339.9
Isa	17.67	0.76	53.04	11.297	313.7
ELF	23.26	3.35	40.45	1.391	320.6

The changes in the vent configurations will change the buoyancy factor used in the BLP program. Table 5-10 below shows the updated averaged parameters and the revised buoyancy factor for the roof vents.

Figure 5-10: Future Vent Configuration
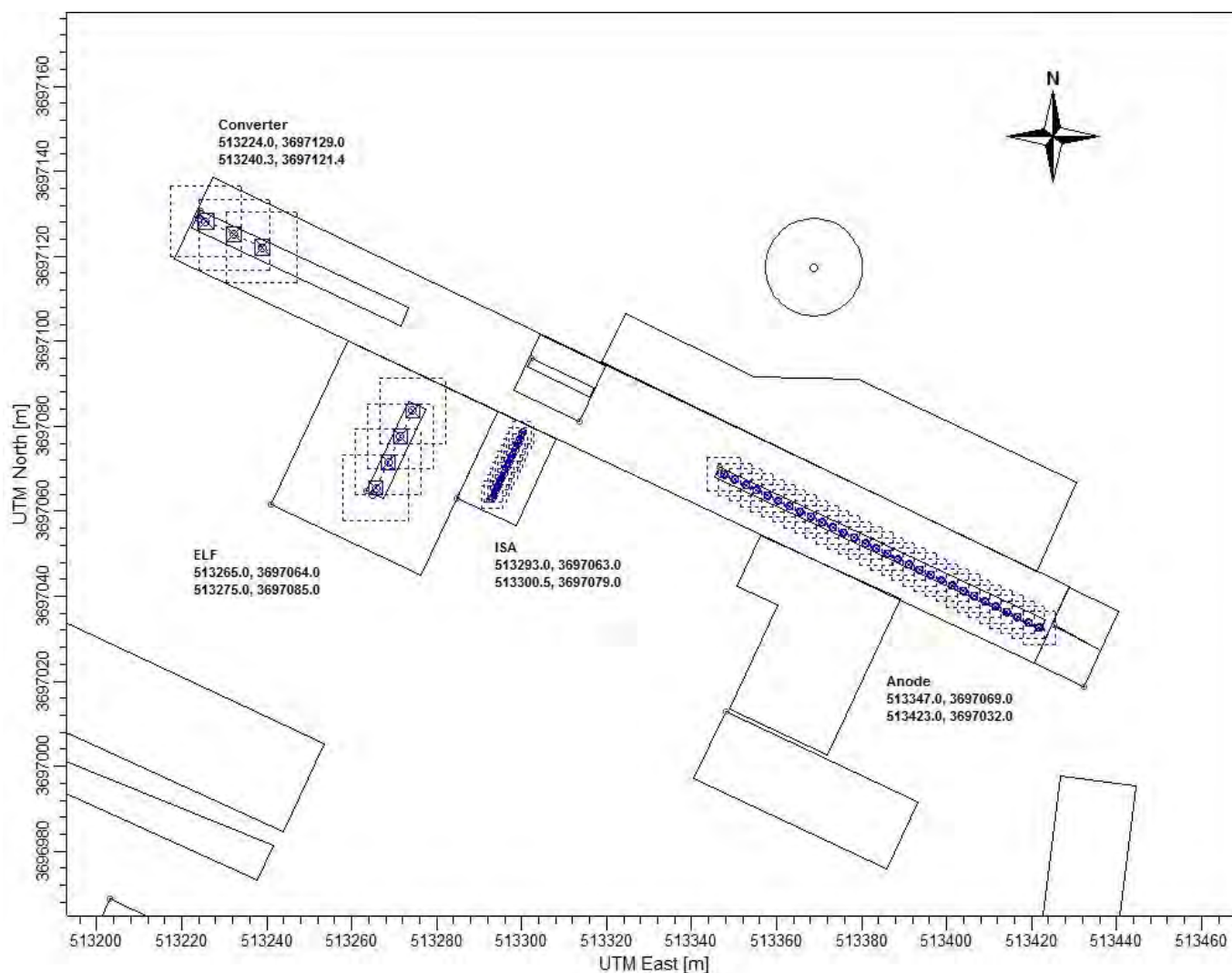
Table 5-10: Averaged Parameters for Roof Vents

Vent Width (m)	Building Length (m)	Building Width (m)	Building Height (m)	Building Separation (m)	Buoyancy Parameter (m⁴/s³)
2.30	65.75	22.5	38.07	0.0	235.49

The new stack locations, additional aisle scrubber source and vent configuration were applied in the modeling to determine the required control efficiency for demonstrating compliance with the NAAQS.

5.3   Emissions Variability and Independence Assessment

The sources associated with the Miami Smelter have highly variable SO_2 emission rates as a combination of both continuous and batch processes are present. Because of this inherent emission variability, the Smelter has historically complied with cumulative occurrence and emission limits via a Multi-Point Rollback (MPR) approach designed in collaboration with ADEQ to ensure compliance with the historic SO_2 NAAQS (3-hour, 24-hour and annual averages). The MPR approach successfully brought the planning area into attainment while allowing for a compliance demonstration procedure that accommodated the highly variable SO_2 emissions from the Smelter.

A goal for the revised SIP is to develop an approach that will both successfully achieve attainment of the maximum daily 1-hour SO_2 NAAQS and provide for a new compliance demonstration procedure that accommodates the variable emissions of the Smelter sources.   EPA's SO_2 SIP guidance provides for the consideration of emission limit averaging periods as long as 30 days for sources with highly variable emission rates where hourly emission rates occasionally exceed the critical emission value (CEV) rate. Therefore, ADEQ has adopted a 30-day emission limit. ADEQ believes that a 30-day emission limit will similarly assure NAAQS attainment while accommodating the high variance of emissions. As EPA notes in their guidance (U.S. EPA, 2014a):

> *"The EPA believes that making this option available to states could reflect an appropriate balance between providing a strong assurance that the NAAQS will be attained and maintained, while still acknowledging the necessary variability in source operations and the impairment to source operations that would occur under what could be in some cases an unnecessarily restrictive approach to constraining that variability."*

Because emissions from the Smelter are highly variable, developing such a longer-term limit requires an assessment of the probability that maximal emissions from each of the individual SO_2 emissions sources at the Smelter could occur simultaneously. This probability is a function of both the variable emissions from each individual SO_2 emissions source and the likelihood that those individual sources run at the same time (the "independence" of these emissions). FMMI's analysis of continuous emissions monitoring data confirms that these SO_2 sources do not emit near their maximum rates at the same time. To fully examine this issue, FMMI performed an emissions variability and independence assessment. The assessment methodology and results are discussed in detail in Appendix E. The purpose of this technical memorandum was to provide a description of smelter operations and an analysis of individual source emissions, which demonstrate the highly variable emissions from each source and the independence of source operations. These important factors must be accounted for in developing an emissions limit for the Smelter that is protective of the NAAQS and is further discussed in Section 8 of this TSD.

5.4   Load Analysis

EPA and ADEQ modeling guidelines require evaluation of various operating loads for any proposed project's emission sources where varying operating conditions could affect plume rise. Load conditions are evaluated when appropriate because model-predicted concentrations from reduced load conditions can be greater than from full load conditions. This results from reduced plume rise due to reduced exhaust flow and/or reduced exhaust temperature.

Current CEMS data for the Tail Stack indicate little variation in stack temperatures and flowrate and current CEMS data for the Vent Fume Stack indicate little variation in flowrate and a small diurnal and seasonal variation in temperature. The planned upgrades to the Smelter include the addition of a new scrubber (Aisle Scrubber), changing the scrubbing reagent in the existing scrubbers, a new baghouse, and additional wet ESPs that are tied into fixed speed fans. Thus, stack exhaust flows and velocities are expected to have minimal variation. Stack temperatures will be governed by the caustic scrubbers and consequently exhaust temperature is also expected to have diurnal and seasonal variations which are accounted for in the modeling. The Aisle Scrubber will have two different exhaust condition scenarios, one during normal operation when the flow will be due to the Converter and Anode Aisle capture systems, and the other during bypass operation when the flow will be due to the Converter and Anode Aisle capture systems plus Acid Plant Bypass emissions. Thus, for the Aisle Scrubber, FMMI modeled the exhaust conditions under both operating scenarios. The roof vents are modeled using a single buoyancy factor based on averaged flowrates and temperatures to meet the input requirements of the BLP model. As such, variable exhaust conditions cannot be used for modeling the roof vents.

5.5   Good Engineering Practice (GEP) Stack Height

There are two definitions of Good Engineering Practice (GEP) stack height: (i) formula GEP stack height and (ii) regulatory GEP stack height. EPA requires sources to evaluate building downwash effects when a stack is less than formula GEP stack height (see Equation 5-2 below). Regulatory GEP stack height is either 65 meters or formula GEP stack height, whichever is greater. EPA does not allow sources to take credit for ambient air concentrations that result from stacks that are higher than regulatory GEP stack height. After implementation of recently permitted changes, FMMI will have constructed all stacks onsite after January 12, 1979.

FMMI conducted an analysis of the stack heights, with respect to GEP, in accordance with EPA's guidelines for air quality impact modeling. EPA's Building Profile Input Program for PRIME (BPIPPRM, version 04274; U.S. EPA, 2004a) was used to compute the formula GEP stack height and to generate wind-direction specific building profiles for each stack for the purpose of sequential modeling. For stacks constructed after January 12, 1979, EPA defined the Formula GEP stack height as:

Equation 5-2: GEP Stack Height Formula

$$H_{GEP} = H_B + 1.5L_B$$

Where:

H_{GEP} = GEP stack height;
H_B = Building height above stack base; and
L_B = Lesser of building's height or maximum projected width

BPIPPRM requires a digitized footprint of the facility's buildings and stacks. The source must evaluate the position and height of buildings relative to the stack position in the building wake effects analysis. FMMI obtained the building positions from a site plan of the proposed changes. FMMI identified coordinates for each of the existing building tier corners by mapping the site plan to rectified aerial photographs of the site. FMMI obtained roof heights for the proposed changes from preliminary designs of proposed facility structures and actual heights of existing structures.

Simplified layouts of the facility are provided in Figures 5-2 and 5-3. These figures also identify stack locations. This report provides the associated BPIPPRM building-tier identifications in Table 5-11.

Tables 5-12 and 5-13 provides the results of the analysis. Presented for each evaluated stack are:

- Structure(s) that defines formula GEP for the stack (controlling structure);
- Height of the controlling structure;
- Projected width of the controlling structure;
- Structure shape (i.e., squat or tall);
- Formula GEP stack height;
- Regulatory GEP stack height; and
- Actual stack height.

In all cases, the proposed stack heights are less than the calculated formula GEP height. Therefore, building wake effects will be considered in all modeling runs for these stacks. The actual stack heights will be modeled because the actual stack heights are less than or equal to the calculated GEP heights. ADEQ will provide BPIPPRM input and output files on CDROM per the nomenclature described in Appendix A.

Table 5-11: BPIPPRM Building-Tier/Site Plan Cross Reference

BPIPPRM Bldg-Tier No. for CEV runs	BPIPPRM Bldg Tier No. for Performance Runs	Site Plan Building Tier(s)	Tier Elev. Above Base (m)
1	31	BEDPLNT	8.61
6	36	PWRHS	16.78
16	46	ADMIN	23.07
21	51	TRACK5	9.35
31	56	BLACKSTACK	76.2
36	61	BLD_8	10.0
41	66	BLD_9	10.0
46	71	BLD_10	11.58
51	76	BLD_11	10.0
56	1	RODPLNT (BLD_18)	6.4
57	2	RODPLNT (BLD_18)	9.14
58	3	RODPLNT (BLD_18)	12.2
TBR	6	APTANK1	23.16
61	11	APTANK2	23.77
66	16	APTANK3	22.71
TBR	21	BLDG1	6.95
76	26	LARGTANK	12.5
96	101	CHNGRM6	6.00
101	106	MISBLG	5.79
11	41	SMELTER	31.18
12	42	SMELTER	32.55
13	43	SMELTER	32.70
14	44	SMELTER	35.98
15	45	SMELTER	37.50
81	86	CRNBLDG	52.43
82	87	CRNBLDG	52.93
86	91	ISABLDG	52.43
87	92	ISABLDG	53.34
91	96	ELFBLDG	37.50
92	97	ELFBLDG	40.45
116	111	BLD_24 (Tank)	12.7
2	--	Scrubber (new)	41.15
71	--	Bldg_1 (new)	23.16
106	--	Bld_22 (new)	54.3
111	--	Bld_23 (new)	54.3
121	--	WESP2 (new)	9.75
126	--	BLDWESP2 (new)	9.75

Table 5-12: BPIPPRM Results, Existing Stacks

Stack	Stack Height (m)	Stack-Building Base Elevation Difference (m)	Formula GEP Height (m)	Regulatory GEP Height (m)
TAILSTK	60.96	-4.01	105.14	105.14
VENTSTK	48.80	13.74	87.39	87.39
APPREHT	2.10	-1.00	102.12	102.12
RPTB	3.05	0.00	30.47	65.00
RPSFS	19.81	0.00	30.47	65.00
CHRMWTH	4.67	-4.76	98.51	98.51
ISAAUXBL	32.55	-1.00	94.75	94.75
SCRNENG	1.37	NA	NA	65.00
CMPRS1	5.0	13.46	87.67	87.67
CMPRS2	5.0	-5.50	100.58	100.58
BYPASS	60.96	-1.40	98.17	98.17
SLAG	0.00	NA	0.00	65.00

Table 5-13: BPIPPRM Results, Future Stacks

Stack	Stack Height (m)	Stack-Building Base Elevation Difference (m)	Formula GEP Height (m)	Regulatory GEP Height (m)
TAILSTK	65.00	-4.01	105.14	105.14
VENTSTK	65.00	12.02	89.10	89.10
Aisle Scrubber	57.00	-6.33	104.91	104.91

5.6   Urban/Rural Determination

Dispersion coefficients for air quality modeling are selected based on the land use classification technique suggested by Auer (Auer, 1978), which is EPAs preferred method. The classification determination involves assessing land use by Auer's categories within a 3-kilometer radius of the proposed site. A source should select urban dispersion coefficients if greater than 50 percent of the area consists of urban land use types; otherwise, rural coefficients apply.

FMMI identified land use categories for areas within the 3-kilometer radius of the facility from US Geological Survey (USGS) maps and EPA's AERSURFACE modeling tool (version 13016; EPA, 2013b). Figure 5-7 shows the 3-kilometer radius centered on the project's scrubber stack. The area within 3-kilometers of the facility is primarily rural. FMMI used AERSURFACE to confirm the land use within a 3-kilometer radius of the facility. The EPA developed AERSURFACE to identify surface roughness length within a defined radius from a specified point.   In this case, FMMI input the UTM coordinates of the proposed scrubber stack to AERSURFACE and specified a 3-kilometer analysis radius. FMMI acquired USGS National Land Cover Data (NLCD) for 1992 for the area and used this data as an input to AERSURFACE per EPA guidance. FMMI

calculated the rural fraction of the area to be 97.3 percent. Therefore, FMMI selected rural dispersion coefficients for the air quality modeling.

Consideration is being given by the modeling community to allow the use of urban dispersion coefficients for facilities that produce a significant heat island effect, as was discussed during EPA's 2013 modeling workshops held recently in Research Triangle Park, North Carolina. However, for the purposes of this modeling TSD, FMMI used rural dispersion coefficients.

Figure 5-11: 3-km Radius of the Smelter Facility
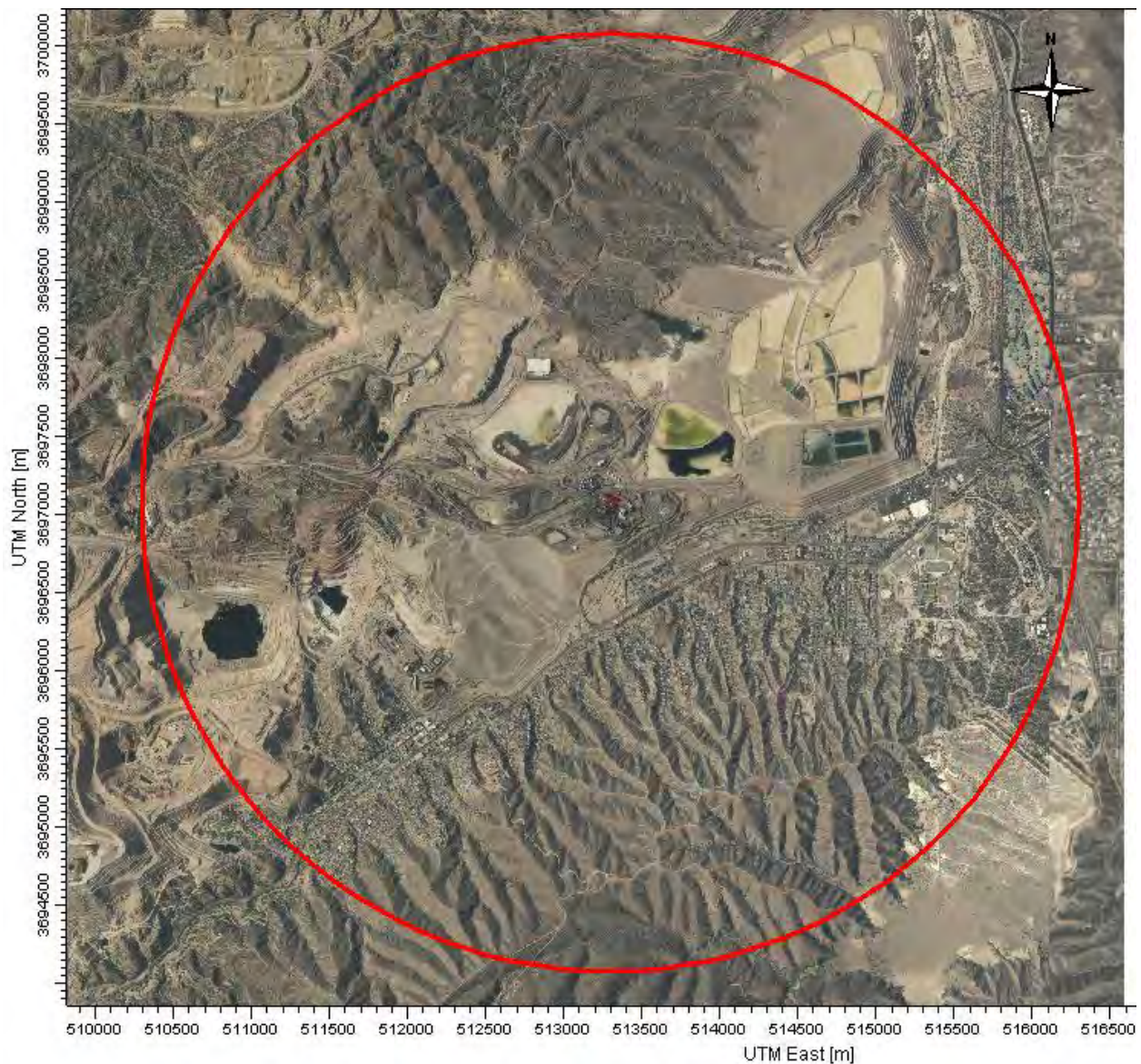
6.0   Meteorological Data

The proposed BLP/AERMOD hybrid approach requires the use of two types of meteorological datasets, AERMET and MPRM.

6.1   AERMET

EPA's AERMET tool (version 14134; EPA, 2014c) was used to process meteorological data for use with AERMOD. AERMET merges National Weather Service (NWS) surface observations with NWS upper air observations and performs calculations of meteorological parameters required by AERMOD. Surface observations from on-site instruments can optionally be included. The latter can be useful because the data are more relevant to the site being modeled and in cases where on-site data are collected at multiple elevations above ground, AERMET can construct a more accurate vertical profile of meteorological data. In addition to the meteorological observations, AERMET further requires the inclusion of the characteristics of land use surfaces that FMMI calculated using EPA's AERSURFACE tool.

6.1.1   Surface Observations

EPA recommends that AERMOD be run with a minimum of 5 years of NWS data or 1 year of on-site meteorological data. The meteorological data used in the sequential modeling consists of on-site hourly surface observations collected by FMMI from a 30.5-meter tower located approximately 0.32 kilometers southwest of the project site. The meteorological data used in the modeling cover the period from the second quarter of 2010 through the first quarter of 2013, with the raw on-site data provided by FMMI. The use of three years of on-site data exceeds the EPA recommendation of one year for on-site data. Figure 6-1 shows the location of the tower site relative to the proposed project.

FMMI has installed the meteorological instruments at elevations of 9.14 and 30.5 meters above ground level (AGL). The tower is equipped with the following instrumentation:

- Wind speed, wind direction, standard deviation of horizontal wind, and ambient temperature at 30.5 meters;
- Ambient temperature at 9.14 meters beginning in March of 2007;
- Atmospheric pressure; and
- Precipitation.

The installation meets the requirements of ADEQ and meets or exceeds EPA's recommendations available at the time of installation. Instrument performance is audited on a regular basis in accordance with ADEQ and EPA requirements.

Concurrent surface observations are required to provide parameters not collected by the Miami Smelter Tower, which includes relative humidity, and cloud cover data. The closest station to the Miami Smelter facility is the Remote Automated Weather Station (RAWS) network Globe station. However, this station lacks the required sky cover and surface pressure data required by AERMET. The two closest National Weather Service (NWS) stations with available cloud cover and surface pressure data are Phoenix and the Safford Airport. Although the Phoenix NWS station is slightly closer to the Miami Smelter, Safford's location is more representative of the cloud cover and relative humidity at the Miami Smelter site. The 30-year average rainfall at the RAWS Indian School (Phoenix) site between 1920 and 1975 was 7.55 inches while the Globe RAWS site had 15.9 inches on average and Safford had 9.02 inches on average for the same period. This indicates that Safford is more representative with respect to cloud cover than the Phoenix site. FMMI downloaded the Safford Integrated Surface Hourly (ISH) meteorological data from the National Oceanic and Atmospheric Administration (NOAA) website and used this data in AERMET.

Tables 6-1 and 6-2 provide the raw data completeness respectively for the Miami Smelter Tower and Safford meteorological parameters used in the modeling. The tables demonstrate three continuous years of record

where EPA's data completeness guideline (U. S. EPA, 2000) for raw data of 90% exists from the 2nd quarter of 2010 through the 1st quarter of 2013. Because EPA requires only one year of data from on-site meteorological monitoring stations, this on-specific dataset is sufficient for regulatory modeling purposes. FMMI used the 3-year data set, which meets the data completeness requirements. Using this 3-year data set provides additional assurance that FMMI account for conservative meteorological conditions in the attainment demonstration. For AERMOD to calculate the 99th percentile of the maximum daily hourly impact accurately, FMMI will move the AERMET output from the 2nd quarter, 3rd quarter and 4th quarter of 2010 to year 2013 to ensure three complete years of meteorological data in the AERMOD run.

6.1.2   Upper Air Observations

FMMI obtained concurrent upper air radiosonde data for the Tucson NWS site (WBAN 23160). An analysis of the NWS FSL radiosonde data showed that many soundings did not contain the base (surface) measurements (FSL Level 9), but measurements for the balance of the sounding depths were available. ADEQ identified an alternate source of radiosonde data from the University of Wyoming which contained base measurements. ADEQ confirmed with University personnel that the source of the radiosonde data was the same as that used by NWS. The data was downloaded in a text format (non-FSL) so a short FORTRAN program was used to reformat the data into FSL format for AERMET and MIXHTS. A copy of the program is included on the attached DVD-ROM.

Table 6-1: Tower Data Percent Completeness

Year	Quarter	Wind Speed	Wind Direction	Sigma Theta	Temp. (30 feet)	Temp. (100 feet)	Pressure
2009	Q1	99.31%	98.66%	98.29%	100.00%	100.00%	100.00%
	Q2	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Q3	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Q4	100.00%	83.12%	83.12%	100.00%	100.00%	100.00%
2010	Q1	100.00%	84.81%	84.77%	100.00%	100.00%	100.00%
	Q2	99.95%	100.00%	100.00%	100.00%	100.00%	100.00%
	Q3	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Q4	100.00%	99.95%	99.95%	100.00%	100.00%	100.00%
2011	Q1	100.00%	99.95%	99.95%	100.00%	100.00%	100.00%
	Q2	99.73%	99.73%	99.73%	99.73%	99.13%	99.73%
	Q3	100.00%	99.86%	99.77%	100.00%	100.00%	100.00%
	Q4	100.00%	100.00%	100.00%	100.00%	98.64%	100.00%
2012	Q1	100.00%	99.91%	99.91%	100.00%	99.12%	100.00%
	Q2	100.00%	100.00%	100.00%	100.00%	99.95%	100.00%
	Q3	100.00%	100.00%	100.00%	100.00%	99.05%	100.00%
	Q4	100.00%	100.00%	100.00%	100.00%	98.73%	100.00%
2013	Q1	100.00%	100.00%	100.00%	100.00%	99.31%	100.00%
	Q2	86.86%	86.86%	86.86%	86.86%	86.68%	86.86%
	Q3	100.00%	100.00%	100.00%	100.00%	99.64%	100.00%
	Q4	100.00%	100.00%	100.00%	100.00%	99.37%	100.00%

Table 6-2: Safford Surface Station Data Percent Completeness

Year	Quarter	Cloud Cover	Relative Humidity
2009	Q1	99.26%	99.91%
	Q2	98.72%	100.00%
	Q3	99.14%	100.00%
	Q4	80.62%	99.91%
2010	Q1	86.65%	100.00%
	Q2	93.67%	100.00%
	Q3	90.84%	99.95%
	Q4	94.19%	99.95%
2011	Q1	95.74%	99.81%
	Q2	99.54%	99.95%
	Q3	99.73%	100.00%
	Q4	99.73%	99.86%
2012	Q1	99.13%	99.86%
	Q2	99.73%	99.86%
	Q3	99.98%	99.99%
	Q4	99.50%	100.00%
2013	Q1	99.35%	99.91%
	Q2	99.63%	99.86%
	Q3	80.66%	99.91%
	Q4	86.10%	99.00%

6.1.3   AERSURFACE

FMMI used EPA's AERSURFACE tool to calculate the surface roughness length, albedo and Bowen ratio inputs required by AERMET. EPA developed AERSURFACE to identify these parameters within a defined radius from a specified point. In this case, FMMI input the UTM coordinates of the on-site meteorological tower as well as the Safford site to AERSURFACE along with a 1-kilometer radius per EPA guidance. FMMI acquired USGS National Land Cover Data (NLCD) for the area, and used these data as inputs to AERSURFACE. FMMI calculated the parameters for twelve compass sectors of 30° each, and by month. FMMI assigned the seasonal categories as follows per ADEQ guidance:

- Late autumn after frost and harvest, or winter with no snow: December, January, February, March;
- Winter with continuous snow on the ground: none;
- Transitional spring (partial green coverage, short annuals): April, May, June;
- Midsummer with lush vegetation: July, August, September; and
- Autumn with un-harvested cropland: October, November.

FMMI selected surface moisture characteristics based on the annual precipitation measured at each site and compared with the 30-year average value from 1980 to 2010. Table 6-3 provides a summary of the precipitation analysis. Average surface moisture conditions were identified for all five years at both sites. Average moisture was determined to be associated with precipitation rates that fall within the middle 50th percentile of the 30-year distribution. Dry conditions would be associated the lower 25th percentile of 30-year precipitation rates, while wet conditions would be associated with the upper 25th percentile. ADEQ will provide AERSURFACE input and output files on CDROM per the nomenclature described in Appendix A.

Table 6-3: Precipitation Rates (inches)

Station	Lower 25th Percentile	Upper 25th Percentile	2009	2010	2011	2012	2013
Miami	6.62	23.71	9.01	22.45	13.06	10.54	15.10
Safford	3.22	13.79	4.47	11.15	5.37	8.11	7.52
All precipitation rates fall within the middle 50th percentile and as a result, all surface moisture conditions were considered dry.							

The Miami Smelter on-site data, cloud cover data from the Safford Airport, Tucson upper air data and AERSURFACE land use data were processed with the AERMET meteorological processor. ADEQ will provide AERMET input and output files on CD-ROM per the nomenclature described in Appendix A.

6.1.4 Processed Data Completeness

The data completeness for each year of processed data for input to AERMOD are as follows:

- 2011: 99.4 percent
- 2012: 99.2 percent
- 2013 1st quarter with 2010 2nd through 4th quarter: 95.8 percent

Figure 6-2 is a wind rose of the meteorological data from the FMMI on-site meteorological station. The wind rose demonstrates that wind direction frequency generally aligns with the orientation of the valley.

6.2 MPRM

The MPRM model combines twice-daily mixing heights, on-site meteorological data and surface meteorological data, into a BLP-compatible meteorological file. The twice-daily mixing heights are calculated using the EPA's MIXHTS program which uses FSL upper air data with wind speed in knots and surface data in SAMSON or HUSWO format.

6.2.1 Surface Observations

FMMI used the Miami Smelter meteorological data as on-site observation input to MPRM. FMMI used the Safford NWS data as additional surface observation input to MPRM as was performed with AERMET.

BLP requires complete meteorological datasets so data substitution is necessary. For missing onsite data, FMMI substituted meteorological observations from the Jones Ranch monitoring site (3-kilometers south of the Smelter tower. FMMI then applied linear interpolation for three or less consecutive missing hours in the combined tower/Jones Ranch file. In the case of missing Safford data, if one hour was missing, FMMI used the preceding hour's observation. If two or more consecutive hours of data were missing, data substitution

considered past and future conditions as well as other available meteorological data fields. In most cases, FMMI applied linear interpolation between preceding and following data points for two or more missing consecutive hours of data. FMMI performed data substitution using Microsoft Excel® spreadsheets, and ADEQ will provide these to EPA for review of the data substitution performed.

6.2.2   Upper Air Observations

FMMI used the MIXHTS program to determine the twice-daily mixing heights required by MPRM. Both upper air and surface observations are required inputs for the MIXHTS program. FMMI used the upper air observations described previously for use with AERMET for input to MIXHTS. Several data issues prevented the MIXHTS program from calculating many of the morning and some of the evening mixing heights.

FMMI used the Tucson surface level ISH meteorological file for the surface observations input to MIXHTS. The conversion was achieved by running the AERMET Stage 1 processor and then converting the AERMET Stage 1 output into SAMSON format. FMMI then selected Tucson surface level data based on its proximity to the upper air station and the sensitivity of the MIXHTS program to surface temperature and upper air base level temperature consistency.

Next, FMMI ran MIXHTS using the datasets described above. FMMI reassigned any mixing heights that were calculated to be greater than 4000 meters by using a linear interpolation of the preceding and following values. Where there were still single mixing heights missing a simple average between the preceding and following day was used. FMMI used AERMET if more than three consecutive days of data were missing the minimum daily mixing height calculated by AERMET. In a few instances, FMMI substituted the maximum mixing height for three or more missing afternoon mixing heights.

6.2.3   MPRM Output

After running MPRM, a small number of hours in the final output file had missing wind direction data. These were associated with calm wind speed observations, in which case MPRM automatically assigns wind speed and wind direction to be 0.0 meters per second (m/s) and 0°N, respectively. Because BLP cannot run with such wind conditions, FMMI reassigned all calm wind speeds a value of 1.0 m/s and substituted missing wind direction data linear interpolation of preceding and following wind direction observations.

Figure 6-2: Wind Rose of On-site Meteorological Data
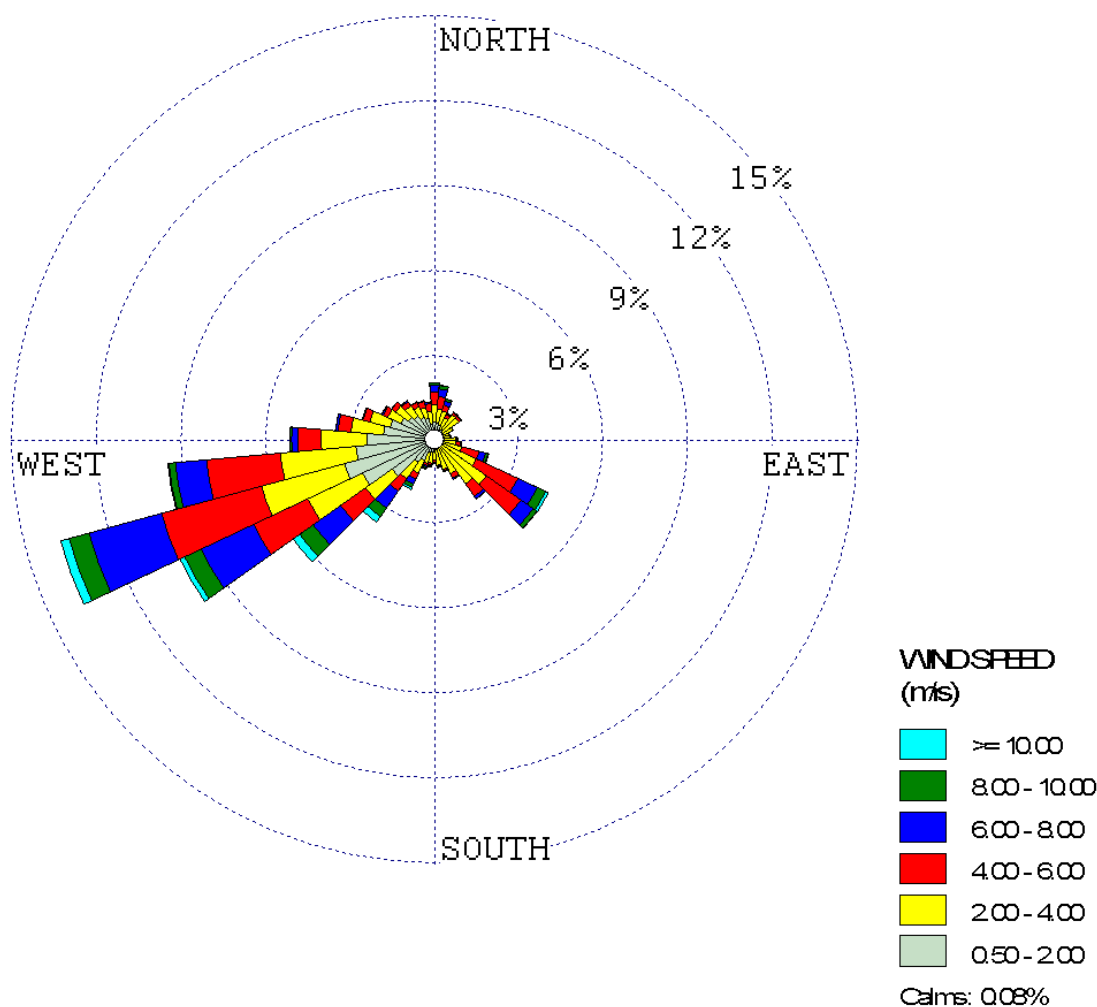
7.0 Background Air Quality

EPA requires background air quality estimates be added to modeling results for comparison to the NAAQS. FMMI based estimates of the background air quality estimates of SO_2 proposed for the dispersion modeling analysis on measured data collected from ambient air monitoring sites located in the Miami-Claypool area. FMMI used data measured at three monitoring sites for SO_2. Figure 6-1 illustrates the locations of these monitoring sites. The data used in the analysis were measured by FMMI during the 4-year period from 2009 to 2012.

Based on an initial analysis of the ambient SO_2 data, contributions from Miami Smelter operations dominate the vast majority of the measurements. FMMI confirmed this by evaluating data measured only during hours of smelter operation shutdowns, during which the three monitoring sites recorded reduced ambient air concentrations. EPA's GAQM (U.S. EPA, 2005) defines background air quality as "pollutant concentrations

due to: (1) Natural sources; (2) nearby sources other than the one(s) currently under consideration; and (3) unidentified sources."

For isolated sources such as the Miami Smelter, the GAQM (U.S. EPA, 2005) specifically states, "Determine the mean background concentration at each monitor by excluding values when the source in question is impacting the monitor." FMMI shut down smelter operations during 1,322 of the hours in the 4-year period of records evaluated. While the shutdown hours represent only 3.8% of the total hours in the 4-year time period, the availability of over 1,000 hours of shutdown data provides compelling evidence of background air quality conditions in the absence of facility impacts. This is particularly true for the determination of 1-hour average SO_2 background concentrations.

Table 7-1 provides a summary of the 1-hour SO_2 concentrations for the shutdown data set. The significant difference found between the design concentrations indicates that the smelter operations dominate the ambient air quality measured at the monitors during periods of smelter operation, and consequently the data collected during shutdowns are representative of background air quality in the Miami-Claypool area. FMMI used ambient air measurements recorded during smelter shutdown as representative of background air quality for SO_2. To offset the reduced data sets, FMMI selected the maximum background concentration among the sites from the 5-year averages of the daily maximum 99th percentile 1-hour average concentrations. Table 7-2 summarizes the proposed background air quality estimates.

Table 7-1: Average 1-Hour Ambient Air Concentrations of SO_2 (ppb)

Period	Jones Ranch Monitor Shutdown 99th (N)	Townsite Shutdown 99th (N)	Ridgeline Monitor Shutdown 99th (N)
2009	3.9	5.0	4.5
2010	4.3	12.0	11.3
2011	8.8	6.0	7.5
2012	18.8	6.1	8.8
2013	4.5	4.5	4.0
5-Yr Avg.	8.1	6.7	7.2

Table 7-2: Background Air Quality Estimates

Parameter	Averaging Period	Background Concentration (ppb)	Background Concentration (µg/m³)
SO_2	1-hour	8.1	21.2

8.0　Air Quality Modeling Results and Emission Limits

This section provides a discussion on the control efficiencies, air quality modeling, and emission limits for the Miami Smelter. The methodology that was applied to define the emission limits for the Smelter is summarized in Figure 8-1 and a detailed discussion is provided throughout this section.

Figure 8-1: The Methodology to Determine Emission Limits
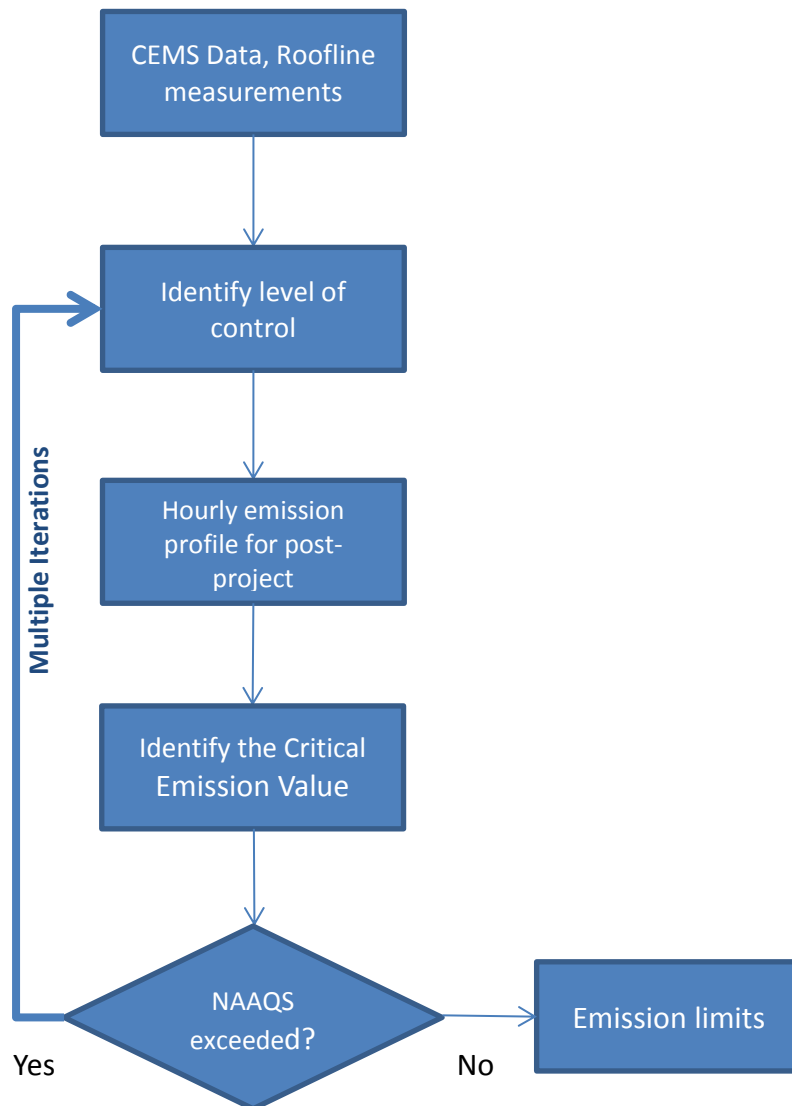
FMMI followed the approach presented in Figure 8-1, as follows:

When the SO_2 NAAQS was revised in 2010, FMMI contracted with a smelter design firm and dispersion modeling experts to work in partnership to develop a SO_2 emission reduction strategy for the FMMI Smelter. This partnership began by identifying design changes to reduce SO_2 emissions and obtaining air quality permits to timely authorize those changes such that the Miami area would meet the 1-hour SO_2 NAAQS attainment compliance deadline.

The initial step in the iterative design process was to identify a dispersion model that could model both roof vents and point sources (stacks) in complex terrain. Working closely with ADEQ, several modeling tools were investigated. After an examination of model performance and acceptability, FMMI and ADEQ determined that the "AERMOD/BLP Hybrid" modeling approach would provide the most representative simulation of ambient concentrations resulting from FMMI facility emissions[14].

The modeling staff then worked closely with the engineering design staff to identify emission levels that demonstrate compliance with the 1-hour SO_2 NAAQS. The modeling results and emission levels were used by the engineering team to develop facility designs that might meet the emissions and modeling criteria. Because engineering designs involved building, stack, and equipment changes, which included evaluations of different stack locations, heights, and exhaust parameters, additional model runs were performed at each step to evaluate the effect of the proposed engineering design changes and to identify alternatives if the proposed engineering designs did not meet the 1-hour SO_2 NAAQS. This process was repeated, resulting in several hundred dispersion modeling analyses, with a final result identifying an engineering design that also modeled compliance with the 1-hour SO_2 NAAQS. During this period, revisions to AERMOD and AERMET were released and the updated model performance had to be considered.

The coupled design/modeling process resulted in a proposed smelter configuration that will reduce facility-wide SO_2 emissions and bring the Miami area into attainment with the 1-hour SO_2 NAAQS while allowing for an increase in allowable smelter throughput. The proposed changes were authorized via a significant revision to FMMI's Class I air permit on July 21, 2014, and in part included:

- Increase of operational flexibility via authorization of 1,000,000 dry tons per year of New Metal Bearing Material (NMBM) throughput capacity;
- Increase of Acid Plant capacity to accommodate the authorized concentrate throughput capacity (i.e., upgraded cooling system, new converter bed, new blower, and new SO_3 cooler);
- Replacement of the existing IsaSmelt® furnace and upgrades of furnace feed, cooling and emissions control systems (i.e., lance seal, feed port hood, and tapping hood controls);
- Upgrade of the electric furnace emissions control system (i.e., tapping hood controls);
- Upgrade of the converters emissions control system (i.e., reconfiguring the roofline to capture emissions and route them to a new Aisle Scrubber including stack);
- Upgrade of the anode furnaces and utility vessel (also known as a mold barrel) emissions control system (i.e., process gas collection system, mouth covers, replacement of utility vessel, new baghouse ducted to the new Aisle Scrubber, new hydrated lime silo, and new baghouse dust return system to the electric furnace);
- Upgrade of the Vent Fume Scrubber and Acid Plant Tail Gas Scrubber to caustic use;
- Addition of two new Wet Electrostatic Precipitator (WESP) modules at the vent fume control system; Increase of the height of the Vent Fume Stack and Tail Gas Stack; and
- Other ancillary facility changes.

Beginning in 2014, ADEQ with assistance from FMMI, began developing the 1-hour SO_2 SIP for the Miami SO_2 Nonattainment Area. Starting with the emission controls developed for the significant permit revision, FMMI and their contractors reanalyzed the proposed smelter design using EPA's SO_2 Nonattainment Area

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[14] The details of this approach are set forth in FMMI's August 11, 2015 Technical Memorandum included in the TSD and titled "Performance Evaluation Modeling Results for the Miami SO2 Nonattainment Area State Implementation Plan (SIP)".

SIP Guidance and incorporating the most recently approved versions of the AERMOD and AERMET models along with a more recent 3-year meteorological dataset covering the second quarter of 2010 through the first quarter of 2013. The analysis resulted in FMMI proposing controls on Bypass Stack emissions that had not been previously included in the permitted control strategy. The control strategy proposed in the TSD represents the culmination of a considerable amount of iterative engineering analysis performed for the permitting and SIP processes.

8.1 Proposed SO$_2$ Control Levels

As discussed above and also in Section 5-1, to address the revised 1-hour SO$_2$ NAAQS, FMMI will undertake a significant project to upgrade the Miami Smelter that will result in SO$_2$ emissions reduction. To demonstrate compliance with the NAAQS, FMMI proposed SO$_2$ emissions reduction for each source. The proposed SO$_2$ control efficiencies necessary to achieve the SO$_2$ emissions reduction are summarized in Table 8-1.

Table 8-1: Proposed SO$_2$ Control Levels

Source	SO$_2$ Control Efficiency	Comment
Acid Plant Tail Gas Stack	99.6% [15]	When inlet SO$_2$ concentration is greater than 500 ppm
	2 ppm	When inlet concentration is between 2-500 ppm
Vent Fume Stack	95.8% [15]	When inlet SO$_2$ concentration is greater than 95 ppm
	4 ppm	When inlet concentration is between 4-95 ppm
Aisle Scrubber Stack- Normal Operations	93.6% [15]	When inlet SO$_2$ concentration is greater than 16 ppm
	1 ppm	When inlet concentration is between 1-16 ppm
Aisle Scrubber Stack- Bypass Operations	34.5% [16]	When inlet SO$_2$ concentration is greater than 1.53 ppm
	1 ppm	When inlet concentration is between 1-1.53 ppm
Isa Roof Vent	55%	SO$_2$ emissions reduction of 55%
ELF Roof Vent	0%	SO$_2$ emissions are projected to remain unchanged due to system improvements
Converter Roof Vent	91% (capture only)	SO$_2$ emissions capture of 91% by Aisle Scrubber system. Control efficiency is addressed for the Aisle Scrubber as noted above.
Anode Roof Vent	93% (capture only)	SO$_2$ emissions capture of 93% by Aisle Scrubber system. Control efficiency is addressed for the Aisle Scrubber as noted above.
Bypass Stack	100% (capture only)	SO$_2$ emissions capture of 100% by Aisle Scrubber system. Control efficiency is addressed for the Aisle Scrubber as noted above.

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[15] For the APTGS and VFS, which are existing units, the effective control efficiency is calculated from the future and existing PTE. For the Aisle Scrubber, which is a future unit, the effective control efficiency is calculated from the scrubber inlet loading and future PTE.

[16] The control efficiency of 34.5% for bypass operation was deemed necessary to meet the procedures provided in Appendices B and C of EPA's SO$_2$ Nonattainment SIP Guidance. The analysis presented in Appendix G of the TSD demonstrates that such a reduction can be achieved.

SO$_2$ capture or removal efficiencies were calculated based on engineering design and professional judgments. More details on SO$_2$ emissions calculation basis and also SO$_2$ capture and removal efficiencies are provided in the Hatch Memo which is included in Appendix F. Appendix G also includes information on emissions calculations and capture/removal efficiency during bypass events, which was provided by Gas Cleaning Technologies (GCT).

8.2   Proposed Future Emissions

FMMI used the actual hourly SO$_2$ data from continuous emissions monitoring system (CEMS) from May 2013 through October 2014 as representative emissions distributions for the Smelter's future configuration. An hourly emissions profile was developed based on engineering design concentrations. The magnitude of future emissions were based on these data records and adjusted to reflect both increased production capacity and future emissions control efficiencies required to demonstrate compliance with the NAAQS.

The future maximum potential SO$_2$ emission rates for the sources listed in table 8-1 result from the proposed modifications and are provided in Table 8-2. Two different emission rates are presented for the Aisle Scrubber Stack. The first represents emissions during normal smelter operations while the second represents emissions during Acid Plant bypass operations.

Table 8-2: Future Smelter SO$_2$ Emissions after Additional Controls

Source	SO$_2$ Emissions (lb/hr)
Acid Plant Tail Gas Stack	3.2 [17]
Vent Fume Stack	13.0 [17]
Aisle Scrubber Stack- Normal Operations	14.3 [17]
Aisle Scrubber Stack- Bypass Operations	275.0
Isa Roof Vent	31.8 [18]
ELF Roof Vent	14.2 [18]
Converter Roof Vent	25.6 [18]
Anode Roof Vent	8.0 [18]

The future SO$_2$ emissions sources at the Smelter that will remain at their existing level of control were also identified. These sources and their future maximum potential SO$_2$ emission rates are presented in Table 8-3.

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[17] Future PTE for SO$_2$ provided by the engineering contractor (Hatch) for the proposed project, based on potential NMBM throughput.

[18] The Future PTE listed for the roofline vents is based on existing PTE from the 2012 roofline vent study. Subsequent continuous monitoring of the roofline vents has shown the 2012 roofline vent study to be a conservative representation of average actual emissions from the vents. For example, the 18-month continuous monitoring data set for the roofline vents includes the following average emissions: Isa = 31.1 lb/hr, ELF = 10.3 lb/hr, Converters = 117.1 lb/hr, and Anode = 58.6 lb/hr. Given these values, the 2012 roofline vent study serves as an appropriate and conservative representation of existing and future PTE from these vents.

Table 8-3: Future Smelter SO$_2$ Emissions Remaining at Existing Level of Control

Source	SO$_2$ Emissions (lb/hr)
Acid Plant Preheater	0.0198
Isa Auxiliary Boiler	0.00612
Change Room Water Heater	0.000437
Rod Plant Thermal Breaker	0.000456
Rod Plant Shaft Furnace	0.350
Screening Engine	0.00102
Compressor	0.00655
Compressor	0.00655
Rod Plant Roof Vent	0.0129
Smelter Building Leaks	3.98
Slag Storage Area	3.75
ISA emergency generator	0.001764
Smelter Emergency Generator	0.000513
Emergency Water Pump	0.000615
Main Server Emergency Generator	0.000205
Moonshine Hill Emergency Generator	0.000717
Smelter Guard House Emergency Generator	0.000041
Communications Office Emergency Generator	0.000102
Radio Tower Emergency Generator	0.001764
Hood Emergency Pump	0.002600

8.3   Identifying the Critical Emission Value

As mentioned in Section 5.3, the sources associated with the Miami Smelter have highly variable SO$_2$ emission rates due to a combination of both continuous and batch processes. EPA's Guidance for 1-Hour SO$_2$ Nonattainment Area SIP Submission (EPA, 2014) provides for the consideration of emission limit averaging periods as long as 30 days for sources with highly variable emission rates where hourly emission rates occasionally exceed the critical emission value (CEV) rate. ADEQ believes that a 30-day emission limit will similarly assure NAAQS attainment while accommodating the high variability of emissions.

FMMI followed the approach set forth in Appendix B and C of EPA's Guidance for 1-Hour SO$_2$ Nonattainment Area SIP Submission (EPA, 2014) to determine the longer term average emission limits. The guidance defines the critical emission value (CEV) as "…the hourly emission rate that the model predicts would result in the 5-year average of the annual 99th percentile of daily maximum hourly SO$_2$ concentrations at the level of the 1-hour NAAQS, given representative meteorological data for the area." To determine the critical emission value, the guidance requires conducting dispersion modeling.

The calculation of a critical emissions value for a facility with a single SO$_2$ emission source is not a challenging task, because the predicted design value is proportional to the modeled emission rate. However, a complex facility such as the Miami Smelter, with seven future emissions sources of consequence, requires an iterative approach. The effectiveness and cost of controlling each of the SO$_2$ emissions sources varies greatly, and the iterative approach must be performed to optimize the control cost required to achieve attainment.

The emission rates listed in Tables 8-2 and 8-3, along with other dispersion model inputs described in Section 4, were input to the BLP/AERMOD Hybrid model to verify that the model predicted an average of the annual 99th percentile of daily maximum hourly concentrations at the level of the 1-hour NAAQS. The resulting predicted design concentration was 172.9 $\mu g/m^3$, just within the available air quality concentration of 174.8 $\mu g/m^3$. Available air quality in the Miami nonattainment area is the difference between the NAAQS (196 $\mu g/m^3$) and background air quality (21.2 $\mu g/m^3$), or 174.8 $\mu g/m^3$.

Based on the dispersion model results, the facility-wide critical emissions value is the sum of the emissions presented in Tables 8-2 and 8-3, or 393 lb/hr. Appendix H presents more details on identifying the facility-wide CEV, which was provided by FMMI.

FMMI will operate nine (9) emergency generators at the Miami Smelter once the proposed Smelter modifications are operational. These engines are subject to permitted restrictions on annual operating hours (i.e., 50 hours per year for non-emergency situations and 100 hour per year total for non-emergency situations, maintenance checks and readiness testing, and emergency demand response)[19]. The engines are run on a weekly maintenance schedule, for no more than an hour at a time, to ensure unit reliability. Based on EPA guidance (EPA's September 6, 1995 Memorandum "Calculating Potential to Emit (PTE) for Emergency Generators"), potential to emit (PTE) is based on the assumption that an emergency engine could be expected to operate no more than 500 hours per year under worst-case conditions.

Given the nature of the emergency engines as intermittent emission sources, they were initially excluded from the modeling consistent with EPA's March 1, 2011, Memorandum, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" ("2011 Memo") because emissions from the engines are not continuous enough or frequent enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations.

As suggested by EPA, FMMI has included these engines in the modeling analysis of the Critical Emissions Value (CEV) by assuming continuous operation at the average hourly rate (i.e., the maximum hourly rate multiplied by 500/8760), consistent with the alternative approach identified in the 2011 Memo. The emergency engines were added to the "fixed" emission sources that FMMI has accounted for in the modeling by assuming constant operation at their respective potential to emit rates. As explained in our March 30, 2016, Technical Memorandum "Contribution of Fixed Emission Sources to CEV Modeling Results Miami SO_2 Nonattainment Area State Implementation Plan (SIP)," the model-predicted SO_2 emission levels associated with these fixed sources, including the emergency engines, are insignificant contributors to the model-predicted concentrations that define the CEV. Because the contribution of the emergency engines is negligible, the emergency engines were included only in the CEV modeling analysis and not in the balance of dispersion modeling performed for the TSD.

EPA requested a contour map of BLP-AERMOD hybrid predicted Design Value concentrations to show the distribution of Design Value concentrations pre- and post-control. Figure 8-2 provides a set of design value isopleths for the post-control CEV case. Pre-control modeling was not performed for the SO_2 SIP attainment demonstration modeling and therefore a set of isopleths for the pre-control CEV case are not available.

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[19] Air Quality Class I Permit No. 53592, as amended by Significant Revision No. 58409 and issued on July 21, 2014.
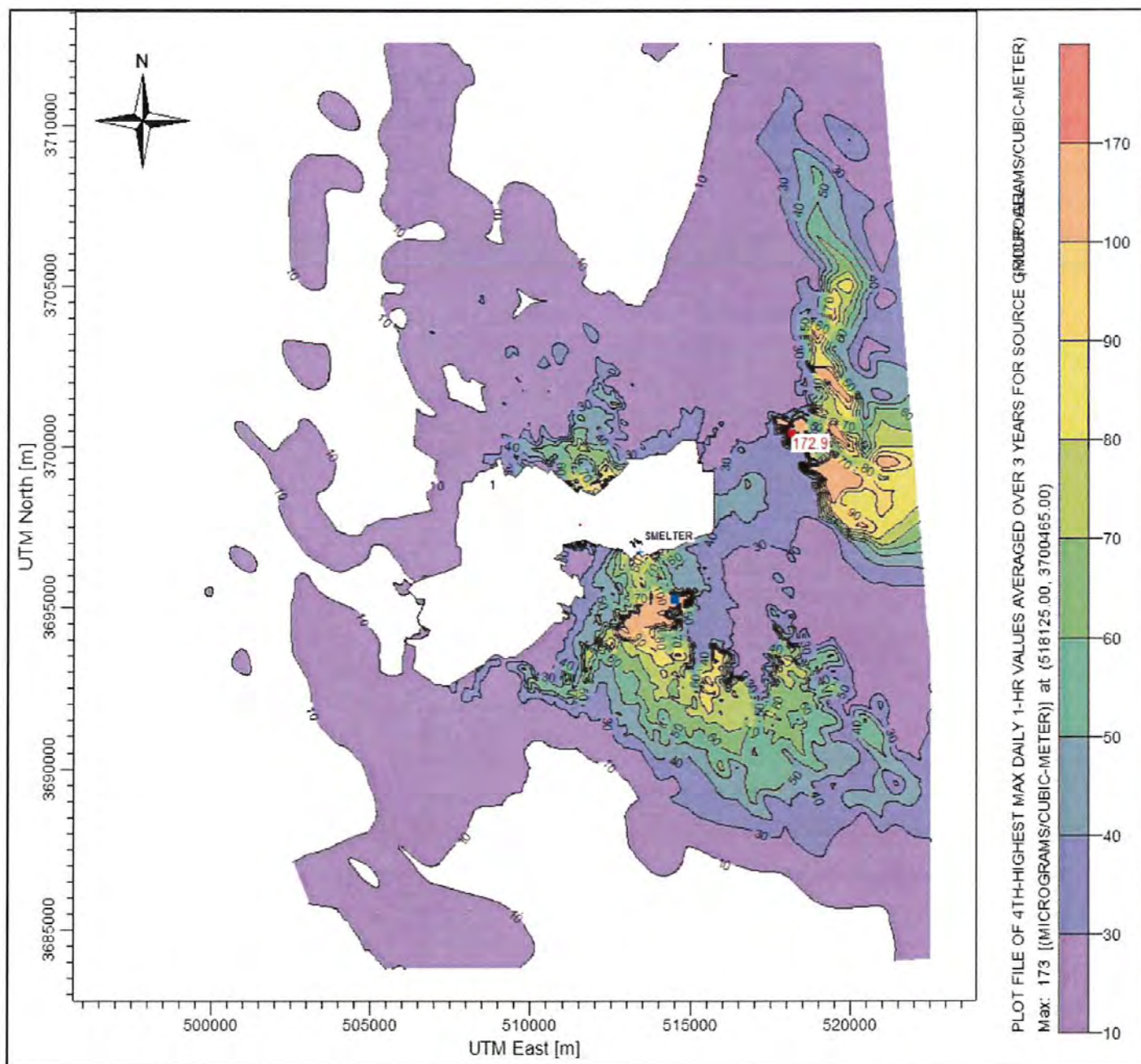
8.4 Emission Limits

The Following steps present the procedure defined in EPA's Guidance for establishing an emission limit for a longer than 1-hour averaging period:

Step 1: Identify the CEV

As described in Section 8.3 a facility-wide CEV of 393 lb/hr was determined using BLP/AERMOD Hybrid modeling.

Step 2: Compile future emissions profile

FMMI prepared an hourly emissions profile to reflect its emissions after the implementation of the Smelter upgrade projects based on engineering design calculations. The development of this emissions profile is described in Section 8.2 and Appendix G.

Step 3: Use the distribution of hourly emissions data obtained in step 2 to compute a corresponding distribution of longer term emission average

FMMI calculated average emissions for 3-hour, 24-hour, 7-day, 30-day, and 365-day. Based on analysis, the 3-hour, 24-hour and 7-day averaging periods were not sufficient to address emissions variability from the source.

Step 4: Calculate the 99th percentile values

In this step the 99th percentile of the 1-hour average emission values (compiled in step 2) and the 99th percentile of the averaged values (compiled in step 3) were determined and presented in Table 8-4.

Table 8-4: 99th Percentile Values of Emission Rates

Averaging Period	99th Percentile of Emission Rate (lb/hr)
1-hour	276.69
3-hour	231.15
24-hour	226.20
7-day	141.13
30-day	102.40
365-day	71.58

Step 5: Calculate the ratio of the longer term average times to the 1-hour 99th Percentile

Table 8-5 shows the ratio of the longer term averaging period's 99th percentile emission rates to the 1-hour 99th percentile emission rate.

Table 8-5: Ratio of Longer Term Averaging Period to 1-hr 99th Percentile

Averaging Period	99th Percentile of Emission Rate (lb/hr)	Ratio of 99th Percentile Emission Rate to 1-hr Percentile Emission Rate
3-hour	231.15	0.84
24-hour	226.20	0.82
7-day	141.13	0.51
30-day	102.40	0.37
365-day	71.58	0.26

Step 6: Multiply the ratio by the CEV to determine the final limit

The final step in EPA's Guidance is to multiply the ratio of the 99th percentile emission rate for each averaging period to the 1-hr 99th percentile emission rate (CEV) to calculate a limit for each averaging period. The results of this step are presented in Table 8-6.

Table 8-6: Calculation of Emission Limits for Longer Term Averaging Periods

Averaging Period	Ratio of 99th Percentile Emission Rate to 1-hr 99th Percentile Emission Rate	Emission Limit (lb/hr) Product of Ratio and CEV
3-hour	0.84	328.24
24-hour	0.82	321.21
7-day	0.51	200.41
30-day	0.37	145.41
365-day	0.26	101.64

Once the emission limits were identified, the proposed limits were compared against the projected emissions distributions to determine if a proposed emissions limit would be exceeded based on its anticipated emissions profile. This analysis was performed for 12,043 total hours in proposed emission profile and is summarized in table 8-7.

Table 8-7: Exceedance Risk for Proposed Longer Term Average Limits

Averaging Period	Calculated Emissions Limit (lb/hr)	Number of Hours Exceeding Emissions Limit	Expected Frequency of Deviations
1-hour	387.0	60	0.50%
3-hour	323.23	63	0.52%
24-hour	316.31	39	0.32%
7-day	197.35	0	0.00%
30-day	143.19	0	0.00%
365-day	100.09	0	0.00%

As shown in Table 8-7, attainment with the 1-hour SO_2 NAAQS can be demonstrated using EPA's long-term emissions limit approach when the emissions limit is based on a the 30-day averaging period. ADEQ recommends the use of a 30-day limit to address the complexity and variability of emissions at the Miami Smelter.

8.5   Supporting Modeling to Demonstrate Attainment

A modeling analysis was performed on the projected future actual 1-hour emissions to demonstrate that the Miami NAA would be in compliance with the NAAQS with the proposed 30-day rolling hourly emission limit.

The modeling analysis aligned the projected future hourly emissions, which were based on the aforementioned existing measurements of hourly emissions from May 2013 through October 2014, with on-site meteorological data that were measured concurrently with the existing measurements of hourly emissions.

The hybrid BLP/AERMOD modeling approach was used consistent with the CEV modeling approach. MPRM and AERMET were run to create 2013 and 2014 hourly meteorological files for use in BLP and AERMOD, respectively. The hourly meteorological data were concurrent with the hourly emissions monitoring data.

The hourly roof vent plume heights were determined by running BLP with the 2013 and 2014 met data. The hourly roof vent plume heights along with the hourly controlled emission rates for all sources were combined into a single AERMOD compatible hourly emission rate file. AERMOD was then run to predict the design concentration at each receptor in the grid. The results at the worst-case receptor (165.2 µg/m^3) were summed with the background concentration of 21.2 µg/m^3 and resulted in a concentration of 186.3 µg/m^3 which is below the SO_2 NAAQS of 196 µg/m^3. The modeling files for this modeling run are provided on the CD.

8.6   Sensitivity of the CEV to the Variations of Predicted SO$_2$ Concentrations

A sensitivity analysis was performed by FMMI to demonstrate that the facility-wide CEV represents an appropriate emission rate that demonstrates compliance with the 1-hour SO$_2$ NAAQS even when there may be variations in the precise sources (which may affect the distribution of emissions leading to differences in emission locations, release heights, and other source parameters) at the Smelter. In other words, the purpose of this technical analysis was to demonstrate that the current facility-wide CEV is a robust value that is not sensitive to changes in the allocation of SO$_2$ emissions among sources within the Smelter.

FMMI evaluated the effect of varying individual source emissions while keeping the facility-wide emissions consistent. To do so, FMMI increased a single source and decreased the other major emission sources by a weighted amount, such that the CEV remained constant.

In each scenario, one individual source's emission rate was increased while the emissions from the remaining major emission sources were decreased by a proportional amount to ensure the facility-wide CEV remained constant. As a result, each source combination maintained the total emission rate constant at the facility-wide CEV of 393 lb/hr while varying the individual source rates.

The sensitivity analysis predicted concentrations that are within 1.0% of the CEV modeled design value concentration. The variation in predicted concentrations is very small when compared to the 20.8% variation in emission rates applied to the various sources for the purposes of the sensitivity analysis. Based on these results, a single facility-wide emission limit based on the CEV is appropriate for the Miami Smelter. More details on this sensitivity analysis are provided in Appendix I.

8.7   CEV Exceedance Risk Analysis

FMMI performed an analysis of the potential risk of exceeding the SO$_2$ NAAQS based on the proposed future configuration of the Smelter.

Because of the variability of the emission rates from the larger sources, an additional analysis was conducted to show, per EPA's SO$_2$ Nonattainment Area SIP Guidance (EPA, 2014), that periods of hourly emissions greater than the CEV are a rare occurrence at the source, and these periods would be unlikely to have a significant impact on air quality, insofar as they would be very unlikely to occur repeatedly at the times when the meteorology is conducive for high ambient concentrations of SO$_2$.

The approach entailed using the 18-month data set of projected future actual emissions paired randomly with an alternative on-site meteorological data set consisting of 3 years of hourly observations from January 2011 through December 2013 in such a way to represent 300 years of modeling (100 runs). The results indicated that for all of the 100 runs, the predicted design concentration was less than the target concentration of 174.8 µg/m^3. These results indicate that compliance with the NAAQS is predicted based on the proposed 30-day limit.

More details on the methodology and results of this analysis are included in Appendix J of this TSD.

8.8   Proposed CEV and 30-Day Emission Limit

FMMI performed an analysis of the contribution of the emissions sources listed in Table 8-3 to the model-predicted design concentrations associated with the CEV. This analysis is presented in Appendix K of this TSD. The analysis determined that the Table 8-3 emissions sources are insignificant contributors to the predicted CEV design concentration. Because the CEV presented in Section 8.3 of 393 lb/hr includes a maximum of 8 lb/hr associated with the Table 8-3 sources operating at their maximum capacity, FMMI is proposing a CEV of 385 lb/hr (i.e., 393 lb/hr minus 8 lb/hr) that applies specifically to the following emissions sources:

- Acid Plant Tail Gas Stack
- Vent Fume Stack
- Aisle Scrubber Stack (normal operations)
- Aisle Scrubber Stack (bypass operations)
- IsaSmelt® Roof Vent
- Electric Furnace (ELF) Roof Vent
- Converter Aisle Roof Vent
- Anode Aisle Roof Vent

The 30-day rolling hourly emission limit that applies specifically to these eight Table 8-2 sources is then derived in the same way as that presented in Section 8.4. The resulting 30-day emission limit is 142.45 lb/hr. By adopting this approach, compliance with the 30-day rolling hourly emissions limit is demonstrated by direct measurement of emissions from the eight Table 8-2 sources via continuous emissions monitoring. Table 8-3 emissions sources are already accounted for and therefore not included in that compliance demonstration.

9.0 References

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10.0 Appendices

10.1 Appendix A: Modeling TSD CD-ROM

Table 10-1: CD-ROM Table of Contents

Folder or File Name	Descriptions
\AERMAP\Receptors	
SIP_fittedgrid.api	AERMAP Input File
SIP_fittedgrid.ast	AERMAP Output File
SIP_FITTEDGRID.ROU	AERMAP Receptor Elevation File
MAPDETAIL.OUT	AERMAP Output File
NED_84304396.tif	NED 10-meter File
CurrentSRC.api	AERMAP Input File
CurrentSRC.AST	AERMAP Output File
CurrentSRC.SOU	AERMAP Source Elevation File
FMI1_1.dem	Onsite DEM file created from CAD File
FMI2_1.dem	Onsite DEM file created from CAD File

Folder or File Name	Descriptions
\AERMET	
10-13fn.PFL	AERMET Profile file (unshifted)
11-13fnc14.PFL	AERMET Profile file (shifted)
11-13fnc14.SFC	AERMET Surface file (shifted)
13-14actual.PFL	AERMET 2013-2014 Profile file for performance evaluation
13-14actual.SFC	AERMET 2013-2014 Surface file for performance evaluation
13fnc14_shift.PFL	2013 AERMET Profile file with 2010 data subbed in
13fnc14_shift.SFC	2013 AERMET Surface file with 2010 data subbed in
2010fnc14.IN1	2010 Stage 1 input file
2010fnc14.IN2	2010 Stage 2 input file
2010fnc14.IN3	2010 Stage 3 input file
2010FN.MG1	2010 AERMET Stage 1 Message File
2010FN.MG2	2010 AERMET Stage 2 Message File
2010FN.MG3	2010 AERMET Stage 3 Message File
2010FN.MRG	2010 AERMET Merge File
2010FNC.OQA	2010 Onsite QA file
2010fnc14.PFL	2010 AERMET Profile file
2010FN.RP1	2010 Stage 1 Report file
2010FN.RP2	2010 Stage 2 Report file
2010FN.RP3	2010 Stage 3 Report file
2010FN.SAX	2010 Surface Intermediate File
2010fnc14.SFC	2010 AERMET Surface File
2010FN.SQA	2010 Surface QA file
2010FN.UAX	2010 Upper Air Intermediate File
2010FN.UQA	2010 Upper Air QA file
2011fnc14.IN1	2011 Stage 1 input file

Folder or File Name	Descriptions
2011fnc14.IN2	2011 Stage 2 input file
2011fnc14.IN3	2011 Stage 3 input file
2011FN.MG1	2011 AERMET Stage 1 Message File
2011FN.MG2	2011 AERMET Stage 2 Message File
2011FN.MG3	2011 AERMET Stage 3 Message File
2011FN.MRG	2011 AERMET Merge File
2011FN.OQA	2011 Onsite QA file
2011fnc14.PFL	2011 AERMET Profile file
2011FNC14.RP1	2011 Stage 1 Report file
2011FNC14.RP2	2011 Stage 2 Report file
2011FNC14.RP3	2011 Stage 3 Report file
2011FN.SAX	2011 Surface Intermediate File
2011fn.SFC	2011 AERMET Surface File
2011FN.SQA	2011 Surface QA file
2011FN.UAX	2011 Upper Air Intermediate File
2011FN.UQA	2011 Upper Air QA file
2012fnc14.IN1	2012 Stage 1 input file
2012fnc14.IN2	2012 Stage 2 input file
2012fnc14.IN3	2012 Stage 3 input file
2012FN.MG1	2012 AERMET Stage 1 Message File
2012FN.MG2	2012 AERMET Stage 2 Message File
2012FN.MG3	2012 AERMET Stage 3 Message File
2012FN.MRG	2012 AERMET Merge File
2012FN.OQA	2012 Onsite QA file
2012fnc14.PFL	2012 AERMET Profile file
2012FNC14.RP1	2012 Stage 1 Report file
2012FNC14.RP2	2012 Stage 2 Report file
2012FNC14.RP3	2012 Stage 3 Report file
2012FN.SAX	2012 Surface Intermediate File
2012fnc14.SFC	2012 AERMET Surface File
2012FN.SQA	2012 Surface QA file
2012FN.UAX	2012 Upper Air Intermediate File
2012FN.UQA	2012 Upper Air QA file
2013fnc14.IN1	2013 Stage 1 input file
2013fnc14.IN2	2013 Stage 2 input file
2013fnc14.IN3	2013 Stage 3 input file
2013FN.MG1	2013 AERMET Stage 1 Message File
2013FN.MG2	2013 AERMET Stage 2 Message File
2013FN.MG3	2013 AERMET Stage 3 Message File
2013FN.MRG	2013 AERMET Merge File
2013FN.OQA	2013 Onsite QA file
2013fnc14.PFL	2013 AERMET Profile file

Folder or File Name	Descriptions
2013FNC14.RP1	2013 Stage 1 Report file
2013FNC14.RP2	2013 Stage 2 Report file
2013FNC14.RP3	2013 Stage 3 Report file
2013FN.SAX	2013 Surface Intermediate File
2013fnc14.SFC	2013 AERMET Surface File
2013FN.SQA	2013 Surface QA file
2013FN.UAX	2013 Upper Air Intermediate File
2013FN.UQA	2013 Upper Air QA file
2014fnc14.IN1	2014 Stage 1 input file
2014fnc14.IN2	2014 Stage 2 input file
2014fnc14.IN3	2014 Stage 3 input file
2014FN.MG1	2014 AERMET Stage 1 Message File
2014FN.MG2	2014 AERMET Stage 2 Message File
2014FN.MG3	2014 AERMET Stage 3 Message File
2014FN.MRG	2014 AERMET Merge File
2014FN.OQA	2014 Onsite QA file
2014fnc14.PFL	2014 AERMET Profile file
2014FNC14.RP1	2014 Stage 1 Report file
2014FNC14.RP2	2014 Stage 2 Report file
2014FNC14.RP3	2014 Stage 3 Report file
2014FN.SAX	2014 Surface Intermediate File
2014fnc14.SFC	2014 AERMET Surface File
2014FN.SQA	2014 Surface QA file
2014FN.UAX	2014 Upper Air Intermediate File
2014FN.UQA	2014 Upper Air QA file
allonsite-fixed(20140714).prn	Onsite Meteorology Input File with Missing Data Flags
AERSURFACE.INP	AERSURFACE input file
AERSURFACE.OUT	AERSURFACE output file
\BLP_code	
BLP-markup.docx	MS Word File Highlighting Code Changes
BLPgfortMH2.FOR	Modified BLP FORTRAN file

\MetData\Onsite	
14TWRJRCM.prn	2014 Merged Tower and Jones Ranch File
2014TWRJRCOMBO.xlsx	2014 MS EXCEL
TWRJRCOMBO.prn	2010-2013 Merged Tower and Jones Ranch File
TWRJRCOMBO.xlsx	2010-2013 MS EXCEL Merged Tower and Jones Ranch File

\MetData\Onsite\JonesRanch	
09-13allJR-fixed.prn	2009 - 2013 Jones Ranch Meteorological Data
09-13HRLYJR.xlsx	2009 - 2013 Jones Ranch Hourly Meteorological Data
09-13JR-fixed.prn	2009-2013 output from EXCEL file

Folder or File Name	Descriptions
09-13JR.inp	AERMET stage 1 file to determine hourly averages of onsite data
09-13JR.MG1	AERMET stage 1 merged file (not used)
09-13JR.OQA	AERMET stage 1 onsite QA file
09-13JR.RP1	AERMET stage 1 report file
14JR.MG1	AERMET 2014 stage 1 merged file (not used)
14JR.OQA	AERMET 2014 stage 1 onsite QA file
14JR.RP1	AERMET 2014 stage 1 report file
2009JR.xlsx	2009 Jones Ranch Meteorological Data
2010JR.xlsx	2010 Jones Ranch Meteorological Data
2011JR.xlsx	2011 Jones Ranch Meteorological Data
2012JR.xlsx	2012 Jones Ranch Meteorological Data
2013JR.xlsx	2013 Jones Ranch Meteorological Data
2014JR-HRLY.xlsx	2014 Jones Ranch Meteorological Data
Jones Ranch data January-April 2014.xlsx	2014 Jones Ranch Raw Meteorological Data

\MetData\Onsite\Tower		
09-13f.OQA		AERMET Stage 1 Onsite QA file
09-13onsite(20140714).prn		2009 -2013 Onsite Meteorological File
2009Tower.xlsx		2009 Raw Onsite Meteorological File
2010tower.xls		2010 Raw Onsite Meteorological File
2011tower.xlsx		2011 Raw Onsite Meteorological File
2012tower.xlsx		2012 Raw Onsite Meteorological File
2013Tower.xlsx		2013 Raw Onsite Meteorological File
2014F.OQA		AERMET 2014 Stage 1 Onsite QA File
2014onsite.prn		2014 Onsite Meteorological File
2014Tower.xlsx		2014 Onsite Meteorological File
2014TWR_HRLY.xlsx		2014 Onsite Hourly Meteorological File
allonsite-fixed(20140714).prn		2009 -2013 Onsite Meteorological File
allonsite-fixed.xlsx		2009 -2013 Onsite Meteorological File

\MetData\Surface	
09-13bsaf.xlsx	Safford Surface Meteorological Data
09-13f.SAX	AERMET Safford Surface Meteorological Hourly File
09-13safford.sam	SAMSON formatted Safford Meteorological File
14dm.xlsx	2014 Davis Monthan Meteorological File
14Tucson.sam	2014 Samson Formatted Tucson Meteorological File
14Tucson.xlsx	2014 Meteorological Data
2014F.SAX	2014 AERMET Safford Surface Meteorological Hourly File
2014TWRJRCOMBO.xlsx	2014 Combined Tower / Jones Ranch Meteorological Data
2014_saf.sam	2014 Safford Samson Formatted Meteorological File
2014_saf.xlsx	2014 Safford Meteorological File

Folder or File Name	Descriptions
722740-23160-2009.ISH	ISH formatted Meteorological Data
722740-23160-2010.ISH	ISH formatted Meteorological Data
722740-23160-2011.ISH	ISH formatted Meteorological Data
722740-23160-2012.ISH	ISH formatted Meteorological Data
722740-23160-2013.ISH	ISH formatted Meteorological Data
722745-23109-2014.ISH	ISH formatted Meteorological Data
722747-93084-2009.ISH	ISH formatted Meteorological Data
722747-93084-2010.ISH	ISH formatted Meteorological Data
722747-93084-2011.ISH	ISH formatted Meteorological Data
722747-93084-2012.ISH	ISH formatted Meteorological Data
722747-93084-2013.ISH	ISH formatted Meteorological Data
722747-93084-2014.ISH	ISH formatted Meteorological Data
Tucson.sam	Samson Formatted Tucson Meteorological File
TUCSON.SAX	AERMET Tucson Surface Meteorological Hourly File
Tucson.xlsx	Tucson Meteorological Data
Tucsub.sam	Tucson Meteorological Data - Substituted

\MetData\UpperAir	
10-13Tuc_new.FSL	2010-2013 Tucson FSL file in New Format
10-13Tuc_old.FSL	2010-2013 Tucson FSL file in Old Format
2010Tuc(UW).FSL	2010-2013 Tucson FSL file in New Format
2010Tuc_old.FSL	2010-2013 Tucson FSL file in Old Format
2011Tuc(UW).FSL	2010-2013 Tucson FSL file in New Format
2011Tuc_old.FSL	2010-2013 Tucson FSL file in Old Format
2012Tuc(UW).FSL	2010-2013 Tucson FSL file in New Format
2012Tuc_old.FSL	2010-2013 Tucson FSL file in Old Format
2013Tuc(UW).FSL	2010-2013 Tucson FSL file in New Format
2013Tuc_old.fsl	2010-2013 Tucson FSL file in Old Format
2014Tuc(UW).FSL	2010-2013 Tucson FSL file in New Format
2014Tuc_old.FSL	2010-2013 Tucson FSL file in Old Format
TXTtoFSLnew.F90	FORTRAN Source Code to Reformat Upper Air Data
TXTtoFSL_old.F90	FORTRAN Source Code to Reformat Upper Air Data

\MetData\UpperAir\RawData	
Apr2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Apr2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Apr2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Apr2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Apr2014Tuc.txt	Raw Upper Air Data from University of Wyoming
Aug2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Aug2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Aug2012Tuc.txt	Raw Upper Air Data from University of Wyoming

Folder or File Name	Descriptions
Aug2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Dec2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Dec2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Dec2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Dec2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Feb2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Feb2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Feb2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Feb2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Feb2014Tuc.txt	Raw Upper Air Data from University of Wyoming
Jan2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Jan2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Jan2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Jan2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Jan2014Tuc.txt	Raw Upper Air Data from University of Wyoming
Jul2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Jul2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Jul2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Jul2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Jun2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Jun2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Jun2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Jun2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Mar2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Mar2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Mar2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Mar2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Mar2014Tuc.txt	Raw Upper Air Data from University of Wyoming
May2010Tuc.txt	Raw Upper Air Data from University of Wyoming
May2011Tuc.txt	Raw Upper Air Data from University of Wyoming
May2012Tuc.txt	Raw Upper Air Data from University of Wyoming
May2013Tuc.txt	Raw Upper Air Data from University of Wyoming
May2014Tuc.txt	Raw Upper Air Data from University of Wyoming
Nov2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Nov2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Nov2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Nov2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Oct2010Tuc.txt	Raw Upper Air Data from University of Wyoming
Oct2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Oct2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Oct2013Tuc.txt	Raw Upper Air Data from University of Wyoming
Sep2010Tuc.txt	Raw Upper Air Data from University of Wyoming

Folder or File Name	Descriptions
Sep2011Tuc.txt	Raw Upper Air Data from University of Wyoming
Sep2012Tuc.txt	Raw Upper Air Data from University of Wyoming
Sep2013Tuc.txt	Raw Upper Air Data from University of Wyoming

\MPRM	
09-13saf.sam	Safford Samson Meteorological File
10-13MXS.txt	2010-2013 Mixing Height File
11-13shift.met	2011-2013 MPRM output with 2010 moved to 2013
MERGE.MRG	MPRM Merged Output File
MPRM.MET	MPRM Output file
MPRMsnw.MET	MPRM Output file with substitutions
MPRMsubnew.xlsx	MPRM EXCEL file showing Substitutions
OS.OQA	MPRM OQA file
S1OS.ERR	MPRM Error File
S1OS.INP	MPRM Stage 1 Onsite Input File
S1OS.RPT	MPRM Stage 1 Onsite Report File
S1SF.ERR	MPRM Stage 1 Surface Error File
S1SF.INP	MPRM Stage 1 Surface Input File
S1SF.RPT	MPRM Stage 1 Surface Report File
S1UA.ERR	MPRM Stage 1 Upper Air Error File
S1UA.INP	MPRM Stage 1 Upper Air Input File
S1UA.RPT	MPRM Stage 1 Upper Air Report File
S2.ERR	MPRM Stage 2 Error File
s2.INP	MPRM Stage 2 Input File
S2.RPT	MPRM Stage 2 Report File
S3.ERR	MPRM Stage 3 Error File
s3.INP	MPRM Stage 3 Input File
S3.RPT	MPRM Stage 3 Report File
SF.IQA	MPRM Stage 1 Output File
SF.OQA	MPRM Stage 1 Output File
STAGE1N2.EXE	MPRM Executable
STAGE3.EXE	MPRM Executable
TWRJRCOM.prn	Combined Tower and JR Meteorological Data
UA.IQA	MPRM Stage 1 Output File
UA.OQA	MPRM Stage 1 Output File

\MPRM\MIXHTS	
10-13MXHT.prn	Mixing Height File
10-13MXHT.TXT	Mixing Height Output File
10-13MXHT.xlsx	Mixing Height Substitution File

Folder or File Name	Descriptions
10-13MXHTS.txt	Mixing Height Output File with Substitutions
10-13old.FSL	FSL File with 8 Character Name
10-13Tuc_old.FSL	FSL File
2010Tuc_old.FSL	2010 Tucson FSL File
2011Tuc_old.FSL	2011 Tucson FSL File
2012Tuc_old.FSL	2012 Tucson FSL File
2013Tuc_old.FSL	2013 Tucson FSL File
aermet.xlsx	Mixing Heights from AERMET Used for Substitutions
MIXHTS.EXE	Mixing Height Executable
MIXHTS.INP	Mixing Height Input File
MIXHTS.LOG	Mixing Height Log File
Tucsub.sam	Tucson Samson File

\MPRM14	
14MPRMs.MET	2014 MPRM Output File with Substitutions
14TRJRCM.prn	2014 Combined Onsite and JR Meteorological File
2014_saf.sam	2014 Safford Surface Meteorological File
MERGE.MRG	MPRM Merge File
MPRM.MET	MPRM Output File
MPRMsub.xlsx	MPRM Substitution File
MXHTdmS.TXT	MPRM File with Davis Monthan Surface Data
OS.OQA	MPRM QA File
S1OS.ERR	MPRM Error File
S1OS.INP	MPRM Stage 1 Onsite Input File
S1OS.RPT	MPRM Stage 1 Onsite Report File
S1SF.ERR	MPRM Stage 1 Surface Error File
S1SF.INP	MPRM Stage 1 Surface Input File
S1SF.RPT	MPRM Stage 1 Surface Report File
S1UA.ERR	MPRM Stage 1 Upper Air Error File
S1UA.INP	MPRM Stage 1 Upper Air Input File
S1UA.RPT	MPRM Stage 1 Upper Air Report File
S2.ERR	MPRM Stage 2 Error File
s2.INP	MPRM Stage 2 Input File
S2.RPT	MPRM Stage 2 Report File
S3.ERR	MPRM Stage 3 Error File
s3.INP	MPRM Stage 3 Input File
S3.RPT	MPRM Stage 3 Report File
SF.IQA	MPRM Surface QA File
SF.OQA	MPRM Onsite QA File
STAGE1N2.EXE	MPRM Executable
STAGE3.EXE	MPRM Executable
UA.IQA	MPRM Stage 1 Output File

Folder or File Name	Descriptions
UA.OQA	MPRM Stage 1 Output File

\MPRM14\MIXHTS	
14dm.sam	2014 Davis Monthan Samson Meteorological File
14Tucold.FSL	2014 Tucson Upper Air FSL File
MIXHTS.EXE	Mixhts Executable
MIXHTS.INP	2014 Mixhts Input File
MIXHTS.LOG	2014 Mixhts Log File
MXHTdm.TXT	Mixhts Output File
MXHTdmS.TXT	Mixhts Substituted Output File

\Model Performance Evaluation\BLP-AERMOD-Additive (SingleVent and MultiVent)	
13A_JR_P.INP	BLP input file for Anode at Jones Ranch monitor for 2013
13A_MI_P.INP	BLP input file for Anode at Miami monitor for 2013
13A_RL_P.INP	BLP input file for Anode at Ridgeline monitor for 2013
13C_JR_P.INP	BLP input file for Converter at Jones Ranch monitor for 2013
13C_MI_P.INP	BLP input file for Converter at Miami monitor for 2013
13C_RL_P.INP	BLP input file for Converter at Ridgeline monitor for 2013
13C5_JRP.INP	BLP input file for Converter5 at Jones Ranch monitor for 2013
13C5_MIP.INP	BLP input file for Converter5 at Miami monitor for 2013
13C5_RLP.INP	BLP input file for Converter5 at Ridgeline monitor for 2013
13E_JR_P.INP	BLP input file for ELF at Jones Ranch monitor for 2013
13E_MI_P.INP	BLP input file for ELF at Miami monitor for 2013
13E_RL_P.INP	BLP input file for ELF at Ridgeline monitor for 2013
13I_JR_P.INP	BLP input file for Isa at Jones Ranch monitor for 2013
13I_MI_P.INP	BLP input file for Isa at Miami monitor for 2013
13I_RL_P.INP	BLP input file for Ridgeline monitor for 2013
14A_JR_P.INP	BLP input file for Anode at Jones Ranch monitor for 2014
14A_MI_P.INP	BLP input file for Anode at Miami monitor for 2014
14A_RL_P.INP	BLP input file for Anode at Ridgeline monitor for 2014
14C_JR_P.INP	BLP input file for Converter at Jones Ranch monitor for 2014
14C_MI_P.INP	BLP input file for Converter at Miami monitor for 2014
14C_RL_P.INP	BLP input file for Converter at Ridgeline monitor for 2014
14C5_JRP.INP	BLP input file for Converter5 at Jones Ranch monitor for 2014
14C5_MIP.INP	BLP input file for Converter5 at Miami monitor for 2014
14C5_RLP.INP	BLP input file for Converter5 at Ridgeline monitor for 2014
14E_JR_P.INP	BLP input file for ELF at Jones Ranch monitor for 2014
14E_MI_P.INP	BLP input file for ELF at Miami monitor for 2014
14E_RL_P.INP	BLP input file for ELF at Ridgeline monitor for 2014
14I_JR_P.INP	BLP input file for Isa at Jones Ranch monitor for 2014

Folder or File Name	Descriptions
14I_MI_P.INP	BLP input file for Isa at Miami monitor for 2014
14I_RL_P.INP	BLP input file for Ridgeline monitor for 2014
13A_JR_P.OUT	BLP output file for Anode at Jones Ranch monitor for 2013
13A_MI_P.OUT	BLP output file for Anode at Miami monitor for 2013
13A_RL_P.OUT	BLP output file for Anode at Ridgeline monitor for 2013
13C_JR_P.OUT	BLP output file for Converter at Jones Ranch monitor for 2013
13C_MI_P.OUT	BLP output file for Converter at Miami monitor for 2013
13C_RL_P.OUT	BLP output file for Converter at Ridgeline monitor for 2013
13C5_JRP.OUT	BLP output file for Converter5 at Jones Ranch monitor for 2013
13C5_MIP.OUT	BLP output file for Converter5 at Miami monitor for 2013
13C5_RLP.OUT	BLP output file for Converter5 at Ridgeline monitor for 2013
13E_JR_P.OUT	BLP output file for ELF at Jones Ranch monitor for 2013
13E_MI_P.OUT	BLP output file for ELF at Miami monitor for 2013
13E_RL_P.OUT	BLP output file for ELF at Ridgeline monitor for 2013
13I_JR_P.OUT	BLP output file for Isa at Jones Ranch monitor for 2013
13I_MI_P.OUT	BLP output file for Isa at Miami monitor for 2013
13I_RL_P.OUT	BLP output file for Ridgeline monitor for 2013
14A_JR_P.OUT	BLP output file for Anode at Jones Ranch monitor for 2014
14A_MI_P.OUT	BLP output file for Anode at Miami monitor for 2014
14A_RL_P.OUT	BLP output file for Anode at Ridgeline monitor for 2014
14C_JR_P.OUT	BLP output file for Converter at Jones Ranch monitor for 2014
14C_MI_P.OUT	BLP output file for Converter at Miami monitor for 2014
14C_RL_P.OUT	BLP output file for Converter at Ridgeline monitor for 2014
14C5_JRP.OUT	BLP output file for Converter5 at Jones Ranch monitor for 2014
14C5_MIP.OUT	BLP output file for Converter5 at Miami monitor for 2014
14C5_RLP.OUT	BLP output file for Converter5 at Ridgeline monitor for 2014
14E_JR_P.OUT	BLP output file for ELF at Jones Ranch monitor for 2014
14E_MI_P.OUT	BLP output file for ELF at Miami monitor for 2014
14E_RL_P.OUT	BLP output file for ELF at Ridgeline monitor for 2014
14I_JR_P.OUT	BLP output file for Isa at Jones Ranch monitor for 2014
14I_MI_P.OUT	BLP output file for Isa at Miami monitor for 2014
14I_RL_P.OUT	BLP output file for Ridgeline monitor for 2014
13MPRMs	BLP MET file for 2013
14MPRMs	BLP MET file for 2014
13A_JR_P.UF2	BLP unformatted output file for Anode at Jones Ranch monitor for 2013
13C_JR_P.UF2	BLP unformatted output file for Converter at Jones Ranch monitor for 2013
13C5_JRP.UF2	BLP unformatted output file for Converter5 at Jones Ranch monitor for 2013

Folder or File Name	Descriptions
13E_JR_P.UF2	BLP unformatted output file for ELF at Jones Ranch monitor for 2013
13I_JR_P.UF2	BLP unformatted output file for Isa at Jones Ranch monitor for 2013
13JRPOST.INP	Input file for post processor application
13JRPOST.MAX	Output file from additive processor with maximum daily concentrations
14A_JR_P.UF2	BLP unformatted output file for Anode at Jones Ranch monitor for 2014
14C_JR_P.UF2	BLP unformatted output file for Converter at Jones Ranch monitor for 2014
14C5_JRP.UF2	BLP unformatted output file for Converter5 at Jones Ranch monitor for 2014
14E_JR_P.UF2	BLP unformatted output file for ELF at Jones Ranch monitor for 2014
14I_JR_P.UF2	BLP unformatted output file for Isa at Jones Ranch monitor for 2014
14JRPOST.INP	Input file for post processor application
14JRPOST.MAX	Output file from additive processor with maximum daily concentrations
JRRECT.TXT	Receptors information for Jones Ranch monitor
1314JRNOVENTS.TXT	AERMOD post file for sources rather than the buoyant line sources for Jones Ranch monitor
13A_MI_P.UF2	BLP unformatted output file for Anode at Miami monitor for 2013 for Jones Ranch Monitor
13C_MI_P.UF2	BLP unformatted output file for Converter at Miami monitor for 2013
13C5_MIP.UF2	BLP unformatted output file for Converter5 at Miami monitor for 2013
13E_MI_P.UF2	BLP unformatted output file for ELF at Miami monitor for 2013
13I_MI_P.UF2	BLP unformatted output file for Isa at Miami monitor for 2013
13MIPOST.INP	Input file for post processor application
13MIPOST.MAX	Output file from additive processor with maximum daily concentrations
14A_MI_P.UF2	BLP unformatted output file for Anode at Miami monitor for 2014
14C_MI_P.UF2	BLP unformatted output file for Converter at Miami monitor for 2014
14C5_MIP.UF2	BLP unformatted output file for Converter5 at Miami monitor for 2014
14E_MI_P.UF2	BLP unformatted output file for ELF at Miami monitor for 2014
14I_MI_P.UF2	BLP unformatted output file for Isa at Miami monitor for 2014
14MIPOST.INP	Input file for post processor application

Folder or File Name	Descriptions
14MIPOST.MAX	Output file from additive processor with maximum daily concentrations
MIRECT.TXT	Receptors information for Miami monitor
1314MINOVENTS.TXT	AERMOD post file for sources rather than the buoyant line sources for Miami monitor
13A_RL_P.UF2	BLP unformatted output file for Anode at Ridgeline monitor for 2013 for Jones Ranch Monitor
13C_RL_P.UF2	BLP unformatted output file for Converter at Ridgeline monitor for 2013
13C5_RLP.UF2	BLP unformatted output file for Converter5 at Ridgeline monitor for 2013
13E_RL_P.UF2	BLP unformatted output file for ELF at Ridgeline monitor for 2013
13I_RL_P.UF2	BLP unformatted output file for Isa at Ridgeline monitor for 2013
13RLPOST.INP	Input file for post processor application
13RLPOST.MAX	Output file from additive processor with maximum daily concentrations
14A_RL_P.UF2	BLP unformatted output file for Anode at Ridgeline monitor for 2014
14C_RL_P.UF2	BLP unformatted output file for Converter at Ridgeline monitor for 2014
14C5_RLP.UF2	BLP unformatted output file for Converter5 at Ridgeline monitor for 2014
14E_RL_P.UF2	BLP unformatted output file for ELF at Ridgeline monitor for 2014
14I_RL_P.UF2	BLP unformatted output file for Isa at Ridgeline monitor for 2014
14RLPOST.INP	Input file for post processor application
14RLPOST.MAX	Output file from additive processor with maximum daily concentrations
RLRECT.TXT	Receptors information for Ridgeline monitor
1314RLNOVENTS.TXT	AERMOD post file for sources rather than the buoyant line sources for Ridgeline monitor
1314_1vent.TXT	The actual hourly emission profile for rooflines
COMBPERF.EXE	The additive processor application to combine BLP UF2 files with AERMOD post files
COMBPERF.F95	Fortran program to combine BLP UF2 files with AERMOD post files

\Model Performance Evaluation\AERMOD-Only	
JR-AERMOD-Only.ADI	Input file for AERMOD run with downwash for Jones Ranch monitor
JR-AERMOD-Only.ADO	Output file for AERMOD run with downwash for Jones Ranch monitor
MI-AERMOD-Only-DW.ADI	Input file for AERMOD run with downwash for Miami monitor

Folder or File Name	Descriptions
MI-AERMOD-Only-With-DW.ADO	Output file for AERMOD run with downwash for Miami monitor
RL-AERMOD-ONLY-DW.ADI	Input file for AERMOD run with downwash for Ridgeline monitor
RL-AERMOD-ONLY-DW.ADO	Output file for AERMOD run with downwash for Ridgeline monitor
JR-AERMOD-Only-No-DW.ADI	Input file for AERMOD run without downwash for Jones Ranch monitor
JR-AERMOD-Only-No-DW.ADO	Output file for AERMOD run without downwash for Jones Ranch monitor
MI-AERMOD-Only-No-DW.ADI	Input file for AERMOD run without downwash for Miami monitor
MI-AERMOD-Only-No-DW.ADO	Output file for AERMOD run without downwash for Miami monitor
RL-AERMOD-ONLY-No-DW.ADI	Input file for AERMOD run without downwash for Ridgeline monitor
RL-AERMODONLY-No-DW.ADO	Output file for AERMOD run without downwash for Ridgeline monitor
1314hrlypts.TXT	Hourly emission profile for all sources run in AERMOD
13-14actual.PFL	AERMET 2013-2014 profile file
13-14actual.SFC	AERMET 2013-2014 surface file

\Model Performance Evaluation\Hybrid-Approach	
JR-Perf-Eval-Oct15.ADI	AERMOD input file for Jones Ranch monitor
JR-Perf-Eval-Oct15.ADO	AERMOD output file for Jones Ranch monitor
MI-Hybrid-Perform-Evaluation.ADI	AERMOD input file for Miami monitor
MI-Hybrid-Perform-Evaluation.ADO	AERMOD output file for Miami monitor
RL-Hybrid-Perform-Evaluation.ADI	AERMOD input file for Ridgeline monitor
RL-Hybrid-Perform-Evaluation.ADO	AERMOD output file for Ridgeline monitor
1314HRLY(14Oct15)	Hourly emission profile including plume heights calculated by BLP

\FMMI-CEV-Determination-7-07-2016	
FMMI_CEV(07072016).ADI	AERMOD input file for CEV calculation
FMMI_CEV(07072016).ADO	AERMOD output file for CEV calculation
FMMI_hrly_delT(05292016).txt	Hourly emission profile including the plume heights calculated by BLP and temperature variations for Scrubber and Vent Fume Stack
11-13fn.PFL	AERMET 2011-2013 profile file
11-13fn.SFC	AERMET 2011-2013 surface file

\7-07-2016-Attainment-Demonstration	
1314prop(07112016).ADI	AERMOD input file
1314prop(07112016).ADO	AERMOD output file

Folder or File Name	Descriptions
1314HRPROP_MAR16.TXT	Hourly emission profile for projected emission rates after applying controls, based on actual emission data from May 2013 through April 2014.

\CEV-Emission-Sensitivity-Analysis	
CV_1H-Jul16.ADI	AERMOD input file for increasing the Tail Stack emissions
CV_1H-Jul16.ADO	AERMOD output file for increasing the Tail Stack emissions
HRLY11-13_CV1_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_2H-Jul16.ADI	AERMOD input file for increasing the Vent Fume Stack emissions
CV_2H-Jul16.ADO	AERMOD output file for increasing the Vent Fume Stack emissions
HRLY11-13_CV2_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_3H-Jul16.ADI	AERMOD input file for increasing the Aisle Scrubber emissions
CV_3H-Jul16.ADO	AERMOD output file for increasing the Aisle Scrubber emissions
HRLY11-13_CV3_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_4H-Jul16.ADI	AERMOD input file for increasing the Converter roofline emissions
CV_4H-Jul16.ADO	AERMOD output file for increasing the Converter roofline emissions
HRLY11-13_CV4_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_5H-Jul16.ADI	AERMOD input file for increasing the Anode roofline emissions
CV_5H-Jul16.ADO	AERMOD output file for increasing the Anode roofline emissions
HRLY11-13_CV5_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_6H-Jul16.ADI	AERMOD input file for increasing the Isa roofline emissions
CV_6H-Jul16.ADO	AERMOD output file for increasing the Isa roofline emissions
HRLY11-13_CV6_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP
CV_7H-Jul16.ADI	AERMOD input file for increasing the ELF roofline emissions
CV_7H-Jul16.ADO	AERMOD output file for increasing the ELF roofline emissions
HRLY11-13_CV7_H-May16.TXT	Hourly emission profile including buoyant source parameters calculated by BLP

\CEV-Exceedance-Risk-Analysis	
EXDRSK-Jul16-AA-AZ	Proposed hourly emissions and AERMOD input and output files for exceedance risk analysis-scenario #1-26

Folder or File Name	Descriptions
EXDRSK-Jul16-A-Z	Proposed hourly emissions and AERMOD input and output files for exceedance risk analysis-scenario #27-53
EXDRSK-Jul16-BA-BZ	Proposed hourly emissions and AERMOD input and output files for exceedance risk analysis-scenario #54-79
EXDRSK-Jul16-CA-CU	Proposed hourly emissions and AERMOD input and output files for exceedance risk analysis-scenario #80-100

\FMMI-AppendixD-Model-Files	
11ACdw.INP	2011 BLP input file for anode and converter vents with downwash
11ACdw.OUT	2011 BLP output file for anode and converter vents with downwash
11ACdw.UNF	2011 BLP output file for anode and converter vents with downwash
11ACdwP.OUT	2011 BLP Post output file for anode and converter vents with downwash
11ACndw.INP	2011 BLP input file for anode and converter vents without downwash
11ACndw.OUT	2011 BLP output file for anode and converter vents without downwash
11ACndw.UNF	2011 BLP output file for anode and converter vents without downwash
11ACndwP.OUT	2011 BLP Post output file for anode and converter vents without downwash
11IEdw.INP	2011 BLP input file for ISA and ELF vents with downwash
11IEdw.OUT	2011 BLP output file for ISA and ELF vents with downwash
11IEdw.UNF	2011 BLP output file for ISA and ELF vents with downwash
11IEdwP.OUT	2011 BLP Post output file for ISA and ELF vents with downwash
11IEndw.INP	2011 BLP input file for ISA and ELF vents without downwash
11IEndw.OUT	2011 BLP output file for ISA and ELF vents without downwash
11IEndw.UNF	2011 BLP output file for ISA and ELF vents without downwash
11IEndwP.OUT	2011 BLP Post output file for ISA and ELF vents without downwash
11shft.met	2011 MPRM meteorology
12ACdw.INP	2012 BLP input file for anode and converter vents with downwash
12ACdw.OUT	2012 BLP output file for anode and converter vents with downwash
12ACdw.UNF	2012 BLP output file for anode and converter vents with downwash
12ACdwP.OUT	2012 BLP Post output file for anode and converter vents with downwash
12ACndw.INP	2012 BLP input file for anode and converter vents without downwash

Folder or File Name	Descriptions
12ACndw.OUT	2012 BLP output file for anode and converter vents without downwash
12ACndw.UNF	2012 BLP output file for anode and converter vents without downwash
12ACndwP.OUT	2012 BLP Post output file for anode and converter vents without downwash
12IEdw.INP	2012 BLP input file for ISA and ELF vents with downwash
12IEdw.OUT	2012 BLP output file for ISA and ELF vents with downwash
12IEdw.UNF	2012 BLP output file for ISA and ELF vents with downwash
12IEdwP.OUT	2012 BLP Post output file for ISA and ELF vents with downwash
12IEndw.INP	2012 BLP input file for ISA and ELF vents without downwash
12IEndw.OUT	2012 BLP output file for ISA and ELF vents without downwash
12IEndw.UNF	2012 BLP output file for ISA and ELF vents without downwash
12IEndwP.OUT	2012 BLP Post output file for ISA and ELF vents without downwash
12shft.met	2012 MPRM meteorology
13ACdw.INP	2013 BLP input file for anode and converter vents with downwash
13ACdw.OUT	2013 BLP output file for anode and converter vents with downwash
13ACdw.UNF	2013 BLP output file for anode and converter vents with downwash
13ACdwP.OUT	2013 BLP Post output file for anode and converter vents with downwash
13ACndw.INP	2013 BLP input file for anode and converter vents without downwash
13ACndw.OUT	2013 BLP output file for anode and converter vents without downwash
13ACndw.UNF	2013 BLP output file for anode and converter vents without downwash
13ACndwP.OUT	2013 BLP Post output file for anode and converter vents without downwash
13IEdw.INP	2013 BLP input file for ISA and ELF vents with downwash
13IEdw.OUT	2013 BLP output file for ISA and ELF vents with downwash
13IEdw.UNF	2013 BLP output file for ISA and ELF vents with downwash
13IEdwP.OUT	2013 BLP Post output file for ISA and ELF vents with downwash
13IEndw.INP	2013 BLP input file for ISA and ELF vents without downwash
13IEndw.OUT	2013 BLP output file for ISA and ELF vents without downwash
13IEndw.UNF	2013 BLP output file for ISA and ELF vents without downwash
13IEndwP.OUT	2013 BLP Post output file for ISA and ELF vents without downwash

Folder or File Name	Descriptions
13shft.met	2013 MPRM meteorology
\FMMI-AppendixK-Model-Files	
FMMI_CEV(07142016)_noslag2.ADI	AERMOD input file including different scenarios to exclude the fixed emission sources from CEV calculation
FMMI_CEV(07142016)_noslag2.ADO	AERMOD output file including different scenarios to exclude the fixed emission sources from CEV calculation
FMMI_hrly_(05292016).TXT	Hourly emission profile including the plume heights calculated by BLP and temperature variations for Scrubber and Vent Fume Stack
\FMMI-AppendixL-Model-Files\SCREEN3	
AnodExst.inp	SCREEN3 fumigation analysis input file for existing anode plume height
AnodExst.out	SCREEN3 fumigation analysis output file for existing anode plume height
AnodExst.lst	SCREEN3 fumigation analysis list file for existing anode plume height
AnodFutr.inp	SCREEN3 fumigation analysis input file for future anode plume height
AnodFutr.out	SCREEN3 fumigation analysis output file for future anode plume height
AnodFutr.lst	SCREEN3 fumigation analysis list file for future anode plume height
CNV5Exst.inp	SCREEN3 fumigation analysis input file for existing CONVERTER 5 plume height.
CNV5Exst.out	SCREEN3 fumigation analysis output file for existing CONVERTER 5 plume height
CNV5Exst.lst	SCREEN3 fumigation analysis list file for existing CONVERTER 5 plume height
ConvExst.inp	SCREEN3 fumigation analysis input file for existing Converter plume height
ConvExst.out	SCREEN3 fumigation analysis output file for existing Converter plume height
ConvExst.lst	SCREEN3 fumigation analysis list file for existing Converter
ConvFutr.inp	SCREEN3 fumigation analysis input file for future Converter plume height plume height
ConvFutr.out	SCREEN3 fumigation analysis output file for future Converter plume height
ConvFutr.lst	SCREEN3 fumigation analysis list file for existing Converter plume height
ELFExst.inp	SCREEN3 fumigation analysis input file for existing ELF plume height
ELFExst.out	SCREEN3 fumigation analysis output file for existing ELF plume height
ELFExst.lst	SCREEN3 fumigation analysis list file for existing ELF plume height

Folder or File Name	Descriptions
ELFFutr.inp	SCREEN3 fumigation analysis input file for future ELF plume height
ELFFutr.out	SCREEN3 fumigation analysis output file for future ELF plume height
ELFFutr.lst	SCREEN3 fumigation analysis list file for future ELF plume height
ISAExst.inp	SCREEN3 fumigation analysis input file for existing ISA plume height
ISAExst.out	SCREEN3 fumigation analysis output file for existing ISA plume height
ISAExst.lst	SCREEN3 fumigation analysis list file for existing ISA plume height
ISAFutr.inp	SCREEN3 fumigation analysis input file for future ISA plume height
ISAFutr.out	SCREEN3 fumigation analysis output file for future ISA plume height
ISAFutr.lst	SCREEN3 fumigation analysis list file for future ISA plume height
\FMMI-AppendixL-Model-Files\AERSCREEN	
AnodFutr.inp	AERSCREEN fumigation analysis input file for future Anode
AnodFutr.out	AERSCREEN fumigation analysis output file for future Anode
AnodFutr.log	AERSCREEN fumigation analysis log file for future Anode
Anodexst.inp	AERSCREEN fumigation analysis input file for existing Anode
Anodexst.out	AERSCREEN fumigation analysis output file for existing Anode
Anodexst.log	AERSCREEN fumigation analysis log file for existing Anode
APTGFutr.inp	AERSCREEN fumigation analysis input file for future APTGS
APTGFutr.out	AERSCREEN fumigation analysis output file for future APTGS
APTGFutrlog	AERSCREEN fumigation analysis log file for future APTGS
APTGexst.inp	AERSCREEN fumigation analysis input file for existing APTGS
APTGexst.out	AERSCREEN fumigation analysis output file for existing APTGS
APTGexst.log	AERSCREEN fumigation analysis log file for existing APTGS
CNV5exst.inp	AERSCREEN fumigation analysis input file for existing CONVERTER 5
CNV5exst.out	AERSCREEN fumigation analysis output file for existing CONVERTER 5
CNV5exst.log	AERSCREEN fumigation analysis log file for existing CONVERTER 5
ConvFutr.inp	AERSCREEN fumigation analysis input file for future Converter
ConvFutr.out	AERSCREEN fumigation analysis output file for future Converter
ConvFutrlog	AERSCREEN fumigation analysis log file for future Converter

Folder or File Name	Descriptions
Convexst.inp	AERSCREEN fumigation analysis input file for existing Converter
Convexst.out	AERSCREEN fumigation analysis output file for existing Converter
Convexst.log	AERSCREEN fumigation analysis log file for existing Converter
ELFFutr.inp	AERSCREEN fumigation analysis input file for future ELF
ELFFutr.out	AERSCREEN fumigation analysis output file for future ELF
ELFFutr.log	AERSCREEN fumigation analysis log file for future ELF
ELFexst.inp	AERSCREEN fumigation analysis input file for existing ELF
ELFexst.out	AERSCREEN fumigation analysis output file for existing ELF
ELFexst.log	AERSCREEN fumigation analysis log file for existing ELF
ISAFutr.inp	AERSCREEN fumigation analysis input file for future ISA
ISAFutr.out	AERSCREEN fumigation analysis output file for future ISA
ISAFutr.log	AERSCREEN fumigation analysis log file for future ISA
ISAexst.inp	AERSCREEN fumigation analysis input file for existing ISA
ISAexst.out	AERSCREEN fumigation analysis output file for existing ISA
ISAexst.log	AERSCREEN fumigation analysis log file for existing ISA
SCRBFUTR.inp	AERSCREEN fumigation analysis input file for future Aisle Scrubber
SCRBFUTR.out	AERSCREEN fumigation analysis output file for future Aisle Scrubber
SCRBFUTR.log	AERSCREEN fumigation analysis log file for future Aisle Scrubber
VFSFutr.inp	AERSCREEN fumigation analysis input file for future VFS
VFSFutr.out	AERSCREEN fumigation analysis output file for future VFS
VFSFutr.log	AERSCREEN fumigation analysis log file for future VFS
VFSexst.inp	AERSCREEN fumigation analysis input file for existing VFS
VFSexst.out	AERSCREEN fumigation analysis output file for existing VFS
VFSexst.log	AERSCREEN fumigation analysis log file for existing VFS
\FMMI-AppendixL-Model-Files\SCREEN3\HighBuoyancy	
AnodExst.inp	SCREEN3 fumigation analysis input file for existing anode plume height with high buoyancy
AnodExst.out	SCREEN3 fumigation analysis output file for existing anode plume height with high buoyancy
AnodExst.lst	SCREEN3 fumigation analysis list file for existing anode plume height with high buoyancy
AnodFutr.inp	SCREEN3 fumigation analysis input file for future anode plume height with high buoyancy
AnodFutr.out	SCREEN3 fumigation analysis output file for future anode plume height with high buoyancy
AnodFutr.lst	SCREEN3 fumigation analysis list file for future anode plume height with high buoyancy

Folder or File Name	Descriptions
CNV5Exst.inp	SCREEN3 fumigation analysis input file for existing CONVERTER 5 plume height. with high buoyancy
CNV5Exst.out	SCREEN3 fumigation analysis output file for existing CONVERTER 5 plume height with high buoyancy
CNV5Exst.lst	SCREEN3 fumigation analysis list file for existing CONVERTER 5 plume height with high buoyancy
ConvExst.inp	SCREEN3 fumigation analysis input file for existing Converter plume height with high buoyancy
ConvExst.out	SCREEN3 fumigation analysis output file for existing Converter plume height with high buoyancy
ConvExst.lst	SCREEN3 fumigation analysis list file for existing Converter plume height with high buoyancy
ConvFutr.inp	SCREEN3 fumigation analysis input file for future Converter plume height plume height with high buoyancy
ConvFutr.out	SCREEN3 fumigation analysis output file for future Converter plume height with high buoyancy
ConvFutr.lst	SCREEN3 fumigation analysis list file for existing Converter plume height with high buoyancy
ELFExst.inp	SCREEN3 fumigation analysis input file for existing ELF plume height with high buoyancy
ELFExst.out	SCREEN3 fumigation analysis output file for existing ELF plume height with high buoyancy
ELFExst.lst	SCREEN3 fumigation analysis list file for existing ELF plume height with high buoyancy
ELFFutr.inp	SCREEN3 fumigation analysis input file for future ELF plume height with high buoyancy
ELFFutr.out	SCREEN3 fumigation analysis output file for future ELF plume height with high buoyancy
ELFFutr.lst	SCREEN3 fumigation analysis list file for future ELF plume height with high buoyancy
ISAExst.inp	SCREEN3 fumigation analysis input file for existing ISA plume height with high buoyancy
ISAExst.out	SCREEN3 fumigation analysis output file for existing ISA plume height with high buoyancy
ISAExst.lst	SCREEN3 fumigation analysis list file for existing ISA plume height with high buoyancy
ISAFutr.inp	SCREEN3 fumigation analysis input file for future ISA plume height with high buoyancy
ISAFutr.out	SCREEN3 fumigation analysis output file for future ISA plume height with high buoyancy
ISAFutr.lst	SCREEN3 fumigation analysis list file for future ISA plume height with high buoyancy
\FMMI-AppendixL-Model-Files\SCREEN3\HighMomentum	
AnodExst.inp	SCREEN3 fumigation analysis input file for existing anode plume height with high momentum
AnodExst.out	SCREEN3 fumigation analysis output file for existing anode plume height with high momentum

Folder or File Name	Descriptions
AnodExst.lst	SCREEN3 fumigation analysis list file for existing anode plume height with high momentum
AnodFutr.inp	SCREEN3 fumigation analysis input file for future anode plume height with high momentum
AnodFutr.out	SCREEN3 fumigation analysis output file for future anode plume height with high momentum
AnodFutr.lst	SCREEN3 fumigation analysis list file for future anode plume height with high momentum
CNV5Exst.inp	SCREEN3 fumigation analysis input file for existing CONVERTER 5 plume height. with high momentum
CNV5Exst.out	SCREEN3 fumigation analysis output file for existing CONVERTER 5 plume height with high momentum
CNV5Exst.lst	SCREEN3 fumigation analysis list file for existing CONVERTER 5 plume height with high momentum
ConvExst.inp	SCREEN3 fumigation analysis input file for existing Converter plume height with high momentum
ConvExst.out	SCREEN3 fumigation analysis output file for existing Converter plume height with high momentum
ConvExst.lst	SCREEN3 fumigation analysis list file for existing Converter plume height with high momentum
ConvFutr.inp	SCREEN3 fumigation analysis input file for future Converter plume height plume height with high momentum
ConvFutr.out	SCREEN3 fumigation analysis output file for future Converter plume height with high momentum
ConvFutr.lst	SCREEN3 fumigation analysis list file for existing Converter plume height with high momentum
ELFExst.inp	SCREEN3 fumigation analysis input file for existing ELF plume height with high momentum
ELFExst.out	SCREEN3 fumigation analysis output file for existing ELF plume height with high momentum
ELFExst.lst	SCREEN3 fumigation analysis list file for existing ELF plume height with high momentum
ELFFutr.inp	SCREEN3 fumigation analysis input file for future ELF plume height with high momentum
ELFFutr.out	SCREEN3 fumigation analysis output file for future ELF plume height with high momentum
ELFFutr.lst	SCREEN3 fumigation analysis list file for future ELF plume height with high momentum
ISAExst.inp	SCREEN3 fumigation analysis input file for existing ISA plume height with high momentum
ISAExst.out	SCREEN3 fumigation analysis output file for existing ISA plume height with high momentum
ISAExst.lst	SCREEN3 fumigation analysis list file for existing ISA plume height with high momentum
ISAFutr.inp	SCREEN3 fumigation analysis input file for future ISA plume height with high momentum
ISAFutr.out	SCREEN3 fumigation analysis output file for future ISA plume height with high momentum

Folder or File Name	Descriptions
ISAFutr.lst	SCREEN3 fumigation analysis list file for future ISA plume height with high momentum
\FMMI-AppendixL-Model-Files\AERSCREEN\HighBuoyancy	
AnodFutr.inp	AERSCREEN fumigation analysis input file for future Anode with high buoyancy
AnodFutr.out	AERSCREEN fumigation analysis output file for future Anode with high buoyancy
AnodFutr.log	AERSCREEN fumigation analysis log file for future Anode with high buoyancy
Anodexst.inp	AERSCREEN fumigation analysis input file for existing Anode with high buoyancy
Anodexst.out	AERSCREEN fumigation analysis output file for existing Anode with high buoyancy
Anodexst.log	AERSCREEN fumigation analysis log file for existing Anode with high buoyancy
CNV5exst.inp	AERSCREEN fumigation analysis input file for existing CONVERTER 5 with high buoyancy
CNV5exst.out	AERSCREEN fumigation analysis output file for existing CONVERTER 5 with high buoyancy
CNV5exst.log	AERSCREEN fumigation analysis log file for existing CONVERTER 5 with high buoyancy
ConvFutr.inp	AERSCREEN fumigation analysis input file for future Converter with high buoyancy
ConvFutr.out	AERSCREEN fumigation analysis output file for future Converter with high buoyancy
ConvFutrlog	AERSCREEN fumigation analysis log file for future Converter
Convexst.inp	AERSCREEN fumigation analysis input file for existing Converter with high buoyancy
Convexst.out	AERSCREEN fumigation analysis output file for existing Converter with high buoyancy
Convexst.log	AERSCREEN fumigation analysis log file for existing Converter with high buoyancy
ELFFutr.inp	AERSCREEN fumigation analysis input file for future ELF with high buoyancy
ELFFutr.out	AERSCREEN fumigation analysis output file for future ELF with high buoyancy
ELFFutr.log	AERSCREEN fumigation analysis log file for future ELF with high buoyancy
ELFexst.inp	AERSCREEN fumigation analysis input file for existing ELF with high buoyancy
ELFexst.out	AERSCREEN fumigation analysis output file for existing ELF with high buoyancy
ELFexst.log	AERSCREEN fumigation analysis log file for existing ELF with high buoyancy
ISAFutr.inp	AERSCREEN fumigation analysis input file for future ISA with high buoyancy

Folder or File Name	Descriptions
ISAFutr.out	AERSCREEN fumigation analysis output file for future ISA with high buoyancy
ISAFutr.log	AERSCREEN fumigation analysis log file for future ISA with high buoyancy
ISAexst.inp	AERSCREEN fumigation analysis input file for existing ISA with high buoyancy
ISAexst.out	AERSCREEN fumigation analysis output file for existing ISA with high buoyancy
ISAexst.log	AERSCREEN fumigation analysis log file for existing ISA with high buoyancy
\FMMI-AppendixL-Model-Files\AERSCREEN\High Momentum	
AnodFutr.inp	AERSCREEN fumigation analysis input file for future Anode with high buoyancy
AnodFutr.out	AERSCREEN fumigation analysis output file for future Anode with high buoyancy
AnodFutr.log	AERSCREEN fumigation analysis log file for future Anode with high buoyancy
Anodexst.inp	AERSCREEN fumigation analysis input file for existing Anode with high buoyancy
Anodexst.out	AERSCREEN fumigation analysis output file for existing Anode with high buoyancy
Anodexst.log	AERSCREEN fumigation analysis log file for existing Anode with high buoyancy
CNV5exst.inp	AERSCREEN fumigation analysis input file for existing CONVERTER 5 with high buoyancy
CNV5exst.out	AERSCREEN fumigation analysis output file for existing CONVERTER 5 with high buoyancy
CNV5exst.log	AERSCREEN fumigation analysis log file for existing CONVERTER 5 with high buoyancy
ConvFutr.inp	AERSCREEN fumigation analysis input file for future Converter with high buoyancy
ConvFutr.out	AERSCREEN fumigation analysis output file for future Converter with high buoyancy
ConvFutrlog	AERSCREEN fumigation analysis log file for future Converter
Convexst.inp	AERSCREEN fumigation analysis input file for existing Converter with high buoyancy
Convexst.out	AERSCREEN fumigation analysis output file for existing Converter with high buoyancy
Convexst.log	AERSCREEN fumigation analysis log file for existing Converter with high buoyancy
ELFFutr.inp	AERSCREEN fumigation analysis input file for future ELF with high buoyancy
ELFFutr.out	AERSCREEN fumigation analysis output file for future ELF with high buoyancy
ELFFutr.log	AERSCREEN fumigation analysis log file for future ELF with high buoyancy

Folder or File Name	Descriptions
ELFexst.inp	AERSCREEN fumigation analysis input file for existing ELF with high buoyancy
ELFexst.out	AERSCREEN fumigation analysis output file for existing ELF with high buoyancy
ELFexst.log	AERSCREEN fumigation analysis log file for existing ELF with high buoyancy
ISAFutr.inp	AERSCREEN fumigation analysis input file for future ISA with high buoyancy
ISAFutr.out	AERSCREEN fumigation analysis output file for future ISA with high buoyancy
ISAFutr.log	AERSCREEN fumigation analysis log file for future ISA with high buoyancy
ISAexst.inp	AERSCREEN fumigation analysis input file for existing ISA with high buoyancy
ISAexst.out	AERSCREEN fumigation analysis output file for existing ISA with high buoyancy
ISAexst.log	AERSCREEN fumigation analysis log file for existing ISA with high buoyancy

⬕ HATCH

Project Memo

H377000

November 18, 2014

To:	C. West	From:	J. Nikkari
cc:	**FCX**		**Hatch**
	A. Binegar		I. Carruthers
	J. Spehar		R. Sullivan
	T. Weaver		

Freeport-McMoRan Inc. (FCX)
Miami Smelter Expansion Project

Estimate of Unmeasured Smelter Building SO2

1. Introduction

Freeport-McMoRan Inc. (FCX) is undertaking a project at their Miami copper smelter in Arizona to increase production capacity and to ensure the smelter's operation does not cause or contribute to a violation of the new National Ambient Air Quality Standard (NAAQS) for Sulfur Dioxide of 75 ppbv (1-h).

The Feasibility Study SO_2 mitigation scope and current permit application are based on a 3-4 day sampling campaign completed in June 2012. To account for sampling variability and unmeasured emissions from other building openings, Hatch included, and FCX adopted in its permit application, a 20% design (safety) factor for annual smelter building fugitive SO_2 emissions on top of the measured June 2012 baseline SO_2 emissions. This design (safety) factor, however, is not directly related to ADEQ's current request.

This response specifically addresses an ADEQ request for the estimated unmeasured SO_2 emissions which leak through small openings in the building shell and are not captured or reported via the roofline monitoring system.

2. Conclusions

The leakage through unmeasured openings is estimated at 4.5% of the future reported smelter roofline fugitive emissions. Expressed as a portion of total SO_2 from stacks and building fugitives, the percentages are even lower.

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Page 1

Safety • Quality • Sustainability • Innovation
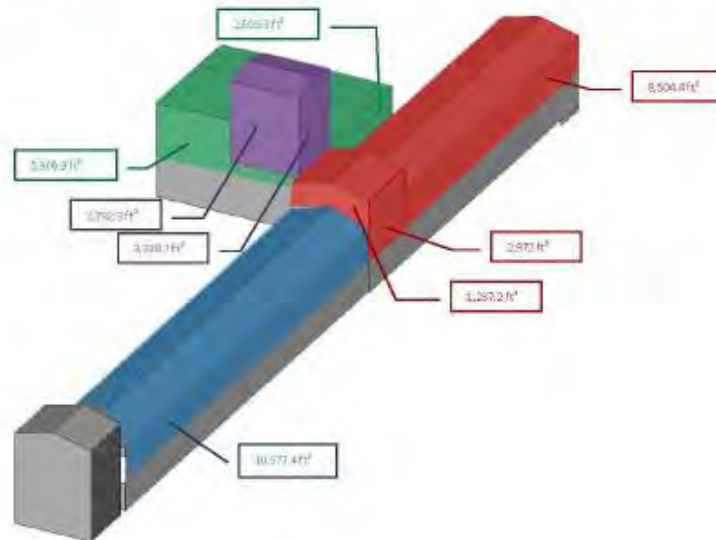
Area Measurements: taken from model

Summary of Surface Area:

Converter Aisle (ft²)	Anode Aisle (ft²)	ELF (ft²)	Smelting (ft²)	
18,037.8	9,760.5	5,990.4	3,463.00	
18,037.8	26,073.4	29,006.6	2,918.04	
5,453.9	26,073.4	4,387.8	2,918.04	
8,504.4	10,577.4	2,509.3	3,423.18	
1,970.4		5,966.9	3,388.70	
1,237.2			3,792.30	
3,766.5				**Total (ft²)**
3,766.5	72,484.8	47,861.0	19,903.3	205,232.6
2,972.0				
1,237.2				
64,983.6				

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10.3 Appendix C: Performance Evaluation of BLP/AERMOD Hybrid Approach

Technical Memorandum
Performance Evaluation Modeling Results for the
Miami SO₂ Nonattainment Area State Implementation Plan (SIP)
August 11, 2015

This memo presents the model performance evaluation results for five air quality dispersion model approaches for use in the Arizona Department of Environmental Quality's (ADEQ) Miami sulfur dioxide (SO₂) Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA). Performance modeling is an important step in determining the best model to predict offsite impacts from emission sources. Freeport-McMoRan Miami Inc. (FMMI) is performing modeling to support the SIP submittal.

Smelter SO₂ Emissions Configuration

The FMMI Smelter is configured with five roof vents, which account for a significant proportion of the Smelter's current SO₂ emissions (approximately 44% of Smelter SO₂ emissions during the period from May 2013 through April 2014). The roof vents are located above the IsaSmelt® (Isa) vessel, the Electric Furnace (ELF), the converter aisle (2 vents), and the anode aisle. The three roof vents over the converter aisle and anode aisle are aligned along the length of the Smelter building. The shorter roof vents over the Isa and ELF are oriented perpendicular to the converter aisle and anode aisle roof vents. In addition to the roof vents, three stacks are located at the Smelter. The locations of the roof vents and stacks are shown in Figures 1 and 2.

The EPA's Buoyant Line and Point Source (BLP) model is EPA's preferred dispersion model for buoyant line sources such as the roof vents. However, the BLP model employs antiquated methods for addressing complex terrain and meteorology when compared to EPA's more modern AERMOD dispersion model. Although AERMOD implements contemporary treatment of complex terrain and meteorology, it is not equipped with EPA's preferred treatment of buoyant line sources as of the date the modeling analysis was completed using AERMOD Version 14134, the most up-to-date version of AERMOD available at the time.

SO₂ is emitted from each roof vent at an elevated temperature and with a convective velocity. As noted in the BLP User's Guide, plumes from buoyant line sources tend to rise higher when the wind aligns along the long axis of the roof vent than when the wind is perpendicular to the roof vent. Plume rise from buoyant line sources also exhibits relationships with buoyancy (dependent on plume temperature and velocity), wind speed, distance, and building downwash that are different from those of stack releases, therefore AERMOD will not adequately predict roof vent plume rise. The reduced plume rise calculated by AERMOD would tend to result in over-predicted concentrations.

A key issue in calculating the plume rise for buoyant line sources is determining which roof vents to model together in the BLP model run. BLP cannot adequately address perpendicular roof vents and the code prevents all five roof vents from being run simultaneously. Not being able to account for all roof vents in a single run limits BLP's computation of plume rise enhancement due to mixing of the buoyant plumes. The result is that the calculated plume rise for each roof vent is conservatively low because the full benefit of plume rise enhancement is not accounted for. The reduced plume rise enhancement would be expected to result in over-predicted concentrations.

Figure 1. Aerial Photograph of Miami Smelter, Showing Stacks and Roof Vents
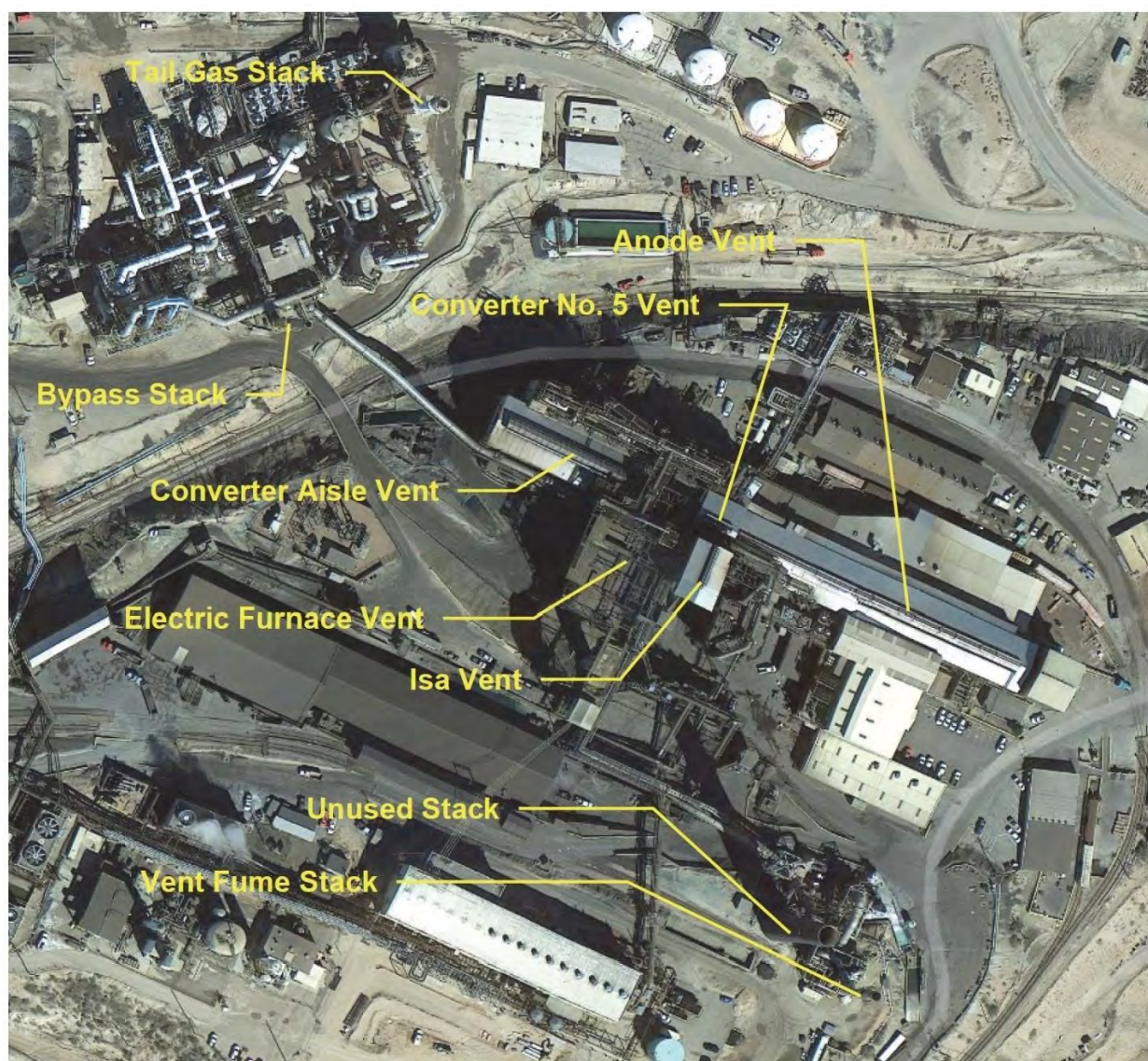
Figure 2. Photograph of Miami Smelter, Showing Stacks and Visible Roof Vents

Photograph taken at the Jones Ranch Ambient SO$_2$ Monitoring Station

Dispersion Model Options

EPA has asked ADEQ to examine the performance of several modeling approaches. Due to the physical configuration of the Smelter (i.e., the roof vents that are buoyant line sources) and the proximity of complex terrain to the Smelter, an alternative model that employs relevant and appropriate features of EPA's preferred models is expected to perform better for this facility than EPA's preferred guideline dispersion models alone. EPA's recent proposal to include the BLP plume rise treatment for buoyant line sources in AERMOD is indicative of EPA's recognition that AERMOD alone (Versions 14134 and earlier) is not appropriate for facilities with buoyant line sources, specifically roof vents that release hot building air such as those located at the Miami Smelter.

Section 3.2.2 of the GAQM provides recommendations for Regional Administrators to find that an alternative model is more appropriate than a preferred model. Section 3.2.2 identifies three conditions under which a model may be approved for use:

1. A demonstration that the alternative model produces concentration estimates equivalent to the estimates obtained using a preferred model;

2.   A statistical performance evaluation using measured air quality data that demonstrates the alternative model performs better for the given application than a comparable preferred model; or

3.   The preferred model is less appropriate for the specific application, or there is no preferred model for the specific application.

The purpose of this technical memo is to present a performance evaluation under the second condition, for situations where an alternative model performs better than a comparable preferred model, whereby model-predicted concentrations are compared to relevant measured air quality data.   FMMI evaluated the following five modeling approaches based on implementation of EPA's preferred "BLP"[1] and "AERMOD"[2] dispersion models, both of which have features relevant to modeling the Smelter:

- Additive BLP/AERMOD, Multi-Vent BLP Plume Rise

- Additive BLP/AERMOD, Single-Vent BLP Plume Rise

- Hybrid BLP/AERMOD

- AERMOD, Roof Vents with Downwash

- AERMOD, Roof Vents without Downwash

While the BLP model implements EPA's preferred approach for modeling buoyant line source plume rise, it does not implement EPA's preferred approach for modeling sources located in complex terrain. In contrast, AERMOD implements EPA's preferred approach for modeling sources located in complex terrain, but it does not implement EPA's preferred approach for modeling buoyant line source plume rise.

With regard to complex terrain, BLP implements a plume/terrain interaction strategy of using stability-dependent plume path coefficients. For neutral and unstable conditions, the plume is lifted one-half of the difference between the elevation of the receptor and the base elevation of the source, with the additional constraint that the plume always be at least half the height above ground that it would be with no topography.   For stable conditions, the plume is lifted approximately one-third of the difference between the elevation of the receptor and the base elevation of the source, with the additional constraint that the plume always be at least one-third the height above ground that it would be with no topography.

The AERMOD dispersion model, in contrast, implements EPA's preferred strategy for addressing plume/terrain interaction by identifying a dividing streamline to determine weighting assigned to two

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[1] BLP is a Gaussian plume dispersion model designed to handle unique modeling problems associated with industrial sources where buoyant plume rise and downwash effects from stationary line sources are important. With EPA's proposed changes to AERMOD, EPA is also proposing to delist BLP as a preferred model.

[2] AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

extreme plume states: plume impacting terrain or plume following terrain. In stable conditions, plume impacting terrain is more heavily weighted, whereas in neutral and unstable conditions, plume following terrain is more heavily weighted. The total concentration predicted by AERMOD is the weighted sum of these two extreme possible plume states. BLP is not equipped to predict concentrations in complex terrain in accordance with EPA's preferred approach to complex terrain. Again, EPA's recent proposal to include the BLP plume rise treatment for buoyant line sources in AERMOD is indicative of EPA's recognition that BLP alone is not appropriate for the Smelter's proximity to complex terrain.

A brief discussion of each approach follows. Detailed discussion of implementation is provided in Attachment A to this memo.

Multi-Vent Additive BLP/AERMOD. This approach uses the BLP dispersion model to predict hourly ambient concentrations resulting from roof vent emissions, and the AERMOD dispersion model to predict hourly ambient concentrations resulting from stack emissions. BLP is implemented to incorporate enhanced plume rise due to interacting roof vent plumes, per EPA guidance. BLP and AERMOD results are added receptor-by-receptor, hour-by-hour, to calculate the facility-wide predicted concentration. This approach relies on BLP's antiquated implementation of complex terrain and meteorology.

Single-Vent Additive BLP/AERMOD. This approach uses the BLP dispersion model to predict hourly ambient concentrations resulting from roof vent emissions, and the AERMOD dispersion model to predict hourly ambient concentrations resulting from stack emissions. Contrary to EPA guidance, BLP is implemented to run each source separately, thereby eliminating from consideration the enhanced plume rise due to interacting roof vent plumes. BLP and AERMOD results are added receptor-by- receptor, hour-by-hour, to calculate the facility-wide predicted concentration. This approach relies on BLP's antiquated implementation of complex terrain and meteorology.

Hybrid BLP/AERMOD. This approach uses the BLP dispersion model to predict hourly plume height and vertical spread (sigma-z) resulting from roof vent emissions. AERMOD is used to predict hourly ambient concentrations resulting from stack and roof vent emissions. The roof vent emissions are input to AERMOD as volume sources, with release height and initial sigma-z (vertical dispersion) inputs set at the BLP-calculated plume height and sigma-z. This approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, and incorporates EPA's preferred plume rise and building downwash calculations for buoyant line sources. Of the approaches evaluated, this approach treats plume rise most consistently with EPA's recently proposed change to AERMOD (80 FR 45340), which would incorporate the BLP plume rise algorithms directly into AERMOD.

AERMOD, Roof Vents with Downwash. AERMOD is used to predict hourly ambient concentrations resulting from stack and roof vent emissions. The roof vent emissions are input to AERMOD as a series of point sources placed along the length of the roof vents. Building Profile Input Program for PRIME (BPIPPRM) downwash parameters for the roof vent sources are included in the AERMOD input. BPIPPRM is EPA's program used for identifying building dimensions to be used in AERMOD's plume downwash calculations. This approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, but does not address buoyant line source plume rise and building downwash from the roof vents in accordance with EPA guidance.

AERMOD, Roof Vents without Downwash. AERMOD is used to predict hourly ambient concentrations resulting from stack and roof vent emissions. The roof vent emissions are input to AERMOD as a series of point sources placed along the length of the roof vents. BPIPPRM downwash parameters for the roof vent sources are not included in the AERMOD input. The approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, but does not address buoyant line source plume rise and building downwash from the roof vents in accordance with EPA guidance.

Ambient Monitor Locations

Three ambient SO$_2$ air quality monitors operate around the FMMI facility: Jones Ranch, Ridgeline, and Miami Townsite. Their locations are shown in Figure 3, which also references the Smelter location.

Figure 3. Ambient Monitor Locations Relative to the Miami Smelter
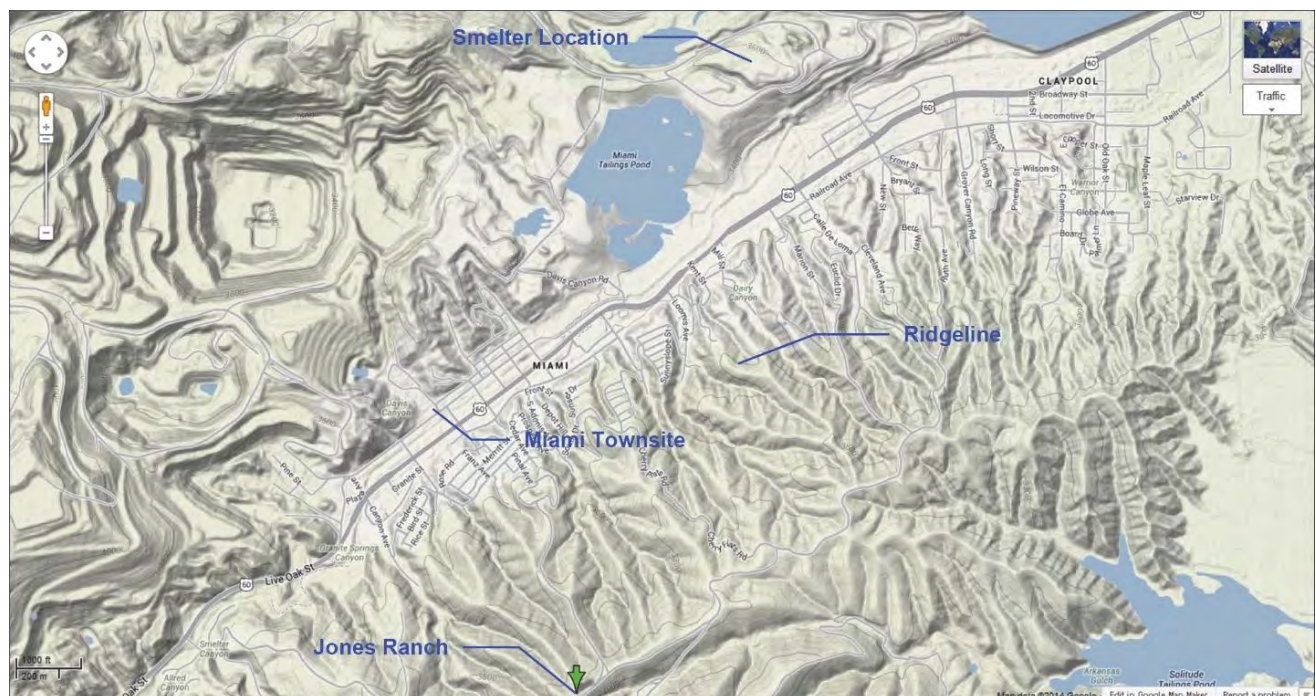
The Jones Ranch monitor is located atop a ridgeline approximately 3 kilometers across the valley south-southwest of the Smelter at an elevation of 4,075 feet (1,242 meters) above sea level (ASL). The Jones Ranch monitor consistently measures the highest design value with respect to the 1-hour SO$_2$ National Ambient Air Quality Standard (NAAQS). The Jones Ranch monitor has been operated by ADEQ since February 1, 2013.

The Ridgeline monitor is located on a slope of the same ridge as the Jones Ranch monitor, approximately 1.6 kilometers south of the Smelter at an elevation of 3,560 feet (1,085 meters) ASL. Despite the monitor location's name, it is located at an elevation 300 feet below the top of the ridge. The Ridgeline monitor was used by ADEQ in establishing the nonattainment designation for the area as it was the only ADEQ-run SO$_2$ monitor in the Miami Planning Area at the time of designation. The Ridgeline monitor has been operated by ADEQ since October 5, 1995.

The Miami Townsite monitor operates approximately 2 kilometers southwest of the Smelter within the town of Miami at the bottom of the valley at an elevation of 3,419 feet (1,042 meters) ASL. The Miami Townsite monitor consistently measures the lowest design value with respect to the 1-hour SO_2 NAAQS. The Miami Townsite monitor has been operated by ADEQ since February 1, 2013.

By comparison to the ambient monitor elevations, the Smelter is located at a base elevation of approximately 3,560 feet (1,085 meters) ASL.   In consideration of the release height of emissions (107 to 213 feet above ground level) and subsequent buoyant and momentum plume rise, the Jones Ranch site would be expected to measure higher concentrations than the other locations due to its elevation being 475 feet higher than the base elevation of the Smelter, and most likely to be subject to direct plume impaction.   For the year of record used in the model performance evaluation (May 2013 through April 2014), the 4th highest daily maximum concentration measured at the Jones Ranch monitor location was considerably greater than the concentration measured at the other two sites, as is evident by the measured values presented in Table 1.

Table 1. Measured 4th Highest Daily Maximum Ambient SO_2 Concentrations (μg/m^3) May 2013-April 2014

Jones Ranch	540
Ridgeline	364
Miami Townsite	285

The measured concentrations presented in Table 1 illustrate the importance of the Jones Ranch site in establishing model performance.   Despite the greater distance of the Jones Ranch monitor from the Smelter, the higher concentrations measured there are indicative of the monitor being located at an elevation that is representative of Smelter plume heights.

Modeling Protocol

Smelter Emissions

FMMI's modeling evaluation was based on continuous hourly emissions measured from May 2013 through April 2014.   Data include hourly emission rate, plume temperature, and plume velocity or flow rate.   The AERMOD dispersion model allows for the input of hourly emissions, facilitating analyses that use hourly emissions monitoring data.   In all of the modeling approaches, the actual hourly emissions data were input to AERMOD using an hourly emission rate file.

The BLP model is not equipped to read an hourly emission rate file, but it can produce an output of hourly predicted concentrations for each receptor.   For the Additive BLP/AERMOD approaches, BLP was run with roof vent sources set to a normalized emission rate of 1 gram per second (g/s).   Because BLP's predicted concentrations are linearly related to emission rate, model post processing was performed to apply the actual hourly emission rates to the hourly predicted concentrations.   The buoyancy factor is fixed in BLP so averaged values of plume temperature and velocity were used in the BLP runs.

Receptors

EPA model performance guidelines and several published articles recommend a domain-wide comparison of model results to monitor values to account for wind variability, which is more pronounced in short term averaging periods such as 1-hour or 3-hour periods. EPA's 1992 *Protocol for Determining the Best Performing Model* states that for pollutants such as SO_2, where short-term ambient standards exist, the statistic of interest involves the network-wide highest concentrations:

For a pollutant such as SO_2 for which short-term ambient standards exist, the statistic of interest involves the network-wide highest concentrations. In this example, the precise time, location and meteorological condition is of minor concern compared to the magnitude of the highest concentrations actually occurring.

EPA further elaborates in its performance evaluation of the AERMOD dispersion model (EPA, 2003):

Operational performance of models for predicting compliance with air quality regulations, especially those involving a peak or near peak value at some unspecified time and location, can be assessed with quantile-quantile (Q-Q) plots (Chambers et al., 1983). Q-Q plots are created by sorting by rank the predicted and the observed concentrations from a set of predictions initially paired in time and space. The sorted list of predicted concentrations are then plotted by rank against the observed concentrations also sorted by rank. These concentration pairs are no longer paired in time or location. However, the plot is useful for answering the question, "Over a period of time and over a variety of locations, does the distribution of the model predictions match those of observations?" Scatterplots, which use data paired in time (and / or space), provide a more strict test, answering the question: "At a given time and place, does the magnitude of the model prediction match the observation?" It is the experience of model developers (e.g., Weil, et al., 1992 and Liu and Moore, 1984) that wind direction uncertainties can and do cause disappointing scatterplot results from what are otherwise well-performing dispersion models. Therefore, the Q-Q plot instead of the scatterplot is a more pragmatic procedure for demonstrating model performance of applied models. Venkatram et al. (2001) makes a cogent argument for the use of Q-Q plots for evaluating regulatory models.

Based on the EPA guidance, ADEQ and FMMI agreed to place a set of receptors within 100 meters of each monitor location for the purpose of conducting the performance evaluation. The BLP model is limited to 100 receptors so each modeling approach was run with a set of 100 receptors located within a 100 meter radius of each monitor location. Additionally, a larger receptor grid identified in the modeling protocol was used to predict domain-wide concentrations.

Meteorological Data

Hourly meteorological data collected at the Smelter tower during the May 2013 through April 2014 period were used as on-site observation inputs for AERMET (the meteorological data processor for AERMOD) and MPRM (the meteorological data processor for BLP). Additional surface observations (cloud cover, atmospheric pressure) for the period were obtained for the National Weather Service (NWS) site located in Safford, Arizona. Upper air observations for the period were obtained for the NWS site located in Tucson, Arizona. Missing data substitution procedures followed those identified in the modeling protocol.

Results

The EPA SO_2 NAAQS specifies that the design value is calculated by first identifying the 99th percentile of the 1-hour daily maximum concentrations for each of three years, and then by averaging those three values.

The 99th percentile value for each year is represented by the 4th highest value of the 365 daily 1- hour maximum values over the year.   In the case of AERMOD, the predicted 4th highest daily value for each year of meteorological data input to the model is retained for each receptor, and these values are then averaged to compute the predicted design value.   For the performance evaluation, these predicted design values are compared to the measured design values.

Table 2 provides a comparison of both measured and model-predicted ambient design values at the monitoring stations (Jones Ranch, Ridgeline and Miami).   EPA guidance identifies an acceptable result as a predicted concentration that is within a factor of two of the observed concentration (EPA, 1992).   As Table 2 shows, some, but not all, model results fall into this range and their performance varies with monitoring station.   The Jones Ranch monitor location is of particular importance because the highest SO_2 design concentrations in the area are consistently measured there.   The Ridgeline monitor is also important because ADEQ uses that monitor to designate the attainment status of the area. The colors and bold text are provided in Table 2 to emphasize the importance of the Jones Ranch and Ridgeline monitor locations in evaluating model performance.   In contrast, the Miami monitor location consistently has the lowest measured design concentration.   A comparison of predicted concentrations is provided for the Miami location, but is not considered in evaluating model performance.

The model results show that the Hybrid BLP/AERMOD approach is the one that performs best for the Jones Ranch location, and is within a factor of two at the Ridgeline location.   In contrast, the Additive BLP/AERMOD approaches substantially over-predict measured concentrations at both locations.

While the AERMOD-only options are each within a factor of 2 at the Jones Ranch location, these options cannot be justified from a technical perspective.   The modeling results demonstrate that buoyant line source plume rise is an important consideration for the Smelter, particularly for the Ridgeline monitor comparison where the AERMOD-only approach with downwash substantially over-predicts measured concentrations.   The AERMOD-only approach with downwash is calculating significantly reduced plume rise, due both to the model's inability to address enhanced plume rise due to the buoyant line source configuration and the mixing of plumes from adjacent vents, as well as the application of point source building downwash to the roof vent sources.

Figures 4 through 6 provide Q-Q plots for the three monitor locations and five modeling approaches. The bold black line represents a perfect fit between the monitor and the model.   The dashed lines represent the acceptable range (within 2 times) for the model performance.   The Q-Q plots present comparisons of daily maximum 1-hour concentrations predicted by each modeling approach against those measured at each monitor.   The Q-Q plots therefore provide a more in-depth evaluation of model performance because the design value is only a subset of the plot. Nevertheless, the plots confirm the results provided in Table 2.

Table 2. Summary Comparison of Measured and Predicted Ambient SO$_2$ Concentrations (µg/m^3)

Description	Ambient Monitor Location			Highest Modeled Ground Level Concentration
	Jones Ranch	Ridgeline	Miami *	
	Monitor With Highest Measured Concentration	*Monitor Used for Miami Attainment Designation*	*Monitor With Lowest Measured Concentration*	
Observed, Actual Measurements	**540**	**364**	285	NA
Predicted, Multi-Vent Additive BLP/AERMOD	**1370**	**879**	175	6362
Predicted, Single-Vent Additive BLP/AERMOD	**1487**	**1850**	283	7981
Predicted, Hybrid BLP/AERMOD	**512**	**228**	79	1752
Predicted, AERMOD, Roof Vents with Downwash	**333**	**1484**	363	3830
Predicted, AERMOD, Roof Vents without Downwash	**313**	**278**	112	2108

Notes:
- Listed concentrations are the 4th highest daily 1-hour concentration in a 1-year period.
- "Highest Modeled Ground Level Concentration" refers to the highest predicted concentration for all ambient air beyond the facility fenceline, not just the ambient monitor locations.
- Green shading indicates model result is within a factor of 1.5 of observation.
- Orange shading indicates model result is within a factor of 2 of observation.
- Red shading indicates model result is beyond a factor of 2 of observation.

*   Comparison provided for Miami, but because the measured design concentration at Miami is much lower than at Jones Ranch, the results are not considered in evaluating model performance.

Selected Approach

The Hybrid Approach is the selected approach for identifying the Smelter critical emissions value because the model performs best at the worst-case monitoring location (Jones Ranch).   The two Additive BLP/AERMOD approaches considerably over-predict concentrations at both the Jones Ranch and Ridgeline monitor locations and are unacceptable.   The AERMOD-only approaches are unacceptable because they do not properly account for plume rise from buoyant line sources.

Additional Discussion

While the Hybrid Approach is selected for the Miami Smelter, a question has been asked about the differences between the Miami Smelter and the Hayden Smelter because the Hayden Smelter selected the EPA-preferred AERMOD approach.   The key difference between the facilities is that the Hayden Smelter's emissions are predominantly emitted from their single stack with a 1,000 foot height above ground elevation.   Emissions from the Hayden Smelter's roof vents are negligible by comparison, comprising less than 2 percent of the facility's SO$_2$ emissions.   As noted previously in this memo, the

Miami Smelter's roof vent emissions comprise nearly half of the facility's SO_2 emissions (44% for the period evaluated).

Figure 4. Q-Q Plot, Jones Ranch Monitor
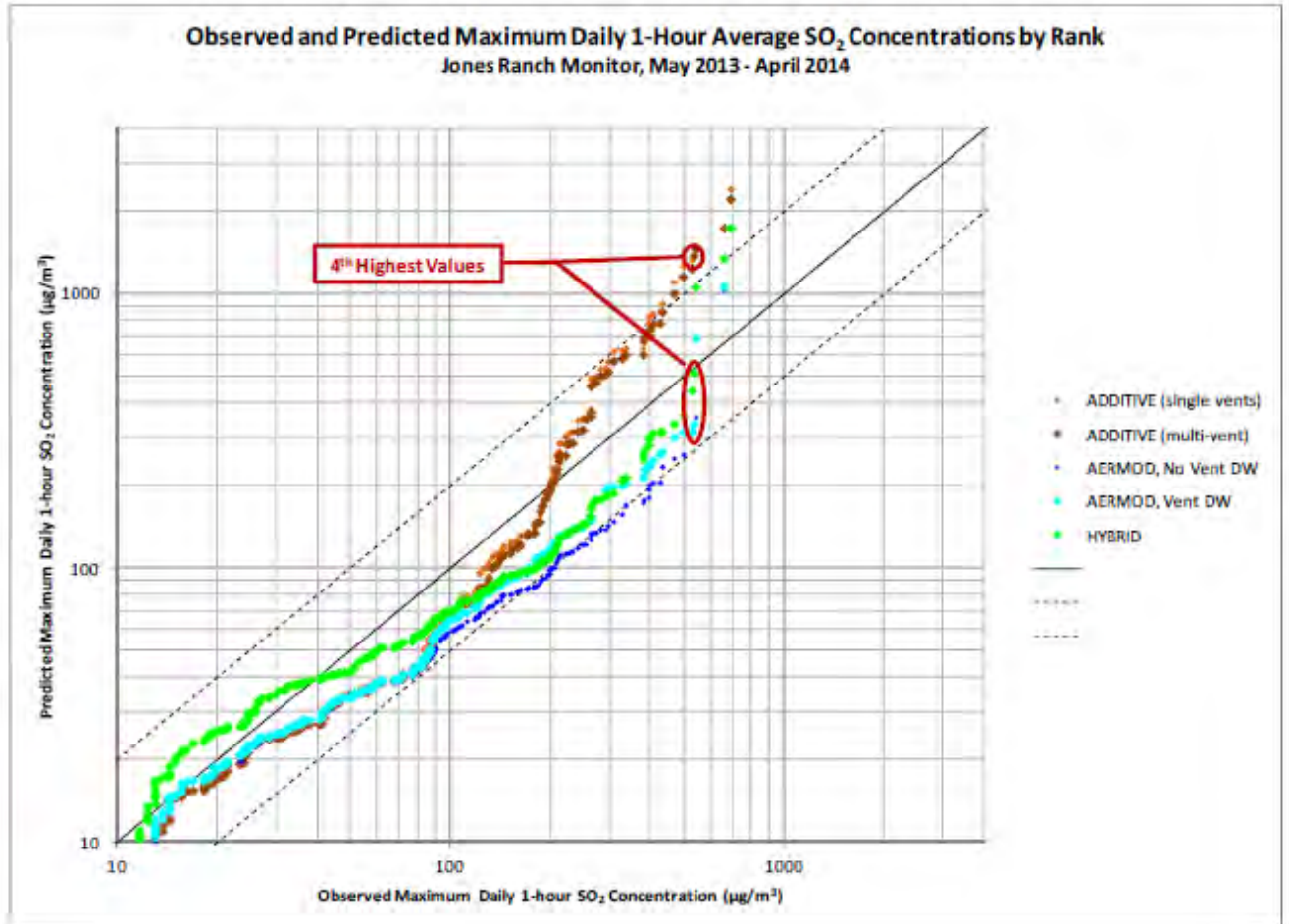
Figure 5. Q-Q Plot, Ridgeline Monitor
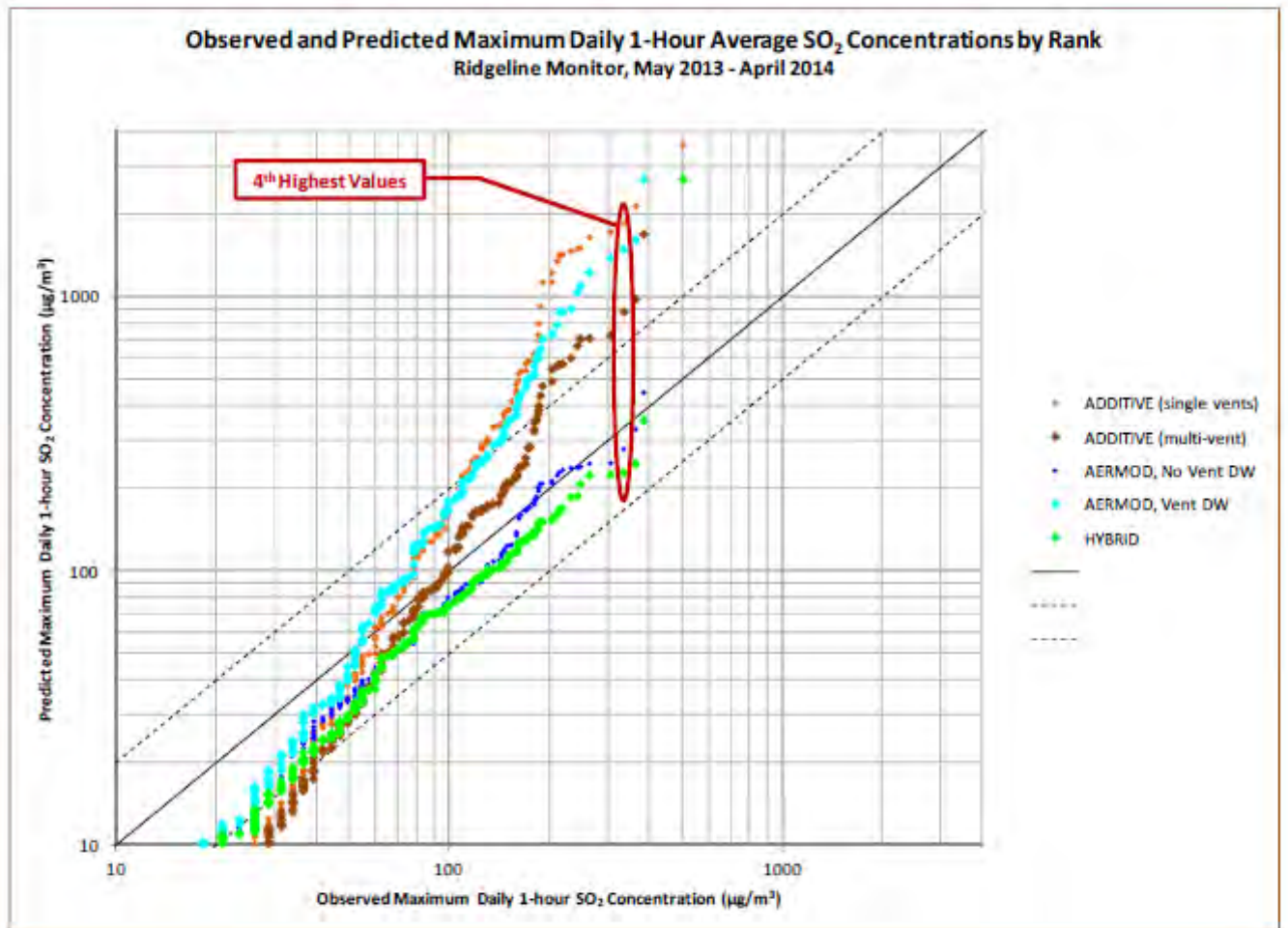
Figure 6. Q-Q Plot, Miami Townsite Monitor

Observed and Predicted Maximum Daily 1-Hour Average SO₂ Concentrations by Rank
Miami Monitor, May 2013 - April 2014
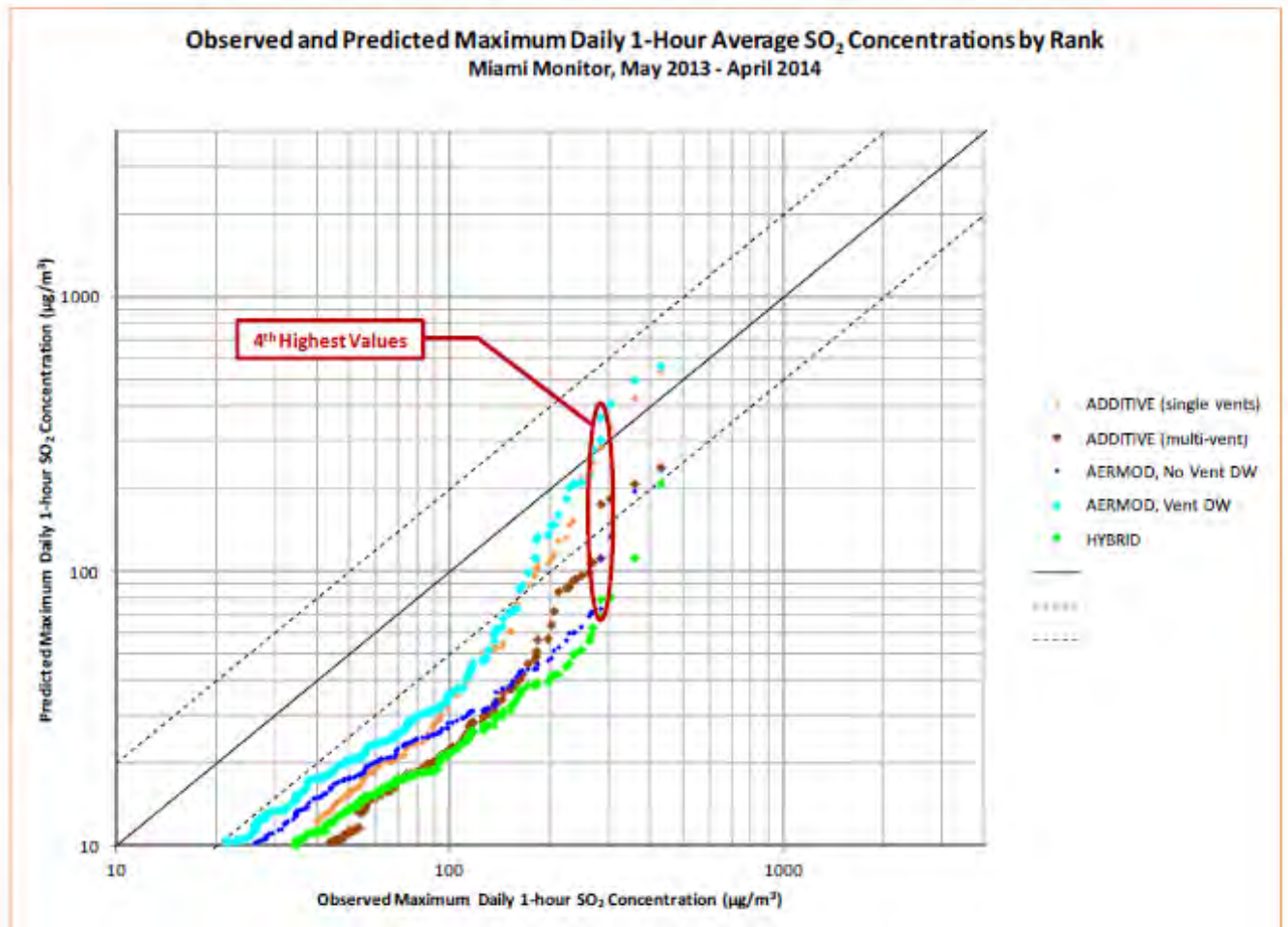
10.4   Appendix D: BLP Plume Rise and Sigma-z Analysis

Technical Memorandum
BLP Plume Rise and Sigma-Z
Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP)
July 28, 2015

Nearly half of the SO$_2$ emissions from Freeport-McMoRan Miami, Inc.'s (FMMI) primary copper smelter are emitted from roof vents in its current operational configuration. These roof vents provide for the ventilation of various smelter operations, and the temperature of the roof vent exhaust is characteristically high due to the heat of those operations.   The U.S. Environmental Protection Agency's (EPA) Buoyant Line and Point Source (BLP) model is EPA's preferred dispersion model for buoyant line sources such as the roof vents. However, the BLP model employs antiquated methods for addressing complex terrain and meteorology when compared to EPA's more modern AERMOD dispersion model.   Although AERMOD implements contemporary treatment of complex terrain and meteorology, it is not equipped with EPA's preferred treatment of buoyant line sources[1].   Given the complex terrain and meteorology in the immediate vicinity of the Smelter, and given the importance of the roof vents in the assessment of SO$_2$ impacts from the Smelter, a Hybrid BLP/AERMOD dispersion modeling approach (Hybrid Approach) has been proposed for the Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP) being prepared by the Arizona Department of Environmental Quality (ADEQ).   This memo presents the results of a study evaluating the roof vent plume rise and vertical plume spread calculated by the BLP dispersion model.

Proposed Modeling Approach

The proposed Hybrid Approach uses AERMOD to predict hourly ambient concentrations resulting from stack and roof vent emissions.   The roof vent emissions are input to AERMOD as volume sources, which requires input of volume release height (center of volume) above ground level and the initial horizontal and vertical dimensions of the volume (i.e., initial sigma-y and initial sigma-z, respectively).   In the Hybrid Approach, the BLP model is used to calculate hourly plume height and hourly initial sigma-z. The BLP-calculated hourly plume height is assigned to the AERMOD volume source's release height. Similarly, the BLP-calculated hourly initial sigma-z is assigned to the AERMOD volume source's initial vertical dimension. This Hybrid Approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, relying instead on AERMOD's implementation of complex terrain and meteorology, and incorporates EPA's preferred plume rise and building downwash calculations for buoyant line sources which AERMOD is not equipped to perform.

Plume Rise Analysis

Approach

EPA requested an evaluation of receptor distances used in BLP to identify final plume height and initial sigma-z.   FMMI analyzed the final plume heights from receptor distances of 250 meters (m), 1 kilometer (km), 1.5 km, 2 km, 3 km, 4 km, and 5 km.   These distances were evaluated for several compass

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[1] EPA proposed changes to 40 CFR 51 Appendix W, Guideline on Air Quality Models (80 FR 45340). The proposed changes include a BETA implementation of the BLP plume rise algorithms in AERMOD (version 15181), which was not available when the TSD modeling work was initiated.

directions, specifically 110 degrees (ESE), 150 degrees (SSE), 180 degrees (South), 210 degrees (SSW), and 260 degrees (WSW), from the North. These directions were selected because they align with the closest fence line receptors to the Smelter.

As Figure 1 shows, the Smelter is located on a hill at an elevation of 1085 meters. The bottom of the valley located in the near field area to the south has an approximate elevation of 1030 meters. For emissions from the vents to impact the near field (valley) area, the plume would need to be subject to building downwash at or beyond the fence line. The BLP model was run with building downwash and normalized emission rates for each of the future vents to determine how the vent plume dynamics and terrain affected the near field results.

Figure 1. Topography in the Vicinity of the Smelter, Showing Distance from the Smelter
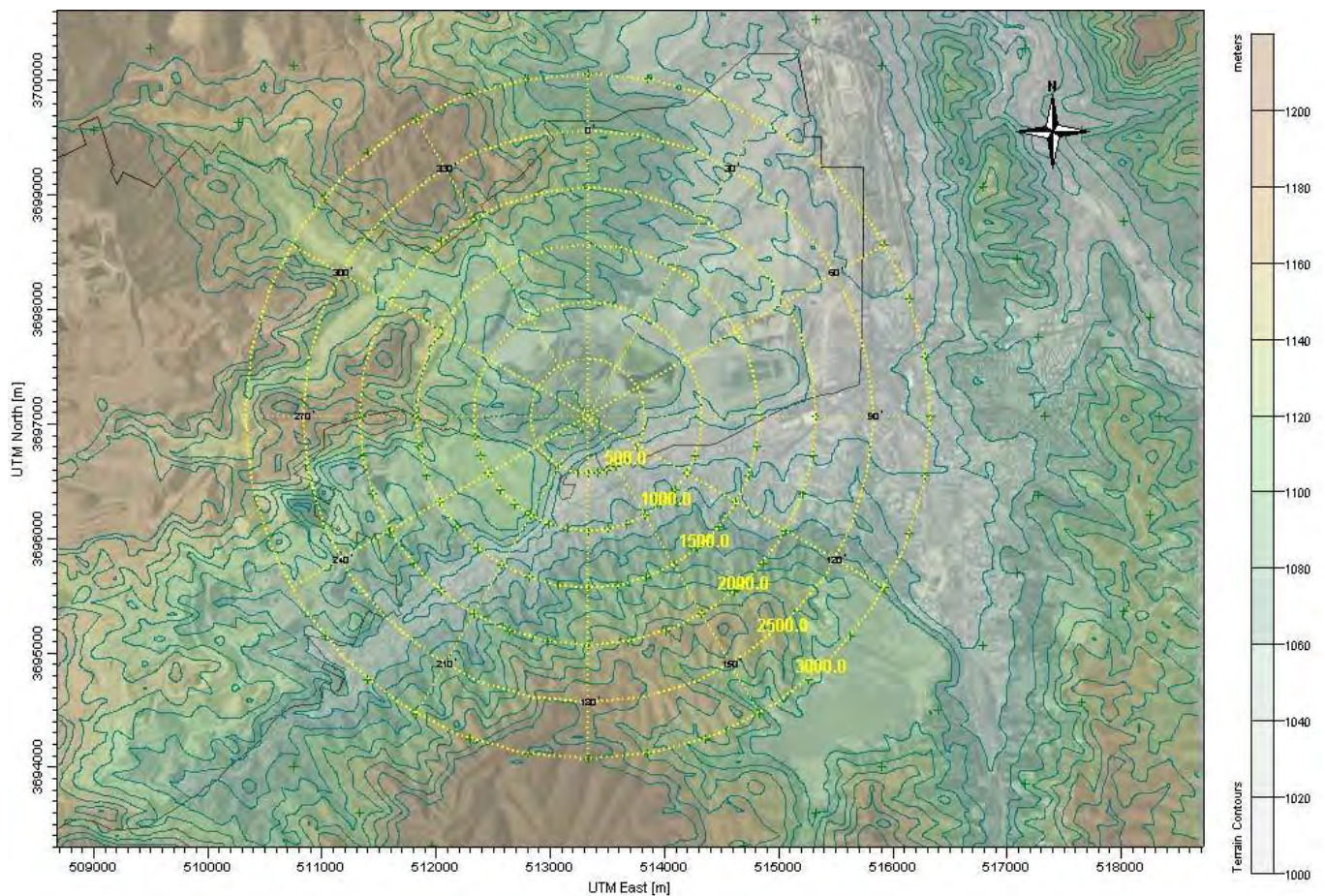
Further discussion of BLP implementation, including source configurations, is provided in the modeling protocol developed for the SIP submittal.

Results

A large difference in predicted plume heights is observed between the 250 m and 1 km receptors with the 250 m receptor case significantly under-predicting the final plume height. A slight difference between the 1 km and 1.5 km receptors is observed with the Isa/ELF/Converter modeling case showing higher differences than the Converter/Anode modeling case. The predicted plume rise does not change beyond the 1.5 km receptor. Therefore, the analysis shows the final plume

rise occurs between 1 km and 1.5 km downwind from the Smelter.   A summary of the BLP-predicted plume heights for the Isa/ELF/ Converter and Converter/Anode modeling cases are presented in Tables 1A and 1B, respectively.

Table 1A. Results of BLP Plume Rise Evaluation, Anode / Converter Run

	Anode / Converter Vent Plume Heights						
Distance	**250m**	**1 km**	**1.5 km**	**2 km**	**3 km**	**4 km**	**5 km**
Average	64.29	110.51	111.11	111.10	111.10	111.10	111.10
75th percentile	78.60	126.04	126.78	126.78	126.72	126.72	126.72
Median	60.97	80.67	81.13	81.12	81.12	81.12	81.12
25th Percentile	39.82	64.14	64.38	64.37	64.37	64.37	64.37

Table 1B. Results of BLP Plume Rise Evaluation, Isa / ELF / Converter Run

	Isa / ELF / Converter Vent Plume Heights						
Distance	**250m**	**1 km**	**1.5 km**	**2 km**	**3 km**	**4 km**	**5 km**
Average	74.70	127.56	134.52	134.52	134.52	134.52	134.52
75th percentile	87.52	134.33	142.10	142.10	142.10	142.10	142.10
Median	69.91	94.57	98.54	98.54	98.54	98.54	98.54
25th Percentile	54.84	79.28	80.96	80.96	80.96	80.96	80.96

A sensitivity analysis was performed with the Hybrid Approach using the critical emissions values (CEV) to determine if predicted concentrations are sensitive to the use of BLP-predicted plume heights for the 1 km and 1.5 km receptors.   The highest 1-hour and 4th highest 1-hour design value concentrations for both plume heights were identical, indicating negligible effect on the maximum predicted design value concentration when the slightly higher 1.5 km final plume rises were applied.

The Hybrid Approach results were also evaluated to assess the near-field effect of gradual plume rise. The results, as provided in Table 2, demonstrate that receptors located within the valley below the Smelter had much lower predicted design values than those receptors at or above the Smelter elevations.   The majority of the receptors located at or above Smelter elevation (1085 m) are located more than 1.5 km from the Smelter, indicating that these receptors with the highest predicted design value concentrations are located in areas where maximum plume height has been achieved.

Table 2. Results of Near-Field Evaluation of Gradual Plume Rise

Distance (meters)	ESE Conc.	ESE Height	SE Conc.	SE Height	S Conc.	S Height	SW Conc.	SW Height	WSW Conc.	WSW Height
500			11.9	1021.9	11.5	1021.9				
1000	4.5	1014.3	3.9	1050.2	6.4	1021.9	42.2	1101.3	62.1	1105
1500	4.4	1020.9	41.9	1096.8	22.7	1080.7	4.4	1035.3	27.1	1114*
2000	4.5	1037.8	89.5	1160.4	110	1145.5	13.1	1071.5	18.7	1076*
3000	3.3	1028.5	115.7	1030.7	165	1239.5	46	1124.9		

Conc. = Predicted 1-Hour Design Value Concentration ($\mu g/m^3$)

Height = Receptor height (m)

Blank cells in the table indicate that receptor distances are located within FMMI's fence line.

* Receptor heights adjusted after review of Google Earth aerials which showed recent modifications to the land contours.

Conclusion

The plume height analysis presented here shows the use of BLP-predicted plume heights at a 1 km receptor distance is adequate for the volume source release height input in the AERMOD model. Gradual plume rise does not need to be considered for near-field receptors because the maximum predicted 1-hour design value concentrations are located in the area where final plume rise has been achieved.

Sigma-Z Determination

Approach

EPA also requested further information on how the sigma-z value was derived for the Hybrid Approach. BLP calculates sigma-z at each receptor point.   To determine sigma-z values near the release points, a 250 meter polar grid measured from the Smelter center was used to capture sigma-z values. The 250 meter distance places the receptors beyond the northern and southern ends of the Smelter building which is expected to allow building interactions and ridge vent plume mixing to be included the sigma-z calculation.   The 250 meter distance also uses a uniform receptor grid for each source and prevents receptors from overlapping with the source which is not allowed in BLP.   Other BLP/AERMOD approaches have used sigma-z values based on the final plume rise, which likely overestimates the sigma-z value and dilutes the plume in the near field. The 250 meter distance is necessary to allow the plume and building dynamics to be addressed without diluting the plume.

Results

A sensitivity analysis was performed by constructing a tight rectangular receptor grid around the anode and converter vents and the ISA and ELF vents.   BLP was run with receptor grids at distances of 10m, 20m, 50m and 100m and the sigma-z values were extracted and compared.   The results are provided in Tables 3A and 3B.

Table 3A. Results of BLP Sigma-Z Evaluation, Anode / Converter Run

Receptor Distance	Sigma-Z (m) for Anode / Converter Vents				
	10m	20m	50m	100 m	250 m (polar)
Average	23.13	24.42	25.06	27.22	29.49
75th Percentile	30.65	30.89	31.89	33.32	35.49
50th Percentile	30.41	30.43	30.58	30.8	31.325
25th Percentile	14.35	17.16	17.18	20.06	21.11

Table 3B. Results of BLP Sigma-Z Evaluation, Isa / ELF / Converter Run

Receptor Distance	Sigma-z (m) for ISA/ELF Vents				
	10m	20m	50m	100 m	250 m (polar)
Average	24.86	25.36	26.42	28.28	31.72
75th Percentile	30.76	31.09	32.02	33.4	36.25
50th Percentile	30.42	30.48	30.65	30.89	31.46
25th Percentile	19.84	20.39	21.6	23.72	27.15

A sensitivity analysis was performed with the Hybrid Approach using the critical emissions values to determine if predicted concentrations are sensitive to the use of BLP-predicted sigma-z values for the 10 m and 250 m receptors.   The difference between the sigma-z values at the 10m and 250m distances is 0.38% or 1.6 $\mu g/m^3$ for the highest 1-hour and 1.6% or 2.7 $\mu g/m^3$ for the 4th highest 1-hour design value concentrations.   The use of sigma-z values determined from a 250m polar grid has negligible effects on the modeled impact.

Table 4. Results of Hybrid Approach Sensitivity Analysis to Sigma-Z

Averaging	CEV Case with 10 meter Receptor Grid	CEV Case with 250 m Receptor Grid
H1H ($\mu g/m^3$)	427.3	425.7
H4H ($\mu g/m^3$)	166.1	163.4

Conclusion

The sigma-z analysis presented here shows the use of the BLP-calculated values from the proposed 250 m receptor grid are adequate for the volume source sigma-z input in the AERMOD model.   Sensitivity analysis of the sigma-z value show the expected range of sigma-z values have negligible effects on the predicted off-site concentrations.

10.5 Appendix E: Emission Variability and Independent Assessment

Technical Memorandum
Emissions Variability and Independence Assessment for the
Miami SO₂ Nonattainment Area State Implementation Plan (SIP)
July 28, 2015

This technical memorandum presents Freeport-McMoRan Miami Inc.'s (FMMI) emissions variability and independence assessment for use in the Arizona Department of Environmental Quality's (ADEQ) Miami SO₂ Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA). As explained in more detail below, evaluating emissions variability and independence is an important step in identifying an SO₂ emission limit for FMMI's primary copper smelter. FMMI is performing dispersion modeling to support the SIP submittal.

Introduction

The SO₂ National Ambient Air Quality Standard (NAAQS) is based on the 3-year average of the annual 99th percentile of the maximum daily 1-hour SO₂ concentration. The NAAQS could be implemented through an hourly emissions limit set at the critical emissions value, but as EPA has acknowledged in its SO₂ Nonattainment Area SIP Guidance (EPA, 2014), such an hourly emissions limit is excessively stringent in many cases. As a result, EPA allows SIPs to set emission limits longer than 1-hour (up to 30 days), provided that the longer term emission limit is protective of the NAAQS and comparably stringent to the critical emissions value.

Because emissions from the Smelter are highly variable, developing such a longer-term limit for the Smelter requires an assessment of the probability that maximal emissions from each of the individual SO₂ emissions sources at the Smelter could occur simultaneously. This probability is a function of both the variable emissions from each individual SO₂ emissions source and the likelihood that those individual sources run at the same time (the "independence" of these emissions). FMMI's analysis of continuous emissions monitoring data confirms that these SO₂ sources do not emit near their maximum rates at the same time. The purpose of this technical memorandum is to provide a description of smelter operations and an analysis of individual source emissions, which demonstrate the highly variable emissions from each source and the independence of source operations. These important factors should be taken into account in developing an emissions limit for the Smelter that is protective of the NAAQS.

Smelter SO₂ Emissions Configuration

SO₂ Emissions Release Points

The FMMI Smelter is currently configured with five roof vents, which account for a significant proportion of the Smelter's current SO₂ emissions (approximately 44% of Smelter SO₂ emissions during the period from May 2013 through December 2014). The roof vents are located above the IsaSmelt® (Isa) vessel, the Electric Furnace (ELF), the converter aisle (2 vents), and the anode aisle. In addition to the roof vents, three stacks (Acid Plant Tail Gas Stack, Vent Fume Stack, and Bypass Stack) are located at the Smelter. The locations of the existing vents and stacks are shown in Figures 1 and 2.

Figure 1. Aerial Photograph of Miami Smelter, Showing Stacks and Roof Vents

Figure 2. Photograph of Miami Smelter, Showing Stacks and Visible Roof Vents

Photograph taken at the Jones Ranch Ambient SO$_2$ Monitoring Station

The future Smelter configuration will consist of four roof vents and three stacks. The roof vent located above Converters 2 through 5 will be reconfigured as part of a collection system for fugitive emissions. In addition, the anode and mold vessels will be modified to collect emissions generated during the refining of blister copper. The collected emissions from the converter roofline and anode vessel capture systems will be routed to the new Aisle Scrubber to treat the captured SO$_2$ emissions. The roofline above the non-functional Inspiration Converter and the Anode Aisle will still vent to the atmosphere. Additionally, Acid Plant Bypass emissions will be routed to the Aisle Scrubber for treatment prior to discharge to atmosphere. FMMI is proposing additional changes to the Smelter configuration, as set forth in greater detail in the separate modeling protocol document.

Smelter Processes and Relationship to SO$_2$ Emissions Release Points

The Smelter process includes multiple steps, most of which are performed in batches. The episodic nature of these batches causes significant variability in SO$_2$ emissions over time.

IsaSmelt® (Isa) Bath-Smelting Furnace

Unlike the conventional flash smelting or reverberatory furnace technology used at other copper smelters, FMMI processes copper concentrates using an IsaSmelt® (Isa) bath-smelting furnace.   Ore concentrates, fluxes and reverts are fed into the Isa though a feed port and mixed with oxygen enriched air and fuel (natural gas).   The resulting bath of copper matte and slag is transferred in batches from the Isa to the Electric Furnace (ELF) using one of two available launders.

Process off-gases produced in the Isa vessel are captured and exhausted to the Smelter's Acid Plant for conversion of SO_2 to sulfuric acid, with unconverted SO_2 vented to the Acid Plant Tail Gas Stack.   The Isa process off-gases are merged with emissions from other units at the Smelter.   While the Isa process off-gas emissions are continuous in nature, the SO_2 concentration varies significantly due to the variable sulfur content of the concentrate feed.

Most gases released from the launder during the batch Isa to ELF transfers (i.e., tapping) are captured and exhausted to the Vent Fume Stack via the Vent Fume System. These SO_2 emissions are merged with emissions from other units at the Smelter.   The Isa tapping emissions to the Vent Fume Stack are variable due to the batch nature of the process (i.e., Isa tapping only occurs for approximately 15 minutes of every hour) and the variable sulfur content of the concentrate feed.

Uncaptured emissions are released to atmosphere via the roof vent located above the Isa vessel. These emissions are highly variable over time due to the batch nature of the process (i.e., the periodic nature of the tapping process).

Electric Furnace (ELF)

The ELF serves as a slag separation device.   The copper matte settles to the bottom of the ELF, from where the copper matte is tapped in batches into ladles and transported by crane to one of four Hoboken converters.   Typically, three converters are operable and one is undergoing major maintenance at any given time.   The slag on the top of the bath is removed in batches via a slag tapping launder and transported by slag hauler truck to the slag storage area.

Process off-gases released from the ELF are captured and exhausted to the Smelter's Acid Plant for conversion of SO_2 to sulfuric acid, with unconverted SO_2 vented to the Acid Plant Tail Gas Stack.   The ELF process off-gases are merged with emissions from other units at the Smelter.   The off-gas emissions are continuous in nature, but are relatively minor compared to the emissions from the other units at the Smelter.

Most gases released from the launders during the batch slag and matte transfers are captured and treated in the Vent Fume Scrubber prior to being exhausted to the Vent Fume Stack.   These SO_2 emissions are merged with tapping emissions from the Isa.   Uncaptured emissions are released to atmosphere via the roof vent located above the ELF.   Both the emissions from the Vent Fume Stack and the uncaptured emissions are highly variable over time due to the batch nature of the process (i.e., the periodic nature of the tapping process).

<u>Hoboken Converters</u>

At FMMI, the converters perform a batch operation scheduled to operate in cycles. The cycle consists of receiving matte from the ELF, performing a slag blow to remove iron and other impurities, followed by a copper blow to remove sulfur from the remaining bath. Upon completion of the copper blow, the product (blister copper) is transferred in batches into ladles which are transported to one of two anode vessels by crane. Converter slag is transferred in batches into ladles which are transported by crane to the electric furnace for recovery of residual copper values.

Process off-gases are vented from the converters to the Smelter's Acid Plant for conversion of SO_2 to sulfuric acid, with unconverted SO_2 vented to the Acid Plant Tail Gas Stack. The converter process off-gases are merged with emissions from other units at the Smelter. Uncaptured emissions are released to atmosphere via the roof vent located above the converters. Both the off-gas and the uncaptured emissions are highly variable due to the batch nature of the converter cycle (i.e., the periodic nature of the converting process).

Planned upgrades to the Smelter will include a canopy roof collection system to capture converter aisle emissions, which will be treated with a scrubber and released to atmosphere via a stack (the future Aisle Scrubber). Uncaptured emissions will be considerably reduced, but not eliminated, by the canopy roof collection system.

<u>Anode Furnaces</u>

Anode vessels perform a batch operation scheduled to operate in cycles that refine the blister copper to anode copper. The cycle consists of oxidizing the bath to remove the trace sulfur in the blister, reducing the bath using a mixture of steam and natural gas to remove oxides, casting, and skimming slag. The anode copper is poured into molds (casting) in batches to produce copper anodes, the end product for the Smelter. Anode slag is transferred in batches into ladles which are transported by crane to the converters for recovery of any residual copper values.

Emissions from the Anode Aisle operations are not presently captured. Rather, Anode Aisle emissions are released to atmosphere via the roof vent located above the anode furnaces. These emissions are highly variable over time due to the batch nature of the process (i.e., the periodic operation of the anode process).

Planned upgrades to the Smelter will include a collection system to capture most of the Anode Aisle emissions, which will be treated with a scrubber and released to atmosphere via a stack (the future Aisle Scrubber). Uncaptured emissions will be considerably reduced, but not eliminated, by the collection system.

Uniqueness of Smelter Operations

The process description set forth above demonstrates that smelter operations are nothing like power plant operations which are the focus of EPA's SO_2 Nonattainment Area SIP Guidance (EPA, 2014). The batch nature of the smelter process is a striking difference to the continuous nature of power plant operations. Furthermore, the feasibility of capturing and controlling SO_2 emissions depends on the unique configuration of each process vessel and transfer point (i.e., launders and ladles) within the Smelter, unlike a power plant where the units are either identical or very similar in nature and emissions are generated in a confined device (e.g., a boiler) which enhances the feasibility of emissions capture for control.

FMMI's evaluation of the feasibility of capture and control options for the future smelter operations required independent analysis of each specific operation. Existing control systems, specifically the Acid Plant and the Vent Fume System, were evaluated for upgrades to improve emissions reductions. Each of these control systems is unique. Emissions to the roof vents were evaluated for capture and control options. The equipment configuration (e.g., crane rails and vessel placement) and the quantity of emissions in each process area are also unique and require careful consideration. As addressed in the technical memorandum that covers the derivation of the critical emissions value, the effectiveness and cost of controlling each of the SO_2 emissions sources varies greatly, and an iterative approach must be performed to optimize the control cost required to achieve attainment.

Sequencing of Batch Smelter Operations

The sequencing of the batch operations at the Smelter dictates the variable nature of SO_2 emissions from the Smelter, which is highly variable due to the changing nature, length, and scheduling of operations and the multiple process units working at any one time. At FMMI, the converter operational cycle dictates the sequencing of the various batch operations within the Smelter as a whole. The operational cycles of the primary smelter processes are summarized below.

Converter Cycle

The converter operational cycle ranges from 10 to 15 hours in duration and results in variable SO_2 emissions levels to different points in the Converter Aisle at different times in the cycle. To illustrate, during this cycle a single converter performs the following operations:

- Transfer of copper matte from the ELF to a converter (up to 8 ladles, approximately 1.5 hours). During this time, SO_2 is emitted through the Converter Aisle Roof Vents as each ladle moves through the Converter Aisle (no emissions to the Acid Plant).

- Conversion of copper matte to blister copper, consisting of slag blowing and copper blowing phases (approximately 6 to 8 hours). Slag skimming occurs during the slag blowing phase, with the skimmed slag returned to the ELF. Anode slag is also returned to the converter during the slag blowing phase. The slag transfers in ladles contribute variable SO_2 emissions to the Converter Aisle Roof Vents. During the slag blowing and copper blowing phases, SO_2 is vented to the Acid Plant, reducing SO_2 emissions to the Converter Aisle Roof Vents. In the future, converter mouth covers will be in place after slag skimming is completed, further reducing SO_2 emissions to the Converter Aisle Roof Vents.

- Transfer of blister copper to the anode vessels (between 0.5 to 1 hour). During this time, low levels of SO_2 are emitted through the Converter Aisle Roof Vents as each ladle moves through the Converter Aisle (no emissions to the Acid Plant).

- Converter turn-around (4 to 8 hours). During this time, minimal amounts of SO_2 are emitted through the Converter Aisle Roof Vents (no emissions to the Acid Plant).

During any given day, three of the four converters are run through the cycle on a staggered schedule such that six converter cycles are typically completed (as many as eight cycles may be completed if turn- around time is short). No more than two converters can be blowing at the same time due to a limitation of the gas handling system. The transfers from converters to anode furnaces are governed by this cycle, as are the transfers from the ELF to the converters. Normally, one converter is undergoing major maintenance and is not operational.

Anode Cycle

The anode cycle ranges from 15 to 18 hours in duration and results in variable SO_2 emissions levels to the Anode Aisle Roof Vent at different times in the cycle. To illustrate, during this cycle a single anode furnace performs each of the following operations:

- Transfer of blister copper to the anode vessels (between 0.5 to 1 hour) from the converter, with 2 charges required to fill a vessel. During this time, minimal levels of SO_2 are emitted through the Anode Aisle Roof Vent as each ladle moves through the Anode Aisle.

- Oxidation of blister copper to remove the trace sulfur (approximately 1 hour). During this time, elevated SO_2 levels are emitted through the Anode Aisle Roof Vent.

- Reduction of blister copper to remove oxides (approximately 1 hour). During this time, reduced SO_2 levels are emitted through the Anode Aisle Roof Vent.

- Casting of anode copper (approximately 5 to 6 hours). During this time, minimal amounts of SO_2 levels are emitted through the Anode Aisle Roof Vent.

- Idle operation (approximately 7 to 10 hours). During this time, the anode vessels are charged with blister copper and temperature is maintained using a burner. Slag skimming is performed at this time with the skimmed slag returned to an operating converter. Minimal amounts of SO_2 are emitted through the Anode Aisle Roof Vent.

During any given day, the two anode furnaces are run through the cycle on a staggered schedule such that two or three casting operations are performed.

Isa and ELF Cycles

The Isa and ELF continuously maintain a bath, and consequently process off-gas is continuously directed to the Acid Plant and SO_2 emission leaks from the vessels are continuously emitted through the Isa or ELF Roof Vent. In the future, emissions that escape from the Isa feedport will be captured and routed to the Vent Fume System. The variable SO_2 emissions from this area are due to the batch transfer of material in and out of the ELF, as follows:

- Isa tapping approximately every 45 minutes, with a duration of 15 minutes typical for each tap.

- Slag tapping 45 times per day, with a duration 7 to 12 minutes typical for each tap.

- Matte tapping 60 times per day, with a duration of 10 minutes typical for each tap.

The resulting variable SO_2 emissions from these batch operations are captured by the Vent Fume System.

Independence of Process Cycles

The operational cycles identified above are depicted in Figure 3, which shows representative daily smelter production cycles. Each step in the process has variable SO_2 emissions, and the sequencing of the steps minimizes the occurrence of simultaneous maximal SO_2 emissions from the various processes. Working from top to bottom in the figure, the following factors into the variability of SO_2 emissions and the independence of SO_2 emissions from each source:

- The Isa process off-gases are continuously routed to the Acid Plant. SO_2 concentration in the off-gas varies based on the sulfur content of the concentrate fed to the vessel.

- Isa tapping occurs approximately every 45 minutes, with a duration of 15 minutes for each tap. Each arrow in the figure signifies an individual tap. SO_2 emissions cycle according to the tapping schedule and are routed to the Vent Fume System.

- The ELF process off-gases are continuously routed to the Acid Plant. SO_2 concentration in the off-gas varies based on the sulfur content of the bath inside the vessel. Changes in sulfur content lag in time compared to sulfur content changes in the Isa vessel.

- ELF matte and slag tapping occurs in cycles, with matte tapping approximately 60 times per day at 10 minute durations, and slag tapping approximately 45 times per day at 7-12 minute durations. Matte is tapped when a converter becomes available for charging. Slag is tapped when the slag layer is sufficiently high above the tap hole in the furnace. Each arrow in the figure signifies an individual matte tap to the converter charge. SO_2 emissions cycle according to the tapping schedule and are routed to the Vent Fume System. Matte transfer emissions from ladles report to the roof vents.

- The production cycle of each converter is shown as: (1) charging; (2) slag blowing; (3) copper blowing; (4) copper blister transferring; and (5) turn-around. Converter off-gas is routed to the Acid Plant during slag blowing and copper blowing. Some off-gas during converter charging is also captured and routed to the Acid Plant to reduce SO_2 emissions to the roof vent. SO_2 concentration in the off-gas increases as the slag blow progresses, peaks during the copper blow, and then decreases as the blowing cycle is completed. SO_2 emissions to the roof vent cycle according to the converter charging cycle. SO_2 emissions to the roof vent during molten metal transfers and converter turn-around are minimal.

- Transfers of converter slag back to the ELF occur only during slag blowing. Each arrow in the figure signifies an individual slag transfer. SO_2 emissions cycle according to the transfer schedule and are routed to the roof vents.

- The production cycle of each anode furnace is shown, including charging, slag skimming, oxidizing, reducing, and casting. SO_2 emissions are greatest during the oxidizing step and are routed to the roof vent. SO_2 emissions to the roof vent during the balance of operations are minimal.

Figure 3. Representative Daily Smelter Production Batch Cycles and Impact on SO_2 Emissions

Figure 3 demonstrates that it is highly improbable for all SO_2 sources to be emitting near their maximum rates at the same time. As set forth below, analysis of continuous emissions monitoring data confirms that SO_2 sources do not emit near their maximum rates at the same time.

While the smelter emissions capture and controls will be undergoing considerable changes to bring about compliance with the NAAQS, the processes shown in Figure 1 will remain fundamentally unchanged.   Therefore, SO_2 emissions produced by the various process areas will continue to cycle in accordance with the process schedules.

Acid Plant Bypass Events

In addition to the normal smelter operations described above, Acid Plant bypass events must also be considered in addressing the variable nature of SO_2 emissions from the Smelter.   Acid Plant bypass events occur as a result of either planned maintenance or unplanned power loss and Acid Plant malfunctions. For planned maintenance, smelter operations are shut down and process off-gas is run through the Acid Plant until SO_2 concentration in the off-gas is less than 0.5 percent.   At this point, the Bypass Stack is opened and the low-strength process off-gas is emitted through the Bypass Stack.   Gases from the ELF are routed to the VFS, unless the hot gas fans are down for maintenance.

Occasionally, an unplanned malfunction occurs at the Acid Plant, during which the process off-gases bypass the Acid Plant and are routed to the Bypass Stack.   Such a malfunction initiates the shutdown of all smelter operations, resulting in uncontrolled SO_2 emissions being quickly reduced.

Because a smelter shutdown is initiated for bypass events, SO_2 emissions from the Bypass Stack are independent of SO_2 emissions from other smelter sources.

Analysis of Continuous Emissions Monitoring Data

To support the above discussion, an analysis of continuous SO_2 emissions monitoring data for the period from May 2013 through October 2014 was performed.   The period of record includes over 13,000 hours of normal and Acid Plant bypass operations.

A set of scatterplots was prepared to show the independence of SO_2 emissions between multiple pairs of SO_2 emissions sources.   The scatterplots are provided in Attachment A.   Examination of the scatterplots reveals no correlation of SO_2 emissions between source pairs.   Further examination reveals that the simultaneous occurrence of maximal SO_2 emissions is a very rare occurrence between source pairs. Maximal SO_2 emissions shown on the scatterplots tend to be plotted near the horizontal and vertical axes, demonstrating that emissions from one source tend to be low when emissions from the other source are high.

The continuous SO_2 emissions monitoring data were further examined to evaluate the probability of simultaneous occurrence of maximal emissions for all SO_2 emissions sources combined.   This additional analysis was performed only for normal operations and did not include Acid Plant bypass events because Bypass Stack SO_2 emissions are distinctly independent of emissions from other sources, as could be seen in the scatterplots and as expected based on the nature of Acid Plant bypass events.

The probability of simultaneous occurrence of maximal emissions from all SO_2 emissions sources combined is provided in Table 1.   The left column in the table represents the percentile level of SO_2 emissions from an individual source, with the first row in the table specifically evaluating the simultaneous occurrence of the SO_2 emission rate of each source being at 99th percentile or greater

levels of emissions. The results indicate that there was never an hour in the period of record where all of the emissions sources were simultaneously emitting at 99th percentile levels or greater.

The analysis demonstrates that the simultaneous occurrence of maximal emissions for all SO_2 emissions sources at the Smelter is exceedingly rare, further supporting the previous discussion of the sequencing of smelter processes.   For example, the simultaneous occurrence of 95th percentile level emissions and greater is never expected to occur, while 90th percentile level emissions from each source are expected to occur only 1 hour in a year.   These results must be considered in the identification of longer term emission limits for the Smelter.

Table 1. Probability of Simultaneous Occurrence of Maximal Emissions from Smelter SO_2 Sources [a]

Emissions Percentile	Probability of Simultaneous Occurrence at Stated Percentile	Expected Hours of Simultaneous Occurrence in a Year [b]
99th	0%	0
95th	0%	0
90th	0.01%	1
75th	0.07%	6

Notes:
[a] Sources evaluated were the Acid Plant Tail Gas Stack, Vent Fume Stack, Isa Roof Vent, ELF Roof Vent, Converter Roof Vent, and Anode Roof Vent.
[b] Expected hours considers 8760 potential hours of operation in a year.

Establishing a Longer Term Emission Limit

EPA allows SIPs to set emission limits longer than 1-hour (up to 30 days) provided that the longer term emission limit can be demonstrated to be protective of the NAAQS and comparably stringent to the critical emissions value.   Such longer-term limits require FMMI to assess the probability that maximal emissions from each of the SO_2 emissions sources at the Smelter occur simultaneously, which is a function of both the highly variable emissions from each individual SO_2 emissions source and the likelihood those individual sources are to run at the same time (the "independence" of these emissions). FMMI's analysis of hourly emissions data from the Smelter demonstrates that it is rare for all of these sources to be emitting near their maximum rates at the same time.

Appendix B to EPA's nonattainment area SIP guidance offers an approach to identifying longer-term emission limits for simple facilities that have highly variable emissions from a single emission source. The accompanying Appendix C to EPA's guidance provides an example power plant implementation of Appendix B, and specifies a 6-step process for identifying a 30-day emission limit:

1. Determine critical emissions value with dispersion modeling,
2. Develop 1-hour emissions frequency distributions for each future source,
3. Develop 30-day emissions frequency distributions for each future source,
4. Determine the 99th percentile emission rate for the 1-hour and 30-day distributions,
5. Calculate the ratio of the two 99th percentile values, and
6. Multiply the calculated ratio of 99th percentile values by the critical emissions value (CEV) to determine the 30-day emission limit.

The approach can be adapted for facilities with multiple similar sources, such as a power plant with three identical units that could be equipped with similar control technologies. Unfortunately, the guidance does not address how the Appendix B approach is to be applied for complex facilities such as the Smelter, which has multiple SO_2 sources to be considered with batch operations that operate independently of each other, and each of which are sufficiently different that alternative control strategies must be evaluated independently for each of them.

While FMMI identified several Appendix B approaches that can be devised for the Smelter, the most appropriate method is to sum the hourly continuous emissions for the multiple future sources to produce facility-wide 1-hour and 30-day emissions frequency distributions. The 99th percentile values are then determined for the facility-wide 1-hour and 30-day distributions and the ratio of the two values is calculated and multiplied by the CEV. This approach inherently considers the joint frequency distribution of SO_2 emissions from the individual sources, including Bypass Stack emissions. The independence of the sources' SO_2 emissions is accounted for, and the resulting facility-wide emissions variability is used to calculate the ratio.

Other approaches to Appendix B have inherent flaws. For example, one could develop the 1-hour and 30-day emissions frequency distributions and determine the 99th percentile values for *each* future source and then sum the 99th percentile values to determine facility-wide 1-hour and 30-day values.

This approach is flawed because it assumes that high emissions from the sources can simultaneously occur (i.e., the 99th percentile emissions from each source are summed, including 99th percentile emissions from the Bypass Stack). As was summarized in Table 1, such a scenario is extremely unlikely to occur. No such events were identified over a 20-month period of smelter operating time. Due to the high variability of SO_2 emissions from each source, this approach would produce an unrealistically low ratio, which in turn would result in an unrealistic 30-day emission limit.

For the reasons identified in this technical memorandum, the Appendix B approach was implemented by summing the hourly continuous emissions for the expected future emissions of the sources that will be in place after the Smelter modifications are completed. The results of the analysis to establish longer term emission limits are provided in Section 8-2 to 8-4 of ADEQ's Technical Support Document (TSD) for the SIP submittal.

Scatterplots of Hourly Emission Rates
Showing Independence of Operations

Scatterplots of Hourly Emission Rates Showing Independence of Operations

Acid Plant Tail Gas Stack
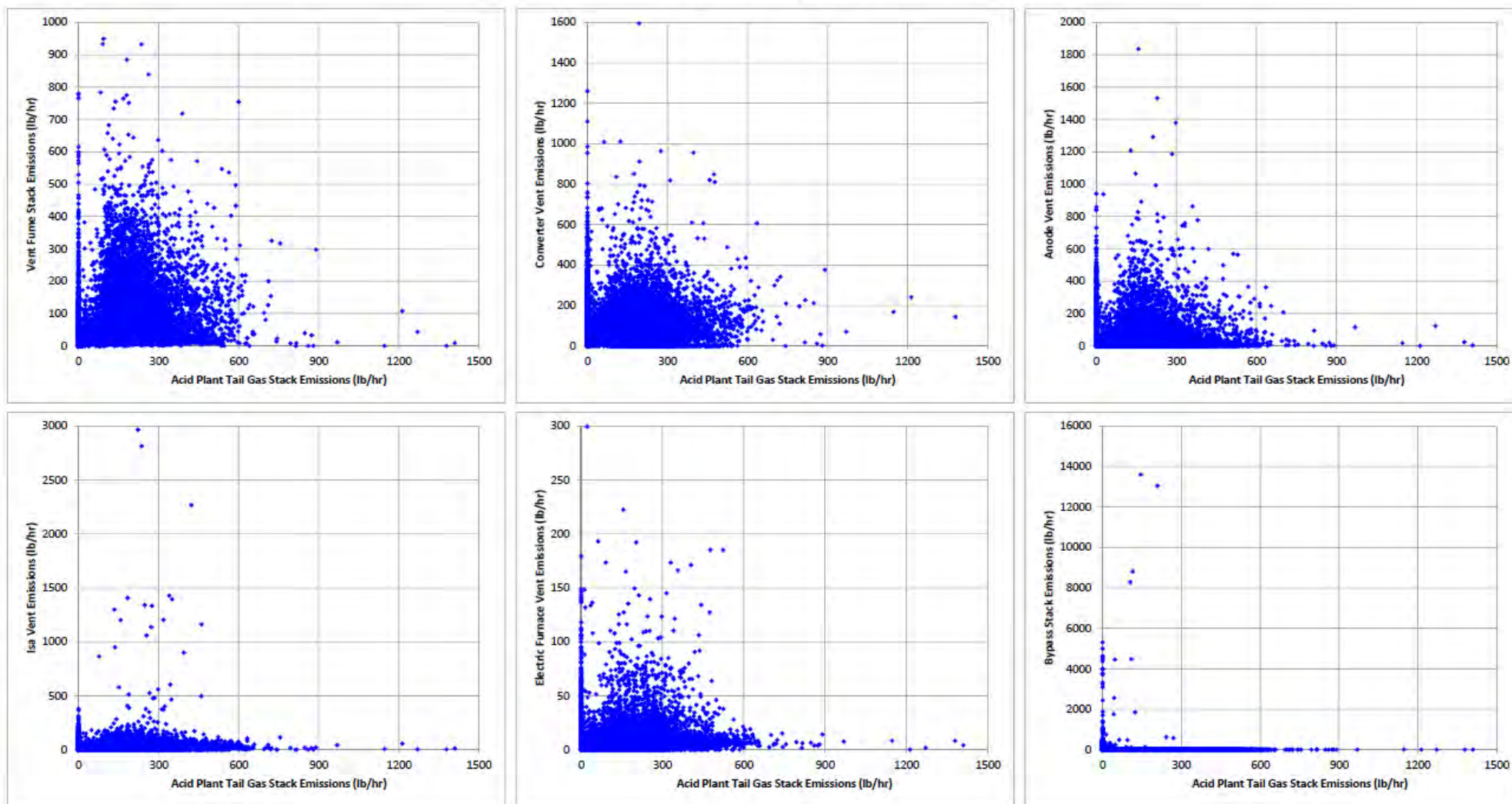
Scatterplots of Hourly Emission Rates Showing Independence of Operations

Converter Vent
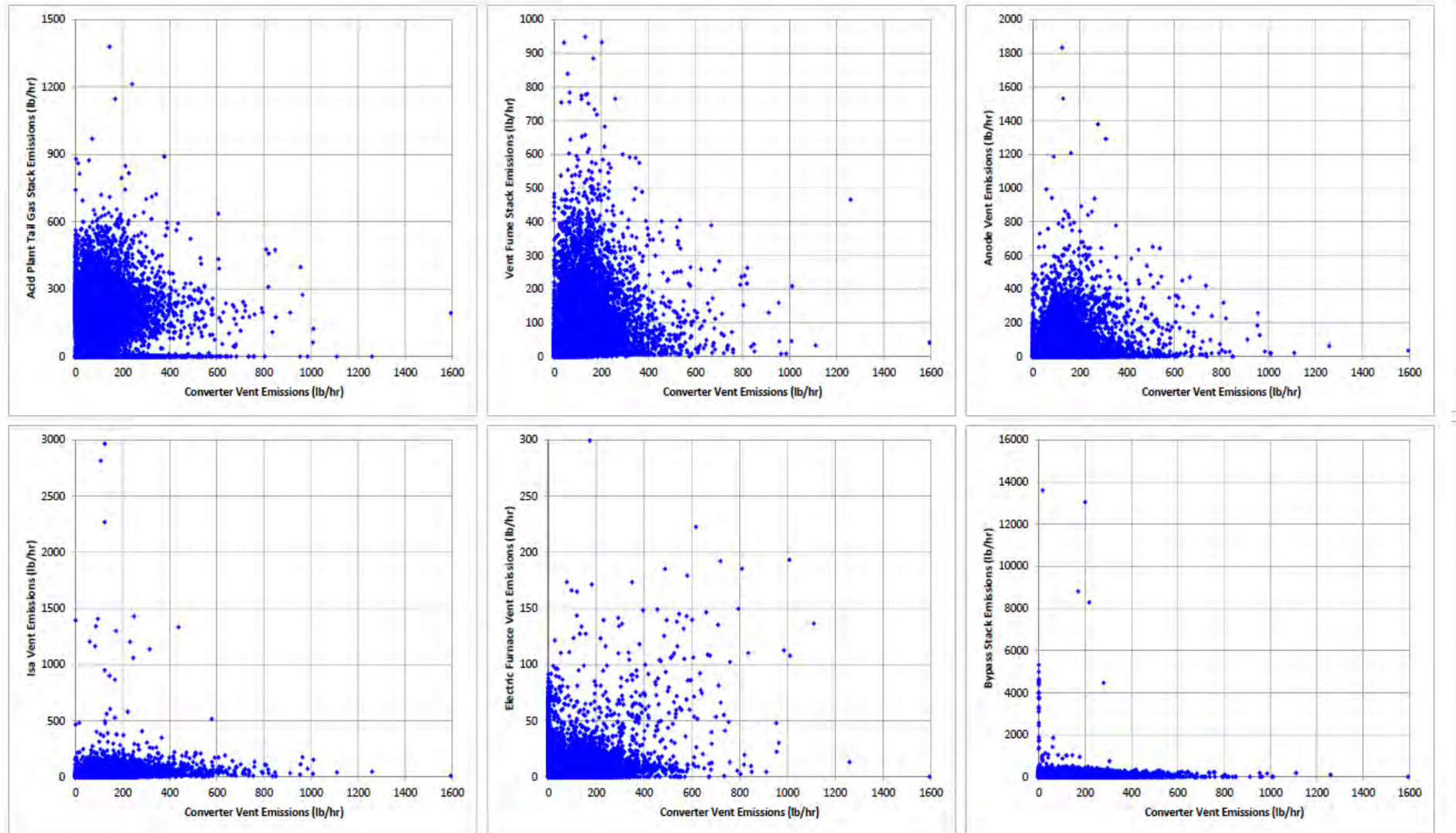
Scatterplots of Hourly Emission Rates Showing Independence of Operations

Anode Vent
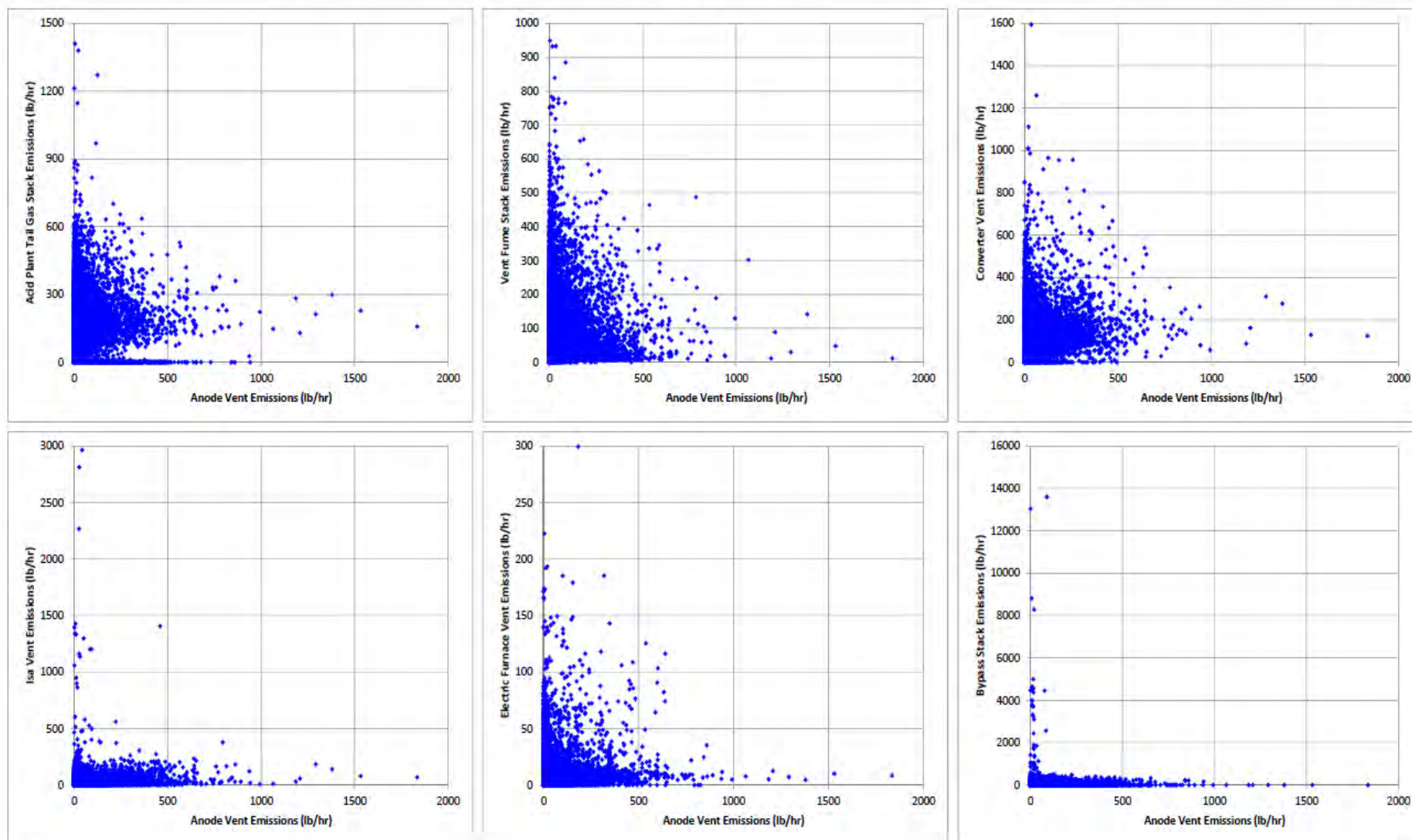
Scatterplots of Hourly Emission Rates Showing Independence of Operations

Electric Furnace Vent
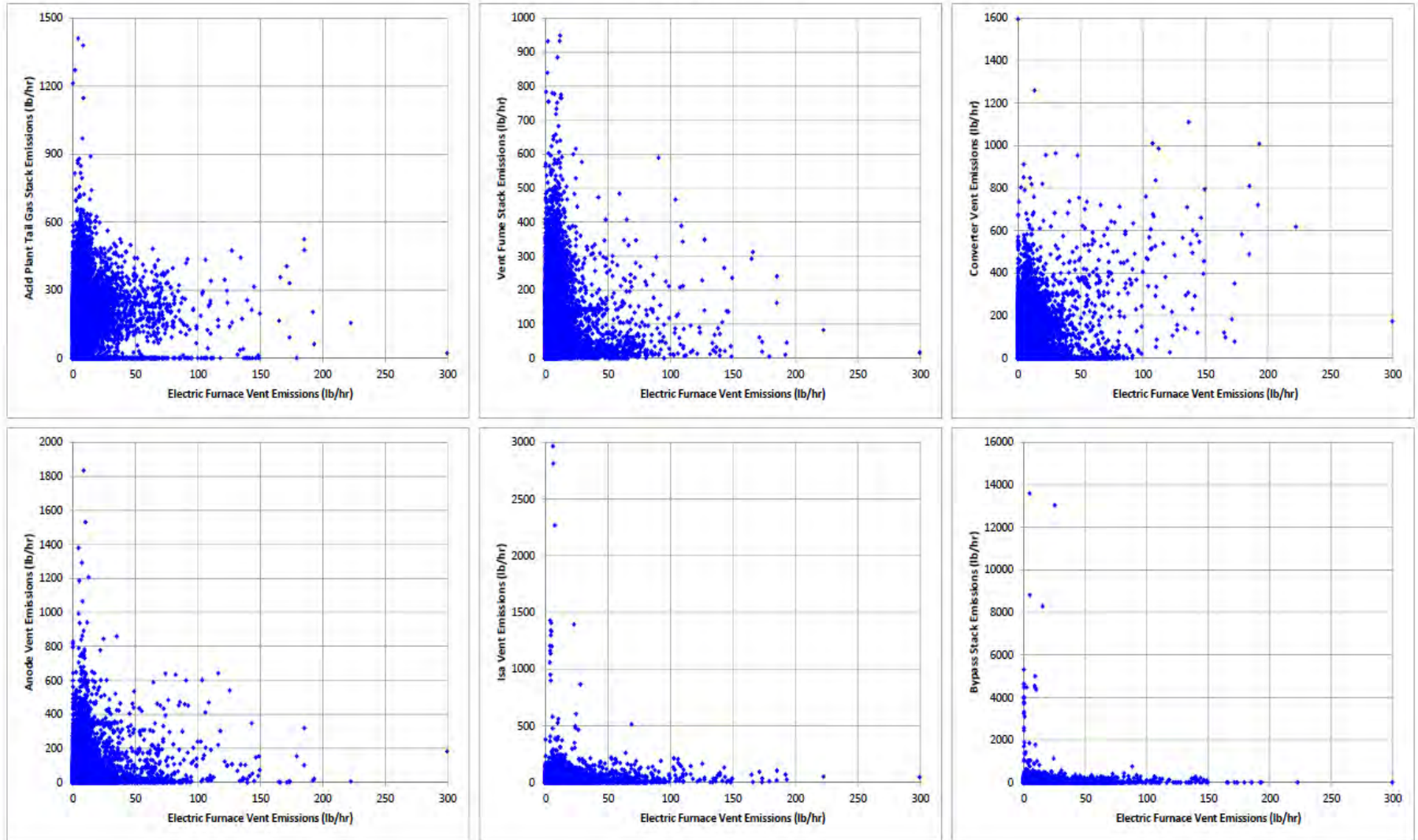
10.6 Appendix F: HATCH Memo Regarding Verification of SIP SO2 Emission Basis and Capture/Removal Efficiency

HATCH

Project Memo

H377000

August 28, 2015

To: C. West   From: J. Nikkari

cc: **FMMI**   **Hatch**
A. Binegar   I. Carruthers
J. Spehar   R. Sullivan
T. Weaver

Freeport-McMoRan Miami Inc. (FMMI)
Miami Smelter Project

Verification of SIP SO2 Emission Basis

1.   Introduction

In response to the revised 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standard (NAAQS), the Freeport-McMoRan Miami Inc. (FMMI) copper smelter in Miami, Arizona (Miami Smelter) will undertake a significant project to upgrade the smelter that will result in reduced SO_2 emissions.

In support of FMMI's ongoing efforts to demonstrate that the proposed upgrade of the Miami Smelter will result in attainment of the 1-hour SO_2 NAAQS, Hatch has been asked to provide an engineering justification for the SO_2 emission levels used in FMMI's dispersion modeling to represent the post construction condition, from the following sources:

- Vent fume scrubber (VFS) stack

- Tail gas scrubber (TGS) stack

- Aisle scrubber stack

- Residual smelter building roofline (fugitive) emissions

2. SO_2 Emissions Calculation Basis

The basis for current plant annual SO_2 emissions was established in an earlier phase of this project based on plant operating data provided by FMMI. Baseline emissions from the VFS and TGS stack were based on FMMI's 2010 reported annual emissions from the continuous emission monitoring systems (CEMS). Smelter building annual roofline SO_2 emissions were based on direct measurements in June 2012, with adjustments to reflect baseline throughput.

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This assessment of baseline SO_2 emissions at the smelter building roofline did not provide sufficiently detailed data on the emission contribution from numerous operations within the smelter to determine which combination of controls would be required to achieve the necessary SO_2 capture. As a result, Hatch refined the baseline inventory using the following:

- **Smelter Roofline SO_2 Emissions:** Average total SO_2 measured from each building was scaled to reflect future annual throughput and operating hours.

- **Emission Contribution from Individual Sources:** A qualitative assessment of the relative SO_2 emission contribution from individual sources within each smelter building, while operating/active, was performed using professional judgement and visual observations from both Hatch and FCX personnel.

- **Process Data:** Where possible, process modeling data was used to translate emissions while operating to annual operating average emissions. This included the frequency and duration of batch operations over a typical year at higher throughput. Process data was also used to estimate an increase on the order of 5% in annual operating hours at higher throughput.

Based on this analysis and FMMI's dispersion modeling for residual emissions from each source, Hatch determined the necessary controls to reduce the Miami Smelter's annual operating average SO_2 emissions to a level that will be consistent with a demonstration of attainment for the Miami area. The following emission controls contributed to reduced SO_2 emissions:

- Conversion of the VFS and TGS from magnesium hydroxide to caustic, along with increased recirculation flows

- Upgrades to the acid plant required to achieve increased throughput that will also result in improved conversion efficiency

- Installation of mouth covers on all 4 Hoboken converters

- Installation of a roofline capture system above the 4 operating converters, directed to a new aisle SO_2 scrubber

- Installation of mouth covers on all vessels operating as anode furnaces

- Installation of new process gas hoods on all anode furnaces, directed to the new aisle SO_2 scrubber

- Installation of a smelting furnace lance seal and charge port hood

For each of these controls, Hatch calculated the expected reduction in SO_2 emissions, as described below.

The Miami Smelter upgrade will include conversion of the VFS and TGS to use caustic reagent, at higher recirculation flow rates. Extensive upgrades to local piping systems are included. New packing will be installed in the VFS. The TGS will now be used at all times. Compared to the current scrubbers operating with magnesium hydroxide, SO_2 removal efficiencies will be increased from roughly 80% to 98%. Hatch based its estimate of SO_2 scrubber removal efficiency on mass transfer calculations for the upgraded VFS and TGS.

Upgrades to the acid plant will be required to achieve higher throughput. While the acid plant package has not yet been awarded, information obtained from a vendor indicated that the

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average conversion efficiency would be improved from roughly 99.8% to 99.9% via improved catalyst selection and equipment sizing. Combined with the upgraded TGS efficiency of 98%, total process gas capture in the acid plant is roughly 99.998%. Effectively all SO_2 contained in process gas from the converters, smelting furnace and electric furnace is captured in the acid plant during normal operation.

Mouth covers installed on each converter will be closed at all times when hot except during charging and tapping operations (slag skimming, blister copper transfer, etc.). This is expected to reduce the amount of fugitive SO_2 emissions to the converter aisle by 80% when closed and improve capture of process gas from each blowing converter to the acid plant. The mouth cover capture efficiency is based on conservative Hatch engineering judgement.

To provide additional control of SO_2 emissions from the converter end of the aisle, FMMI will install a roofline capture system above the 4 operating converters. All gas collected will be directed to a new Aisle SO_2 scrubber for treatment. Hatch calculated capture efficiency for the roofline capture system using extensive Computational Fluid Dynamics (CFD) modeling, for 3 different converter operating modes: blowing, charging, and tapping. Additional cladding was required on the smelter buildings to maximize capture of roofline SO_2 emissions. Performance of the Aisle SO_2 scrubber is based upon vendor guarantees, limited to a practical minimum outlet SO_2 concentration of roughly 1 ppmv for most operating conditions. For average annual inlet SO_2 loads, the resulting efficiency is on the order of 85%.

Upgrades to the Miami Smelter will include addition of a refractory lined process gas hood and mouth cover on each anode furnace, with process gas directed to a new baghouse and the Aisle SO_2 scrubber. Each anode furnace mouth cover will be closed at all times when hot except during charging and slag skimming operations. The same capture was used as the converter mouth covers. The new refractory lined process hoods are expected to capture 90% of process gas to the aisle scrubber system, with most SO_2 emissions from the anode furnaces occurring during the oxidation cycle. The mouth cover and process hood capture efficiencies are based on conservative Hatch engineering judgement.

The installation of a new Smelting Furnace lance seal air system is expected to reduce emissions around the lance that ultimately contribute to roofline emissions by roughly 80%. Effectively all SO_2 contained in the Smelting Furnace is captured in the acid plant system. The installation of a new Smelting Furnace charge port hood is expected to reduce emissions from the charge port by 80%, with all gas directed to the upgraded VFS system (98% SO_2 removal). For each of these controls, Hatch made conservative estimates of capture efficiencies based on its own smelter engineering experience.

The resulting SO_2 capture and removal efficiencies are summarized in Table 2-1.

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Table 2-1: SO₂ Capture and Removal Efficiency Assumptions

Project Scope	Capture or Removal Efficiency (%)
Stacks:	
Acid Plant Conversion Efficiency	99.9%
Upgraded Scrubber Efficiency (VFS, TGS)	98%
New Aisle Scrubber Efficiency	1 ppmv exit (~85%)
Roofline Fugitives:	
New Mouth Covers – Converters and Anode Furnaces	80%
Anode Furnace Process Hoods	90%
Electric Furnace Slag Returns	Per CFD - Charging
Electric Furnace Matte Tapping	Per CFD - Skimming
Crane/Ladle Movements – Converter End of Aisle	75%
Smelting Furnace Lance Seal	80%
Smelter Furnace Charge Port Hood	80%

To determine the resulting facility-wide emission rates at future throughput, these projected removal efficiencies were applied to relevant activities and contributing sources. Table 2-2 provides a summary comparison of the baseline annual emissions for current operation to the emissions at increased throughput with all above mitigations in place. The can be converted to lb/h average operating emissions using the appropriate operating hours for each source.

Table 2-2: Current vs. Future SO₂ Annual Emissions

Source	Current Emission (st/y)	Expected Post Construction Emission (st/y)	Overall Reduction (%)
Smelter Buildings*	1031	311	70%
Stacks	1746	112	94%
VFS	331	46	86%
TGS	1415	11	99%
Aisle Scrubber	--	55	--

*Total emissions from converter/anode aisle, smelting furnace building and electric furnace building.

3. Conclusion

Upgrades proposed for the Miami Smelter will include significant controls to reduce SO₂ emissions. The application of these controls results in projected facility-wide annual operating average SO₂ emission rates that are consistent with the facility-wide emission rates used in FMMI's dispersion modeling analysis. This comparison is summarized in Table 3-1.

Table 3-1: SO₂ Emission Comparison – Annual Operating Average

Source	Project Emission Estimate (lb/h)	FMMI Modeling Basis (lb/h)***
Smelter Buildings*	77	79.6
Stacks**	27	30.5

*Total emissions from converter/anode aisle, smelting furnace building and electric furnace building.
**Vent fume, tail gas and aisle scrubber stack.
***Data provided by AMEC Foster Wheeler July 24, 2015.

J. Nikkari

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10.7 Appendix G: GCT Memo Regarding Emissions calculations and Capture/Removal Efficiency during Bypass Events

GCT
Metallurgical Process Specialists

Gas Cleaning Technologies, LLC
4953 N. O Connor Blvd.
Irving, TX 75062 USA
Telephone   +1 214 613 1785
Facsimile   +1 214 613 1786

September 2, 2015

MEMORANDUM

Chris West
Chief Environmental Engineer
Miami Operations
Freeport-McMoRan Miami, Inc.
P.O. Box 4444
Claypool, Arizona 85532-4444

Re: Acid Plant Bypass Emissions SO$_2$ Treatment

Dear Chris,

GCT evaluated potential treatment options for addressing Acid Plant bypass emissions of sulfur dioxide (SO$_2$) from the bypass stack during startup, shutdown, and emergency events at the Freeport-McMoRan Miami, Inc. (FMMI) Smelter. GCT's analysis, set forth in more detail below, evaluated the feasibility of using SO$_2$ control devices to provide partial control of the SO$_2$ emissions from the bypass stack. Both the emissions control equipment currently installed at the Smelter and equipment included in FMMI's Significant Permit Revision (No. 58409) were considered, as were other options. Based on our analysis, GCT concludes that use of the planned converter aisle vent scrubber (Aisle Scrubber) is a technically feasible solution for treating bypass emissions.

Analysis of Emissions Data

GCT's analysis examined planned and unplanned bypass events from 2010 through 2012 using CEMS data provided by FMMI. Unplanned bypass events, due to their greater emissions, dictate the feasibility of applying emissions controls to bypass emissions in general and therefore our analysis focused on the worst-case unplanned bypass event. GCT reviewed 22 unplanned bypass events in the above mentioned data set, averaging 7 unplanned events per year, with a maximum of 11 unplanned events in 2011. Of the unplanned events, GCT found that the worst case event lasted 1 hour and 54 minutes and emitted a total of 8,884 pounds of SO$_2$ on November 10, 2011. FMMI has obtained a significant permit revision that will permit it to increase annual concentrate throughput by 31%. In an attempt to provide a conservative estimate of the worst-case emissions scenario under these future operating conditions, GCT projected future unplanned bypass stack emissions by linearly scaling the provided existing emissions. As such, the scaled worst case, unplanned and untreated bypass event could be expected to emit a total of 11,638 pounds of SO$_2$.

For the purpose of evaluating control options, an emissions profile for the worst case event can be developed over the duration of an event as shown in Figure 1 below for both current and future production levels.

Figure 1.

Profile of Worst-Case Unplanned Bypass Event, No Emissions Control Applied
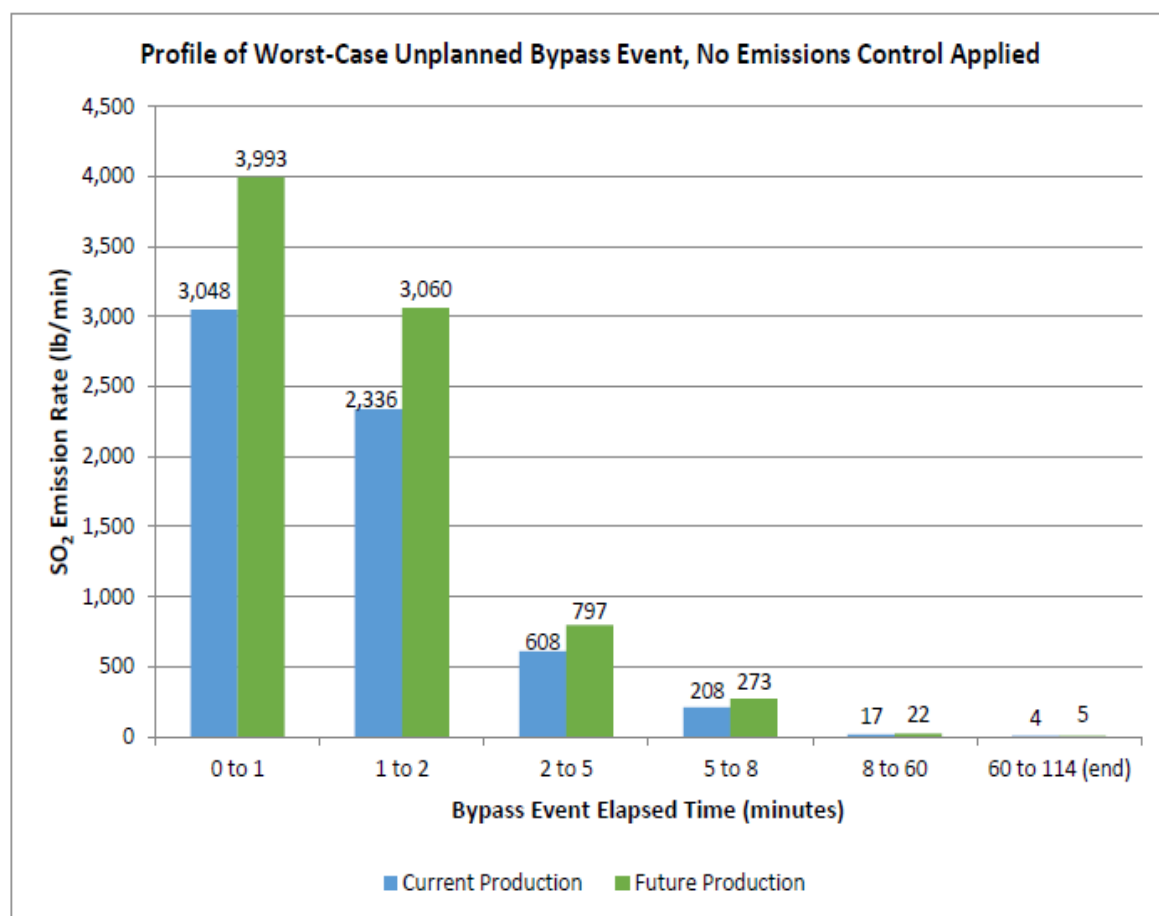
As illustrated above, most of the emissions occur in the first five to eight minutes of the bypass event, with approximately 34% of the emissions occurring in the first minute. Because emissions are greatest at the beginning of an unplanned bypass event and then decline quickly, significant reductions of unplanned bypass emissions can only be achieved by technologies that are available to control emissions from the bypass stack within 2 minutes of the beginning of an unplanned bypass event. In contrast, a planned bypass event has much lower emissions throughout, and significant reductions can be achieved through the duration of the event.

GCT

Metallurgical Process Specialists

Evaluation of Options for Control of Bypass Emissions

GCT's evaluated the potential of each of the existing and planned SO_2 emissions control devices to treat SO_2 from the bypass stack. GCT considered the following options:

- Use of the Acid Plant Tail Gas Scrubber, with and without the existing Wet Gas Cleaning Plant (WGCP) located within the Acid Plant. This is not technically feasible due to existing scrubber size;

- Use of the Vent Fume Scrubber, with and without the existing WGCP. This is not technically feasible due to existing scrubber size;

- Use of the Aisle Scrubber, with and without the existing WGCP. Selected option, further discussion below;

- Use of Bionatur adsorbent. Rejected due to excessive cost compared to the selected option;

- Dry sorbent injection. Rejected due to generation of solid waste and need for additional particulate matter (PM) emission control as well as excessive cost compared to the selected option;

- Amine absorbent such as CANSOLV®. Rejected due to excessive cost compared to the selected option;

- Hydrogen peroxide. Rejected due to excessive cost compared to the selected option.

GCT's analysis concluded that the most feasible solution to control an unplanned bypass event is to route the bypass emissions to the planned Aisle Scrubber. Under normal average operating conditions, the amount of caustic reagent (129 lb./min) in the recirculating sprays in the Aisle Scrubber has the capacity to absorb 90 to 100 lb./min of SO_2. Therefore, the reduction capacity of the Aisle Scrubber in the first eight minutes would be limited at this design level of caustic reagent. After the first eight minutes, this design level of caustic reagent would be able to achieve the expected design reduction capability of the scrubber. Assuming a 95% reaction efficiency of the limiting component (caustic in first several minutes, SO_2 for the remainder of the event), the Aisle Scrubber would reduce total worst case unplanned bypass event emissions in the first hour by approximately 16 to 18% if the normal caustic recirculation rate is used. Improved reduction efficiencies would be expected for both planned bypass events and lesser unplanned bypass events.

To achieve higher scrubbing efficiency in the first several minutes of an unplanned bypass event, additional caustic would need to be introduced to the sprays. To achieve the quantity of caustic required, FMMI would have to pump 20 wt% caustic makeup solution directly to the scrubber spray header at a rate of 2,500 to 3,000 gpm (i.e., 5,000 to 6,000 lb./min NaOH), in addition to the normal

recirculating liquor for the first several minutes of a worst-case unplanned bypass event. To achieve the higher caustic flow rates, additional pumping equipment and controls to deliver the caustic to the sprays would be required. Reduced volumes of additional caustic would be needed for planned bypass events and lesser unplanned bypass events.

Once sufficient caustic is provided in the sprays, a scrubbing efficiency of 95% can likely be achieved. However, there is a concern regarding any delay between when the bypass gas reaches the scrubber and when caustic makeup pumps could ramp up and deliver the high caustic rate to the sprays. If 95% efficiency is assumed once the high caustic rate reaches the sprays, then the expected reduction efficiency in the first hour of a worst-case unplanned bypass event would depend on the length of that initial delay as summarized in Table 1 below, assuming the minimum estimated time of 10 seconds for the bypass emissions to transit the ductwork from the bypass valve and reach the scrubber.

Table 1
Worst Case Unplanned Event SO_2 Reduction Efficiency in
First Hour versus Delay in High Caustic Addition

Delay Time	SO_2 Reduction Efficiency
10 second delay after Bypass commences:	95%
40 second delay after Bypass commences:	79%
70 second delay after Bypass commences:	63%
100 second delay after Bypass commences:	50%
130 second delay after Bypass commences:	38%

As Table 1 demonstrates, supplemental high caustic addition can be added to the Aisle Scrubber system to provide additional SO_2 control if the Aisle Scrubber as designed is not adequate to allow for compliance with ambient air quality standards. We stress that this analysis is based on a worst-case unplanned bypass event, and such events are uncommon based on our review of the data set provided to us. The Aisle Scrubber as designed will provide for better SO_2 emissions control than shown herein for planned and lesser unplanned bypass events.

Sincerely,

Matt Russell
Senior Process Engineer
Gas Cleaning Technologies, LLC
4953 N. O'Connor Rd
Irving, Texas 75062

10.8 Appendix H: Technical Memo Regarding Calculation of CEV

Technical Memorandum
Critical Emissions Value Assessment for the
Miami SO₂ Nonattainment Area State Implementation Plan (SIP)
March 30, 2016

This memo presents the critical emissions value assessment for use in the Arizona Department of Environmental Quality's (ADEQ) Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA). Establishing the critical emissions value is an important step in identifying an SO$_2$ emission limit for Freeport-McMoRan Miami Inc.'s (FMMI) primary copper Smelter. FMMI is performing dispersion modeling to support the SIP submittal.

Introduction

The EPA's Guidance for 1-Hour SO$_2$ Nonattainment Area SIP Submissions (EPA, 2014) defines the critical emissions value as "*…the hourly emission rate that the model predicts would result in the 5-year average of the annual 99th percentile of daily maximum hourly SO$_2$ concentrations at the level of the 1-hour NAAQS, given representative meteorological data for the area.*"

To determine the critical emissions value, EPA guidance specifically states that dispersion modeling be used. Due to the physical configuration of the Smelter (i.e., the roof vents that are buoyant line sources) and the proximity of complex terrain to the Smelter, EPA's preferred guideline dispersion models do not directly apply. Consequently, any modeling approach requires EPA approval per 40 CFR Appendix W (Air Quality Modeling Guidelines). As identified in a separate technical memo, a performance evaluation was conducted of five dispersion modeling approaches for the Miami Smelter and the Hybrid BLP/AERMOD approach was selected for determining the critical emissions value.

The Hybrid BLP/AERMOD approach uses the BLP dispersion model to predict hourly plume height and vertical spread (sigma-z) resulting from roof vent emissions. AERMOD is used to predict hourly ambient concentrations resulting from stack and roof vent emissions. The roof vent emissions are input to AERMOD as volume sources, with release height and initial sigma-z (vertical dispersion) inputs set at the BLP-calculated plume height and sigma-z. This approach avoids use of BLP's antiquated implementation of complex terrain and meteorology, and incorporates EPA's preferred plume rise and building downwash calculations for buoyant line sources.

Smelter SO₂ Emissions Configuration

The FMMI Smelter is currently configured with five roof vents, which account for a significant proportion of the Smelter's current sulfur dioxide (SO$_2$) emissions (approximately 44% of Smelter SO$_2$ emissions during the period from May 2013 through April 2014). There are five roof vents on the Smelter building. The roof vents are located above the IsaSmelt® (Isa) vessel, the Electric Furnace (ELF), the converter aisle (2 vents), and the anode aisle. The three vents over the converter aisle and anode aisle are aligned along the length of the Smelter building. The shorter vents over the Isa and ELF are oriented perpendicular to the converter aisle and anode aisle vents. In addition to the roof vents, three stacks (Acid Plant Tail Gas Stack, Vent Fume Stack, and Bypass Stack) are located at the Smelter. The locations of the existing vents and stacks are shown in Figures 1 and 2.

Figure 1. Aerial Photograph of Miami Smelter, Showing Stacks and Roof Vents

Figure 2. Photograph of Miami Smelter, Showing Stacks and Visible Roof Vents

Photograph taken at the Jones Ranch Ambient SO$_2$ Monitoring Station

The future Smelter configuration will consist of four roof vents and three stacks (Acid Plant Tail Gas Stack, Vent Fume Stack, and Aisle Scrubber). The roof vent located above Converters 2 through 5 will be reconfigured as part of a collection system for fugitive emissions. In addition, the anode and mold vessels will be modified to collect emissions generated during the refining of blister copper. The collected emissions from the converter roof and anode vessel capture systems will be routed to the new Aisle Scrubber to treat the captured SO$_2$ emissions. The roof above the non-functional Inspiration Converter and the Anode Aisle will still vent to the atmosphere. Additionally, Acid Plant Bypass emissions will be routed to the Aisle Scrubber for treatment prior to discharge to atmosphere. FMMI is proposing multiple additional changes to the Smelter configuration, as set forth in greater detail in the separate modeling protocol document.

Determination of Critical Emissions Value

The calculation of a critical emissions value for a facility with a single SO$_2$ emission source is a simple task, because the predicted design value is proportional to the modeled emission rate. The ratio of the available air quality (i.e., the difference between the NAAQS and background concentration plus interactive source contribution) to the predicted design value is calculated and then multiplied by the modeled emission rate to determine the critical emission value. In contrast, a complex facility such as the Smelter,

with seven future emissions sources of consequence, requires an iterative approach. The effectiveness and cost of controlling each of the SO_2 emissions sources varies greatly, and the iterative approach must be performed to optimize the control cost required to achieve attainment.

Identification of Available Air Quality

The first step in the assessment is to identify the available air quality for the Smelter. As described in the modeling protocol report, interactive sources are not required to be modeled. Therefore, available air quality in the Miami nonattainment area is simply the difference between the NAAQS (196 μg/m^3) and background air quality (21.2 μg/m^3), or 174.8 μg/m^3.

Identification of Future SO$_2$ Emissions Sources for Consideration of Additional Control

The next step in the assessment is to identify the candidate future SO_2 emissions sources at the Smelter for consideration of additional control, all of which are listed in the modeling protocol report. In anticipation of the nonattainment designation, FMMI worked to redesign and identify potential upgrades to the Smelter's emissions capture and control systems to better control SO_2 and other emissions as part of proposed changes to increase operational efficiency and capacity. FMMI engaged in a significant engineering study, incorporating multiple iterations of dispersion modeling, and proposed the following Smelter modifications in its air permit application filed with ADEQ in July 2013 (the permit was subsequently issued by ADEQ on July 21, 2014):

- Upgrade the bedding plant conveyor belts and IsaSmelt® (Isa) furnace feed paddle mixers;
- Replace the existing Isa;
- Upgrade the Isa furnace cooling and emissions control system (i.e., lance seal, feed port hood, and tapping hood controls);
- Upgrade the electric furnace emissions control system (i.e., tapping hood controls);
- Upgrade the converters emissions control system (i.e., reconfiguring the roofline to capture emissions and route them to a new Aisle Scrubber including stack);
- Upgrade the anode furnaces and utility vessel (also known as a mold barrel) emissions control system (i.e., process gas collection system, mouth covers, replacement of utility vessel, new baghouse ducted to the new Aisle Scrubber, new hydrated lime silo, and new baghouse dust return system to the electric furnace);
- Increase operational flexibility via authorization of 1,000,000 dry tons per year of New Metal Bearing Material (NMBM) throughput capacity;
- Increase Acid Plant capacity to accommodate the authorized concentrate throughput capacity (i.e., upgraded cooling system, new converter bed, new blower, and new SO_3 cooler);
- Upgrade the Vent Fume Scrubber and Acid Plant Tail Gas Scrubber to caustic use;
- Add three new Wet Electrostatic Precipitator (WESP) modules at the vent fume control system;
- Enclose the temporary on-site concentrate storage piles with an enclosed structure;

- Increase the height of the Vent Fume Stack and Tail Gas Stack; and

- Other support facility changes.

FMMI has also committed to an additional modification that will direct Bypass emissions to the proposed Aisle Scrubber for treatment. This will effectively eliminate the use of the Bypass Stack except under rare emergency conditions.

The future maximum potential SO_2 emission rates for these sources resulting from the proposed modifications are provided in Table 1. Two different emission rates are presented for the Aisle Scrubber Stack. The first represents emissions during normal smelter operations while the second represents emissions during Acid Plant bypass operations.

Table 1. Future Smelter SO_2 Emissions Sources Considered for Additional Control

Source	SO_2 (lb/hr)
Acid Plant Tail Gas Stack	3.2
Vent Fume Stack	13.0
Aisle Scrubber Stack (normal ops)	14.3
Aisle Scrubber Stack (bypass ops)	275.0
Converter Aisle Roof Vent	25.6
Anode Aisle Roof Vent	8.0
Isa Roof Vent	31.8
Electric Furnace Roof Vent	14.2

Identification of Future SO_2 Emissions Sources to Remain at Existing Level of Control

The next step in the assessment is to identify the future SO_2 emissions sources at the Smelter that will remain at their existing level of control, all of which are listed in the modeling protocol report. These sources and their future maximum potential SO_2 emission rates are listed in Table 2.

Dispersion Model Results

The identified emissions, along with other dispersion model inputs described in the modeling protocol, were input to the Hybrid BLP/AERMOD model to verify that the model predicted an average of the annual 99th percentile of daily maximum hourly SO_2 concentrations at the level of the 1-hour NAAQS. The resulting predicted design concentration was 172.9 $\mu g/m^3$, just within the available air quality of 174.8 $\mu g/m^3$.

Critical Emissions Value Results

Based on the dispersion model results, the facility-wide critical emissions value is the sum of the emissions presented in Tables 1 and 2, or 393 lb/hr.

Table 2. Future Smelter SO$_2$ Emissions Sources Remaining at Existing Level of Control

Source	SO$_2$ (lb/hr)
Acid Plant Preheater	0.0198
Isa Auxiliary Boiler	0.00612
Change Room Water Heater	0.000437
Rod Plant Thermal Breaker	0.000456
Rod Plant Shaft Furnace	0.350
Screening Engine	0.00102
Compressor	0.00655
Compressor	0.00655
Rod Plant Roof Vent	0.0129
Smelter Building Leaks	3.98
Slag Storage Area	3.75

Note: Emergency Generators are not included in the 1-hour impact modeling per EPA guidelines (U.S. EPA, 2013). All emergency generators operate less than 500 hours per year.

10.9   Appendix I: Technical Memo Regarding CEV Sensitivity Analysis

Technical Memorandum
Sensitivity of Predicted Concentrations to CEV Variations Miami
SO$_2$ Nonattainment Area State Implementation Plan (SIP)
June 5, 2016

This memorandum presents a sensitivity analysis of the critical emissions value (CEV) developed for the Freeport-McMoRan Miami Inc. (FMMI) primary copper smelter (Miami Smelter), located in Miami, Arizona. The CEV was identified as part of the air quality dispersion modeling conducted in support of the Arizona Department of Environmental Quality (ADEQ) Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA).   As explained in more detail in a separate memorandum [Critical Emissions Value Memo, 2015], the CEV is the hourly emission rate that the model predicts would result in the 5-year average of the annual 99th percentile of daily maximum hourly SO$_2$ concentrations at the level of the NAAQS.   Because ADEQ's draft SIP contemplates the use of a facility-wide emission limitation that covers all of the emissions sources at the Miami Smelter, additional technical analysis is necessary to demonstrate that the facility-wide CEV represents an appropriate emission rate that demonstrates compliance with the 1-hour SO$_2$ NAAQS even when there may be variations in the precise emissions sources—which may affect the distribution of emissions leading to differences in emission locations, release heights, and other source parameters—at the Smelter.

Accordingly, the purpose of this memorandum is to demonstrate that the current facility-wide CEV is a robust value that is not sensitive to changes in the allocation of SO$_2$ emissions among sources within the Smelter.   This memorandum documents the technical analysis undertaken by FMMI to make this demonstration.

Approach

To demonstrate that the facility-wide CEV is not sensitive to the variability of emissions among sources within the Smelter, FMMI evaluated the effect of varying individual source emissions while keeping the facility-wide emissions consistent.   To do so, FMMI increased a single source and decreased the other major emission sources by a weighted amount, such that the CEV remained constant.

In each scenario, one individual source's emission rate was increased by 20.8 percent while the emissions from the remaining major emission sources were decreased by a proportional amount to ensure the facility-wide CEV remained constant.   As a result, each source combination maintained the total emission rate constant at the facility-wide CEV of 387 lb/hr while varying the individual source rates.

FMMI determined the 20.8 percent value by evaluating the distribution of non-bypass facility-wide future projected hourly emissions.   The upper tail of that distribution, defined as those facility-wide emissions levels that are in the upper 1% of facility-wide emissions, were first identified.   The minimum value of the upper tail (178 lb/hr) and the median value of the upper tail (275.4 lb.hr) were then identified.   The minimum value represents the 99th percentile of the hourly emissions distribution. Due to the skewness of the emissions distribution in the upper tail, the median was selected as being representative of the expected emissions value within the upper tail.   The percent difference between the two values, is 20.86% which is representative of the emissions variability in cases where non-bypass facility-wide emissions are near the CEV.

Only the major stacks (*i.e.,* the aisle scrubber stack during normal operations, tail stack and vent fume stack) and roof vent sources were varied in this sensitivity analysis.   Other sources (*e.g.*, compressors, water heaters, engines) are included in the modeling analyses, but were not varied because their potential emissions are too small to have an appreciable impact on the modeling outcomes and therefore assessing

them would not be informative. The Bypass Stack emissions were not included in this sensitivity analysis as they operate independently of the other sources' emissions as demonstrated in the emissions independence analysis provided separately.

To evaluate the impact of changing the emission rates at various sources while holding the facility-wide CEV constant, each combination of emission rates was used as a series of inputs to the Hybrid BLP/AERMOD model. The results of these model runs were compared to the design concentration of 196 μg/m^3, with a target concentration of 174.8 μg/m^3 when background is considered.

Results

Tables 1 and 2 present the emission rates modeled and results for the source combinations described above.

Table 1 provides the scenarios where the individual stack emissions were increased by 20.8%. Predicted design value concentrations range from 172.5 to 172.8 μg/m^3, all less than the design value concentration of 172.9 μg/m^3 predicted when using the CEV.

Table 2 provides the scenarios where the individual vent emissions were increased by 20.8%. Predicted design value concentrations range from 172.2 to 174.5 μg/m^3, all within 1% of the design value concentration of 172.9 μg/m^3 predicted when using the CEV.

Conclusion

The sensitivity analysis results demonstrate that predicted design value concentrations range from 172.5 to 174.5 μg/m^3. Modeling of the CEV presented in the SIP submittal results in a predicted concentration of 172.9 μg/m^3. Thus, the sensitivity analysis predicts concentrations that are within 1.0% of the CEV- modeled design value concentration. The variation in predicted concentrations is very small when compared to the 20.8% variation in emission rates applied to the various sources for the purposes of the sensitivity analysis. Based on these results, a single facility-wide emission limit based on the CEV is appropriate for the Miami Smelter.

TABLE 1. Sensitivity Analysis of Stack Critical Emissions Values

Major Emission Sources	PTE g/s	STACKS					
		CV1 H APTGS(+)		CV2 H VFS(+)		CV3 H AS(+)	
		change (g/s)	Emission (g/s)	change (g/s)	Emission (g/s)	change (g/s)	Emission (g/s)
Acid Plant - Tail Gas Stack	0.4034	0.0839	0.4873	-0.0112	0.3922	-0.0126	0.3908
Vent Fume System	1.6350	-0.0102	1.6248	0.3401	1.9751	-0.0509	1.5841
Aisle Scrubber (normal)	1.8072	-0.0112	1.7960	-0.0502	1.7570	0.3759	2.1831
Anode	1.0089	-0.0063	1.0026	-0.0280	0.9809	-0.0314	0.9775
Converter	3.2285	-0.0201	3.2084	-0.0896	3.1389	-0.1005	3.1280
ISA	4.0105	-0.0250	3.9855	-0.1113	3.8992	-0.1248	3.8857
ELF	1.7908	-0.0111	1.7797	-0.0497	1.7411	-0.0557	1.7351
Bypass	34.6490		34.6490		34.6490		34.6490
Total emissions g/s			48.5333		48.5333		48.5333
H4H ($\mu g/m^3$)			172.8		172.5		172.5

TABLE 2. Sensitivity Analysis of Roof Vent Critical Emissions Values

Major Emission Sources	PTE g/s	Vents							
		CV4 H CONV(+)		CV5 H Anode (+)		CV6 H ISA(+)		CV7 H ELF (+)	
		change (g/s)	Emission (g/s)	change (g/s)	Emission (g/s)	change (g/s)	Emission (g/s)	change (g/s)	Emission (g/s)
Acid Plant - Tail Gas Stack	0.4034	-0.0254	0.3779	-0.0066	0.3968	-0.0341	0.3693	-0.0124	0.3909
Vent Fume System	1.6350	-0.1030	1.5320	-0.0266	1.6083	-0.1381	1.4969	-0.0504	1.5846
Aisle Scrubber (normal)	1.8072	-0.1139	1.6933	-0.0295	1.7777	-0.1527	1.6545	-0.0557	1.7515
Anode	1.0089	-0.0636	0.9453	0.2099	1.2188	-0.0852	0.9237	-0.0311	0.9778
Converter	3.2285	0.6715	3.9000	-0.0526	3.1759	-0.2728	2.9557	-0.0994	3.1291
ISA	4.0105	-0.2527	3.7578	-0.0654	3.9451	0.8342	4.8447	-0.1235	3.8870
ELF	1.7908	-0.1129	1.6779	-0.0292	1.7616	-0.1513	1.6395	0.3725	2.1633
Bypass	34.6490		34.6490		34.6490		34.6490		34.6490
Total emissions g/s			48.5333		48.5333		48.5333		48.5333
H4H (mg/m3)			172.2		172.7		174.5		173.1

10.10 Appendix J: CEV Exceedance Risk Analysis

Technical Memorandum
SO₂ NAAQS Exceedance Risk Analysis for Proposed Miami Smelter Configuration Miami SO₂
Nonattainment Area State Implementation Plan (SIP)
June 5, 2016

This memorandum presents an analysis of the potential risk of exceeding the sulfur dioxide (SO_2) national ambient air quality standard (NAAQS) based on the proposed future configuration of the Freeport-McMoRan Miami Inc. (FMMI) primary copper smelter (Miami Smelter), located in Miami, Arizona. The Miami Smelter operates with batch processes as explained in the *Emissions Variability and Independence Assessment Memorandum* [July 2015] prepared in support of the Arizona Department of Environmental Quality (ADEQ) Miami SO_2 Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA). Because of the variability of the emission rates from the larger sources, additional analysis was undertaken to show, per EPA's SO_2 Nonattainment Area SIP Guidance (EPA, 2014), that periods of hourly emissions greater than the critical emission value (CEV) are a rare occurrence at a source, and these periods would be unlikely to have a significant impact on air quality, insofar as they would be very unlikely to occur repeatedly at the times when the meteorology is conducive for high ambient concentrations of SO_2.

Based on the analysis performed per EPA's guidance to establish the 30-day rolling emission limit, projected future actual 1-hour facility-wide emissions would be greater than the facility-wide CEV approximately 0.50 percent of the hours in a year (approximately 44 hours out of the potential 8,760 hours in a year). FMMI believes that a frequency of 0.50% constitutes a rare occurrence. The analysis was based on applying a proposed control strategy to an 18-month data set of existing actual hourly emissions measured from May 2013 through October 2014.

A modeling analysis was performed on the projected future actual 1-hour emissions and demonstrated that the Miami Smelter would be in compliance with the NAAQS with the proposed 30-day rolling hourly emission limit. The modeling analysis aligned the projected future hourly emissions, which were based on the aforementioned existing measurements of hourly emissions from May 2013 through October 2014, with on-site meteorological data that were measured concurrently with the existing measurements of hourly emissions. Clearly, in this particular analysis, the periods where hourly emissions were greater than the CEV did not align with meteorological conditions that were conducive for predicted high ambient concentrations of SO_2.

ADEQ subsequently expressed concern that the 18-month period of record for the hourly emissions data and concurrent 18-month period of hourly meteorological data may not be adequate to address the pairing of high emissions with meteorological conditions that are conducive for high ambient concentrations of SO_2. Accordingly, FMMI performed additional analysis to assess the probability that exceedances of the NAAQS would occur. This memorandum documents the technical analysis undertaken by FMMI to make this demonstration.

Approach

The approach entailed using the 18-month data set of projected future actual emissions paired with an

alternative on-site meteorological data set consisting of 3 years of hourly observations from April 2010 through March 2013. Development of this 3-year on-site meteorological data set is described in the modeling protocol submitted with ADEQ's SIP documentation, and this data set was used in performing the CEV modeling.

The approach randomized the pairing of the emissions data set with the meteorological data set in such a way to represent almost 300 years of modeling.   The hourly sequence of emissions and meteorology were retained in the analysis.   To perform the pairings, a program was developed to randomly pick an hour within the meteorological data set against which the first hour of the emissions data set would be aligned.   Each subsequent hour was then assigned such that the sequence of hourly emissions and meteorology was maintained.   Because the hourly emission data set was smaller than the meteorological data set, the hourly emission data was repeated to complete a 3-year emission file.   The first 3-year analysis did not incorporate the random alignment; in this case, the first hours of both data sets were aligned.   The hourly emission data was repeated as described above to complete a 3-year emission file.

After the first 3-year data set was prepared, the randomized alignment was then repeated 99 times to create 99 additional 3-year data sets.   A total of 100 paired data sets were prepared, which corresponds to 300 years of analysis. These pairings of emissions and meteorology were then input to the AERMOD dispersion model, which was run in accordance with the methods described in the modeling protocol submitted with the SIP documentation.   The hourly plume heights for the roof vents, based on the use of the Hybrid Approach, were provided in a separate AERMOD input file.

Results

Table 1 presents the predicted design concentrations for each of the 100 runs. The results for each year of analysis are shown to evaluate the contribution of a given year of meteorological data to the 3-year average. The background concentration of 21.2 $\mu g/m^3$ is not included in the results, and therefore the results are to be compared to a target concentration of 174.8 $\mu g/m_3$ (i.e., the NAAQS of 196 $\mu g/m^3$ minus the background concentration of 21.2 $\mu g/m_3$). For all 100 3-year runs, the predicted design concentration was less than the target concentration of 174.8 $\mu g/m_3$. These results indicate that for all 3-year periods, compliance with the NAAQS is predicted based on the proposed 30-day limit.

Conclusion

An analysis was performed to evaluate periods of hourly emissions greater than the critical emission value (CEV). The data set of projected future actual emissions indicates that periods of emissions greater than the CEV are expected to be rare, with an expected frequency of 0.50% of the operating hours in a year. A modeling analysis which included this expected emissions frequency was then performed to assess the effect on ambient air quality. The results of that analysis indicate that these periods would not have a significant impact on air quality, insofar as the joint pairing of high emissions with meteorology conducive for high ambient concentrations of SO_2 would be very unlikely to occur repeatedly.

TABLE 1. Predicted 4th Highest Maximum Daily 1-Hour SO₂ Concentration

Case ID	Random Starting Index	1-Hour H4H µg/m³
BASE	1	110.6
A	5077	97.4
B	3519	92.1
C	8216	105.0
D	4992	110.4
E	1091	98.3
F	5467	121.7
G	6407	92.3
H	5097	106.0
I	7627	77.2
J	4161	120.3
K	7887	92.1
L	3174	107.5
M	8753	77.3
N	3201	100.0
O	3005	112.6
P	7059	138.3
Q	1955	98.2
R	239	96.4
S	5452	109.8
T	7142	95.7
U	2067	130.0

Case ID	Random Starting Index	1-Hour H4H µg/m³
V	6418	121.9
W	1285	96.0
X	7609	129.6
Y	6787	83.7
Z	3365	120.3
AA	3646	98.0
AB	4600	78.8
AC	1400	99.8
AD	6170	109.0
AE	1821	91.4
AF	2955	125.9
AG	1016	99.7
AH	3480	110.4
AI	8569	106.6
AJ	4836	84.3
AK	809	86.2
AL	1856	108.1
AM	4515	123.5
AN	2142	132.0
AO	3504	101.2
AP	4854	106.7
AQ	492	86.9
AR	4302	138.0

Case ID	Random Starting Index	1-Hour H4H μg/m^3
AS	2837	104.0
AT	3769	129.2
AU	2607	97.4
AV	1468	137.5
AW	2646	104.4
AX	3879	94.0
AY	1147	90.3
AZ	6958	89.6
BA	1793	84.9
BB	1752	118.7
BC	4928	115.2
BD	8408	102.3
BE	6988	103.8
BF	4751	94.6
BG	1359	91.5
BH	8056	82.5
BI	4919	92.5
BJ	4217	81.6
BK	791	96.4
BL	8701	86.1
BM	7314	74.2
BN	6271	124.2
BO	5286	94.8

Case ID	Random Starting Index	1-Hour H4H μg/m³
BP	2718	98.9
BQ	4118	92.6
BR	1968	108.4
BS	5284	119.1
BT	5006	105.4
BU	4094	104.5
BV	1835	103.6
BW	2343	87.7
BX	7553	95.6
BY	1572	80.2
BZ	3038	84.8
CA	8129	85.8
CB	2184	115.3
CC	1564	115.2
CD	4857	100.7
CE	952	90.6
CF	6296	92.6
CG	8568	92.7
CH	7699	84.2
CI	2450	110.6
CJ	3164	88.2
CK	7004	98.5
CL	676	124.2

Case ID	Random Starting Index	1-Hour H4H µg/m³
CM	8009	94.3
CN	384	110.6
CO	4223	100.3
CP	3356	94.4
CQ	1991	94.1
CR	3021	102.4
CS	3693	96.9
CT	1860	86.4
CU	6387	119.5

10.11 Appendix K: Contribution of Fixed Emission Sources to CEV Modeling Results

Technical Memorandum

Contribution of Fixed Emission Sources to CEV Modeling Results
Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP)

March 30, 2016

This memorandum presents an analysis of the contribution of the assumed "fixed source" sulfur dioxide emissions on the model-predicted concentrations associated with the critical emission value (CEV) developed for the Freeport-McMoRan Miami Inc. (FMMI) primary copper smelter (Miami Smelter), located in Miami, Arizona. The CEV was identified as part of the air quality dispersion modeling conducted in support of the Arizona Department of Environmental Quality (ADEQ) Miami SO$_2$ Nonattainment Area State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA). As explained in more detail in a separate memorandum [Critical Emissions Value Memo, 2016], the CEV is the hourly emission rate that the model predicts would result in the 5-year average of the annual 99th percentile of daily maximum hourly SO$_2$ concentrations at the level of the NAAQS.

The purpose of this memorandum is to demonstrate that the fixed source emissions have been accounted for in the development of the 30-day rolling hourly SO$_2$ emission limit and therefore those emissions need not be part of the limit's compliance demonstration via continuous emissions monitoring. The model-predicted concentrations associated with the fixed sources are insignificant contributors to the model-predicted concentrations that define the CEV.

Background

As identified in the CEV Memo, eleven fixed emissions sources at the Miami Smelter were included in the modeling analysis to ensure their contribution to ambient SO$_2$ air quality impacts were accounted for in the development of the 30-day rolling hourly SO$_2$ emission limit. Most of these sources (e.g., the 9 emergency generators) are small combustion units, and in all of these cases the combustion units are assumed to operate at their maximum potential heat input capacity and to emit at their maximum potential SO$_2$ rate at all times. The other two fixed emissions sources are intermittent fugitive releases of SO$_2$, one being the slag storage area and the other being smelter building leaks. Derivation of the emissions from these two intermittent fugitive sources is described in Section 5.2.4 of the Technical Support Document (TSD). These two intermittent fugitive emission sources are assumed to emit at the calculated SO$_2$ emission rate at all times. The modeled SO$_2$ emission rates for the fixed emissions sources are provided in Table 1.

Dispersion Modeling

To demonstrate that the facility-wide CEV is not sensitive to the fixed emissions sources, FMMI evaluated the effect of fixed emissions sources on the predicted SO$_2$ design concentration at the CEV emission rate. The cases specifically evaluated include:

- All SO$_2$ emissions sources located at the Miami Smelter (i.e., the CEV model run described in the TSD);

- The above CEV run with the two non-combustion fugitive fixed sources excluded from the analysis (i.e., the slag storage area and smelter building leaks were excluded);

- The above CEV run with all fixed emissions sources excluded (i.e., all sources listed in Table 1 were excluded);

- Slag storage area fugitive emissions only; and

- Smelter building leaks fugitive emissions only.

The dispersion model results are presented in Table 2 and Figures 1 through 5. Table 2 shows that the contribution from the fixed emissions sources to the predicted design concentration amounts to an insignificant level of 0.7 μg/m^3, and this contribution is due to the two fugitive fixed sources. In evaluating these two fugitive sources individually, their maximum predicted design concentrations are small (as can be seen in Table 2) and their locations of maximum predicted design concentration are far removed from the locations associated with the larger smelter emissions sources (as can be seen in Figures 1 through 5).

Table 1. Future Smelter Fixed SO$_2$ Emissions Sources

Source	SO$_2$ (lb/hr)
Acid Plant Preheater	0.0198
Isa Auxiliary Boiler	0.00612
Change Room Water Heater	0.000437
Rod Plant Thermal Breaker	0.000456
Rod Plant Shaft Furnace	0.350
Screening Engine	0.00102
Compressor	0.00655
Compressor	0.00655
Rod Plant Roof Vent	0.0129
Smelter Building Leaks	3.98
Slag Storage Area	3.75
Total Fixed Source Emissions	8.13

Note: Emergency Generators are not listed as their contribution and impacts are negligible.

Table 2. Predicted Design Concentrations for Evaluation of Fixed Source Emissions

Scenario	Predicted Design Conc. (µg/m^3)	General location of H4H impact
CEV Run	172.9	Approximately 5.9 km NE of Smelter
CEV Run, Excluding Fugitive Fixed Sources	172.2	Approximately 5.9 km NE of Smelter
CEV Run, Excluding All Fixed Sources	172.2	Approximately 5.9 km NE of Smelter
Slag Storage Area Only	1.3	Approximately 2 km NW of Smelter
Smelter Building Leaks Only	28.4	Approximately 0.25 km S of Smelter

Discussion

The analysis demonstrates that the fixed emissions sources have negligible impact on the predicted design concentration that defines the CEV for the Miami Smelter. As a consequence, these sources need not be included in the derivation of the proposed 30-day rolling hourly average emission limit. For the purposes of the CEV calculation of 393 lb/hr presented in Section 8.4 of the TSD, the fixed emissions sources contribute a maximum of 8 lb/hr. Based on the analysis described herein, a CEV of 385 lb/hr (i.e., 393 lb/hr minus 8 lb/hr) should instead be based on the following Smelter emissions sources:

- Acid Plant Tail Gas Stack

- Vent Fume Stack

- Aisle Scrubber Stack (normal operations)

- Aisle Scrubber Stack (bypass operations)

- Converter Aisle Roof Vent

- Anode Aisle Roof Vent

- Electric Furnace (ELF) Roof Vent

- IsaSmelt® Roof Vent

The resulting 30-day rolling hourly average measured emission limit for the above Smelter emissions sources amounts to 142.45 lb/hr.

Conclusion

FMMI proposes a 30-day rolling hourly average emission limit of 142.45 lb/hr and a CEV of 385 lb/hr based on the results of the foregoing analysis, which shows that emissions from the fixed emissions sources are insignificant contributors to the predicted CEV design concentration. Because the fixed emission sources have been accounted for in the development of the proposed limit, those sources are not part of the limit's compliance demonstration. Compliance with the 30-day rolling hourly average emissions limit is demonstrated by direct measurement of emissions from the eight Smelter sources (identified above) via continuous emissions monitoring.
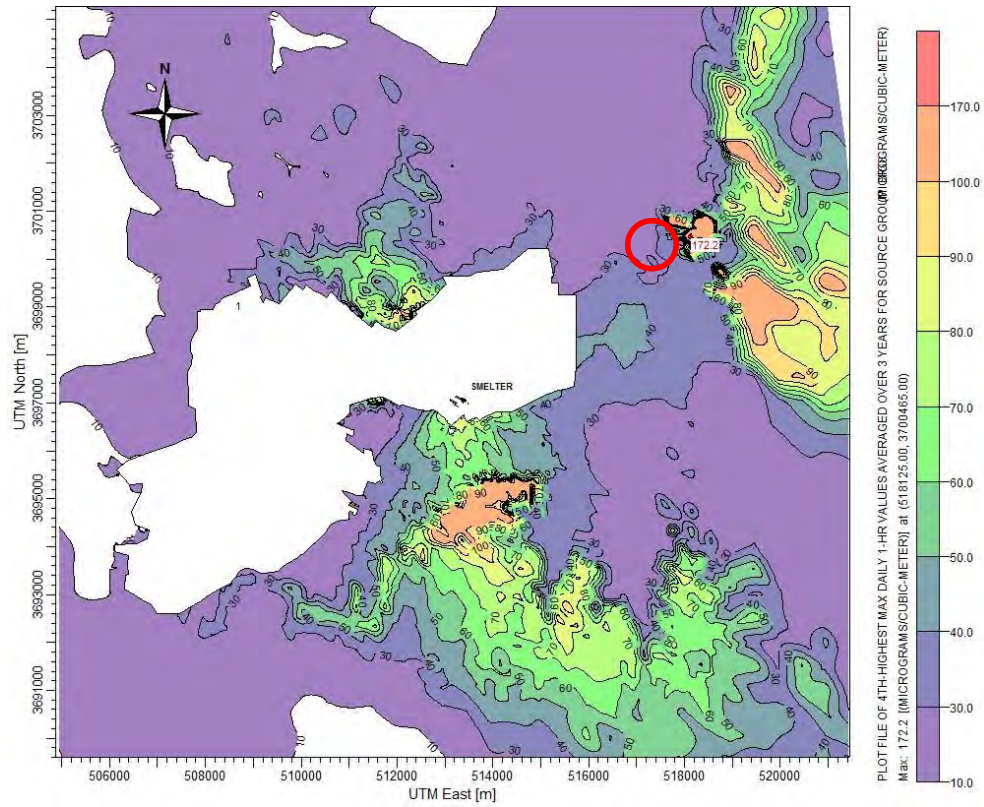
Figure 1: Predicted Design Concentrations, CEV Run

Figure 2: Predicted Design Concentrations, CEV Run Excluding Fugitive Fixed Emissions Sources
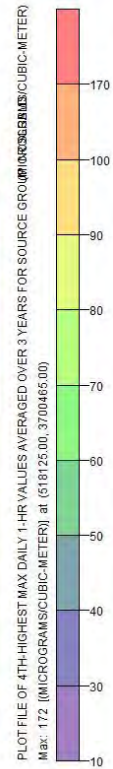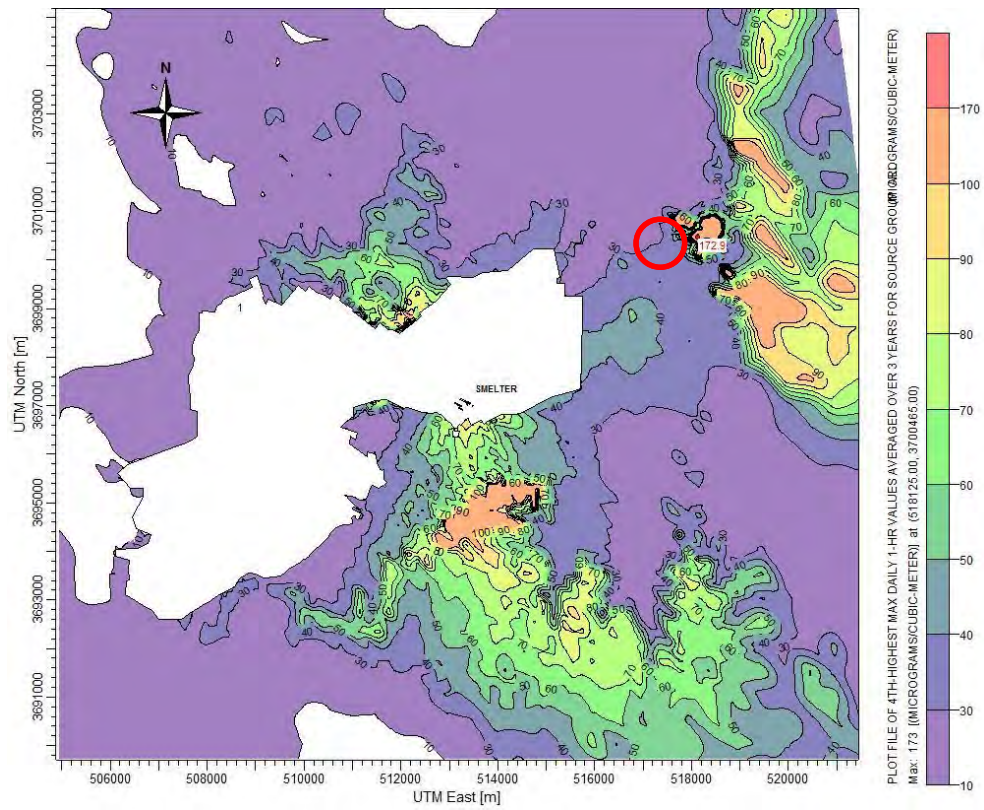
Figure 3: Predicted Design Concentrations, CEV Run Excluding All Fixed Emissions Sources
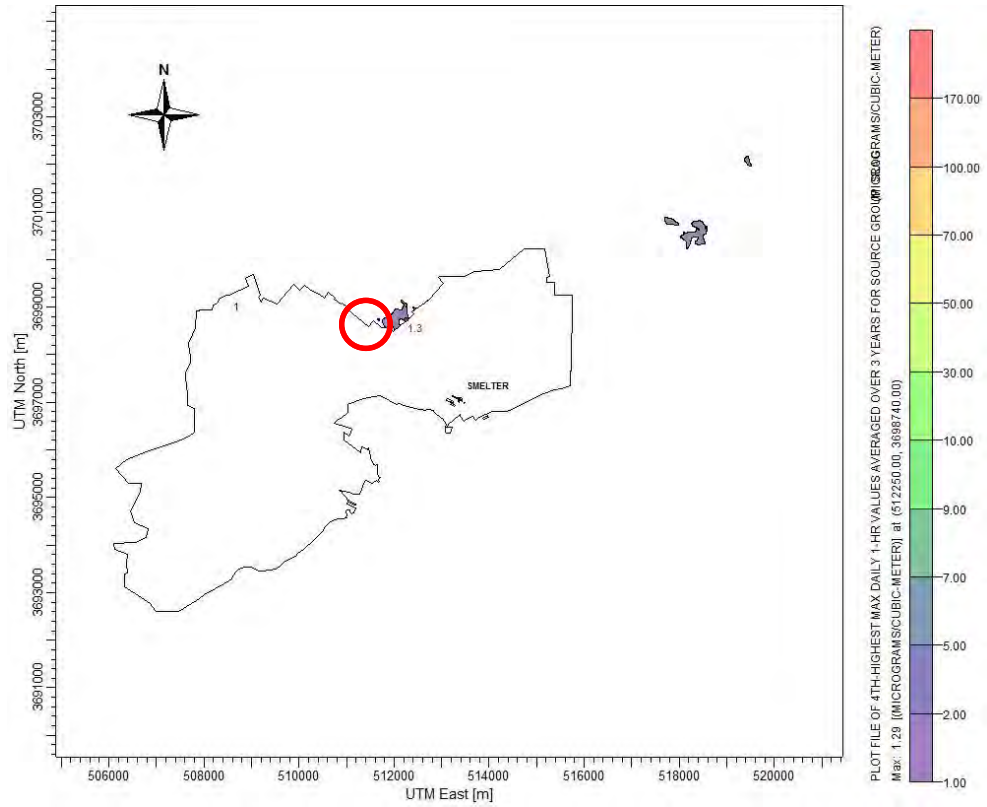
Figure 4: Predicted Design Concentrations, Slag Storage Area Only
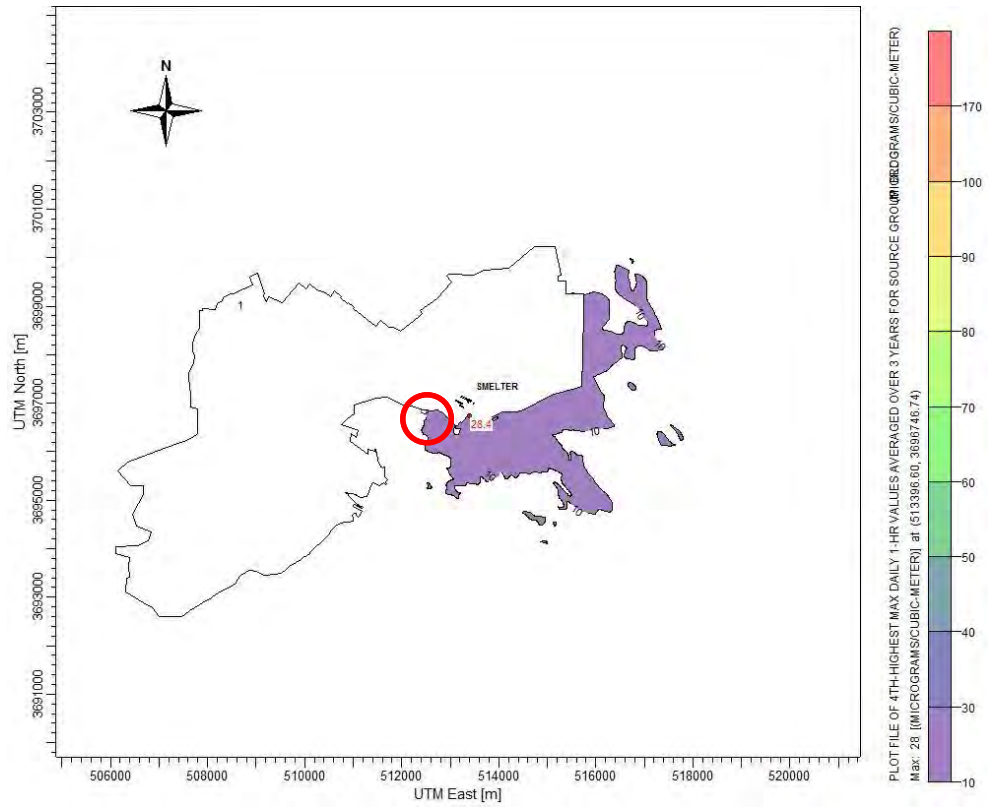
Figure 5: Predicted Design Concentrations, Smelter Building Leaks Only

10.12 Appendix L: Fumigation Analysis

Technical Memorandum
Inversion Breakup Fumigation Evaluation
Miami SO₂ Nonattainment Area State Implementation Plan (SIP)
August 24, 2016

This memorandum presents an evaluation of inversion breakup fumigation for individual sources located at the Freeport-McMoRan Miami Inc. (FMMI) primary copper smelter (Miami Smelter) in Miami, Arizona. The Environmental Protection Agency (EPA) requested an evaluation that identified which sources were most likely to contribute to the ambient SO_2 concentrations observed at the Miami Townsite monitor.

Only EPA's AERSCREEN and SCREEN3 models address inversion breakup fumigation conditions. Because these models are limited to evaluation of single sources and because of other limitations of these screening models, this evaluation is inherently a screening level evaluation of the source contributions. The modeling procedure and results are presented herein.

Enclosed with this memorandum is a CD-ROM provided by ADEQ that includes modeling files associated with the inversion breakup fumigation evaluation.

Background

The fumigation evaluation does not involve a specific modeling domain. AERSCREEN determines the point of maximum impact under fumigation conditions for distances out to 100 kilometers (km).

The evaluated sources include:

- The proposed aisle scrubber stack
- The existing and proposed vent fume stack (VFS);
- The existing and proposed acid plant tail gas stack (APTGS);
- The IsaSmelt® (Isa) building roofline vent;
- The electric furnace (ELF) building roofline vent;
- The existing and proposed converter building roofline vent; and
- The anode building roofline vent;

Model Selection

EPA's Guideline on Air Quality Models (GAQM) at 40 CFR Part 51, Appendix W, Section 7.2.8.a.i states:

> *There are no recommended refined techniques to model th[e] phenomenon [of fumigation]. There are, however, screening procedures that may be used to approximate the concentrations. Considerable care should be exercised in using the results obtained from the screening techniques.*

The EPA screening procedures cited by the GAQM are an EPA guideline dated October 1992 (EPA, 1992). The screening procedures for inversion breakup fumigation provided in the 1992 guideline have been incorporated in the SCREEN3 and AERSCREEN models.

AERSCREEN has replaced SCREEN3 as EPA's preferred screening model (EPA, 2011) and therefore, AERSCREEN was used to evaluate the relative contributions of smelter emissions sources to the inversion breakup fumigation conditions observed at the Miami Townsite monitor.

Existing Smelter Sources

The current and proposed FMMI smelter operations and the upgrade project are discussed in detail in the modeling protocol included in the TSD. Table 1 presents the stack and exhaust parameters modeled for existing stacks located at the facility.

Table 1. Stack and Exhaust Parameters, Existing Stacks

Source ID	Stack	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp. (K)
TAILSTK	APTGS	60.96	1.83	23.19	323.0
VENTSTK	VFS	48.8	3.048	20.85	amb

Table 2 provides vent-specific parameters for the existing configuration of the roofline vents.

Table 2. Actual Vent-Specific Parameters, Existing Roofline Vents

Roofline Vent	Vent Length (m)	Vent Width (m)	Vent Velocity (m/s)	Vent Temperature (K)
Anode	84.53	1.42	2.508	361.3
Converter	54.13	3.66	2.352	339.9
Converter 5	16.16	3.66	2.198	339.9
Isa	17.67	0.76	11.297	313.7
ELF	23.26	3.35	1.391	320.6

The modeling of the roofline vents in AERSCREEN for inversion breakup fumigation evaluation presents a unique problem. AERSCREEN is not equipped with a buoyant line source type, so the roofline vents cannot be explicitly modeled. Furthermore, the fumigation algorithms apply only to point type sources, so the Hybrid Model approach of modeling the roofline vents as volume sources cannot be applied. To provide the most accurate representation of FMMI roofline vents within the limitations of the inversion breakup fumigation calculation technique, the roofline vents were modeled as point sources, with effective stack parameters iteratively developed until the calculated final plume heights matched those calculated by BLP and used in the Hybrid Model for the CEV analysis. The approach used is described in the following paragraphs and the results presented in Tables 3 and 6.

The ambient monitoring data collected at the Miami Townsite monitor indicates that inversion breakup fumigation conditions are most likely to be observed during the 9:00 am hour and in the month of April. The plume heights predicted by BLP for hour 9 during the month of April for the 2010 – 2013 analysis years were extracted from the Hybrid Model CEV run and averaged.

An iterative analysis was then performed to identify effective point source parameters for the roofline vents that result in a predicted plume height within 1 percent of the BLP-predicted plume height. EPA's screening procedures specify "stack height" meteorological conditions of Pasquill-Gifford stability class F and a wind speed of 2.5 m/s in performing inversion breakup fumigation evaluations, so the iterative roofline vent plume height analysis was performed with this specific meteorological condition. AERSCREEN would ideally be used for this iterative plume height analysis, but the model does not allow

for the input of a specific meteorological condition (i.e., AERSCREEN would need to be re-coded to allow for such input). In contrast, SCREEN3 does allow the input of a specific meteorological condition so it was used to perform the iterative plume height analysis to identify effective point source parameters for the roofline vents. These point source parameters were then input to the AERSCREEN model to perform the inversion breakup fumigation evaluation.

The effective point source parameters resulting from the iterative plume height analysis are presented in Table 3. The release heights were set equal to the roofline vent heights.

Table 3. SCREEN3-Identified Point Source Parameters, Existing Roofline Vents

Roofline Vent	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	Release Height (m)	SCREEN3 Predicted Plume Height (m)	Averaged BLP Predicted Plume Height (m)
Anode	14.8	28.6	515.8	32.55	372.51	372.40
Converter	18.1	25.9	439.6	32.70	377.44	375.81
Converter 5	11.6	35.5	604.2	53.95	383.16	382.13
Isa	7.4	64.2	1,007	53.34	385.34	386.60
ELF	12.8	33.0	528.8	40.45	371.03	369.19

Future Smelter Sources

ADEQ issued a permit revision for the Miami Smelter to increase allowable production, install and upgrade control equipment, and make physical changes to the facility. The physical changes include the relocation of the APTGS at the Acid Plant and the VFS. Structural changes will shorten the roofline vent on the Converter Building and remove the Converter 5 roofline vent. Additionally, some of the emissions from the roofline vents on the smelter buildings will be exhausted through a new scrubbing system and stack (Aisle Scrubber). Tables 4 and 5 show the stack and vent parameters used in the CEV analysis.

Table 4. Stack and Exhaust Parameters, Future Stacks

Source ID	Stack	Stack Height (m)	Exit Diameter (m)	Exit Velocity[1] (m/s)	Averaged Exhaust Temp.[2] (K)
TAILSTK	APTGS	65.00	2.300	19.5	298.0
VENTSTK	VFS	65.00	2.900	18.5	-1.53
SCRUBBER	Aisle Scrubber	57.00	7.300	16.4	-0.11

The vent fume stack and aisle scrubber stack exhaust temperatures are expected to vary by season and hour of day as ambient conditions and scrubber water temperatures change. A single exhaust temperature value was determined by averaging the expected exhaust temperatures for hour 9 for the

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[1] Average exhaust flow design values.
[2] Negative temperature indicates temperature above ambient, zero temperature indicates ambient temperature. Normal operation vent stack temperature is 2.3 K above ambient.

month of April. The average temperatures were 0.11K and 1.53K above ambient for the aisle scrubber and vent fume stack, respectively, and these are presented in Table 4.

Table 5. Vent-Specific Parameters, Future Roofline Vents

Roofline Vent	Vent Length (m)	Vent Width (m)	Release Height (m)	Vent Velocity (m/s)	Vent Temperature (K)
Anode	84.53	1.42	32.55	2.508	361.3
Converter	18.04	3.66	32.70	2.352	339.9
Isa	17.67	0.76	53.04	11.297	313.7
ELF	23.26	3.35	40.45	1.391	320.6

The same iterative plume height analysis described above was used to identify point source parameters for the roofline vents. The effective point source parameters resulting from the iterative plume height analysis are presented in Table 6. The release heights were set equal to the roofline vent heights.

Table 6. SCREEN3-Identified Point Source Parameters, Future Vents

Roofline Vent	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	Release Height (m)	SCREEN3 Predicted Plume Height (m)	Averaged BLP Predicted Plume Height (m)
Anode	14.2	26.5	478.9	32.55	344.78	344.95
Converter	11.7	32.6	554.6	32.70	345.97	347.54
Isa	8.0	74.0	1,161	53.34	424.68	425.71
ELF	13.6	37.2	597.0	40.45	415.09	413.32

Source Emission Rates and Land Use Type

All AERSCREEN runs used a normalized emission rate of one gram per second (g/s). The fumigation algorithms will only run with a rural land use type. This is consistent with the determination established for the Hybrid Model.

Meteorological Settings

The AERSCREEN inversion breakup fumigation algorithms are performed with built-in conditions of a stable atmosphere (Pasquill-Gifford Stability Class F) and a wind speed of 2.5 meters per second. No meteorological inputs are required by the AERSCREEN fumigation calculations.

Results

The results are presented in Table 7 for both existing and future sources. The highest predicted 1-hour concentrations for each source are presented and are based on the normalized emission rate of 1 g/s. The predicted distance to maximum impact is also presented for each source.

The results for the stacks are one to two orders of magnitude greater than the results for the roofline vents. The results therefore indicate the stacks are likely the primary contributors of smelter-emitted SO_2 to the existing and future inversion breakup fumigation conditions. The roofline vents are likely negligible contributors of SO_2 to existing and future inversion breakup fumigation conditions.

Table 7. AERSCREEN Inversion Breakup Fumigation Results for Normalized 1 g/s Emission Rates

Source	Existing Configuration		Future Configuration	
	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)
APTGS	8.53	2,340	10.2	1,970
VFS	228	100	150	100
Aisle Scrubber	NA	NA	182	100
ISA Roofline Vent	0.122	64,100	0.091	79,900
ELF Roofline Vent	0.134	59,900	0.096	77,000
Converter Roofline Vent	0.162	41,600	0.204	35,300
Converter 5 Roofline Vent	0.116	66,300	NA	NA
Anode Roofline Vent	0.167	40,700	0.221	33,300

Potential SO_2 emissions from the stack sources combined will be reduced from 1,132 lb/hr to 30.5 lb/hr as summed from the values presented in the TSD. This represents a reduction of 97.3 percent of SO_2 emissions potentially contributing to inversion breakup fumigation conditions. Such a reduction, when applied to the existing ambient concentrations measured at the Miami Townsite monitor, demonstrates attainment will be achieved at the Miami Townsite monitor.

Sensitivity Analysis

A sensitivity analysis was performed to evaluate the method used for assigning point source parameters to the roof vents. Two additional evaluations were performed. The first scenario identified point source parameters that resulted in higher plume momentum and lower plume buoyancy than considered for the initial analysis. This was accomplished by increasing both the cross-sectional area of the "stack" exit and the exit velocity by 10%. The exit temperature was then iteratively reduced until the SCREEN3-predicted plume height matched the BLP-predicted plume height within 1 percent.

The second scenario identified point source parameters that resulted in lower plume momentum and higher plume buoyancy than considered for the initial analysis. This was accomplished by decreasing both the cross-sectional area of the "stack" exit and the exit velocity by 10%. The exit temperature was then iteratively increased until the SCREEN3-predicted plume height matched the BLP-predicted plume height within 1 percent.

Table 8 presents the identified point source parameters for the high momentum, low buoyancy scenario. Table 9 presents the identified point source parameters for the low momentum, high buoyancy scenario. The percent increases and decreases relative to the initial analysis are presented alongside the parameter values.

Table 8. SCREEN3-Identified Point Source Parameters
High Momentum, Low Buoyancy Scenario

Roofline Vent	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	SCREEN3 Predicted Plume Height (m)	Averaged BLP Predicted Plume Height (m)
Isa (existing)	7.8 (+4.9%)	70.6 (+10%)	704.6 (-30%)	384.97	386.60
ELF (existing)	13.4 (+4.9%)	36.3 (+10%)	460.0 (-13%)	369.50	369.19
Converter (existing)	18.9 (+4.9%)	28.5 (+10%)	400.0 (-9%)	374.04	375.81
Converter 5 (existing)	12.1 (+4.9%)	39.1 (+10%)	501.5 (-17%)	380.51	382.13
Anode (existing)	15.5 (+4.9%)	31.4 (+10%)	453.9 (-12%)	371.72	372.40
Isa (future)	8.3 (+4.9%)	81.4 (+10%)	789.2 (-32%)	426.92	425.71
ELF (future)	14.3 (+4.9%)	41.0 (+10%)	495.5 (-17%)	411.58	413.32
Converter (future)	12.3 (+4.9%)	35.9 (+10%)	482.5 (-13%)	346.71	347.54
Anode (future)	14.9 (+4.9%)	29.2 (+10%)	431.0 (-10%)	344.66	344.95

Table 9. SCREEN3-Identified Point Source Parameters
Low Momentum, High Buoyancy Scenario

Roofline Vent	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	SCREEN3 Predicted Plume Height (m)	Averaged BLP Predicted Plume Height (m)
Isa (existing)	7.0 (-5.1%)	57.8 (-10%)	2,500 (+148%)	386.30	386.60
ELF (existing)	12.1 (-5.1%)	29.7 (-10%)	639.8 (+21%)	369.44	369.19
Converter (existing)	17.1 (-5.1%)	23.3 (-10%)	492.3 (+12%)	375.52	375.81
Converter 5 (existing)	11.0 (-5.1%)	32.0 (-10%)	791.5 (+31%)	382.20	382.13
Anode (existing)	14.0 (-5.1%)	25.7 (-10%)	629.3 (+22%)	372.74	372.40
Isa (future)	7.6 (-5.1%)	66.6 (-10%)	4,000 (+244%)	425.48	425.71
ELF (future)	12.9 (-5.1%)	33.5 (-10%)	770.2 (+29%)	413.23	413.32
Converter (future)	11.1 (-5.1%)	29.4 (-10%)	715.4 (+29%)	347.45	347.54
Anode (future)	13.5 (-5.1%)	23.9 (-10%)	560.4 (+17%)	344.31	344.95

The parameters presented in Tables 8 and 9 were input to AERSCREEN to examine the sensitivity of the inversion breakup fumigation result to the parameters. The results for each scenario are provided in Tables 10 and 11.

Table 10. AERSCREEN Inversion Breakup Fumigation Results for Normalized 1 g/s Emission Rates
High Momentum, Low Buoyancy Scenario

| Source | Existing Configuration | | Future Configuration | |
	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)
ISA Roofline Vent	0.120	64,600	0.088	81,500
ELF Roofline Vent	0.132	60,400	0.096	76,800
Converter Roofline Vent	0.177	39,100	0.208	34,700
Converter 5 Roofline Vent	0.116	66,200	NA	NA
Anode Roofline Vent	0.174	39,400	0.231	32,300

Table 11. AERSCREEN Inversion Breakup Fumigation Results for Normalized 1 g/s Emission Rates
Low Momentum, High Buoyancy Scenario

| Source | Existing Configuration | | Future Configuration | |
	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)	Predicted Maximum 1-Hour Average Conc. ($\mu g \cdot m^{-3}/g \cdot s^{-1}$)	Predicted Distance to Predicted Maximum Conc. (m)
ISA Roofline Vent	0.122	63,900	0.091	79,500
ELF Roofline Vent	0.138	58,500	0.099	75,300
Converter Roofline Vent	0.158	42,300	0.197	36,100
Converter 5 Roofline Vent	0.119	65,200	NA	NA
Anode Roofline Vent	0.161	41,700	0.214	34,000

Comparing the Table 7 results to those of Tables 10 and 11, the AERSCREEN-predicted calculations for inversion breakup fumigation are clearly insensitive to the identified point source parameters and the result is not a function of momentum-dominated or buoyancy-dominated plume rise. Given that the plume height dictates the inversion breakup fumigation result in the screening procedure, the lack of sensitivity is expected.

References

40 CFR 51, Appendix W. Guideline on Air Quality Models: 40 CFR Part 51, Appendix W. Research Triangle Park, North Carolina.

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U.S. EPA, 2015. AERSCREEN User's Guide, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

10.13 Appendix M: Ambient Air Boundary

1. Overview

On Wednesday, February 22rd Arizona Department of Environmental Quality (ADEQ) personnel performed an on-site tour of the ambient air boundary (AAB) used for the Miami SO_2 nonattainment plan. During this tour ADEQ personnel traveled and documented the portions of the AAB that were reasonably accessible. Figure 1-1 illustrates the current ambient air boundary and the stretches of AAB that were inspected (F1-F4 and T1-T3). Section 2 provides ADEQ staff notes and observations from the inspection, as well as, images taken during the inspection of the specific segments.

The area of most interest to both EPA and ADEQ was the facilities southern boundary. This portion of the AAB is adjacent to the population centers of Claypool and Miami AZ.

The objectives of ADEQ's inspection were as follows:

1. Assess if the map provided by FMMI, which illustrates the AAB, accurately depicts the situation at the facility. The inspection should be focused on the border between the towns of Claypool/Miami and the facility. This border is an aggregation of segments F1-F4 and T1-T3.

2. Document the fencing at the facility.

3. Document the terrain FMMI is using to justify the AAB.

4. Determine if the combination of fencing and terrain reasonably precludes public access to the facility.

Due to being overly inaccessible, AAB segments other than F1-F4 and T1-T3 were not reviewed. As a note, the remaining portions of the AAB not reached during the inspection are fenced, and not delineated by terrain.

In general, upon visiting the site and inspecting the AAB perimeter, ADEQ has determined the boundary represents a practical ability to preclude public access. This conclusion is a result of the observations outlined in section A2 below.

Figure 1-1: Current Ambient Air Boundary
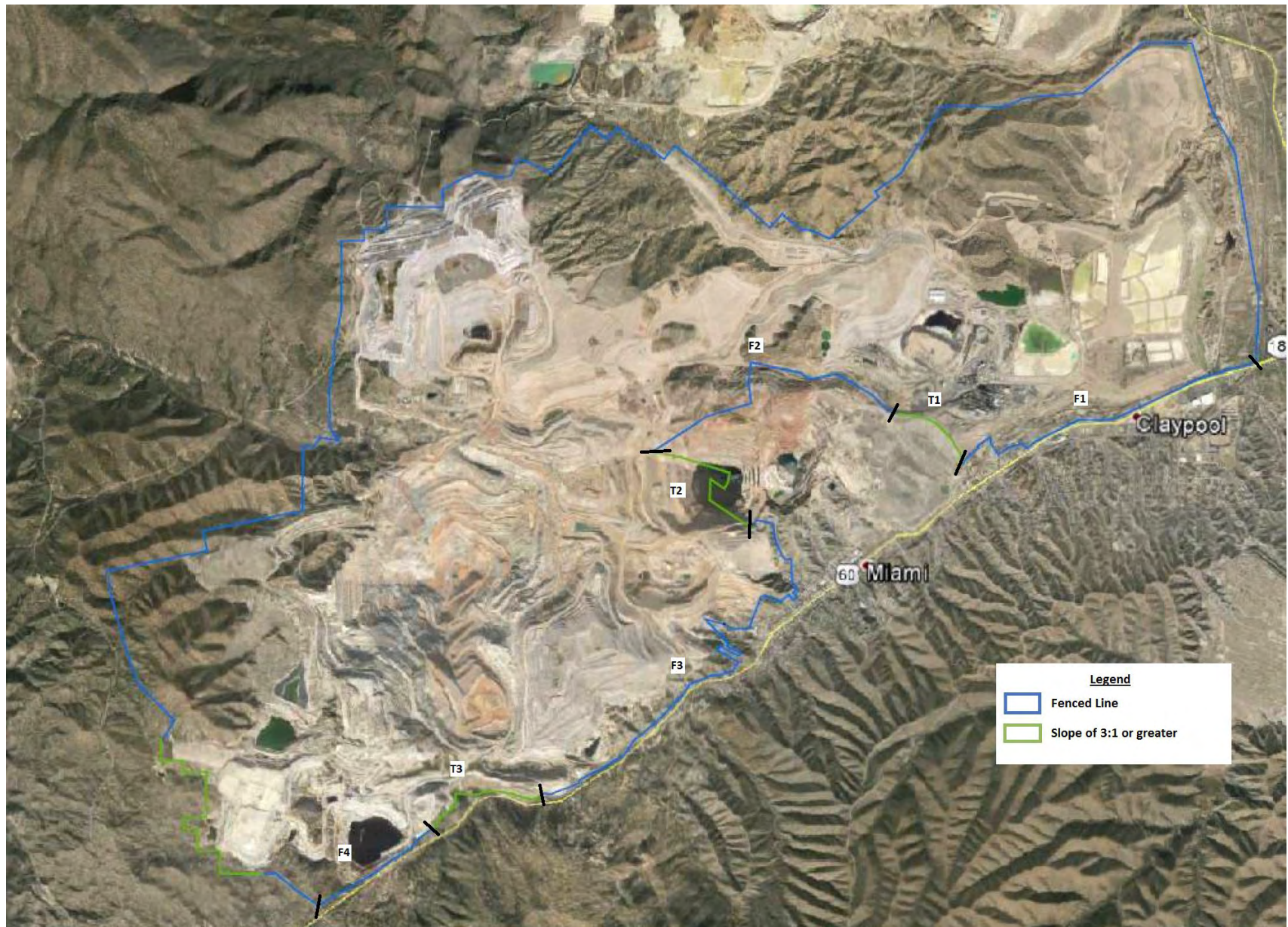
2. Inspection Notes

- Fencing Segment F1

Segment F1 starts roughly 2000 feet east of the most eastern tailings pile. There is a road and gate that allows access into the facility at the start of this segment (going from east to west), and can be seen in Figure 2-1. In addition to the fencing and gate, a channel with high sloping sides also separates the facility from Claypool and U.S. Route 60 (the yellow line segment in Figure 1-1). This channel can be seen in the background of Figure 2-2.

Other obstacles along F1, between U.S. Route 60 and the facility, include FMMI administrative buildings and local businesses. Figure 2-3 shows the transition from FMMI's fencing to the fencing of a local business. As seen in the figure, the lots on which these buildings sit are also fenced, which add further to the prevention of trespassing.

Finally, Figure 2-4 shows where the AAB transitions from F1 to T1. Specifically, in the distance, where the hill transitions from no ground cover to vegetation.

Figure 2-1: F1 Eastern Origin

Figure 2-2: F1 Continued

Figure 2-3: Facility and Local Business

Figure 2-4: F1 Termination

- Fencing Segment F2

The entirety of segment F2 was not inspected due to exceedingly rocky terrain and distance from any road. In addition, BHP Copper's facility sits between U.S Route 60 and fencing segment F2. Given this, the combination of BHP's facility, terrain, and fencing along this portion of the ambient air boundary inhibits public access to the facility.

- Fencing Segment F3

Like Segment F2, the entirety of F3 was not inspected due to the difficult terrain. However, the fencing that was visible (Figures 2-5 through 2-7) was deemed acceptable. Again, like Segment F2, the combination of rugged terrain and fencing along this stretch of the AAB reasonably precludes public access to the facility.

However, one portion of this segment could be seen as a vulnerability, which is the FMMI's training area. The training area is accessed via a road coming off U.S Route 60 at the western end of this segment. At the intersection of this road and the fencing there was no gate. However, the training area appeared to be busy with activity. Given this, any trespassers, which would likely not be in the proper PPE/attire, would stand out and be escorted out of the facility.

Figure 2-5: Fencing F3 Segment 1

Figure 2-6: Fencing F3 Segment 2

Figure 2-7: Fencing F3 Segment 3

- Fencing Segment F4

  The majority of Segment F4 was visible for inspection and was found to be adequate (Figure 2-9). A possible weak spot was found where the boundary transitions from T3 to this segment (Figure 2-8). However, this transition from terrain to fencing was heavily vegetated and not visible from the road. In addition, continuing the fencing east into the facility could prove difficult due to the increasingly rugged terrain, which itself reasonably precludes public access to the facility.

Figure 2-8: F4 Eastern Origin

Figure 2-9: Fencing F4 Segment

- Terrain Segment T1

  Segment T1 runs along a rail line at the top of a tailings pile. The slope leading up to this segment is sufficiently steep and moderately vegetated. Like much of the AAB, to access T1 an individual would need to pass over fencing which runs along U.S Route 60, and then cross several highly sloped channels. This combination, in addition to the slope of the tailings pile, was found to inhibit access to the facility. Figure 2-4 shows this elevated terrain segment in the background.

- Terrain Segment T2

  Segment T2 runs through one of FMMI's open pits. As shown in Figure 2-10, T2 is made up of steep man made ridges that extended down to a holding pond. This portion of the AAB was certainly the most rugged segment. Again, like most segments, additional rugged terrain and fencing would need to be traversed to reach T2.

Figure 2-10: Terrain Segment T2

- Terrain Segment T3
  This segment runs adjacent to U.S Route 60 and is made up of particularly steep terrain. ADEQ feels this segment clearly restricts public access.

Figure 2-11: Terrain T3 Segment 1

Figure 2-12: Terrain T3 Segment 2

Modeling Technical Support Document for the Hayden Sulfur Dioxide (SO$_2$) Nonattainment Area

Submitted To:

Environmental Protection Agency

Region 9

Prepared By:

Arizona Department of Environmental Quality
Air Quality Division

&

ASARCO LLC

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1.0   Introduction

ASARCO LLC (Asarco) concentrates and smelts copper ores at its operations in Hayden, Arizona, approximately 80 miles east-southeast of Phoenix and 60 miles north of Tucson. Sulfur dioxide (SO_2) is generated in the smelting process and is released as emissions to the atmosphere.

On June 2, 2010, the United States Environmental Protection Agency (EPA) established a new 1-hour National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) of 75 parts per billion (ppb). EPA designated the Hayden area of Gila and Pinal Counties as a nonattainment area (NAA) for the 2010 SO_2 NAAQS on August 5, 2013, effective as of October 4, 2013. Because of this designation, the Arizona Department of Environmental Quality (ADEQ) must develop a State Implementation Plan (SIP) revision to demonstrate future attainment of the NAAQS within five years of the effective date of designation. An attainment demonstration using an EPA approved air quality dispersion model is a core piece of SO2 NAA SIP submittals.

As described in this Technical Support Document (TSD), modeling to support the Hayden SO_2 NAA SIP was performed in accordance with the EPA's Guideline on Air Quality Models (GAQM) (40 CFR 51, Appendix W) (U.S. EPA, 2005) and Guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions - Appendix A Modeling Guidance for Nonattainment Areas (U.S. EPA, 2014). Additional Clarification Regarding Application of Appendix W from Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard (U.S. EPA, 2011) [1] was employed when necessary.

The EPA's Modeling Guidance for Non-Attainment Areas (U.S. EPA, 2014) also states:

> "*While this guidance explains the expected general application of dispersion models, there will be applications of dispersion models unique to specific areas where it is necessary to model unique specific sources or types of sources. In such cases, there should be consultation between the state or appropriate air agency and the appropriate EPA Regional Office modeling contact to discuss how best to model a particular source.*"

This TSD presents the modeling methodologies ADEQ and ASARCO LLC (Asarco) followed in completing the ambient air quality analysis of the Hayden planning area. Due to resource constraints, ADEQ appointed Asarco as the lead modeler for the attainment demonstration, while ADEQ used its expertise in an oversight and review capacity. The TSD is organized as follows:

- Section 2 provides an overview of the general regional characteristics of the Hayden SO_2 NAA, including topography, land use, and climate;
- Section 3 provides a discussion on the determination of the modeling domain, sources to explicitly model and the receptor grid;
- Section 4 provides a discussion on the model selection;
- Section 5 provides detailed source inputs, including source configuration, source emissions, source release parameters, emissions variability, forecast emissions description, Good Engineering Practice (GEP) stack height, and urban/rural determination;
- Section 6 provides a discussion on the selection and processing of meteorological data;
- Section 7 provides a discussion on the determination of background concentrations;

---

[1] Although this guidance is for NO_2 modeling, the common 1-hour averaging time and similar form of both the NO_2 and SO_2 standards makes this modeling guidance applicable to the 1-hour SO_2 NAAQS.

- Section 8 provides a discussion on the averaging time for SO_2 emission limit; emission limits, and modeling results.

To help EPA's review, ADEQ has addressed all modeling components, following the structure of the EPA's Modeling Guidance for Non-Attainment Areas (U.S. EPA, 2014). ADEQ will also provide an enclosed CD-ROM, including files associated with building downwash analysis, background concentration determination, assignment of terrain elevations to receptors, preparation of a 1-year onsite meteorological data set, as well as CEV modeling files and support attainment modeling files using the emission limits defined in section 8. The contents of this enclosed CD-ROM are detailed in Appendix B of this document.

2.0   Overview of Hayden Nonattainment Area (NAA) for 1-hour SO_2

The Hayden SO_2 NAA is comprised of the portions of Gila County bound by the townships and ranges as presented in Figure 2-1. The towns of Hayden, Winkelman and Kearny lie within the Hayden SO_2 NAA. Figure 2-1 also depicts the location of the Asarco Smelter. Asarco's proposed Converter Retrofit Project (CRP) will occur at the existing Asarco Smelter located in Hayden, Arizona.

2.1   Population

The Hayden SO_2 NAA has been codified in 40 CFR 81.303 and is comprised of the portions of Gila County and Pinal County bound by the townships and ranges listed in Table 2-1 and represented geographically in Figure 2-1. Population estimates for the entire Hayden SO_2 NAA as well as the respective proportions of Gila and Pinal Counties are also presented in Table 2-1. The Hayden NAA encompasses the towns of Hayden, Winkelman and Kearny, for which population data has been included in Table 2-2.

Table 2-1: Geographic Location and Population

Hayden SO$_2$ NAA[2,3]			
Land Area		275 square miles	
2011 Population		4,645	
2018 Projected Population		5,353	
Gila County Portion		**Pinal County Portion**	
Land Area	58 square miles	Land Area	217 square miles
2011 Population	1,279	2011 Population	3,366
2018 Projected Population	1,315	2018 Projected Population	4,038
Township, Range		**Township, Range**	
4S, 14E		4S, 14E	
4S, 15E		4S, 15E	
4S, 16E		4S, 16E	
5S, 15E		5S, 14E	
5S, 16E		5S, 15E	
-		5S, 16E	
-		6S, 14E	
-		6S, 15E	
-		6S, 16E	

Table 2-2: Towns within Hayden SO$_2$ NAA

Location	2010 Population[4]
Town of Hayden	662
Town of Winkelman	353
Town of Kearny	1,950

2.2 Land use

The Hayden NAA area encompasses portions of two counties: Gila and Pinal. The Gila County portion of the NAA is approximately 58 square miles[5] while the Pinal County portion is approximately 217 square miles[6]. The majority of the land within the NAA is owned and managed by the either the Bureau of Land Management (39.1%) or the Arizona State Land Department (35.5%). The remainder of the land within the NAA is comprised of privately held land along with a small area of land located to the east of Winkelman, which the Bureau of Reclamation manages. A breakdown of the land owners in the Hayden SO$_2$ NAA are presented in Table 2-3 and Figure 2-2.

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[2] ADOA calculated the land area of Gila County and Pinal County based on 2010 department of Census TIGER/Line shapefiles.

[3] ADOA provided the population projections for both Gila County and Pinal County. ADOA's projection methodologies are presented in Appendix A.

[4] U.S. Census Bureau; Census 2010, Profile of General Population and Housing Characteristics: 2010; generated by Michael Burton; using American FactFinder; <http://factfinder2.census.gov>; (17 July 2014)

[5] ADOA calculated the land area of the Miami NA based on 2010 department of Census TIGER/Line shapefiles.

[6] ADOA calculated the land area of the Miami NA based on 2010 department of Census TIGER/Line shapefiles.

Hayden SO$_2$ NAA[7]		
Land Owner	**Area (square miles)**	**Percentage**
Bureau of Land Mgmt.	106.816	39.1%
State Trust Land	96.876	35.5%
Private Land	68.932	25.2%
Bureau of Reclamation	0.499	0.2%

Industrial sources within the Hayden SO$_2$ NAA are provided in Section 3.1.1 of this TSD. Further discussion of land use, as it pertains to dispersion modeling and meteorological processing inputs, is provided in Sections 5.5 and 6.1.3 of this TSD.

2.3   Topography

Asarco operations in Hayden, Arizona are located on the southwestern flank of the Dripping Spring Mountains, a range rising rapidly just to the north and east of Asarco. Bisected by numerous northeast-southwest oriented arroyos, this terrain in the immediate vicinity of the Asarco Hayden operations is rugged and variable in elevation. To the south of Asarco the terrain is smoother, dominated by the northwest-southeast aligned valley of the Gila and San Pedro Rivers. The Tortilla Mountains, which form the western border of the Gila River Valley, are located several miles to the west of Asarco. The topography of the local area, along with the location of Asarco's Hayden processes and operations, is depicted in Figure 2-1.

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[7] Land use information for both Gila County and the Miami NA was garnered from the Arizona Land Resource Information System (ALRIS) GIS tool managed by the Arizona State Land Department.

Figure 2-1: Topography of Area Surrounding Asarco
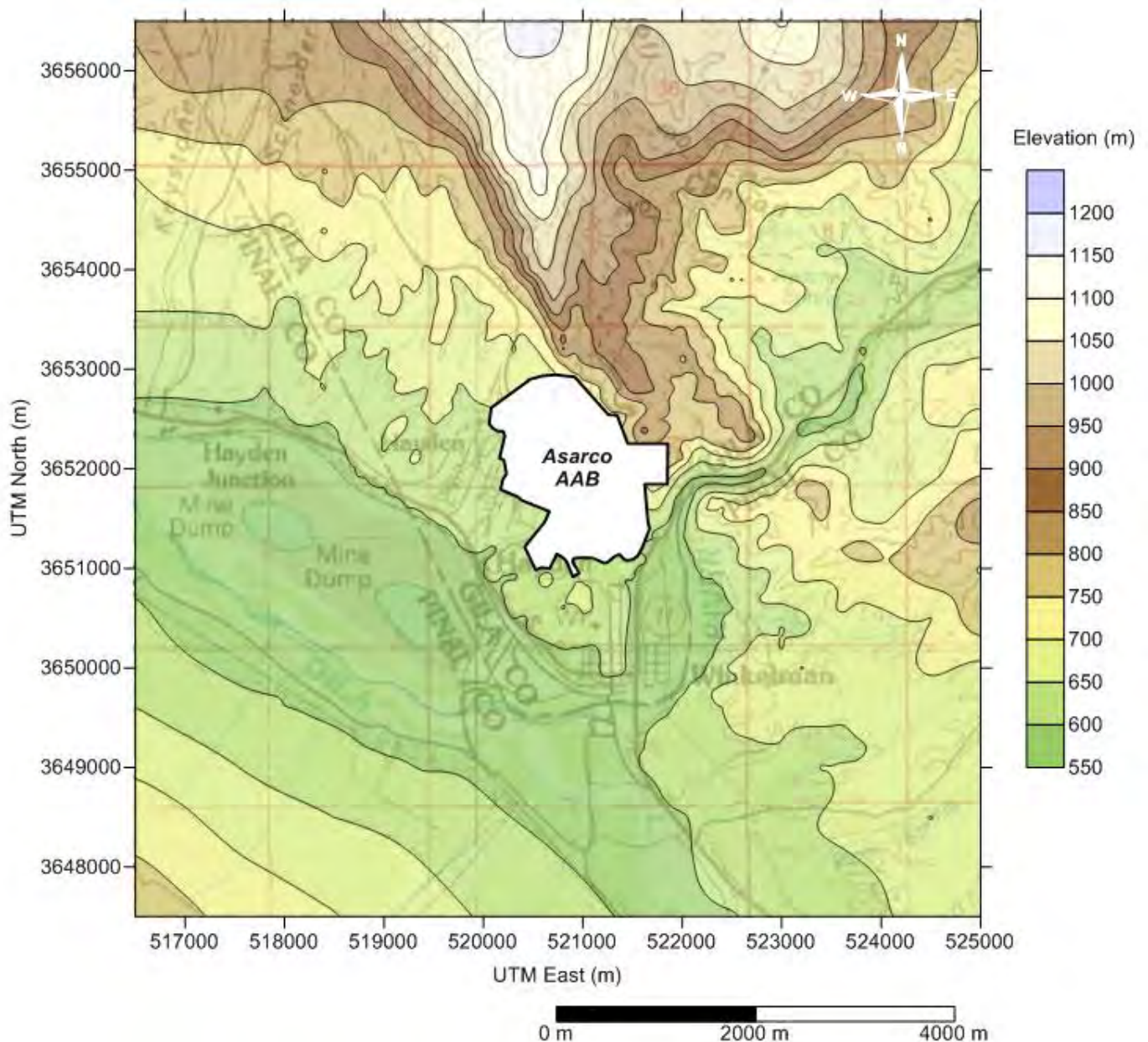
2.4 Climate

Both desert terrain and mountain ranges are found across the southern Gila County and eastern Pinal County landscape. Elevations range from near 1,800 feet to more than 4,400 feet above sea level in the NAA with the town of Hayden situated at an elevation near 2,050 feet. This unique environment experiences both warm desert and cool alpine climates. The climate of the area is arid, with annual average precipitation of about 14 inches. Temperatures range from an average low in the winter of 31°F to an average high of 99°F in the summer. Wind directions in the area generally conform to the river valley orientations, with westerly and southeasterly winds predominating in Hayden.

2.5   Summary of Attainment Status for Criteria Pollutants

Gila County is designated as "unclassified" or in "attainment" for the 8-hour ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$) NAAQS.

The EPA designated a portion of Gila County as "nonattainment" for the PM_{10} NAAQS, specifically the Miami and Hayden planning areas. The Asarco Smelter is located in the Hayden planning area. In July 2006, ADEQ requested the EPA split the Hayden/Miami PM_{10} NAA into separate nonattainment areas. EPA concurred with this request in January 2007.

The EPA designated the Hayden planning area as nonattainment for the 2010 SO_2 NAAQS, effective October 4, 2013.
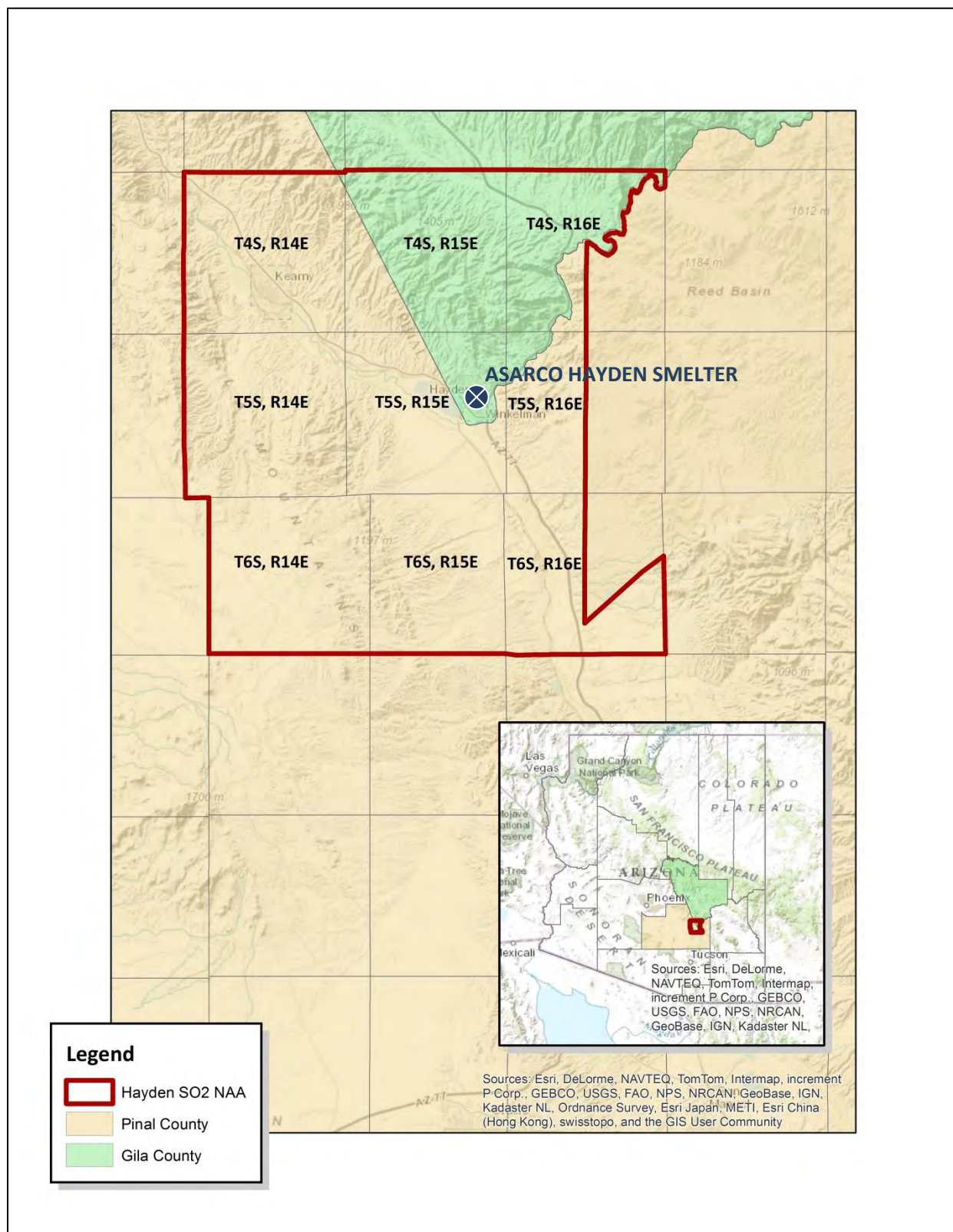
3.0   Modeling Domain

The first step of the SIP modeling exercise is to determine the size of the modeling domain, which depends on the number of sources to explicitly model and size of the receptor network in order to account for the areas of impact (U.S. EPA, 2014a). The modeling domain should at a minimum encompass the nonattainment area and include the sources thought most likely to cause or contribute to NAAQS violations in and around the nonattainment area. In the modeling exercise, all modeled receptors should exhibit modeled attainment of the NAAQS.

3.1   Determining Sources to explicitly model

Per EPA's guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions, Appendix A, there are two key criteria for the determination of sources to explicitly model: whether sources could cause or contribute to a NAAQS violation, and whether the ambient impacts from sources could be represented via background concentrations (U.S. EPA, 2014a).

3.1.1   Sources that Could Cause or Contribute to a NAAQS Violation in the Hayden NAA

ADEQ has identified SO_2 sources within the Hayden SO_2 NAA and a 50-km buffer zone extending from the boundaries of the NAA. Figure 3-1 is a geographical representation of these sources. Table 3-1 and Table 3-2 are an inventory of the individual sources within the Hayden SO_2 NAA and 50 km buffer zone surrounding the NAA, respectively. As shown in Table 3-1 and Table 3-2, the primary smelting of copper concentrate is the most significant source category in contributing to SO_2 emissions in Hayden SO_2 NAA and the surrounding 50 km buffer zone. The SO_2 emissions from the Asarco smelter represent more than 99.9 % of actual SO_2 emissions in the Hayden SO_2 NAA during 2009-2011. Similarly, the FMMI Miami smelter accounted for 99.9% of actual SO_2 emissions in the 50 km buffer zone during 2009-2011. Excluding the two smelters, there are no sources that emitted more than 25 tons per year (TPY) of SO_2 during 2009-2011. Due to their insignificant emissions, it is very unlikely that these minor sources could cause or contribute to a NAAQS violation in the Hayden SO_2 NAA.

One question is whether the FMMI Miami Smelter could cause or contribute to a NAAQS violation in the Hayden SO_2 NAA or not. As mountains surround Hayden in all directions, ADEQ does not expect sources outside Hayden to contribute to exceedances at monitors in the Hayden planning area. ADEQ expects the FMMI Miami Smelter, located around 45 km north of the Hayden Smelter, to have negligible ambient impacts in the Hayden SO_2 NAA because the 7,850-foot Pinal Mountain topographically separates the Miami Smelter from the Hayden SO_2 NAA. For this reason, ADEQ proposed two separate 1-hour SO_2 nonattainment areas for Miami and Hayden and concluded that the Miami and Hayden smelters are the sources causing the violation in their respective proposed nonattainment areas. EPA concurred with the ADEQ's proposal and conclusions. In the *Draft Technical Arizona Area Designations for the 2010 SO_2 Primary National Ambient Air Quality Standard* (US EPA, 2013b), EPA concludes:

> "EPA concludes that the state's recommended boundary contains the area violating the standard as well as areas causing or contributing to the monitored violation, as assessed using our five-factor methodology. The monitor is source-oriented, and is located in the southernmost tip of Gila County. Due to constraints imposed by the complex terrain in the Hayden area (see Geography/Topography discussion above), it is expected that the extent of the area exceeding the SO_2 standard is confined to a relatively small area around the main source of SO_2 emissions, the ASARCO, LLC - Hayden smelter."

As discussed above, Asarco is the only meaningful source of SO$_2$ emissions in the Hayden NAA. Any other sources which may be contributing to SO$_2$ levels in the Hayden SO$_2$ NAA are accounted for in the background SO$_2$ concentration.

Figure 3-1: Hayden SO$_2$ NAA Point Source Map (2011 NEIv1)
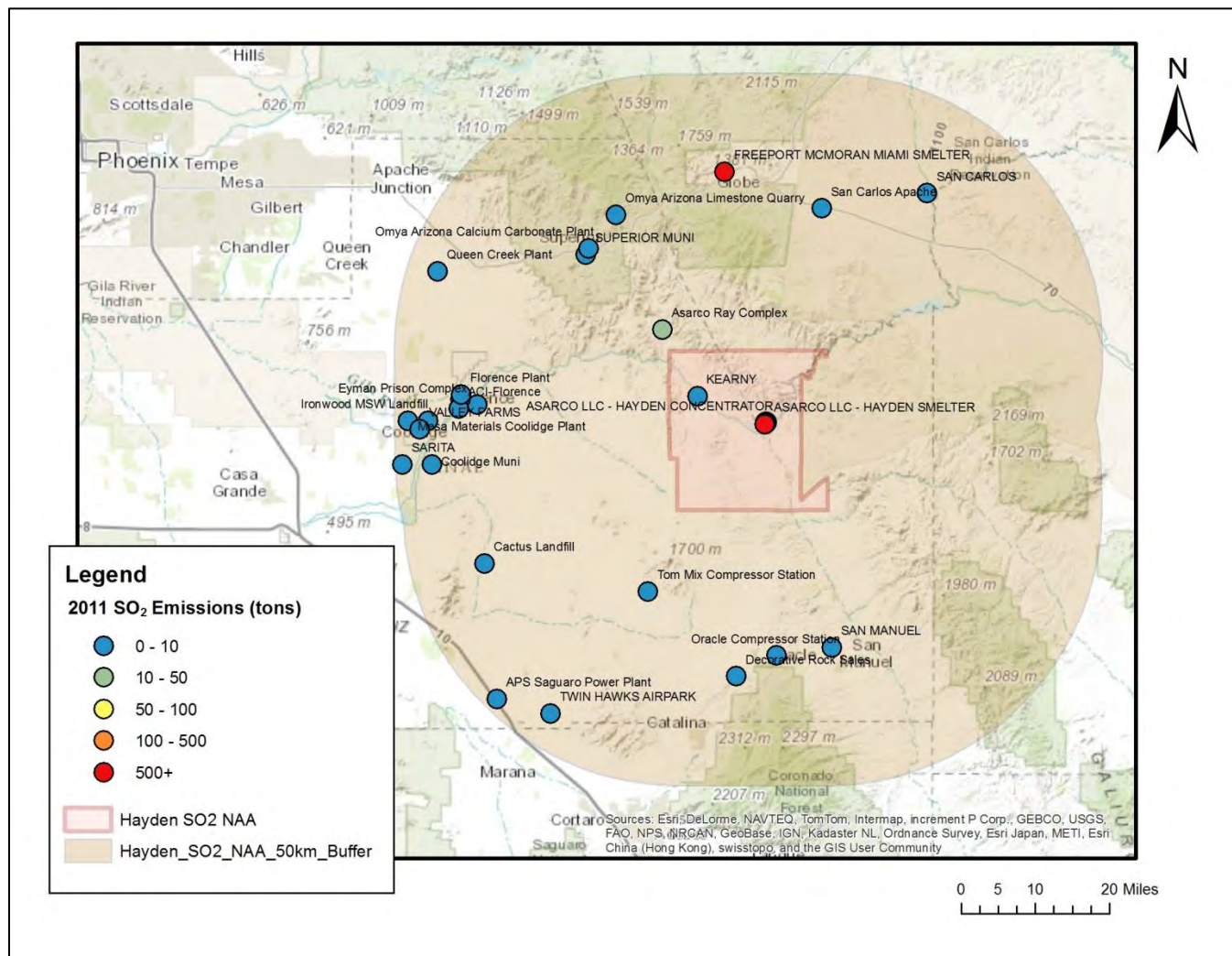
Table 3-1: Hayden SO$_2$ NAA Point Sources (2011 NEIv1)

EIS Identifier	County	Site Name	Facility Type	Latitude	Longitude	2011 SO$_2$ (TPY)
**Hayden SO$_2$ NAA**						
1074511	Gila	ASARCO LLC - HAYDEN SMELTER	Primary Copper Smelting/Refining Plant	33.0018	-110.778	21,747.3850
1073711	Gila	ASARCO LLC - HAYDEN CONCENTRATOR	Mines/Quarries	33.00338	-110.776	0.0018
7721411	Pinal	Asarco Ray Complex	Mines/Quarries	33.156	-110.978	24.1630
11322111	Pinal	KEARNY	Airport	33.0472	-110.909	0.0167
**Hayden SO$_2$ NAA 50km Buffer Zone**						
14774311	Gila	FREEPORT MCMORAN MIAMI SMELTER	Primary Copper Smelting/Refining Plant	33.41266	-110.857	10,119.0640
	Gila	Carlota Copper Co-Pinto Valley Mine		33.384777	-110.989	3.3
11478211	Pinal	Mesa Materials Coolidge Plant		33.007	-111.473	2.2910
1032511	Pinal	Oracle Compressor Station	Compressor station	32.6228	-110.756	0.7400
1032811	Pinal	Cactus Landfill	Landfill	32.774	-111.324	0.7400
11477811	Pinal	Queen Creek Plant		33.251	-111.416	0.5290
11473611	Pinal	Decorative Rock Sales		32.589	-110.834	0.4730
15533411	Pinal	Florence Plant		33.05	-111.37	0.1000
11322211	Pinal	SAN MANUEL	Airport	32.6364	-110.647	0.0972
10735511	Pinal	Tom Mix Compressor Station	Compressor station	32.728	-111.006	0.0920
10932111	Pinal	Eyman Prison Complex	Institutional (school, hospital, prison, etc.)	33.033	-111.338	0.0700
998011	Pinal	APS Saguaro Power Plant	Electricity Generation via Combustion	32.5517	-111.3	0.0410
10545611	Pinal	Coolidge Muni	Airport	32.93594	-111.427	0.0293
10534411	Gila	San Carlos Apache	Airport	33.35315	-110.667	0.0132
1031111	Pinal	Ironwood MSW Landfill	Landfill	33.007	-111.434	0.0090
11313811	Pinal	Florence Correctional Center	Institutional (school, hospital, prison, etc.)	33.043	-111.371	0.0060
12553111	Pinal	Omya Arizona Calcium Carbonate Plant		33.288	-111.121	0.0050
12342911	Pinal	SUPERIOR MUNI	Airport	33.2778	-111.127	0.0014
15533211	Pinal	ACI-Florence		33.027	-111.374	0.0010
11302911	Pinal	TWIN HAWKS AIRPARK	Airport	32.5278	-111.196	0.0007
11911111	Pinal	SARITA	Airport	32.9356	-111.485	0.0006
11898311	Pinal	VALLEY FARMS	Airport	32.9937	-111.451	0.0005
11845511	Gila	SAN CARLOS	Airport	33.3778	-110.462	0.0005
12551911	Pinal	Omya Arizona Limestone Quarry		33.343	-111.068	0.0000

Major Point Source Emission Inventory						
Source	Latitude	Longitude	2009 SO$_2$ Emissions (TPY)	2010 SO$_2$ Emissions (TPY)	2011 SO$_2$ Emissions (TPY)	Facility SO$_2$ PTE[8] (TPY)
Hayden SO$_2$ NAA						
Asarco LLC Hayden Smelter	33.001796	-110.77795	23,660	24,187	21,747	31,435
Asarco Ray Mine Complex	33.156	-110.978	21.24	24.39	24.19	115.60
Hayden SO$_2$ NAA 50km Buffer Zone						
Freeport McMoRan Miami Smelter	33.412655	-110.8565	3,401	3,082	2,776[9]	10,600[10]
APS Saguaro Power Plant	32.5517	-111.3	0.400	0.001	0.052	5[11]

3.1.2   Sources Impacts that Could Be Represented via Background Concentrations

Per Appendix W (U.S. EPA, 2005), background air quality includes pollutant concentrations due to: (i) Natural sources; (ii) nearby sources other than the one(s) currently under consideration; and (iii) unidentified sources.   As previously discussed, the Asarco copper smelter is the sole source that contributes to the non-attainment status of the Hayden SO₂ NAA. In addition, sources that may have a potential contribution to ambient air quality in the immediate vicinity of the Asarco Smelter include: emissions due to the low traffic levels and residential heating during the heating season; nearby industrial facilities; and regional sources.

ADEQ's modeling guidance requests land use information to identify activities that contribute to background air quality. Any area source contribution to ambient air quality in the immediate vicinity of the Asarco Smelter would be due to the low traffic levels and residential heating during the winter season. As described later in this TSD, ADEQ and Asarco can allocate the contributions of these area sources to background air quality from local ambient monitoring performed during Asarco smelter shutdown periods.

In addition to the Asarco Smelter, there are three major point sources located within 50 km of the Hayden SO₂ NAA. While these three sources contribute to background concentrations, the contributions of these point sources to background air quality in the immediate vicinity of the Asarco Smelter are negligible because ADEQ and Asarco cannot discern such impacts from local ambient monitoring data collected during Asarco shutdown periods. These sources are:

- Asarco Ray Mine Complex
- Freeport McMoRan Miami Smelter

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[8] Facility equipment list PTE at 100% load capacity or federally enforceable permit limit in TPY as of December 31, 2011.

[9] Estimate based on FMMI sulfur balance methodology outlined in section 4.3 and attached as an appendix in section 10.3

[10] Maximum allowable emissions as reported in: A.A.C. R18-2-715(H)

[11] Per email from PCAQCD, APS Saguaro has submitted a permit renewal application with a facility-wide PTE of 5 tons per year

- APS Saguaro Power Plant

The Freeport McMoRan Miami copper smelter in Miami is an ADEQ major source located 46 km north of Asarco's operations. Given the distance and topography—the 7,850-foot Pinal Mountain topographically separates the two facilities—ADEQ and Asarco expect the Freeport Smelter to be a minor contributor to background air quality in the Hayden SO_2 NAA. ADEQ and Asarco believe the Freeport Smelter's impacts are negligible to background air quality and cannot be discerned from local ambient monitoring data.

To calculate the background concentration of SO_2 for the SIP modeling, ADEQ proposes using the monitoring data collected from source-oriented monitors located near Asarco during the shutdown of the smelter operations (see Section 7 for details).

3.2   Ambient Air Boundary and Receptor Grid

The land owned by Asarco contiguous to and including Asarco's Hayden Operations covers an area in excess of 15 square miles. This area extends along and on either side of the Gila River Valley approximately 4-1/2 miles to the west of the plant and extends into the Dripping Spring Mountains to the north and northwest. In addition, much of the area is inaccessible to the general public, either because it is fenced or because of the steep and rugged nature of the terrain. Consequently, much of Asarco's property is not considered ambient air. The area encompassing the actual processes and industrial activities associated with the Asarco Hayden Operations is considerably smaller and is located immediately to the north and east of the town of Hayden.

Asarco followed guidance in Section 3.4.3 of the ADEQ's Air Dispersion Modeling Guidelines (ADMG) about how to identify, for permitting modeling purposes, the Ambient Air Boundary (AAB), outside of which modeling receptors are to be placed. This perimeter consists of fencing, steep/rugged terrain, and what ADEQ designates as the "process area boundary" or PAB.

In defining the PAB, Asarco included only areas where processes, operations, and activities associated with and supporting Asarco's concentrating and smelting operations occur. As such, the PAB included the locations of equipment and operations where the handling, processing, movement, and management of feed materials, products, and byproducts are conducted. Asarco properties connected to the Hayden Operations but not part of the PAB - for example, the administration building, grounds, and associated parking lot - were not included in the PAB. Asarco's AAB is shown in Figure 3-2. Appendix C includes additional information on how the Ambient Air Boundary for Asarco's smelter was defined.

In January 2017, Asarco informed ADEQ that they had purchased land to the east of the smelter, which was previously excluded from the AAB. ADEQ included this land to Asarco's AAB and updated the modeling information. However, it did not change the final calculated CEV for the main stack, as it can be seen in section 8. Figure 3-3 shows the updated AAB.

On Thursday, February 23rd Arizona Department of Environmental Quality (ADEQ) personnel performed an on-site tour of the ambient air boundary (AAB) used for the Hayden SO_2 and Pb nonattainment plans. During this tour ADEQ personnel traveled and documented the portions of the AAB that were reasonably accessible. In general, upon visiting the site and inspecting the AAB, ADEQ concurs with the AAB

assessment provided by Asarco[12] and agrees that the boundary represents a practical ability to preclude public access. More details and photographs of the survey are provided in Appendix J of this TSD.

Figure 3-2: Asarco's Previous Ambient Air Boundary

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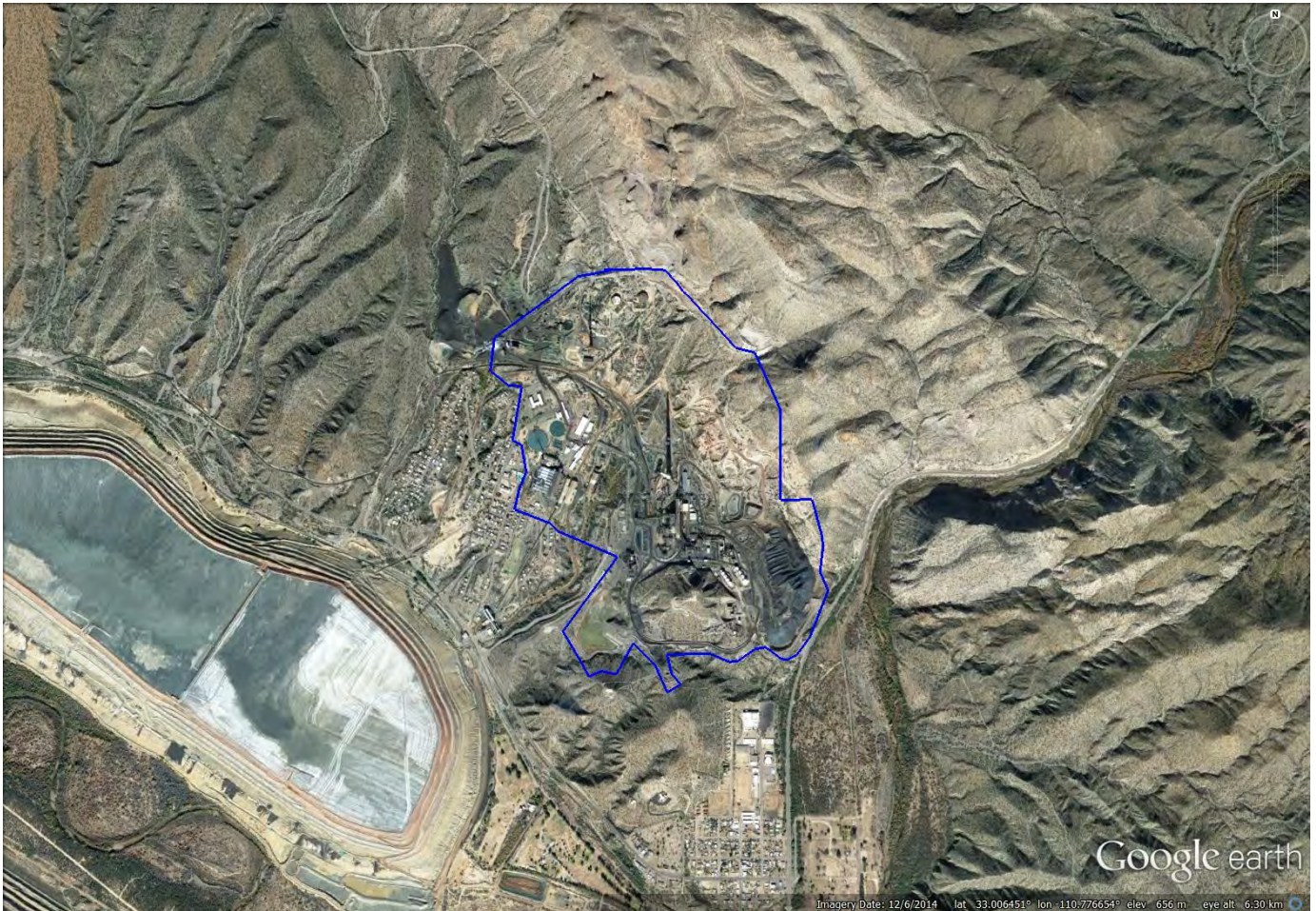
[12] See Hayden SO$_2$ Modeling Technical Support Document Appendix C.

Figure 3-3: Asarco's Updated Ambient Air Boundary

Asarco developed a modeling domain with a total coverage of approximately 33 kilometers by 34 kilometers, centered on the Asarco Smelter facility. The modeling domain covers portions of Gila and Pinal Counties and encompasses the entire Hayden NAA.

Asarco placed 2,753 receptors in the modeling domain, including 540 Process Area Boundary receptors in the grid and spaced these at intervals of no more than 25 meters. Spacing of the receptors is as follows:

- every 25 m along the AAB;
- every 100 m from the AAB to a distance of 1 km (including the towns of Hayden and Winkelman);
- every 500 m from 1 km out to a distance of 4 km;
- every 1000 m from 4 km to the NAA boundary; and
- every 2500 m along the NAA.

In addition, more densely-spaced receptors (25 m spacing) were employed as necessary to refine controlling concentrations in the Dripping Springs Mountains to the north of Asarco.

Asarco used EPA's AERMAP software tool (version 11103; U.S. EPA, 2011b) to estimate receptor elevations and hill heights. AERMAP is the terrain preprocessor for AERMOD (discussed in Section 4) and uses the following procedure to assign elevations to a receptor:

- For each receptor, the program searches through the U.S. Geological Survey (USGS) input files to determine the two profiles (longitude or easting) that straddle this receptor;
- For each of these two profiles, the program then searches through the nodes in the USGS input files to determine which two rows (latitudes or northings) straddle the receptor;
- The program then calculates the coordinates of these four points and reads the elevations for these four points;
- A 2-dimensional distance-weighted interpolation is used to determine the elevation at the receptor location based on the elevations at the four nodes determined above.

Asarco used ten (10) meter USGS National Elevation Dataset (NED) data as inputs to AERMAP. The NED data are produced from digitized map contours or from manual or automated scanning of aerial photographs. A 1/3 arc-second NED data file consists of a regular array of elevations referenced horizontally in the UTM coordinate system, with a uniform horizontal spacing of approximately 10 meters. The NED data used for this analysis are based on the 1983 North American Datum (NAD83). ADEQ/Asarco has provided AERMAP input and output files on CD-ROM per the nomenclature described in Appendix B. The modeled receptors are depicted in Figure 3-3.

Figure 3-4: Modeled Receptors

Figure 3-4: Modeled Receptors

4.0   Model Selection

As outlined in the EPA's Modeling Guidance for Nonattainment Areas (U.S. EPA, 2014a), for SIP development under the 2010 primary SO_2 NAAQS, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD), or one of the other preferred models in Appendix W, should be used for near-field dispersion unless use of an alternative model can be justified.

4.1   AERMOD

Asarco used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (version 15181; U.S. EPA, 2015) to predict ambient concentrations in simple, complex and intermediate terrain. AERMOD is the recommended sequential model in EPA's GAQM (40 CFR 51, Appendix W) (U.S. EPA, 2005) for near-field analysis.

There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET (version 15181; U.S. EPA, 2015), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP (version 11103; U.S. EPA, 2011), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSURFACE (Version 13016; U.S. EPA, 2013), a surface characteristics preprocessor, and BPIPPRIM, a multi-building dimensions program incorporating the Good Engineering Practice technical procedures for PRIME applications (U.S. EPA, 2004).

Asarco used the regulatory default option. This option commands AERMOD to:

- Use the elevated terrain algorithms requiring input of terrain height data for receptors and emission sources;
- Use stack tip downwash (building downwash automatically overrides);
- Use the calms processing routines;
- Use buoyancy-induced dispersion;
- Use the missing meteorological data processing routines.

4.2   BLP

The fugitive emissions from the ridge vents of the flash furnace building and the converter aisle are a source of SO_2 at the Asarco Smelter, as will be described later in Section 5. Initially, ADEQ characterized the ridge vent fugitive emissions as stationary buoyant line sources and therefore proposed the Buoyant Line and Point source (BLP) technique in the modeling protocol to model the ridge vents. However, further analyses showed that this technique is not appropriate for this project and AERMOD alone is the appropriate model to use in the case of Asarco. Detailed information on why the incorporation of BLP into a modeling analysis for Asarco is not appropriate is provided in Appendix D.

A flowchart of the general approach to this modeling analysis is presented in Figure 4-1.

Figure 4-1: Overall Modeling Flowchart for SIP Demonstration
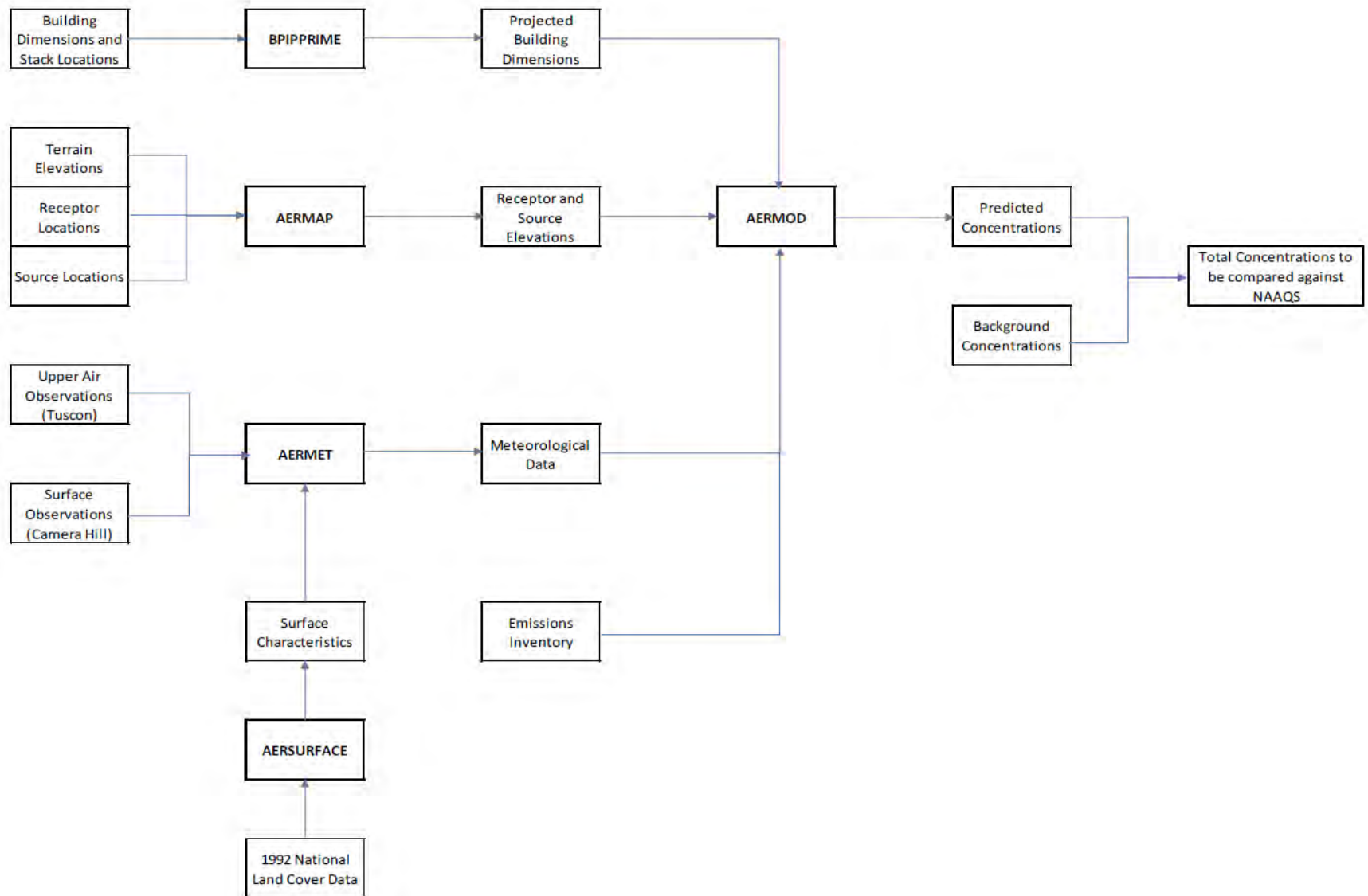
5.0   Source Inputs

This section discusses source characterization to develop appropriate source inputs for dispersion modeling system. Section 5.1 provides an overview of Asarco Smelter operations and proposed smelter upgrade project (control strategies), section 5.2 provides details on source configuration, source types and source release parameters, and section 5.3 discusses modeling methodologies to handle variable emissions of sources. Good Engineering Practice (GEP) stack heights and urban/rural determination of the sources are also discussed in this section.

5.1   Asarco Smelter Operations and Proposed Converter Retrofit Project

The copper smelting facility in Hayden, AZ, operated by Asarco, consists of a flash furnace, five (5) Peirce-Smith converters, three (3) anode furnaces, an acid plant and other support equipment. A plot plan of the facility as proposed is provided in Figure 5-1.

ADEQ classifies the Hayden Smelter as a major source pursuant to A.A.C. R18-2-101.61. The potential emission rates of the following pollutants are greater than major source thresholds: (i) particulate matter with an aerodynamic diameter less than 10 microns, (ii) sulfur dioxide, and (iii) nitrogen oxides.

On June 24th, 2014 Asarco submitted a Class I Significant Permit Application to ADEQ, proposing upgrades to enhance emission capture and control systems at its Hayden Smelter facility (hereafter referred to as the "Converter Retrofit Project"). The following list summarizes the enhancements Asarco has proposed for the Converter Retrofit Project (CRP):

- The five existing converters will be replaced with three larger converters. This change allows a single converter to blow at a time, better matching the process gas volume from the converters to the gas processing capacity of the acid plant;
- The better matching of the gas volumes from the converters with the processing capacity of the acid plant, in combination with new, improved primary and secondary hoods, will reduce the volume of process gas spillage from the primary hood system to the secondary hood system during blowing operations. Additionally, the proposed tertiary ventilation system will capture other converter aisle emissions, e.g., emissions from ladle movements of molten material along the aisle, for routing to the annulus of the main stack;
- Process gas captured by the secondary hood during blowing, which is presently routed to the secondary hood baghouse, will be rerouted to the acid plant, providing for substantial control of the sulfur dioxide that presently contributes the majority of the sulfur dioxide in the main stack emissions, additionally the slag return ventilation hoods will be re-routed to the secondary hood baghouse;
- The existing lime injection upstream of the secondary hood baghouse will be replaced with activated lime injection (high surface area, high efficiency) providing approximately 50% control of secondary hood system emissions routed to the baghouse during periods other than blowing. The efficiency of this control will vary somewhat depending on the inlet concentration, with higher control efficiency likely during periods of higher inlet concentration and lower control efficiency possible during periods of lower inlet concentration.
- A tertiary ventilation system will be installed over the converter aisle. While this system will not reduce emissions, it will capture any converter aisle emissions not collected by the primary and secondary systems and route them to the main stack instead of allowing them to escape as fugitive emissions to the atmosphere at roof level.

- Improvements will be made to the matte tapping, slag skimming, and to reduce fugitives and to direct emissions to a new vent gas baghouse. This change will further reduce fugitives and will also control particulate emissions;
- Activated lime injection will be added to the vent gas baghouse, providing approximately 50% additional control of peak emissions routed to the baghouse. The actual control efficiency will likely vary somewhat depending upon inlet gas concentrations.
- The Anode Baghouse Stack will be removed and the emissions will be directed to the main stack.
- An improved, larger preheater will be installed at the Acid Plant that can bring all four catalyst beds closer to optimum temperature before start of smelting in the flash furnace. This will reduce existing startup peak emissions by over 50%.

More details concerning the CRP are provided in the Asarco Converter Retrofit Permit application (Revision No. 60647).

5.2   Source Configuration, Types and Release Parameters

After CRP implementation, SO$_2$ emissions will be released to the atmosphere from five locations at Asarco's Hayden operations: the main smelter stack, the anode furnace roof monitors, the converter aisle roof monitors, the flash furnace building roof monitors, and outdoor slag pouring. The locations of these sources, all of which were modeled in the SO$_2$ air dispersion modeling analysis, are depicted in Figures 5-1 and 5-2 for the pre- and post-CRP configurations, respectively.

Figure 5-1: Modeled Emission Sources, pre-CRP

Figure 5-2: Modeled Emission Sources, post-CRP

Figure 5-2: Modeled Emission Sources, post-CRP

5.2.1 Stacks (Point Sources)

5.2.1.1 Main Stack

The main smelter stack, which is comprised of an inner stack and an outer annulus, exhausts almost all emissions from the smelting processes at Hayden. With the proposed design changes, the acid plant tail gas will continue to be directed to the inner stack, and secondary and tertiary converter ventilation gases, and the (new) vent gas baghouse emissions (flash furnace matte tapping, slag skimming, and concentrate dryers) will be vented to the annulus.

To properly account for the main stack plume rise in the dispersion modeling, a combined exhaust stream was defined for the stack's two emissions streams. The calculation of this combined stream's parameters, presented in Appendix E, is based on conservation of the total stack flow rate and release area, and calculation of an equivalent exhaust temperature, stack diameter, and exit velocity.

As discussed in the ADEQ's June 2002 "Final Hayden Sulfur Dioxide Assessment Nonattainment Area State Implementation and Maintenance Plan"[13], the GEP height for Asarco's main stack was assessed in a fluid modeling study jointly conducted by North American Weather Consultants and Colorado State University, with that study concluding that the stack's 1,000-foot height meets GEP stack height requirements. EPA subsequently approved Arizona's SIP determination of GEP stack height. No structures have since been

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[13] "Final Hayden Sulfur Dioxide Assessment Nonattainment Area State Implementation and Maintenance Plan," ADEQ, June, 2002

constructed at Asarco that would affect this determination. Asarco's main stack was modeled at its true height of 1,000 feet. More details on GEP stack height is provided in section 5.5.

5.2.1.2 *Anode Furnace Baghouse Stack*

Currently, emissions from the anode aisle are captured and directed to the anode furnace baghouse stack (engineering estimate of 97% capture). Details on the calculated SO_2 emission rate for the anode baghouse stack are given in Appendix E.

After CRP implementation, the Anode Furnace Baghouse Stack will be removed and the emissions will be discharged through the inner stack.

5.2.1.3 *Slag Pouring*

SO_2 is released to the atmosphere as molten slag is poured on the ground outdoors. Emissions modeled for this source are the hourly equivalent of those reported in Asarco's 2010 Emissions Inventory Questionnaire (EIQ) and represent the maximum possible SO_2 emissions that could occur in a single hour.

Due to the high temperature of the molten slag at the point of pouring (about 2000°F), the gas rises rapidly into the air. Recognizing that such heat results in a rising buoyant plume, regulatory agencies have approved methods for calculating equivalent stack parameters for the purposes of the dispersion modeling of slag pouring gases. In particular, the Texas Air Control Board, a predecessor agency to the Texas Commission on Environmental Quality, approved such an approach, involving the use of equivalent exhaust parameters, to account for plume rise in the modeling of slag pouring at Asarco's El Paso Smelter in 1992 and 2006 air quality permit reviews. Similarly, the ADEQ has described in Section 3.3.6 of its ADMG the calculation and use of equivalent release parameters for modeling flares, a category of non-standard sources with heat release that cannot be treated in a straightforward way in dispersion models.

Following a methodology with similarities to the one ADEQ applies to flares, Asarco has calculated, for use in the modeling, an effective upward velocity for emissions arising from the pouring of the slag. This calculation, based on the physical properties of the slag and the nature and dimensions of the pour, is presented in Appendix E.

5.2.2 Point Source Release Parameters

Table 5-1 presents the stack and exhaust parameters modeled for the stacks associated with the proposed changes. Asarco identified coordinates for the stacks by mapping the site plan to rectified aerial photographs of the site. ADEQ and Asarco projected UTM coordinates of each stack to UTM Zone 12. These coordinates are based on the NAD83.

Table 5-1: Stack and Exhaust Parameters- Proposed (post-CRP)

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp.[14] (ºK)	SO$_2$ Emission Rate (lb/hr)
Main Stack	520929	3651932	650.8	304.8	8.88	10.67	346.5	Varies
Slag Pouring	521458	3651636	626.9	0	13.3	1.45	1333	4.1

Table 5-2 presents the stack and exhaust parameters modeled for existing stacks located at the facility. Asarco projected the UTM coordinates of each stack to UTM Zone 12, NAD83. Figure 5-2 shows the location of each existing stack associated with the Smelter.

Table 5-2: Stack and Exhaust Parameters- Existing (pre-CRP)

Stack	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exhaust Temp.[15] (ºK)
Main Stack	520929	3651932	650.8	304.8	8.35	7.29	470.7
Anode Stack	520985.4	3651918.8	647.1	19.4	2.13	15.14	449.3
Slag Pouring	521458	3651636	626.9	0	13.3	1.45	1333

An Excel file containing more detailed specifications of the main stack exit conditions is included in the enclosed CD-ROM per the nomenclature described in Appendix B.

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[14] Negative temperature indicates temperature above ambient, zero temperature indicates ambient temperature
[15] Negative temperature indicates temperature above ambient, zero temperature indicates ambient temperature

5.2.3 Ridge Vents (Fugitive Emissions)

5.2.3.1 Ridge Vents Configuration

ADEQ and Asarco identified coordinates for the ridge vents by mapping the site plan to rectified aerial photographs of the site and adjusting the building footprint to site Computer Assisted Drafting (CAD) drawings. ADEQ and Asarco projected the Universal Transverse Mercator (UTM) coordinates of each vent to UTM Zone 12, 1983 North American Datum (NAD83). Figures 5-3 and 5-4 show each vent location (pre- and post-CRP, respectively) on the simplified plot plan and the representative volume sources used in AERMOD. Table 5-3 lists the coordinates of each vent as well as vent-specific parameters for the post-CRP configurations of the ridge vents.

Figure 5-3: Modeled Volume Sources, pre-CRP
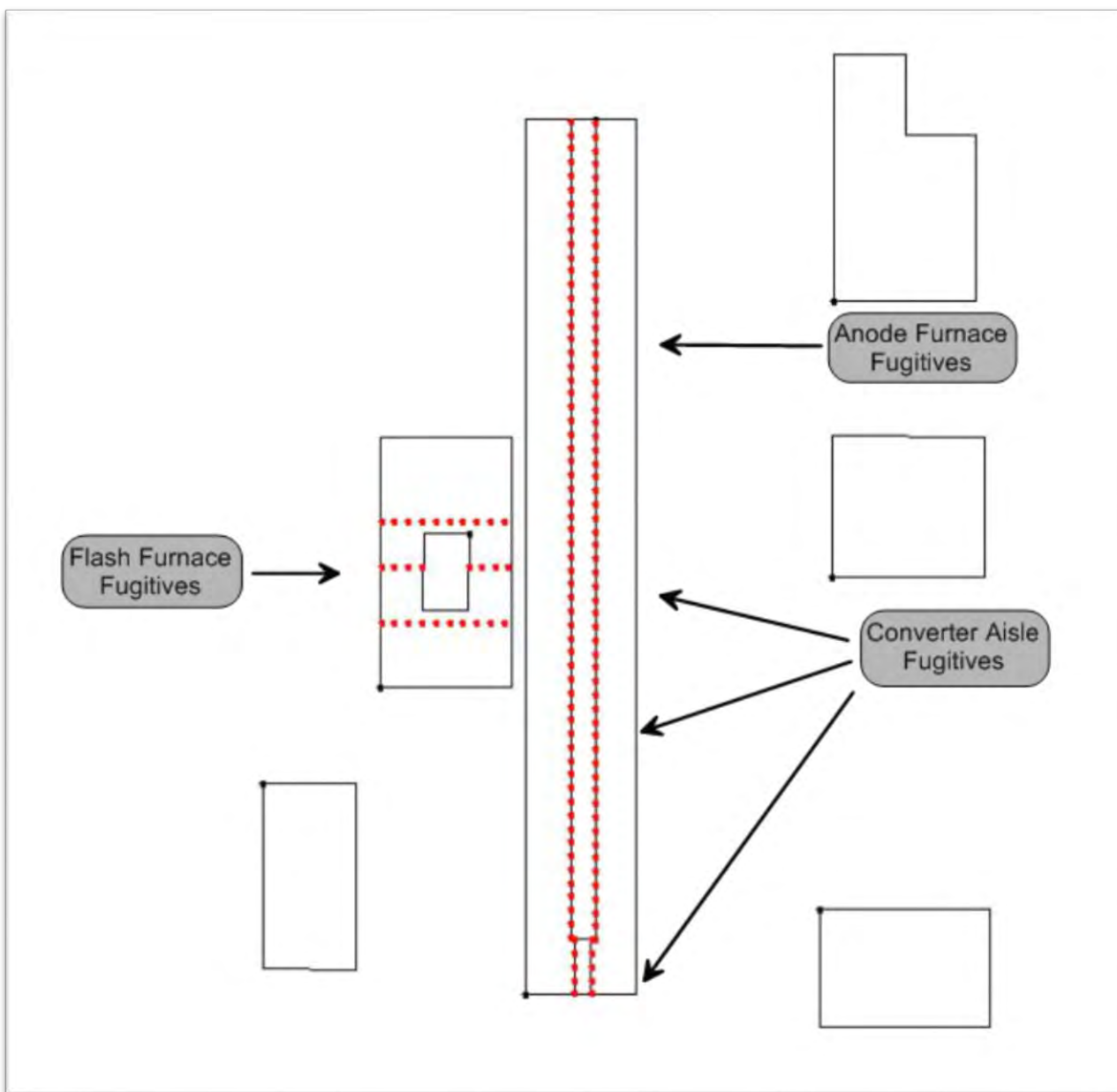
Figure 5-4: Modeled Volume Sources, post-CRP
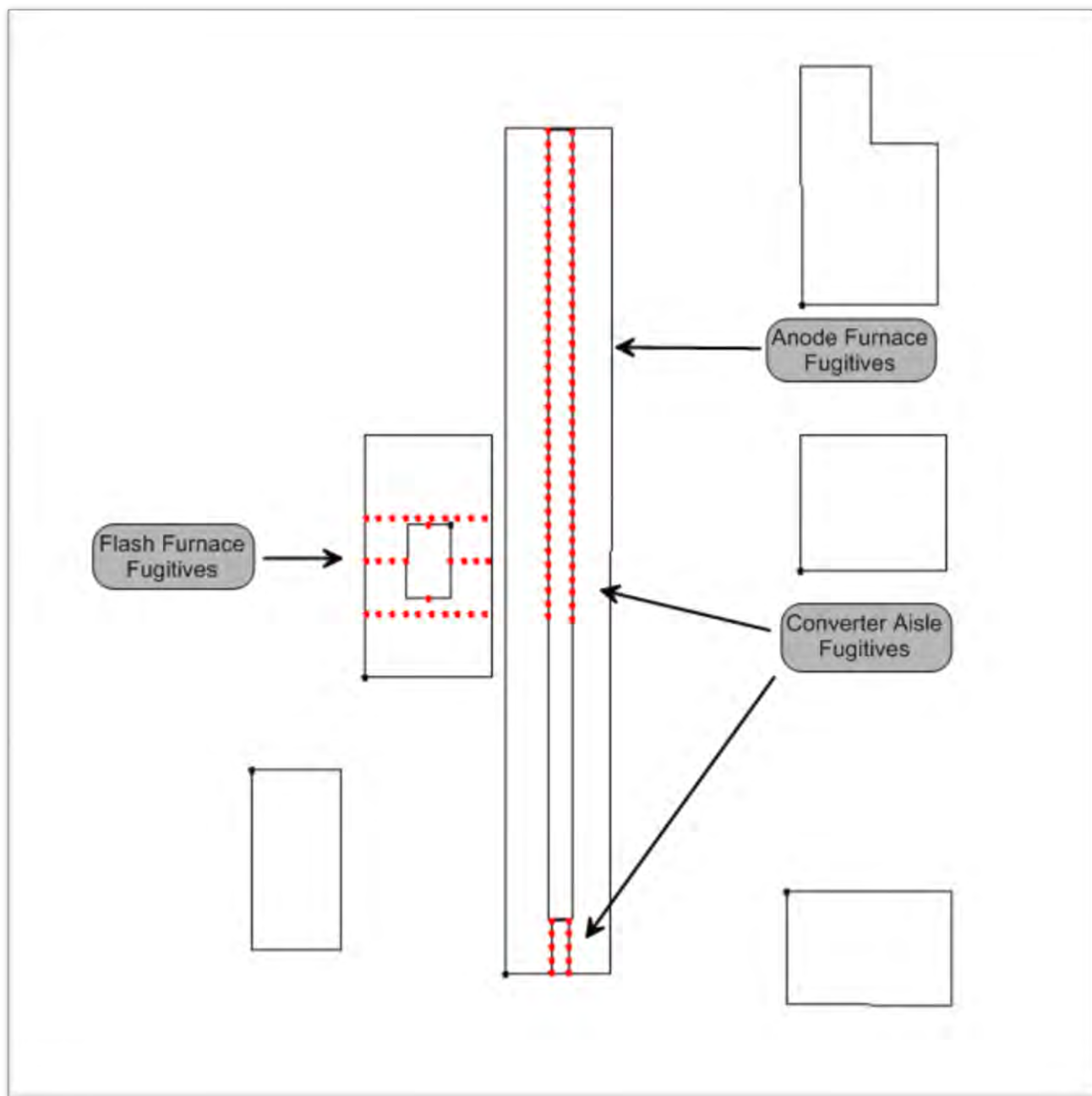
5.2.3.2   Flash Furnace Fugitive Emissions

Emissions not captured from the flash furnace operations and directed to the acid plant are released through roof monitors that run east-west across the top of the flash furnace building. To simulate the roof monitor emissions sources in the dispersion modeling, they were represented as a series of volume sources (32 total). For modeling purposes, the total fugitive emission rate from the flash furnace building was distributed evenly among the 32 individual volume sources. The derivation of the initial horizontal and vertical dimensions is presented in Appendix E.

5.2.3.3 Converter Aisle Fugitive Emissions

Emissions from the converter aisle that are not captured and directed to the acid plant are vented through roof monitors on each side of the penthouses which extend along the north-south axis of the converter building ridge line. To simulate the roof monitor emissions sources in the dispersion modeling, they were represented as a series of volume sources (46 total). For modeling purposes, the total fugitive emission rate from the converter aisle building was distributed evenly among the 46 individual volume sources. The derivation of the initial horizontal and vertical dimensions is presented in Appendix E.

5.2.3.4 Anode Furnace Fugitive Emissions

Emissions from the anode aisle that are not captured and directed to the baghouse are vented through roof monitors on the penthouses which extend along the north-south axis of the anode building ridge line. To simulate the roof monitor emissions sources in the dispersion modeling, they were represented as a series of volume sources (40 total). For modeling purposes, the total fugitive emission rate from the anode aisle building was distributed evenly among the 40 individual volume sources.

The derivation of the initial horizontal and vertical dimensions is presented in Appendix E.

Table 5-3: Ridge Vent Parameters- Proposed (post-CRP)

Ridge Vent	UTM Coordinates (m)		Base Elev.	Release	Initial Horizontal Dimension	Initial Vertical Dimension	SO$_2$ Emission Rate
	East	North	(m)	Height (m)	(m)	(m)	(lb/hr)
Converter Aisle	Varies[a]	Varies[a]	634.11	31.4/25.4b	0.7c	11.34/10.63[c,d]	Varies
Anode Furnace	Varies[a]	Varies[a]	635.86	31.4	0.7c	11.34c	1.4
Flash Furnace	Varies[a]	Varies[a]	635.86	43.6	0.7c	19.85c	Varies

a. Varies with each modeled source
b. Release height provided for Roof Monitor above (existing) Converters Nos. 1 and 2 and then for Roof Monitor to south of (new) Converter No. 5, respectively
c. Based on Table 3-1 of AERMOD Guidance
d. Initial vertical dimension provided for Roof Monitor above Converter Nos. 1 and 2 and then for Roof Monitor to south of (new) Converter No. 5

5.3 Emissions Variability Analysis and Future Emissions Profile

Asarco forecasted the future emissions profile for the Hayden Smelter post-Converter Retrofit Project (CRP). While the CRP will substantially reduce the overall emissions from Asarco, it will not change the variability of the underlying process or the impact of the startup and shutdown emissions. As a result, Asarco conducted an emissions variability study to assess the impact of the CRP on its emissions and to forecast the likelihood and magnitude of various emissions levels after the CRP is implemented. To perform this emissions variability study, the following steps were taken:

- Gathered Continuous Emissions Monitoring System (CEMS) data from the acid plant tail gas stream (AP) (column C), ventilation gas stream reporting to the R&R Cottrell electrostatic precipitator (R&R) (column E) and the converter secondary hood baghouse (SHBH) (column G) for the period 2001 through early 2014 (approximately February). After discussions with GCT and Asarco staff, eliminated the period prior to 2005 as not fully representative of current

Smelter operations, leaving an analysis period of 2005 through early 2014, a little over nine years;

- Cleaned the data to eliminate all flagged data not meeting QA/QC requirements;
- Further cleaned the data to eliminate periods where the Smelter as a whole was down for the entire 24-hour day, consistent with EPA guidance in the Regional Haze Rule;
- Added column I, to reflect historic Main Stack emissions. Column I is the sum of columns C, E and G.

1. **Future Vent Gas Baghouse Emissions:**

Asarco started with the historic Furnace Vent CEMS data. These data were then adjusted as follows to develop the future emissions forecast:

- The mean value of the Vent CEMS data was calculated for the period of record;
- The mean value was adjusted upward to the proposed 693,500 tons/year concentrate feed rate limit by ratioing 693,500 tons/year over the historic concentrate feed rate;
- The adjusted mean value was then further adjusted to reflect a possible future maximum sulfur content of 0.3 instead of 0.29 during the period of record. This provided a conversion ratio of 1.27 (cell C73881);
- Based on process and metallurgical knowledge:
  - o If the Vent CEMS datum for an hour was 750 lb/hr or less, the datum was adjusted by the conversion ratio and a factor of 1.34 approximating improved capture at the matte tapping and slag skimming area. This value was then reduced by 50% to reflect the HSA lime injection.
  - o If the Vent CEMS datum for an hour was between 750 and 1500 lb/hr, the datum reflects either a venting period (e.g., a short period when the flash furnace is shut down and residual gas is vented for employee safety reasons) or a period when process off-gas leaked through the damper system into the ventilation gas system. In this case, the datum is higher than expected matte tapping and slag skimming fugitive emissions would be, so only the 50% HSA lime injection control factor is applied (the capture factor does not apply because ventilation gas is hard-piped or strong gas has entered the ducting system).
  - o If the Vent CEMS datum for an hour was greater than 1500 lb/hr, the datum reflects process off-gas leakage into the exhaust system and it is replaced with 750 lb/hr, which represents the maximum matte tapping and slag skimming emission rate, which is then reduced by 50% for HSA lime injection control. No additional adjustments are made because the maximum value is used.
- The calculated number is then entered into column K as the forecast emission for that hour for the proposed Vent Gas Baghouse exhaust stream.

2. **Future Acid Plant Emissions:**

Asarco started with the historic Acid Plant tail gas CEMS data. These data were then adjusted as follows to develop the future emissions forecast:

- The mean value of the Acid Plant tail gas CEMS data was calculated for the period of record.
- The mean value was adjusted upward to the proposed 693,500 tons/year concentrate feed rate limit by ratioing 693,500 tons/year over the historic concentrate feed rate.

- The adjusted mean value was then further adjusted to reflect a possible future maximum sulfur content of 0.3 instead of 0.29 during the period of record. This provided a conversion ratio of 1.27 (cell E73881).
- The adjusted value was then adjusted upward to account for additional blowing off-gas from the converters being routed to the acid plant. This value was then reduced 99.8% to reflect the estimated control efficiency from the Regional Haze Rule.
- Based upon process and metallurgical knowledge and discussions with an acid plant manufacturer about performance of the acid plant after installation of a larger preheater, the adjusted value was then subjected to a logic test as follows:
  - If the proposed value is greater than 1000 lb/hr, the value was held at 1000 lb/hr based upon engineering judgment on future performance of the acid plant in startup conditions.
  - If the proposed value is less than 1000 lb/hr, the lesser value was used.
- The calculated number is then entered into column L as the forecast emission for that hour for the acid plant tail gas exhaust stream.

3. Future Secondary Hood Baghouse Emissions:

Gas Cleaning Technologies ("GCT"), provided a design estimate of 5% of historic emissions. Asarco started with the historic Secondary Hood Baghouse CEMS data. These data were then adjusted as follows to develop the future emissions forecast:

- A logic test was applied to eliminate some very low readings (<1 lb/hr), which are so low that they are not judged representative of actual operations during the time frame. If the datum was not eliminated, it was then multiplied by 0.05 to give the forecast value post-Converter Retrofit Project.
- Then a 50% control factor was taken for the addition of the HSA lime injection.

The calculated number is then entered into column M as the forecast emissions for that hour for the Secondary Hood Baghouse.

4. Future Anode Furnace Baghouse Emissions:
Asarco has not historically had a CEMS attached to the anode furnace baghouse. A temporary SO_2 monitor was placed on the anode furnace baghouse stack and approximately 160 hours of data obtained. These data were then adjusted as follows to develop the future emissions forecast:

- Each datum was adjusted upward by a multiplier to bring the 160 hour data set to a peak maximum hourly value of 275 lb/hr, which was the highest observed datum in the prior 1995-1996 Fugitive Study, which was conducted for a 6 month period. Because that study was conducted for a substantially greater period, its peak value was judged more representative of future peaks than that obtained during the 160 hour study.
- The adjusted 160 hour block was then repetitively entered into the spreadsheet in column O as the best approximation of anode baghouse emissions.

5. Future Tertiary Ventilation Emissions:

As part of the Converter Retrofit Project, Asarco is installing three canopy hoods over the three new Peirce-Smith converters. These hoods will evacuate approximately 400,000 cfm. GCT, the design firm, estimated that an average of 47.7 lb/hr of SO_2 would be captured by these hoods during periods of

secondary operations in the converter aisle. Asarco forecast future emissions from this capture system as follows:

- A logic test was applied first. If less than 2 lb/hr is predicted in the Secondary Hood Baghouse, then based on process knowledge it was determined that it is unlikely that either converter secondary operations or spillage from the converter secondary hoods is occurring. If neither event is occurring, then there is no source of SO_2 for the tertiary system to capture and "0" was used. This was deemed conservative because the number of blowing hours (when spillage may occur) is relatively great and emissions are assigned at the design rate even though secondary operations may not be occurring.
- If the logic test is passed, then emissions were assigned at a base of 47.7 lb/hr, adjusted by the converter secondary hood number, less 80 lb/hr (slightly below the overall mean hourly converter secondary hood emissions) and this value is then divided by 4. This represents a "best fit" analysis that resulted in tertiary emissions at or slightly above the level anticipated by GCT, while still reflecting some fluctuation judged likely due to the presence of secondary operations and limited spillage from the secondary hoods.
- The calculated value was then entered into the spreadsheet in column N as the best approximation of tertiary ventilation emissions.

6. Future Main Stack Emissions:

After the Converter Retrofit Project, the Main Stack will exhaust emissions from the Vent Gas Baghouse (column K), the Acid Plant tail gas (column L), the secondary hood baghouse (column M), the tertiary ventilation (column N) and the anode furnace baghouse (column O). All of these columns were summed and entered into column P.

7. Fugitive Emissions:

There are three primary sources of process fugitive emissions at the Hayden Smelter: matte tapping and slag skimming at the flash furnace; converter aisle fugitives (mostly from secondary operations), and anode refining fugitives. These emissions were estimated based on past Smelter performance, improvements during the Converter Retrofit Project, and engineering judgment from Asarco and Gas Cleaning Technologies personnel. Each process fugitive is discussed in more detail below.

- *Flash furnace matte tapping and slag skimming fugitives:* Asarco and Gas Cleaning Technologies estimated that emissions from this activity should be approximately 15 lb/hr at the 693,500 ton/year design rate. Assuming a worst case maximum feed throughput rate of 120 tons/hour and a 20% safety factor on the AP-42 4.0 lb SO_2/ton of concentrate fugitive emission factor[16] controlled at 96% gives a short term maximum of 24.0 lb/hr. Asarco and Osman modeled this source at 28.7 lb/hr, nearly twice the expected and 15% above the expected maximum rate.

- *Converter aisle fugitives:* Gas Cleaning Technologies designed the Converter Retrofit Project to achieve a design rate of 3.0 lb/hr for fugitive SO_2 emissions. Gas Cleaning Technologies estimates that there might be instantaneous periods where emissions could approach 17 lb/hr if they lasted that long. Because such instances are of short duration, for modeling purposes Asarco and Osman used 30 minutes at 17 lb/hr and 30 minutes at 3 lb/hr and rounded up to 10.6 lb/hr, nearly three times the expected rate and exceeding the expected maximum rate.

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[16] AP-42, Chapter 12.3, Table 12.3-11, Smelting Furnace (Fugitives).

- *Anode furnace fugitives:* In the prior 1995-1996 Fugitive Study, total emissions from anode furnace operations averaged less than 15 lb/hr. Asarco installed a temporary monitor and detected instantaneous spikes of up to 130 lb/hr on the anode furnace baghouse ventilation system. Using Gas Cleaning Technologies design capture of 97%, this suggests a design peak of approximately 3.9 lb/hr during anode furnace operation. Each anode furnace cycle includes brief periods when the furnace mouth is uncovered to allow metal transfer. Although the furnace remains under draft through the ventilation port, the uncovered mouth becomes a potential source of fugitive sulfur dioxide emissions. Asarco estimates that these periods may last up to 20 minutes, occur 2 to 3 times in a day, and may only achieve 50% capture. Using this worst case analysis, the maximum emissions were anticipated to be approximately 24.3 lb/hr during such periods. Because of the uncertainty, Asarco modeled this source at either 32.2 lbhr, three times the estimated design and 10 lb/hr higher than the anticipated maximum, for the current smelter process area boundary, and 40.1 lb/hr if an ongoing property purchase allowing expansion of the process area boundary occurs.

It is important to note that the variability analysis was conducted before the implementation of the CRP to attempt to create the maximum impact on emissions performance, before damping with controls post-CRP. This emissions variability analysis predicted more than 74,000 hours of hourly emission rates for the Main Stack, Flash Furnace fugitives, Converter Aisle fugitives and Anode Fugitives.

The forecasted emissions profile is in form of an Excel file and included in the modeling CD-ROM.

5.4   Determination of Forecasted Emissions Representativeness

Data quantity and quality: Asarco has operated continuous emissions monitoring systems (CEMS) on the three primary process emission points of the Hayden Smelter for over thirty years. Asarco has selected the years 2005 through February 2014, as the period of record because it provides a representative range of smelter operating conditions, including production rates and concentrate inputs, with the current smelter equipment. Asarco thus meets the requirement that it have "hourly data for at least 3 to 5 years of stable operation." (*EPA Guidance* for 1-Hour SO_2 Nonattainment Area SIP Submissions, 2014- page 30). The CEMS have followed EPA's quality assurance/quality control requirements pursuant to 40 C.F.R. Part 60, Appendices B and F.

Consideration of variability: A second consideration is whether Asarco can predict the resulting emissions profile with some degree of accuracy. In this case, it is challenging to make this determination. The primary goal of the Converter Retrofit Project is to direct more of the emissions from converting to Asarco's existing double contact acid plant. The acid plant will continue to operate as in the past. Neither Asarco nor its engineering consultant, Gas Cleaning Technologies (GCT), anticipate any significant change in the pattern of emissions from the acid plant as a result of the project with the exception that future peaks should be reduced due to the installation of an improved, larger preheater that can bring all four catalyst beds closer to optimum temperature before start of smelting in the flash furnace. This will reduce existing startup peaks by over 50%. Similarly, while Asarco is also proposing to add high surface area (HSA) lime injection to the secondary hood baghouse and the proposed vent gas baghouse, lime injection has been used on the secondary hood baghouse in the past and both the vendors and GCT are confident that lime injection will work at or above its 50% design efficiency during the periods of "peak" emissions of concern in this analysis. The concern, if any, with lime injection is that it may not achieve a full 50% control during periods of low emissions, but these periods do not present a challenge to NAAQS attainment.

Asarco also has planned and evaluated ducting improvements at the flash furnace for improved capture of fugitive emissions and better segregation of process gases from ventilation gases. Finally, Asarco is reasonably comfortable that modeling the secondary hood, vent gas baghouse and tertiary ventilation based on the existing emissions profile will overstate, rather than understate, future variability and hence is a conservative estimate of likely future performance. *See generally EPA Guidance at 30*.

Control device operation: The *EPA Guidance* suggests that variability due to nonoperation of control equipment needs to be considered. Asarco believes that the applied modeling approach addresses this requirement in two ways. First, Asarco always operates and is required to operate its acid plant when the associated smelting and converting operations are in operation. Second, Asarco included elevated emissions from Acid Plant startup emissions that may remain after installation of the Converter Retrofit Project in the emissions forecast used for calculating the limit under EPA's SO_2 Guidance.
With respect to the secondary hood baghouse, vent gas baghouse and anode furnace baghouse, Asarco is also required to operate them at all times. Their future emissions profiles are expected to be similar to existing profiles, with the exception of the secondary hood baghouse, which will no longer see significant blowing emissions. This change is accounted for in the forecast.

Control strategies: As demonstrated in the regional haze rule proceedings, Asarco's Converter Retrofit Project represents "best available" retrofit controls for the smelter. Asarco believes that no additional controls are practicable. *See generally EPA Guidance at 31.*

Source specific variation in operating rates and fuel sulfur content: During the period of time covered, ranging from 2005 to 2014, Asarco's operating rates ranged from less than 400,000 concentrate tons/year to close to the Converter Retrofit Project's design rate of 693,500 tons/year. Similarly, concentrates from the various mines in the Asarco fleet with typical variations in sulfur content were encountered. Asarco uses the sulfur in concentrate as the primary fuel for the smelting process. Asarco uses small quantities of natural gas for drying, heating and poling, but these uses do not substantially affect sulfur dioxide emissions. Asarco does not see any problem with this criterion. *See generally EPA Guidance at 31-32.*

Operating days: Asarco has calculated its emissions based upon operating days only and has excluded days where no operation has occurred. *See generally EPA Guidance at 32-33.*

Choice of limit: Asarco will use pound per hour (lb/hr) as the basis for its modeling exercise and limits. lb/hr is what is used to develop the g/sec required by AERMOD. Additionally, Asarco's process does not lend itself to developing a lb/unit of production measure because the operation consists of three distinct operations, smelting, converting, and anode refining/casting that occur over a considerable span of time and which are not fully dependent upon the timing of the prior activity. As a result, different units of production would apply, which renders a single production measure infeasible for the main stack. For fugitive emissions modeling purposes, Asarco will also use a lb/hr based on engineering analysis of post-CRP operations.

Based on the foregoing discussion, ADEQ and Asarco believe that the data set and projected emissions provide a representative estimate of likely future emissions that surpass the requirements in the *EPA Guidance*.[17]

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[17] For example, in *EPA Guidance* Appendix B, EPA notes that it assumed a different source was representative; it modeled three stacks as always emitting at the same rate, and assumed zero background concentration. As outlined below, Asarco is using emissions from the same source; modeling the dynamic contribution of each

5.5   Load Analysis

EPA and ADEQ modeling guidelines require evaluation of various operating loads for any proposed project emission sources where varying operating conditions could affect the plume rise.

The sources associated with the Hayden Smelter do have highly variable SO_2 emission rates, and ADEQ and Asarco will evaluate these in addressing emission limits. The Hayden Smelter has historically operated under a Multi-Point Rollback (MPR) table in its permit, which ADEQ incorporated to ensure compliance with the historic SO_2 NAAQS (3-hour, 24-hour and annual averages). A goal for the SIP submittal is to construct an analogous approach to identifying an emission limit that is protective of the maximum daily 1-hour SO_2 NAAQS. ADEQ and Asarco addressed variability by conducting an analysis of historic emissions and adjusting the historic emissions variability to reflect the changes at the Smelter contemplated by the Converter Retrofit Project (CRP). Changes in overall loading are addressed by ratioing emissions. Changes to the distribution of emissions are based on recommendations from Gas Cleaning Technologies (GCT), Inc., the design engineer, and encompass a reduction in peak values for the secondary hood system as blowing emissions captured by the secondary hood ventilation system are routed to the acid plant for control in lieu of the uncontrolled emissions currently routed to the main stack annulus through the secondary hood baghouse. Asarco conservatively did not eliminate all of the historic variability, but muted it to reflect the change in capture and control.

The final modeling reflects performance at both regular (design) emissions and includes startup and shutdown emissions to ensure the selected limits are protective of the NAAQS and accommodate the variance at the source.

A memo prepared by GCT is included in Appendix G to address the load analysis. According to this memo, the potential minimum flow conditions for the main stack are as follows:

- Flow: 756,100 ft^3/min, which results in an exit velocity of 6.2 m/s
- Temperature: 149 $^\circ$F (338.15 $^\circ$K)
- SO_2 emission rate: 386 lb/hr (48.64 g/s)

To make sure that these minimum flow conditions will not affect the CEV calculations, ADEQ performed CEV modeling using AERMOD for these new conditions. The results showed that the minimum flow conditions defined in GCT memo, will not affect the CEV calculated for the main stack. More details regarding CEV calculations are included in Section 8.

5.6   Good Engineering Practice (GEP) Stack Height

There are two definitions of Good Engineering Practice (GEP) stack height: (i) formula GEP stack height and (ii) regulatory GEP stack height. EPA requires sources to evaluate building downwash effects when a stack is less than formula GEP stack height. Regulatory GEP stack height is either 65 meters or formula GEP stack height, whichever is greater. The EPA does not allow sources to take credit for ambient air concentrations that result from stacks that are higher than regulatory GEP stack height unless they meet the formula stack height criteria.

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process and their fugitives (which were apparently not considered in EPA's modeling analysis) to the final result; and used a representative background value. *See EPA Guidance,* App. B.

As discussed in the ADEQ's June 2002 "Final Hayden Sulfur Dioxide Assessment Nonattainment Area State Implementation and Maintenance Plan"[18], the GEP height for Asarco's main stack was assessed in a fluid modeling study jointly conducted by North American Weather Consultants and Colorado State University, with that study concluding that the stack's 1,000-foot height meets GEP stack height requirements. EPA subsequently approved Arizona's SIP determination of GEP stack height. No structures have since been constructed at Asarco that would affect this determination.

At EPA's request in mid-2015, Asarco re-assessed the GEP stack height determination with respect to current GEP regulations. This re-assessment confirmed that the original GEP stack height determination is consistent with the 1985 regulations and that the 1,000-foot stack remains an appropriate GEP determination. Therefore, Asarco's main stack was modeled at its true height of 1,000 feet. A memo summarizing the re-assessment of the GEP stack height determination is provided in Appendix F.

After reviewing the available documents on the main stack GEP, ADEQ believes that using the actual height of the main stack in modeling is appropriate.

EPA's Building Profile Input Program for PRIME (BPIPPRM, version 04274; U.S. EPA, 2004a) was used to compute the formula GEP stack height and to generate wind-direction specific building profiles for each stack for the purpose of sequential modeling. BPIPPRM requires a digitized footprint of the facility's buildings and stacks. The source must evaluate the position and height of buildings relative to the stack position in the building wake effects analysis. Asarco obtained the building positions from a site plan of the proposed changes and identified coordinates for each of the existing building tier corners by mapping the site plan to rectified aerial photographs of the site. Asarco obtained roof heights for the proposed changes from preliminary designs of proposed facility structures and actual heights of existing structures. One can find simplified layouts of the facility in Figure 5-5. This figure also identifies stack locations.

The entire BPIPPRIM output is provided in the enclosed CD-ROM per the nomenclature described in Appendix B.

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[18] "Final Hayden Sulfur Dioxide Assessment Nonattainment Area State Implementation and Maintenance Plan," ADEQ, June, 2002

Figure 5-5: Simplified Facility Layout

Figure 5-5: Simplified Facility Layout
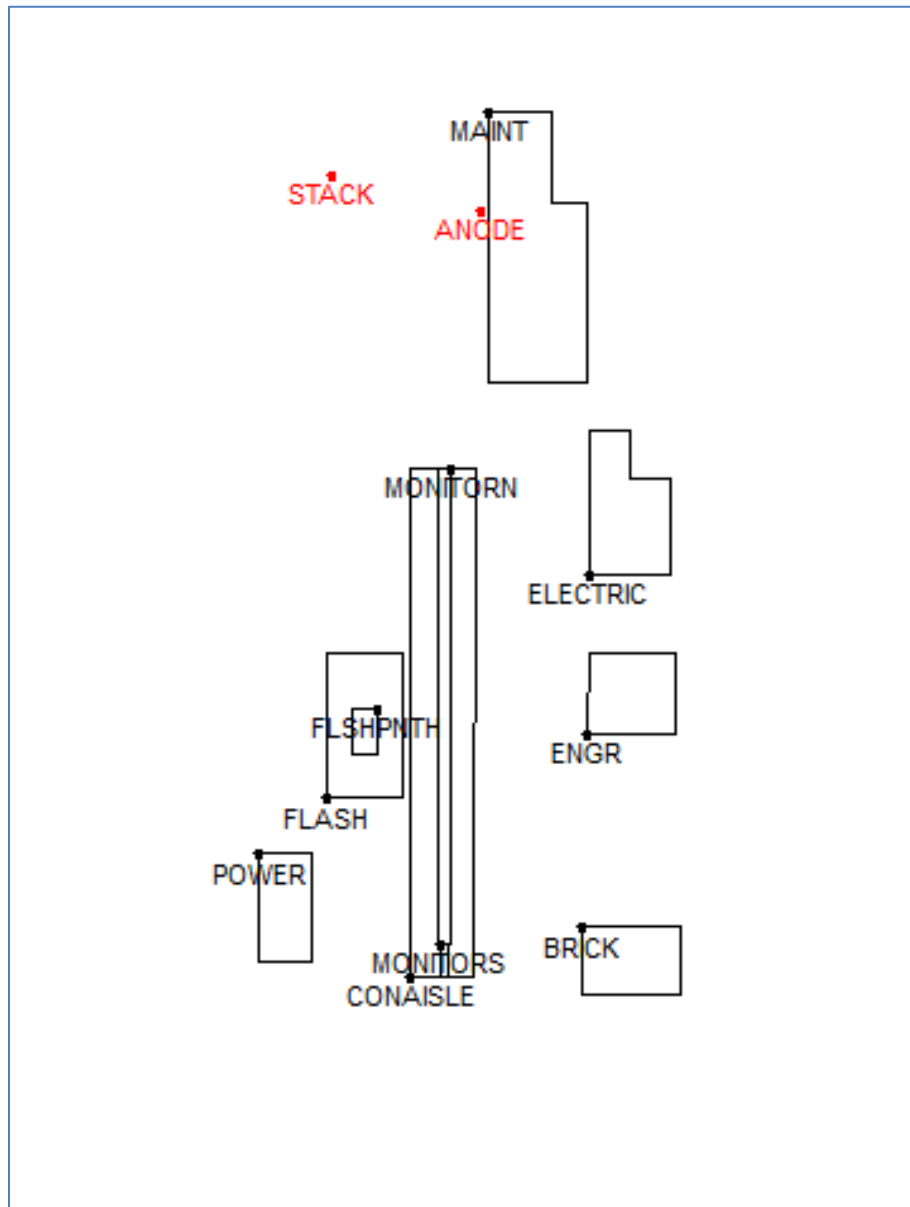
5.7   Urban/Rural Determination

Dispersion coefficients for air quality modeling are selected based on the land use classification technique suggested by Auer (Auer, 1978), which is EPA's preferred method. The classification determination involves assessing land use by Auer's categories within a 3-kilometer radius of the proposed site. A source should select urban dispersion coefficients if greater than 50 percent of the area consists of urban land use types; otherwise, rural coefficients apply.

Following Section 3.7 of the ADEQ Modeling Guidelines, Asarco classified the land use of the area using the land-use procedure set forth in EPA's "Guideline on Air Quality Models" (GAQM). This approach requires determining the amount of specific types of land use categories within a 3-km radius circle

centered on the source; if the total land use (as defined by Auer6) is classified as 50% or more "urban" then the area is designated as urban; otherwise it is designated as rural.

Land use (taken from the U.S. Geological Survey (USGS) National Land Cover Data (NLCD) 1992 archives) was examined for the 3-km radius circle, and totals of each land use category were calculated. These land use categories were then correlated to the categories as established by Auer, and the amount of urban and rural land use within 3 km of Asarco was calculated. The area near Asarco that was examined is depicted in Figure 5-6, while the results of the analysis are presented in Table 5-4.

Figure 5-6: Land Use near Asarco
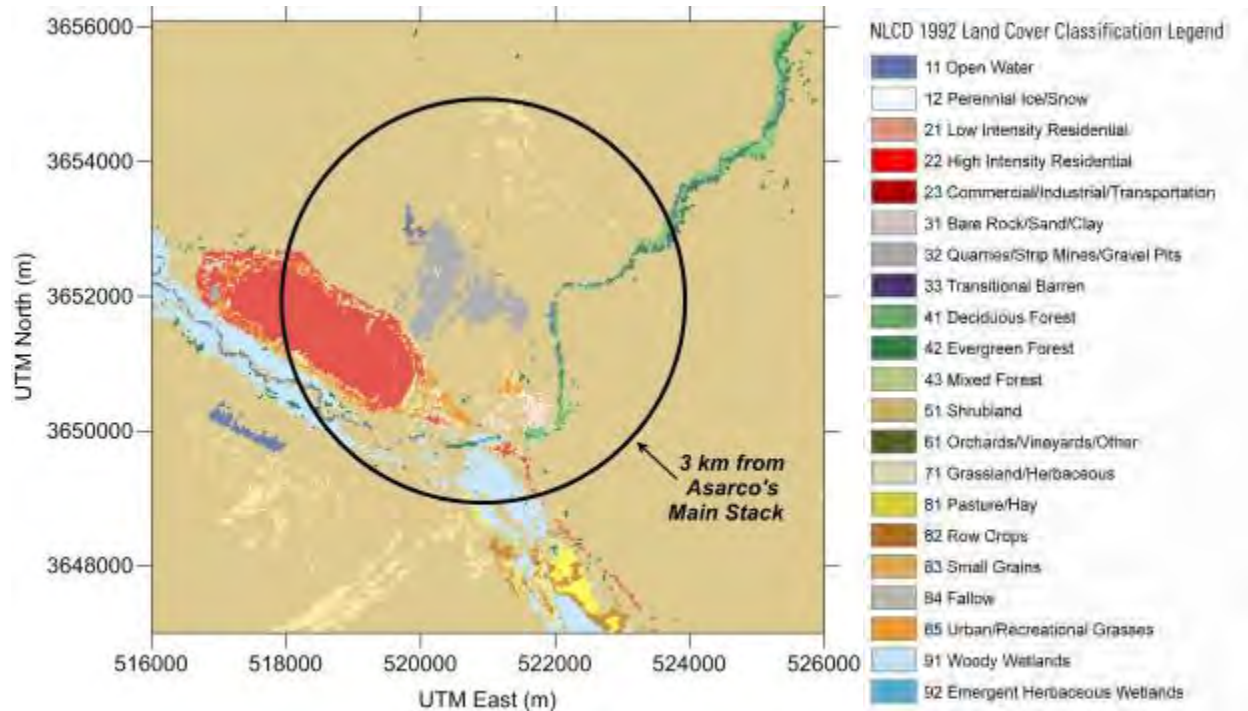
Table 5-4: Land Use within 3km of Asarco Smelter

1992 NLCD Land Use Category		% of Total Land Use within 3 km of Asarco	Auer Land Use Category		
Code	Description		Code	Description	Rural/Urban
11	Open Water	0.7	A5	Water Surfaces	Rural
12	Perennial Ice/Snow	0	A5	Water Surfaces	Rural
21	Low Intensity Residential	0.5	R1 / R4	Common/Estate Residential	Rural
22	High Intensity Residential	0	R2 / R3	Compact Residential	Urban
23	Commercial / Industrial / Transportation	7.4	C1 / I1 / I2	Commercial/Heavy Industrial/Light-Moderate Industrial	Urban
31	Bare Rock / Sand / Clay	0.1	A	N/A	Rural
32	Quarries / Strip Mines / Gravel Pits	3.9	A	N/A	Rural
33	Transitional	0	A	N/A	Rural
41	Deciduous Forest	0.8	A4	Undeveloped Rural	Rural
42	Evergreen Forest	0.7	A4	Undeveloped Rural	Rural
43	Mixed Forest	0	A4	Undeveloped Rural	Rural
51	Shrubland	79.8	A3	Undeveloped	Rural
61	Orchards / Vineyards / Other	0	A2 / A3 / A4	Agricultural Rural / Undeveloped / Undeveloped Rural	Rural
71	Grasslands / Herbaceous	2.5	A3	Undeveloped	Rural
81	Pasture / Hay	0	A2	Agricultural Rural	Rural
82	Row Crops	0	A2	Agricultural Rural	Rural
83	Small Grains	0	A2	Agricultural Rural	Rural
84	Fallow	0	A2	Agricultural Rural	Rural
85	Urban / Recreational Grasses	1.0	A1	Metropolitan Natural	Rural
91	Woody Wetlands	2.5	A3 / A4 / A5	Undeveloped / Undeveloped Rural / Water Surfaces	Rural
92	Emergent Herbaceous Wetlands	0	A3 / A5	Undeveloped / Water Surfaces	Rural

Nearly 80% of the land use within 3 km of Asarco is "shrubland" according to the NLCD92 classification scheme. Under the Auer scheme the sum of the percentage of land use categories classified as urban (R2, R2, C1, I1, and I2) is 7.4%; accordingly, the sum of the rural categories is 92.6%. Therefore, the area around Asarco is defined as "rural" and identified as such in the AERMOD input.

6.0   Meteorological Data

6.1   AERMET

EPA's AERMET tool (version 15181; EPA, 2015) was used to process meteorological data for use with AERMOD. AERMET merges National Weather Service (NWS) surface observations with NWS upper air observations and performs calculations of meteorological parameters required by AERMOD. Surface observations from on-site instruments can optionally be included. The latter can be useful because the data are more relevant to the site being modeled and in cases where on-site data are collected at multiple elevations above ground, AERMET can construct a more accurate vertical profile of meteorological data. In addition to the meteorological observations, AERMET further requires the inclusion of the characteristics of land use surfaces that Asarco calculated using EPA's AERSURFACE tool.

6.1.1   Surface Observations

EPA recommends that AERMOD be run with a minimum of 5 years of NWS data or 1 year of on-site meteorological data. The meteorological data used in the sequential modeling consists of on-site hourly surface observations collected by Asarco from a 10-meter tower located approximately 0.35 kilometers south of the smelter building, on Camera Hill. The meteorological data used in the modeling cover the period from August 16, 2013 through August 15, 2014, with the raw on-site data provided by Asarco. This meteorological monitoring station is located immediately adjacent the smelting complex, directly to the south. Figure 6-1 shows the location of the tower site relative to the proposed project.

The Camera Hill monitoring station is equipped with the following instrumentation:

- Wind speed, wind direction, standard deviation of horizontal wind, and ambient temperature at 10 meters;
- Ambient temperature at 2 meters;
- Atmospheric pressure;
- Relative humidity;
- Solar radiation; and
- Precipitation.

The installation meets the requirements of ADEQ and meets or exceeds EPA's recommendations available at the time of installation. Instrument performance is audited on a regular basis in accordance with ADEQ and EPA requirements.

Figure 6-1: Onsite Meteorological Station

6.1.2   Upper Air Observations

Upper air data were taken from the Tucson International Airport (WBAN 23160) in Tucson, Arizona.

6.1.3   AERSURFACE

Asarco used EPA's AERSURFACE tool to calculate the surface roughness length, albedo and Bowen ratio inputs required by AERMET. EPA developed AERSURFACE to identify these parameters within a defined radius from a specified point. In this case, Asarco input the UTM coordinates of the on-site meteorological tower to AERSURFACE along with a 1-kilometer radius per EPA guidance. Asarco acquired USGS National Land Cover Data (NLCD) for the area, and used these data as inputs to AERSURFACE. Asarco calculated the parameters for twelve compass sectors of 30° each, and by month. For the purposes of developing a meteorological dataset for use in AERMOD, terrain within 1 km of the meteorological monitoring station is considered when developing the surface roughness characteristics. Therefore, Asarco closely examined the area within 1 km of the Camera Hill meteorological tower and assigned the seasonal categories as follows:

- Late autumn after frost and harvest, or winter with no snow: none;
- Winter with continuous snow on the ground: none;
- Transitional spring (partial green coverage, short annuals): January – December;
- Midsummer with lush vegetation: none;
- Autumn with un-harvested cropland: none.

In particular, the Hayden Nonattainment Area does not see the wide seasonal fluctuation in vegetation seen in many other areas of the country. After discussions with ADEQ, Asarco adjusted the month-to-season definitions to reflect low level vegetation throughout the year.

Asarco selected surface moisture characteristics based on a comparison of the precipitation measured at Camera Hill during the meteorological monitoring period and the 30-year average value from 1980 to 2013 (data from 1994, 1995, and 1996 were missing) at the monitoring station in Safford, Arizona.

The amount of precipitation at Camera Hill during the monitoring period would have qualified as the 11th-most dry year at Safford, or well within the 50th percentile of the distribution of the 30 years of precipitation data from Safford. This means that the moisture level for the Camera Hill data is defined as average.

ADEQ/Asarco has provided the AERSURFACE input and output files on CD-ROM per the nomenclature described in Appendix B.

The Hayden Smelter on-site data (Camera Hill), Tucson upper air data and AERSURFACE land use data were processed with the AERMET meteorological processor. ADEQ/Asarco has provided the AERMET input and output files on CD-ROM per the nomenclature described in Appendix B.

6.1.4   Processed Data Completeness

Section 5.3.2 of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" states that to be acceptable for use in regulatory dispersion modeling a meteorological dataset must be 90% complete on a quarterly basis. The 90% requirement applies to wind direction, wind speed, and temperature. The data completeness for each year of processed data for input to AERMOD is presented in Table 6-1.

Table 6-1: Camera Hill Data Completeness

Year	Quarter	Wind Speed	Wind Direction	Sigma Theta	Temp. (10 m)	Temp. (2 m)	Pressure
2013	Q1	N/A	N/A	N/A	N/A	N/A	N/A
	Q2	N/A	N/A	N/A	N/A	N/A	N/A
	Q3	100%	100%	100%	100%	100%	100%
	Q4	100%	100%	100%	100%	100%	100%
2014	Q1	99%	99%	99%	99%	99%	100%
	Q2	100%	100%	100%	100%	100%	100%
	Q3	99%	99%	99%	99%	99%	99%
	Q4	N/A	N/A	N/A	N/A	N/A	N/A

6.1.5 Determination of Representativeness

Section 8.3 of GAQM stipulates that the representativeness of a meteorological dataset depends on four criteria:

- Spatial proximity
- Complexity of terrain
- Exposure of the meteorological monitoring site
- Period of time during which data are collected

These four criteria are examined below:

Spatial Proximity

The Camera Hill meteorological station is located on Asarco's property. As such, there is not a large distance between the location of meteorological data and either the sources of emissions or receptors being modeled. Therefore, these data satisfy the spatial proximity requirements of Section 8.3 of 40 CFR 51 Appendix W.

Complexity of Terrain

Because the Camera Hill meteorological station is located on Asarco's property (and therefore close to Asarco emission sources), the meteorological conditions at that location are influenced by the complexity of the terrain in a similar manner as are the sources of emissions being modeled. Therefore, these data satisfy the complexity of terrain requirements of Section 8.3 of 40 CFR 51 Appendix W.

Exposure of the Meteorological Monitoring Site

The Camera Hill meteorological monitoring tower is located at the top of Camera Hill, with no structures or significant vegetation in the area. Therefore, these data satisfy the exposure requirements of Section 8.3 of 40 CFR 51 Appendix W.

Period of time during which data are collected

The first full year of data available at Camera Hill were used in this analysis. Therefore, these data satisfy the temporal requirements of Section 8.3 of 40 CFR 51 Appendix W.

6.1.6 AERMET Processing

The Camera Hill surface data and the Tucson upper air data were processed using AERMET (Version 15181). Note that because cloud cover was not measured at Camera Hill, the Bulk Richardson method was used to estimate the heat flux under stable conditions, based on the low-level delta-temperature measurement.

7.0 Background Air Quality

EPA requires background air quality estimates be added to modeling results for comparison to the NAAQS. Asarco based estimates of the background air quality estimates of SO_2 proposed for the dispersion modeling analysis on measured data collected from five ambient air monitoring sites located in the Hayden area. Asarco used data measured during the smelter shutdown periods from 2008, 2009, 2011, 2013, and 2014 (only short duration shutdowns occurred in 2010 and 2012 that would not be representative of background):

- 2009: May 18 through June 28 (41 days);

- 2011: February 28 through March 24 (25 days); and

- 2013: March 18 through April 12 (26 days).

For isolated single sources such as the Hayden Smelter, the GAQM (U.S. EPA, 2005) specifically states, "Determine the mean background concentration at each monitor by excluding values when the source in question is impacting the monitor." Based on an initial analysis of the ambient air quality data, contributions from Hayden smelter operations dominate the vast majority of the measured SO_2 in the Hayden area. Asarco confirmed this by evaluating data measured only during hours of smelter operation shutdowns, during which Asarco recorded substantially smaller ambient air concentrations than when the smelter was operating. EPA's GAQM (U.S. EPA, 2005) defines background air quality as "pollutant concentrations due to: (1) Natural sources; (2) nearby sources other than the one(s) currently under consideration; and (3) unidentified sources."

The following methodology was used to develop a conservative SO_2 background concentration for the Asarco environs:

- The maximum daily 1-hr SO_2 concentrations for each monitor during each shutdown period were averaged;
- The highest of those three (shutdown period) concentrations for each of the five monitors was identified;
- The five (monitor locations) concentrations were averaged to derive an overall/area-wide average maximum daily 1-hr SO_2 concentration during shutdowns.

The nearby monitors considered are depicted in Figure 7-1 and Table 7-1, while Table 7-2 summarizes the SO_2 concentrations from these monitors. The derived 1-hr SO_2 background concentration, based on these five monitors, is 6.3 μg/m³.

Figure 7-1: SO₂ Monitors Near Asarco
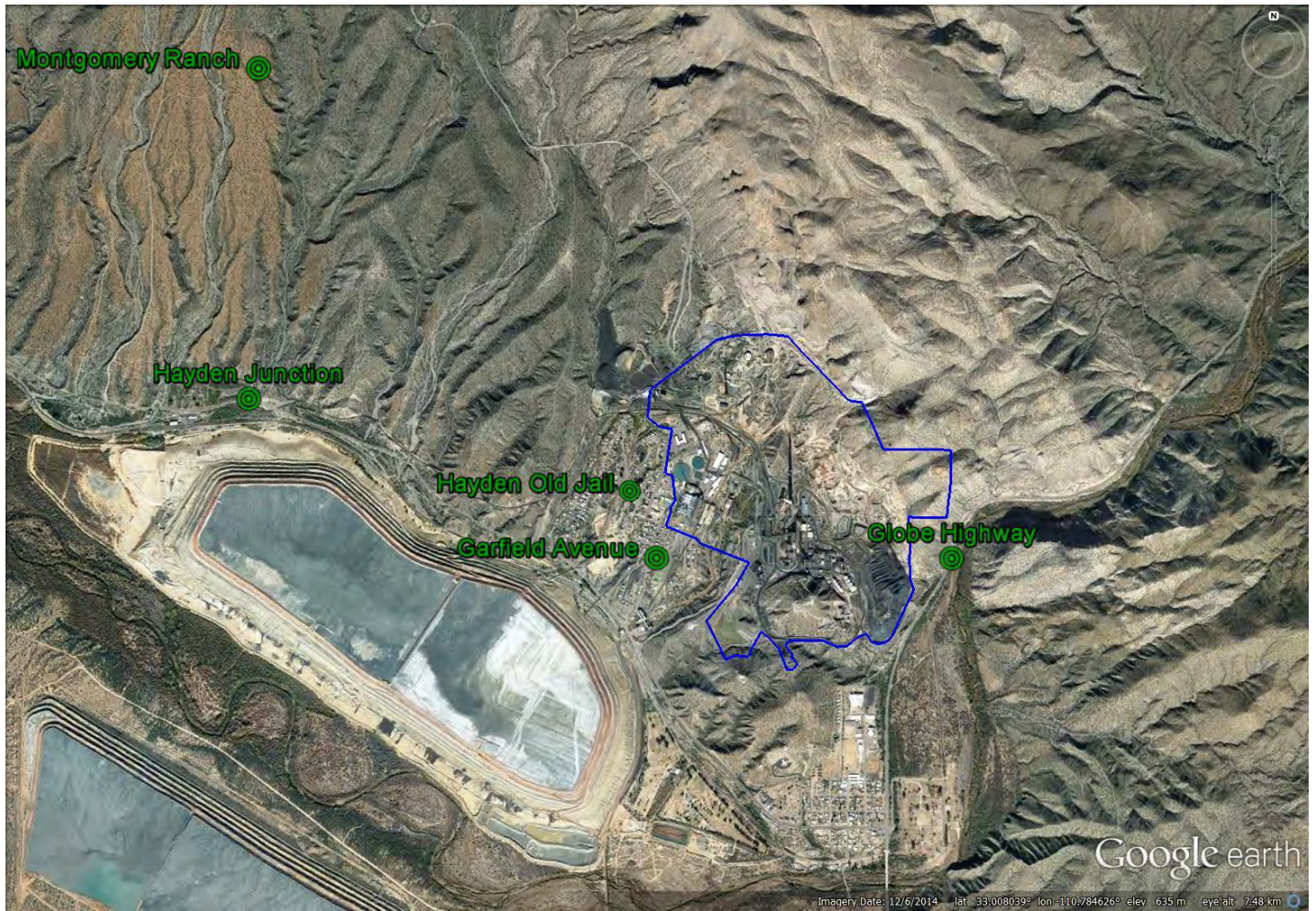
Table 7-1: Hayden SO₂ NAA Monitoring Network

Monitor	Latitude	Longitude
Garfield Avenue	33.00255	-110.78471
Globe Highway	33.00251	-110.76545
Hayden Old Jail	33.00621	-110.78645
Hayden Junction	33.01125	-110.81135
Montgomery Ranch	33.02898	-110.81026

Table 7-2: Determination of SO2 Background Concentration for Asarco Environs

Monitor	SO$_2$ Concentration by Year During Shutdowns			Max Over 3 Shutdown Periods
	2009	2011	2013	
	Avg Max Daily 1-hr	Avg Max Daily 1-hr	Avg Max Daily 1-hr	Avg Max Daily 1-hr
Garfield Avenue	3.7	2.7	7.0	7.0
Globe Highway	2.9	3.6	7.1	7.1
Hayden Old Jail	2.1	2.4	7.2	7.2
Hayden Junction	4.3	4.3	5.8	5.8
Montgomery Ranch	1.2	4.6	4.5	4.6
Average Over Five Monitors				6.3

Based on the above discussions, the Asarco Hayden Smelter facility is the only source of concern. Therefore, the Hayden Smelter was modeled exclusively and the impacts from other sources were taken into account with a representative background concentration.

More details concerning the calculation of this background concentration are presented in Appendix H.

8.0 Air Quality Modeling Results and Emission Limits

This section provides a discussion on the air quality modeling and emission limits for the Asarco Smelter. Modeling was performed for different purposes as part of this analysis:

- Determination of Critical Emission Value in order to define the longer term average emission limits, according to EPA's Guidance for 1-Hour SO$_2$ Nonattainment Area SIP Submission (EPA, 2014),
- Support the development of the State Implementation Plan (SIP) for the Haden NAA by demonstrating that Asarco's implementation of the CRP will result in the SO$_2$ NAAQS being attained.

8.1 Determination of Critical Emission Value

On April 23, 2014, EPA released a guidance document, "Guidance for 1-Hour SO$_2$ Nonattainment Area SIP Submissions," (Guidance), that provides guidance on how States can develop State Implementation Plans (SIPs) to comply with the 2010 1-hr SO$_2$ National Ambient Air Quality Standard (NAAQS). One of the issues addressed by the Guidance is how States can set emissions limits for averaging periods greater than 1 hour that are useful in ensuring compliance with the 2010 1-hr SO$_2$ NAAQS.

EPA suggests in its Guidance that it will consider establishing a longer-term emission limit (i.e., an averaging period greater than 1 hour) as the product of the 1-hr Critical Emissions Value (CEV) and the ratio of the 99th percentile emission rate of the averaging period in question to the 1-hr 99th percentile emission rate.

The guidance defines the critical emissions value as "*…the hourly emission rate that the model predicts would result in the 5-year average of the annual 99th percentile of daily maximum hourly SO_2 concentrations at the level of the 1-hour NAAQS, given representative meteorological data for the area.*"

To determine the critical emissions value, EPA guidance specifically states that dispersion modeling should be used.

The following discussion summarizes the application of EPA's Guidance to Asarco. Specifically, an overview of the dispersion modeling conducted to determine the CEV for the main stack is presented, the application of EPA's Guidance to establish an emissions limit greater than 1 hour is described, and Asarco's proposed emissions limits are presented.

8.1.1 CEV Modeled Emissions and Results

AERMOD was used to conduct the CEV modeling. To determine the CEV for the Main Stack the emission rates of the other sources were fixed at levels representative of their highest sustained hourly emissions:

- Flash furnace fugitive emissions were modeled at 28.7 lb/hr, which is its expected hourly maximum emissions during matte tapping and slag skimming.
- The converter aisle was modeled at 10.6 lb/hr, which is substantially above the design value of 3.0 lb/hr.
- The anode furnace fugitives were originally modeled at 32.2 lb/hr. However, after Asraco completed a land purchase on the east of the smelter, the new ambient air boundary allowed for a higher emission rate of 40.1 lb/hr to obtain the same CEV. This rate is nearly three times the emissions rate determined in the prior fugitive study which included all anode furnace emissions, not just current fugitive emissions.[19]

The fugitive emissions factors thus reflects approximately a 300% safety factor for the converter aisle; a 90% safety factor for the flash furnace building, and 270% safety factor for the anode furnaces compared to expected fugitive rates.

The receptor grids were the same as those described in Section 3, the meteorological data used in this modeling are the same data from the Camera Hill tower described in Section 6, and the background concentration was the same as described in Section 7.

The emission rates for the sources that were used in CEV modeling are listed in Table 8-1.

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[19] During the 1995-1996 Fugitive Study, the anode furnaces exhausted to the anode aisle roof monitor. As presently configured, the anode furnaces are exhausted to the anode furnace baghouse. Emissions from the 1995-1996 Fugitive Study should thus significantly overstate fugitive emissions from the current anode furnace configuration.

Table 8-1: Emission Rates Used in CEV Modeling

Emission Source	Modeled Emission Rate (gr/s)	Modeled Emission Rate (lb/hr)
Slag Pouring	0.51	4.1
Converter Aisle Fugitives	1.336	10.6
Flash Furnace Fugitives	3.616	28.7
Anode Furnace Fugitives	5.053	40.1

The modeling analysis indicated that a 1-hr SO_2 emission rate of 1518 lb/hr for the Main Stack produces a 4th-highest maximum daily 1-hr predicted concentration of 189.4 µg/m^3, which occurs about 1300 meters north of the facility fence line (520700 mE and 3654200 mN). When added to the background concentration of 6.3 µg/m^3, the total concentration is 195.7 µg/m^3, below the 1-hr SO_2 NAAQS of 196 µg/m^3. Therefore, the CEV for the Main Stack is 1518 lb/hr. Similarly, the fugitive sources were modeled at 79.4 lb/hr collectively. The CEV modeling files are included on the modeling CD-ROM.

Figure 8-1 shows isopleths of predicted design value SO_2 concentrations for CEV.

Figure 8-1: Isopleths of Predicted Design Value SO₂ Concentrations, CEV Case

189.4 μg/m³
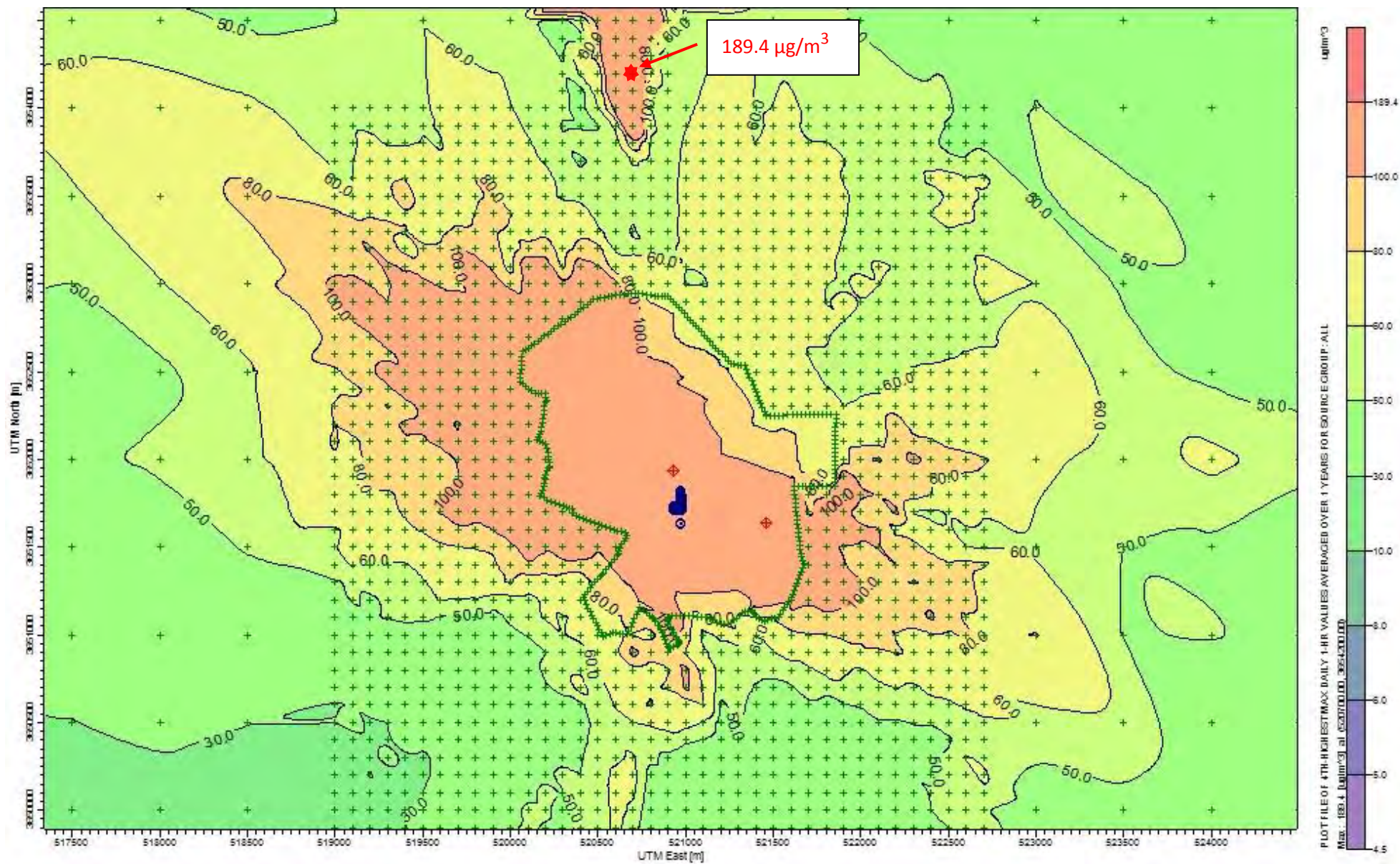
8.1.2   Determination of Emissions Limit for the Main Stack

The following steps follow the procedure presented in EPA's 1-hour SO_2 Guidance for establishing an emissions limit for an averaging period longer than 1 hour:

Step 1: Identify the CEV

As described earlier, the CEV for the Main Stack is 1518 lb/hr.

Step 2: Compile Future Emissions Profile

Asarco prepared an emissions profile to reflect its emissions after the construction of the proposed Converter Retrofit Project (CRP) based on engineering design calculations and estimations. The development of this emissions profile is described in Section 5.3 and the forecasted emissions profile is included in the CD-ROM.

Step 3: Revise Emissions Profile to create Emissions Averages Using the Preferred Longer Averaging Times

Asarco calculated averages for 24-hour, 7-day, 14-day, 30-day, 91-day (quarter) and 365-day (annual) averages. As shown in Table 8-5, the 24-hour averaging period was insufficient to address process variability from the source.

Step 4: Calculate the 99th Percentile Values

The 99th percentile emissions values are as presented in Table 8-2.

Table 8-2: 99th Percentile Value of Emission Rates (lb/hr)

Averaging Period	99th Percentile of Emission Rates (lb/hr)
1-hr	1339.27
24-hr	991.83
7- Day	960.21
14- Day	943.24
30-Day	929.91
91- Day (Quarter)	907.63
365- Day (Annual)	793.28

Step 5: Calculate the Ratio of the Longer Term Average Times to the 1-hour 99th Percentile

Table 8-3 presents the ratio of the longer term averaging period's 99th percentile emission rates to the 1-hr 99th percentile emission rate.

Table 8-3: Ratio of Longer Term Averaging Periods to 1-hr 99th Percentile, by Averaging Period

Averaging Period	99th Percentile Emission Rates (lb/hr)	Ratio of 99th Percentile Emission Rate to 1-hr 99th Percentile Emission Rate*
1-hr	1339.27	1.00
24-hr	991.83	0.74
7- Day	960.21	0.72
14- Day	943.24	0.70
30- Day	929.91	0.69
91- Day (Quarter)	907.63	0.68
365- Day (Annual)	793.28	0.59

Step 6: Multiply the ratio by the CEV to Determine the Final Limit

The final step in EPA's Guidance is to multiply the ratio of the 99th percentile emission rate for each averaging period to the 1-hr 99th percentile emission rate by the CEV to calculate a limit for each averaging period. Table 8-4 presents this calculation.

Table 8-4: Derivation of Emissions Limits for Longer Term Averaging Periods

Averaging Period	Ratio of 99th Percentile Emission Rate to 1-hr 99th Percentile Emission Rate*	Emissions Limit (lb/hr) Product of Ratio and CEV*
1-hr	1.00	1518.00
24-hr	0.74	1124.20
7- Day	0.72	1088.35
14- Day	0.70	1069.12
30- Day	0.69	1054.02
91- Day (Quarter)	0.68	1028.76
365- Day (Annual)	0.59	899.15
*The CEV is 1518 lb/hr		

To determine which proposed emissions limits would be achievable, the proposed limits were compared against the expected emissions distribution of the CRP to determine whether or not a proposed emissions limit would be expected to be exceeded based on its anticipated emissions profile. This analysis is summarized in Table 8-5.

Table 8-5: Emissions Limit Exceedance for the Proposed Longer Term Averaging Periods

Averaging Period	Emissions Limit (lb/hr) Calculated Per Guidance	Number of Hours Exceeding Emissions Limit	Expected Limit Exceedance Rate
24-hr	1124.20	160	0.22%
7- Day	1088.35	0	0.00%
14- Day	1069.12	0	0.00%
30 -Day	1054.02	0	0.00%
91- Day (Quarter)	1028.76	0	0.00%
365- Day (Annual)	899.15	0	0.00%

Asarco next compared the limits calculated in Table 8-4 with the forecast emissions rate for each of the averaging periods. The maximum forecast 14-day value is 1006.2 lb/hr. Asarco therefore concludes that the limit is reasonably achievable and that there is a fair compliance margin to allow continuous compliance with the limit while protecting the NAAQS. Therefore, Asarco has proposed the 14-Day average limit of 1069.1 lb/hour for the main stack.

For the roofline fugitives, Asarco elected to use the Critical Emissions Values for the flash furnace fugitives, converter aisle fugitives, and anode furnace fugitives. Accordingly, the flash furnace fugitives were modeled at 28.7 lb/hr every hour, the converter aisle fugitives at 10.6 lb/hr for every hour, and the anode furnace fugitives at 40.1 lb/hr for every hour using the current process area boundary.

8.2   Supporting Modeling to Demonstrate Attainment

A modeling analysis was performed on the projected future actual 1-hour emissions to demonstrate that the Hayden NAA would be in compliance with the NAAQS with the proposed 14-day rolling average emission limit.

The modeling analysis applied the projected future hourly emissions for the main stack, which were based on the aforementioned existing measurements of hourly emissions from January 2005 through December 2013. The stack's projected hourly emissions along with the post-CRP temperature and exit velocity were used to prepare an AERMOD compatible hourly emission rate file for each year. The roofline fugitive emissions were the same as the emission rates used in the CEV modeling. Slag Pouring was also modeled with the same emission rate as used in CEV modeling. Table 8-6 shows the emission rates used in the modeling.

The receptors grid and meteorological data used for this modeling were consistent with the ones described in Sections 3 and 6. However, the onsite met data SFC and PFL files were revised so that the year of the data matched the year of emissions data.

ARMOD was then run for each year to predict the design concentration at each receptor in the grid. The results at the worst case receptor (188.12 $\mu g/m^3$) were summed with the background concentration of 6.3 $\mu g/m^3$ and resulted in a concentration of 194.42 $\mu g/m^3$, which is below the SO_2 NAAQS of 196 $\mu g/m^3$.

The results of this modeling is summarized in Table 8-7 and the modeling files are included in the CD-ROM.

Table 8-6: Emission Rates used in Supporting Modeling for Attainment Demonstration

Emission Source	Modeled Emission Rate (gr/s)	Modeled Emission Rate (lb/hr)
Main Stack	Varies*	Varies*
Slag Pouring	0.51	4.1
Converter Aisle Fugitives	1.336	10.6
Flash Furnace Fugitives	3.616	28.7
Anode Furnace Fugitives	5.053	40.1
*projected Hourly emission profiles were prepared for the main stack based on CEMS data from 2005 to 2013 and post-CRP controls.		

Table 8-7: Modeling Results for 1-Hour SO$_2$ NAAQS to Support Attainment

Year	Main Stack- 4th Highest Max Daily 1-Hour Concentration ($\mu g/m^3$) [a]	Fugitives- 4th Highest Max Daily 1-Hour Concentration ($\mu g/m^3$) [b]	All Sources- 4th Highest Max Daily 1-Hour Concentration ($\mu g/m^3$) [c]	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$) [d]
2005	86.53	188.12	188.12	6.3	194.42
2006	58.99	188.12	188.12	6.3	194.42
2007	88.25	188.12	188.12	6.3	194.42
2008	107.75	188.12	188.12	6.3	194.42
2009	108.72	188.12	188.12	6.3	194.42
2010	85.19	188.12	188.12	6.3	194.42
2011	84.49	188.12	188.12	6.3	194.42
2012	80.24	188.12	188.12	6.3	194.42
2013	95.07	188.12	188.12	6.3	194.42

a. Highest stack concentrations predicted to occur 2100-3300 m north of the main stack.
b. Highest fugitives concentrations predicted to occur at 520589.50m E, 3651601.80m N, west of the Flash Furnace, and along the Asarco AAB.
c. Highest total concentrations predicted to occur at 520589.50m E, 3651601.80m N, west of the Flash Furnace, and along the Asarco AAB.
d. SO$_2$ NAAQS= 196 $\mu g/m^3$

8.3   CEV Exceedance Risk Analysis

The CEV Exceedance Risk Analysis for the main stack provides an overview of emissions from the Asarco Smelter and shows that:

1) Hourly emissions above the CEV are predicted to be a rare occurrence; and

2) These high emission rates are very unlikely to occur when the meteorology is conducive for high ambient concentrations of SO_2.

The results of this analysis showed that the hourly emissions above the CEV are predicted to be a rare occurrence as only 0.32% of hourly emissions are expected to exceed the CEV. In addition, these high emission rates are very unlikely to occur when the meteorology is conducive for high ambient concentrations of SO_2. Even the highest expected emission rate from the Smelter will only have a 1.66% chance of leading to an exceedance during a single hour.

Detailed methodology and results of the analysis are provided in Appendix I.

8.4   Dual Limit Analysis

ADEQ has proposed the following emission limit for the Asarco smelter:

> *Emissions from the Main Stack shall not exceed 1069.1 pounds per hour on a 14-operating day average unless 1518 pounds or less is emitted during each hour of the 14-operating day period.*

This "dual limit" has been pursued by Asarco for the operational flexibility it extends, especially considering some uncertainties regarding control efficiencies for Converter Retrofit Project (CRP) controls that haven't been installed. ADEQ proposed this dual limit and after review EPA expressed concerns with it and stated that "[t]his combination does not provide the protection against violations of the NAAQS that either limit by itself provides, nor does this combination provide the protection against NAAQS violations contemplated in EPA's guidance".

ADEQ performed an analysis on the dual SO2 limits and their impact on the Hayden Nonattainment Area. The results of the simulations show that there is functionally no difference between the expected ambient impacts of the dual limit and the 14-day guidance limit. Detailed methodology and results are provided in Appendix K of this TSD.

8.5   Modeling Results for Former SO$_2$ NAAQS (3-hr, 24-hr, and Annual)

Modeling results for the former SO$_2$ NAAQS are summarized in Table 8-8.

Table 8-8: Modeling Results for Former SO$_2$ NAAQS

Averaging Period	Predicted Controlling Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Concentration (µg/m^3)	NAAQS (µg/m^3)
3-hr	142.96 [a]		149.26	1300
24-hr	68.54 [b]	6.3	74.84	365
Annual	12.25 [c]		18.55	80
a. H2H 3-hr concentration predicted to occur at (520589.50 m, 3651601.80 m)				
b. H2H 24-hr concentration predicted to occur at (520633.20 m, 3651586.00 m)				
c. Highest annual concentration predicted to occur at (520222.5 m, 3651949.50 m)				

All controlling concentrations were predicted to be below the applicable NAAQS. Details on the results for each averaging period are given below:
- The highest second-high (H2H) 3-hr and 24-hr concentrations were predicted to occur approximately 300 m southwest of the Flash Furnace building, along the Asarco AAB.
- The highest annual concentration was predicted to occur approximately 700 m west of the Flash Furnace building, along the Asarco AAB.

It should be noted that these results are conservative, as they are all based on a worst-case hourly emission rate. Furthermore, as shown in the preceding table, when one conservatively adds the 1-hr background concentration of 6.3 µg/m^3 to the predicted controlling concentrations, all total concentrations are still far below each of the SO$_2$ NAAQS.

Plots of the controlling 3-hr, 24-hr, and annual impacts are depicted in Figures 8-2 through 8-4.

Figure 8-2: Predicted 3-hr SO₂ Concentrations
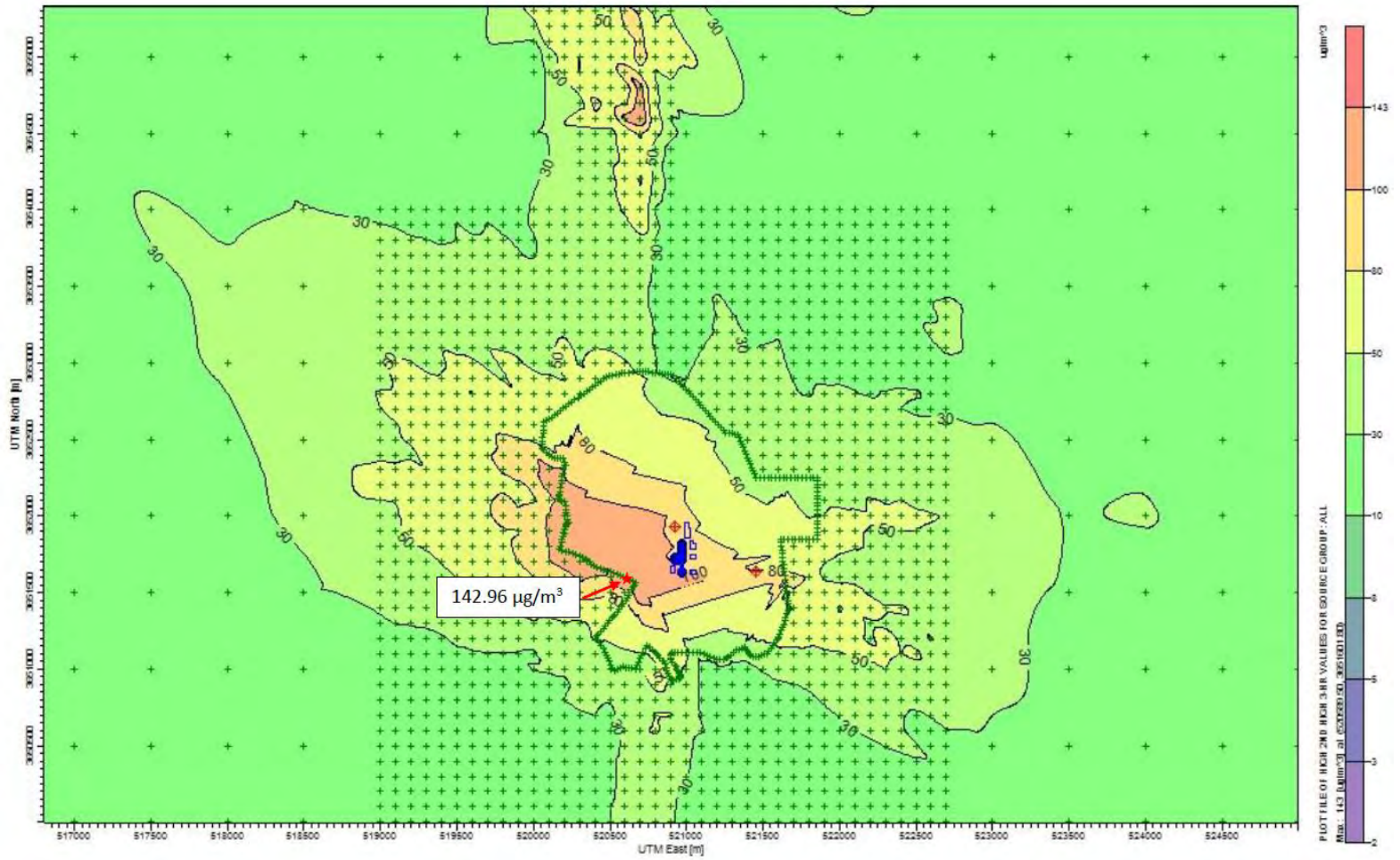
Figure 8-2: Predicted 3-hr SO₂ Concentrations

Figure 8-3: Predicted 24-hr SO₂ Concentrations

Figure 8-3: Predicted 24-hr SO₂ Concentrations

Figure 8-4: Predicted Annual SO₂ Concentrations
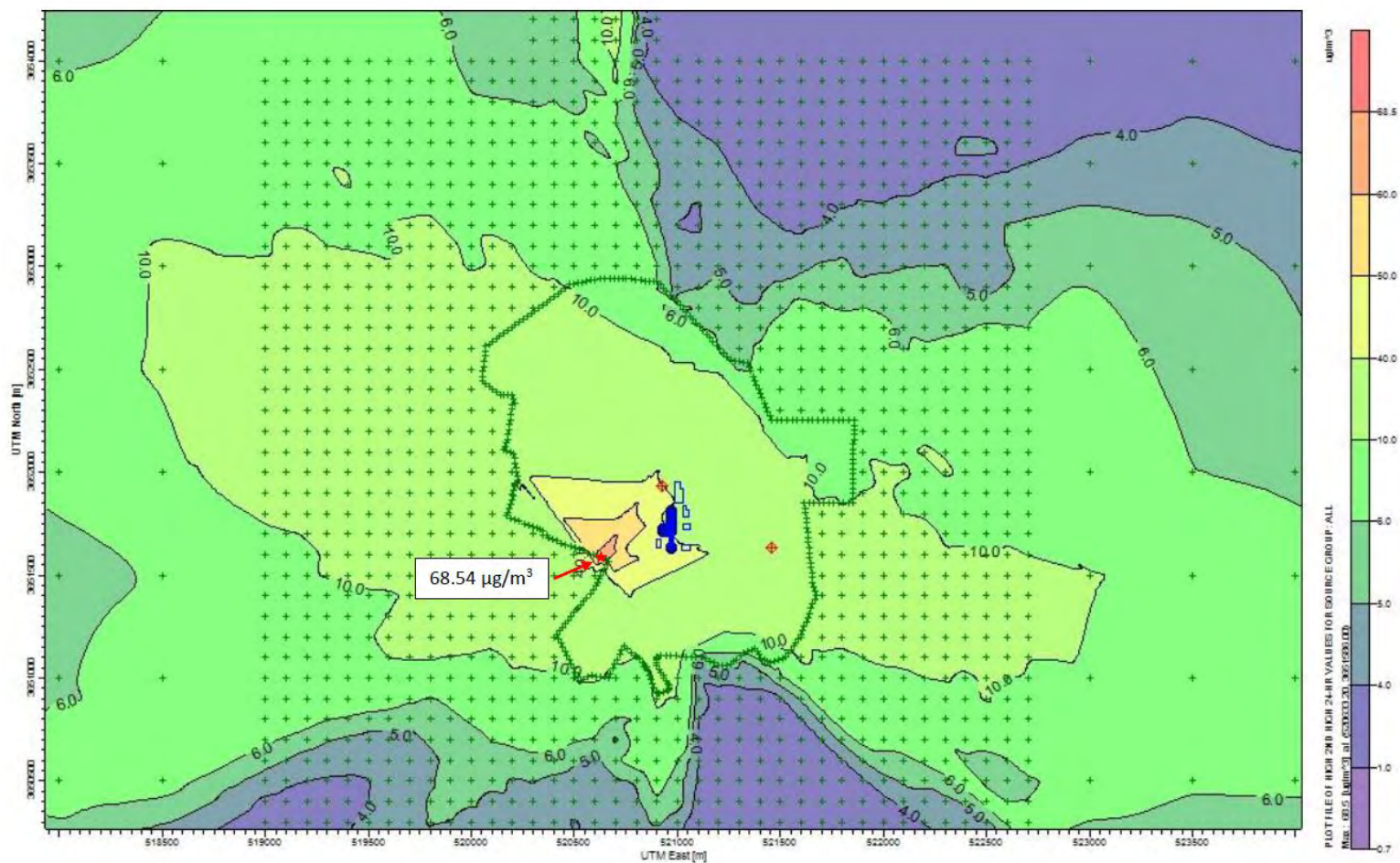
Figure 8-4: Predicted Annual SO₂ Concentrations
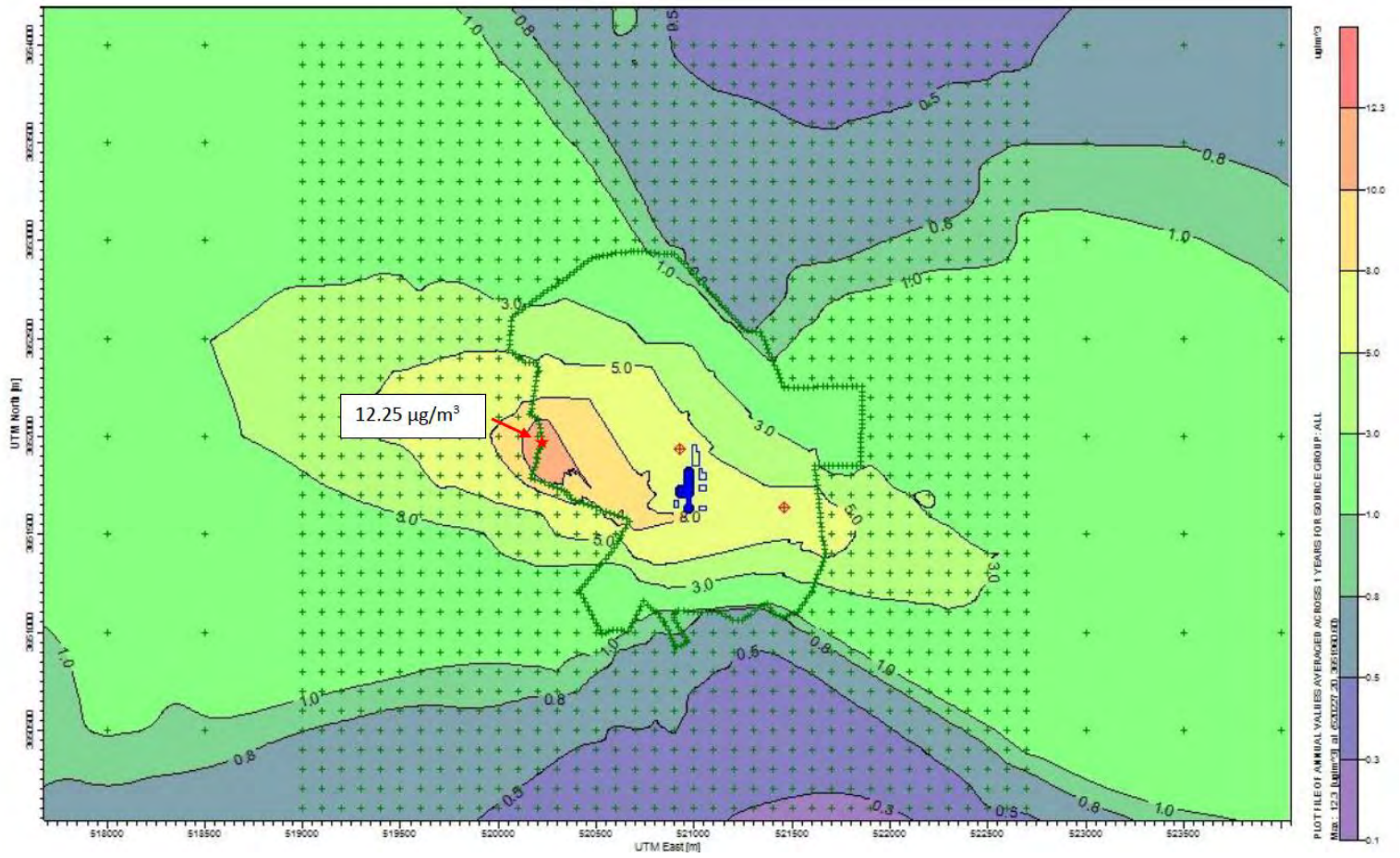
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10.0 Appendices

10.1 Appendix A: ADOA Population Estimation Methodology

Shapefiles:

- Hayden SO$_2$ nonattainment boundary shapefile
- Gila County 2010 block/population shapefile

Population Data Source:

- ADOA Internal Population Report

Method:

The ADOA methodology determines population from an internal population report that contains census population figures from 1990 through 2010 as well as ADOA interscensal population estimates and projections.

1. ADOA uses ArcGIS Geoprocessing tools to calculate the population of the incorporated places and unincorporated areas (including CDP and Non-CDP areas) within the Hayden NAA. ADOA used the following method to calculate the total population inside of the Hayden NAA:
   a. Calculate the area of the census block using the calculate "areas" tool
   b. Merge the two shapefiles using the "union" tool
   c. Determine the proportion of each census block within the Hayden NAA using the "calculate areas" tool.
   d. Calculate the area weighted population for each census block
   e. Aggregate the population for each incorporated and unincorporated place within the Hayden NAA using the Dissolve Tool
2. In step 1, ADOA derived their population for all incorporated places (or their respective parts), Census Designated Places (CDP) and unincorporated non-CDP areas in the Hayden area from the 2010 Census. ADOA used the following steps to estimate population figures for all areas of each year from 1990-2018:
   a. Apply the Constant-Share ratio of the population for each year for Gila and Pinal Counties
   b. Apply the ratio to each year for the total population in the CDPs and unincorporated non-CDPs in Hayden NAA
   c. Multiply the population of the CDPs and unincorporated non-CDPs in the Hayden NAA by the 2010 Census population ratio for each year

10.2 Appendix B: CD-ROM File Nomenclature

Due to their large size and cumbersome format, certain supporting documentation has been included in an enclosed CD-ROM. The files include:

- AERMAP.zip
- Structure Downwash Analysis.zip
- AERMET, Camera Hill.zip
- CEV Modeling
- Modeling to Support Attainment Demonstration
- Forecasted Emissions Profile (Excel File)

LAW OFFICES

JORDEN HISER
& JOY, P.L.C.

5080 N. 40ᵀᴴ STREET, SUITE 245
PHOENIX, ARIZONA 85018
TELEPHONE: 480-505-3900
FACSIMILE: 480-505-3901

ERIC L. HISER

DIRECT LINE: 480-505-3927
e-mail: ehiser@JHJLawyers.com

MEMORANDUM

TO: ADEQ SIP Group; U.S. EPA Region 9 SIP Group

FROM: Eric L. Hiser

DATE: September 16, 2016

SUBJECT: Justification of Asarco Hayden ambient air boundary

As requested by ADEQ and EPA, Asarco is providing the following more refined ambient air boundary around its facility, including the following explanation of why this boundary represents a practical ability to preclude entrance from the general public. Asarco is following precedent established by EPA for the Kennecott smelter in Utah.

As EPA observed regard to the Kennecott smelter when a similar question was raised: "the cumulative effect of Kennecott's property holdings, property exchanges, installation of fences, posts, and no trespassing signs, and security patrolling supports the Company's claim to control and exclusive use of the relevant Property." 50 Fed. Reg. 7056, 7057 (Feb. 20, 1985). EPA guidance is also clear that "'Preclude' does not necessarily imply that public access is absolutely impossible, but rather that the likelihood of such access is small." EPA, June 22, 2007, "Interpretation of 'Ambient Air' in Situations Involving Leased Land Under the Regulations for Prevention of Significant Deterioration (PSD)." As in the Kennecott case, Asarco believes that the cumulative effect of the rugged terrain, its fencing, physical barriers, and active patrolling of the smelter and concentrator sites, combine to ensure that the likelihood of public access is small.

The attached contour map shows the Hayden smelter and surrounding area. Asarco has set forth the proposed ambient air boundary (AAB) in light blue, with other colors on the outside representing the type of barrier used to exclude the public. The following explanation follows the contour map and proposed AAB clockwise, starting at the top with "A".

A. **Northeast section of smelter site.** In this area, the smelter backs up against the Dripping Springs mountains. These mountains are extremely rugged, on a high slope, and cannot easily be accessed from the sides or rear. These areas are identified by orange cross hatching. Asarco has defined the AAB at the north along its quarry access road; then along a section of cliff, and then along another access road, and finally along a section of very steep terrain adjoining the slag pile. In much of this area, Asarco security patrols either patrol the roads or can see the terrain from areas where they patrol. The combination of impassable terrain and security patrols creates a practical ability to exclude the general public.

- **Photo A.1.** Photograph of Dripping Springs Mountains looking east behind smelter site.

B. **Southeast section of smelter at slag pile and contractor gate.** In this area, the smelter site opens up into the Gila River Valley. Asarco has defined the AAB at the north end and to the contractor gate as the edge of the slag pile. The slag pile is nearly vertical and the rock is both loose in places and jagged (slag is glass-like), making access to the smelter over the slag pile essentially impassable. This area is defined by the orange cross hatching. Asarco security patrols the road areas on top of the slag pile. The combination of impassable terrain and security patrols creates a practical ability to exclude the general public.

  - **Photo B.1.** Photograph of slag area at exit from Highway 77.
  - **Photo B.2.** Photograph of slag area and signage at exit from Highway 77.
  - **Photo B.3.** Photograph showing height of slag in area.

C. **Contractor gate area.** In this area, which is located in the south-southeast, Asarco has its contractor gate. The AAB follows the fence line in this area. The fence is a 6 foot chain link topped by barbed wire. The fence is marked by the yellow shading. The contractor gate is manned by Asarco security 24 hours a day. The area is also patrolled by Asarco security. The combination of the gate, security and security goals creates a practical ability to exclude the general public.

D. **South smelter loop road way.** In this area, the smelter is situated above a steep valley. There is also a partial fence near the property boundary considerably south of the proposed AAB. Asarco has drawn the AAB to follow the south side of the smelter loop road, which is the primary access between the contractor gate and the smelter proper. This area is heavily traveled, patrolled by Asarco security and access requires crossing a fence close to the highway and climbing a steep valley side (indicated with orange cross hatching) to reach the loop road, all exposed to view from the road. The combination of rugged terrain, partial fencing, and security patrols creates a practical ability to exclude the general public.

  - **Photo D.1.** Photo looking down from edge of smelter loop road.
  - **Photo D.2.** Photo looking across at smelter loop road.

E. **Former Smithco revert crushing area.** This is an elevated ridge upon which Smithco, an Asarco contractor, formerly operated a revert crushing area. It extends to the west back along the loop road. Asarco has drawn the AAB along the fence line in this area. The fence is a 6 foot chain link fence surmounted by razor wire (indicated with the dark black line; regular 6 foot fence with barbed wire is shown in yellow). Asarco will maintain at least the 6 foot chain link fence in this area; it is also considering placing receptors to the south of the smelter loop road to allow the possibility of pulling the fence line back to the loop road in the future without affecting the attainment demonstration. The area is patrolled by Asarco security. The combination of the fence and security patrols creates a practical ability to exclude the general public from this area.

  - **Photo E.1.** Photo showing typical fence with razor wire.

F. **Calcium sulfate pond.** This area is a fenced calcium sulfate pond that will be closed and remediated in the future. Asarco has drawn the AAB along the fence line. The fence is a 6 foot chain link fence topped with barbed wire (indicated with yellow shading). The

area is easily viewed by security patrols along the smelter loop road. The combination of fence and security patrols creates the practical ability to exclude the general public.

G. **Powerhouse Canyon area.** Powerhouse Canyon is a geographic feature in the central part of the smelter area and divides the concentrator from the smelter. The smelter main gate road goes up the right side of the canyon on the top; the concentrator haul road runs at the bottom. The left side is characterized by steep cliffs (shown by the orange hatching). The bottom of Powerhouse Canyon is the Asarco secondary/tertiary crusher and is controlled by a gate and fencing (shown with yellow shading). The AAB is shown with two possibilities: Option A follows the existing fence line to around the health clinic and then new fencing and a gate will be added at the health clinic and fencing will extend to the start of the steep canyon wall, the canyon itself would not be fenced; Option B pushes further down the smelter main gate access road below the bunk house and then new fencing and a gate will be added below the bunk house and the fencing will extend to the start of the steep canyon wall, the canyon itself would not be fenced. This area is patrolled by Asarco security and subject to observation from the health clinic as well. The combination of fence, rugged terrain, employee observation and security patrols creates the practical ability to exclude the general public.

H. **Town of Hayden area.** Inside the Town of Hayden, Asarco has a six foot chain link or masonry fence, topped with barbed wire (shown with yellow shading), extending up from Powerhouse Canyon along the property boundary and continuing west and north all the way to the railroad tracks on the northeast side of the smelter. Asarco has drawn the AAB along this fence line. The combination of the fence line and Asarco security patrols creates the practical ability to exclude the general public from this area.

I. **Northwest area.** The railroad tracks are located on a steep, difficult to access embankment; further west, the Kennecott slag pile creates a steep, jagged impassable physical barrier; north of the Kennecott slag pile are steep ravines with cholla and other cactus that preclude casual travel. These areas are marked by the orange hatching. Asarco drawn the AAB following the quarry access road, which is patrolled by Asarco security. The combination of the rugged terrain, slag piles, steep slopes, and security patrols creates the practical ability to exclude the general public from this area.

- **Photo I.1.** This photo shows Dripping Springs Mountains behind plant.
- **Photo I.2.** This photo shows Dripping Springs Mountains central area behind plant.
- **Photo I.3.** This photo shows the rugged terrain north of the plant.
- **Photo I.4.** This photo shows concrete barriers, gate and no trespassing sign on road approaching plant site from north.

Asarco hopes that this information is helpful. Please call Jack Garrity, Amy Veek or Eric Hiser if you have any questions.

ASARCO HAYDEN OPERATIONS
PROCESS AREA BOUNDARY

ASARCO
GRUPO MEXICO
Hayden Operations

Photo A.1- Dripping Spring East
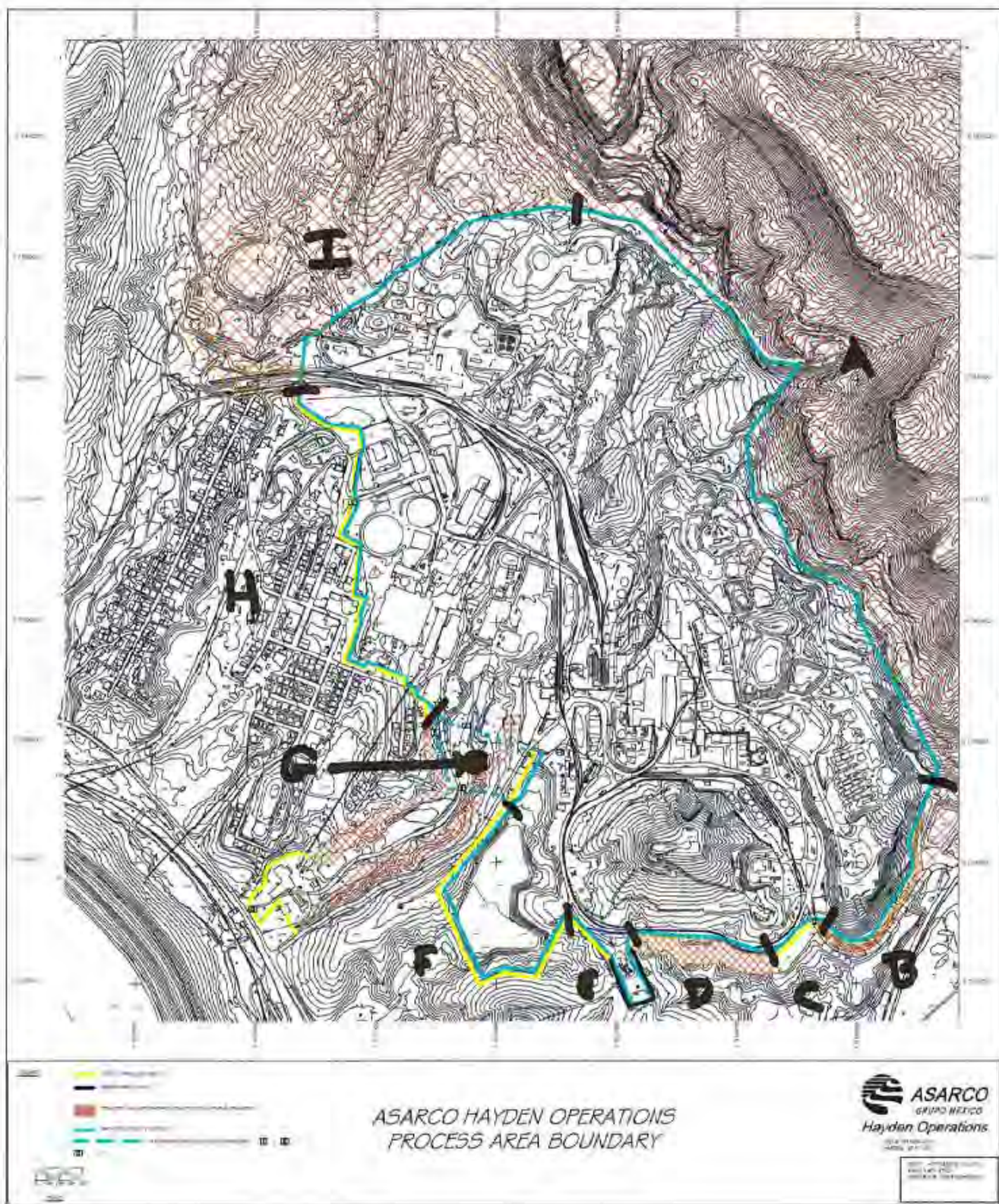
Photo A.1 Dripping Spring East

Photo B.1-Slag

Photo B.3- Slag

Photo D.1- Looking Down from Loop Road

Photo D.1 Looking down from loop road

Photo D.2- Looking Across at Loop Road

Photo E.1- SmithCo. Razor Wire Fence

Photo I.1- Dripping Springs West

Photo I.2- Dripping Springs Central

Photo I.3- Rough Terrain to North

Photo I.4- Barricade on Road in North

Photo I.4 - Barricade on road in north

10.4 Appendix D: Performance Evaluation of AERMOD/BLP Hybrid Approach Memorandum

TO: Michael Burton, ADEQ

FROM: William B. Jones, Osman Environmental Solutions, LLC

CC: Jack Garrity, Asarco
            Amy Veek, Asarco
            Eric Hiser, Jorden Bischoff & Hiser, PLC

DATE: April 2, 2015

SUBJECT: Appropriateness of AERMOD as model of choice in Asarco's SO_2 modeling

ASARCO LLC (Asarco) and the Arizona Department of Environmental Quality (ADEQ) are currently developing a State Implementation Plan (SIP) for the Hayden SO_2 Nonattainment Area (NAA). To that end, Asarco has proposed to construct a Converter Retrofit Project (CRP) at the Hayden Smelter which will substantially reduce its SO_2 emissions. One of the key aspects of that SIP development is an air quality modeling analysis to demonstrate that the CRP will result in attainment of the 2010 SO_2 National Ambient Air Quality Standard (NAAQS).

Over the past year, Asarco has conducted extensive air quality dispersion modeling of its SO_2 emissions using two dispersion models approved by the United States Environmental Protection Agency (EPA): AERMOD and the Buoyant Line and Point Source (BLP) model. Specifically, Asarco has run AERMOD alone as well as a "hybrid" of AERMOD and BLP[1].

This memorandum presents why AERMOD is the appropriate model to use in the case of Asarco, and furthermore, why the incorporation of BLP into a modeling analysis for Asarco is not appropriate.

Why AERMOD is appropriate for Asarco modeling

Historically AERMOD has been the model used by Asarco in its SO_2 modeling. AERMOD is a dispersion model that addresses both surface and elevated sources, and can predict concentrations in both simple and complex terrain—all features of Asarco's facility and the Hayden NAA. Furthermore, AERMOD is a model approved by EPA per the Guideline on Air Quality Models[2], and is, by far, the model most-frequently used in dispersion modeling analyses today.

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[1] BLP was used to estimate hourly-varying plume heights for the Converter Aisle and Flash Furnace building roof monitors, with those hourly-varying plume heights input as hourly-varying release heights in AERMOD. In AERMOD the Converter Aisle and Flash Furnace building roof monitors were simulated as volume sources.
[2] Appendix A to 40 CFR 51, Appendix W

Why BLP is not appropriate for Asarco modeling

BLP was developed specifically for aluminum reduction plants, which "…are a complex arrangement of emission sources, composed of parallel, low-level buoyant line sources called potrooms interspersed, typically, by short point sources."[3]

While Asarco has roofline monitors on some of its structures as do aluminum reduction plants, in fact the source orientation/characteristics of Asarco's roofline monitors are not consistent with those addressed by BLP. As a result, the incorporation of BLP in an Asarco modeling analysis is not appropriate.

Discussions of key facets of BLP and how Asarco's situation does not conform to them are presented below.

Long, Parallel Line Sources

BLP was developed to account for enhanced plume rise from nearby, parallel line sources (up to as many as 10) typically found at aluminum reduction plants. Asarco has only a single line source, the Converter Aisle building roofline monitor. The Flash Furnace building roofline monitors are not long, parallel line sources. Therefore, Asarco and its single roofline monitor does not conform well to the source orientation for which BLP was developed.

Buoyant Line Sources

Aluminum reduction plants emit hot gases from the roofline vents at the tops of potline buildings. These gases are typically much hotter than the ambient temperature, sometimes as much as 100° F (approximately 50 K)[4].

In the case of Asarco, the temperature of the gases venting through the roofline monitors is much closer to the ambient temperature than typically found at an aluminum reduction plant. Engineering calculations for the CRP indicate that the temperature from the roofline monitors will be only roughly 15° F (approximately 8 K) greater than ambient[5].

Therefore, the roofline monitors at Asarco are only minimally buoyant, and are far less buoyant than roofline vent emissions from an aluminum reduction plant. As a result, Asarco's roofline monitors are not the type of buoyant source for which BLP was developed.

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[3] Buoyant line and point source (BLP) dispersion model user's guide. Environmental Research & Technology, Inc. July, 1980.

[4] As an example, see Table 2-1 of "BART Screening Analysis for Alcoa Rockdale Operations in Rockdale, Texas." TRC Environmental Corporation. July 2007.

[5] Asarco Hayden. Converter Aisle Emissions Reduction Basic Engineering – Step 1, Final Report. Gas Cleaning Technologies, LLC. June 2011.

BLP is recommended for simple terrain only. The vast majority of the terrain throughout the NAA area is complex terrain for the roofline monitors. Figure 1 shows the areas within the NAA with terrain above the height of the Converter Aisle Building roofline monitors, while Figure 2 illustrates the areas within the NAA with terrain above the height of the Flash Furnace Building roofline monitors. (Note the two figures are nearly identical.)

Figure 1-Terrain above Converter Aisle Roofline Monitors (contours for terrain below Converter Aisle Roofline Monitors not shaded)
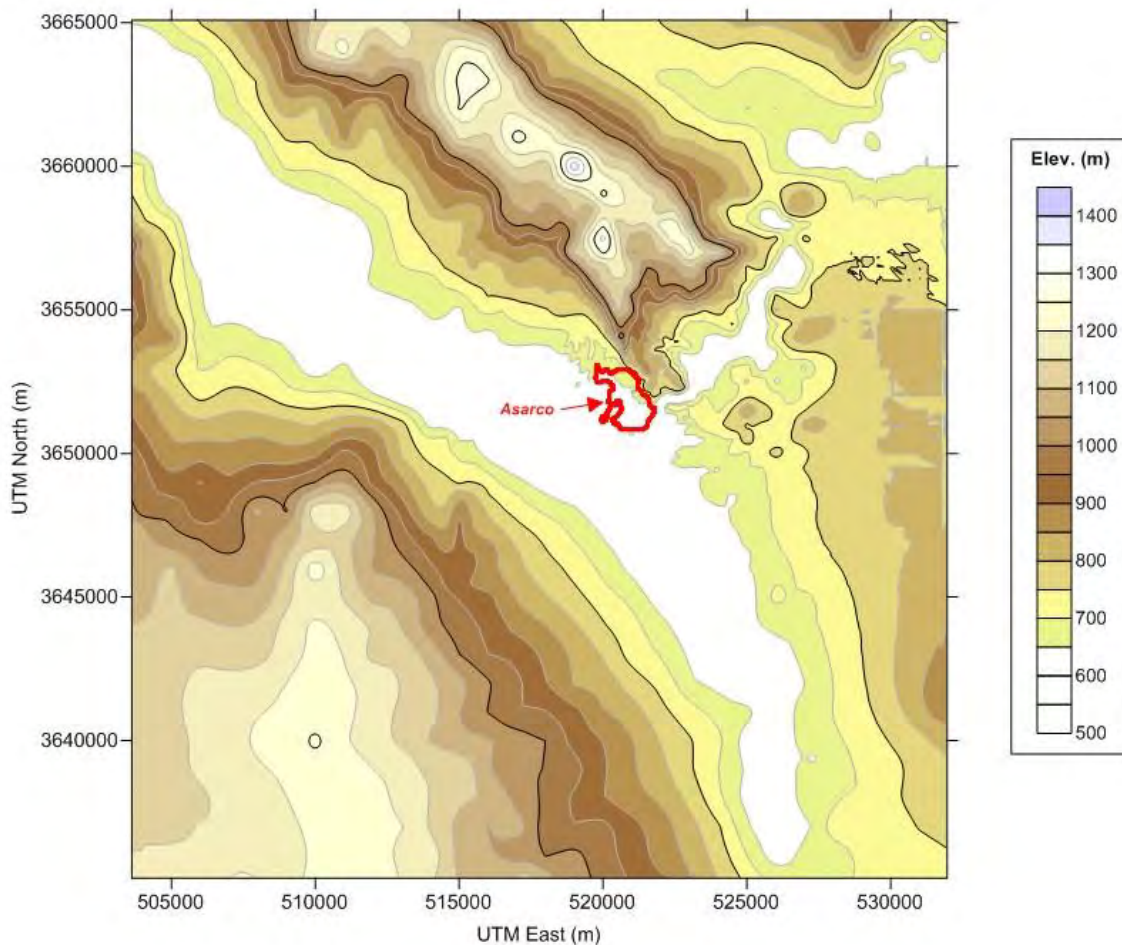
Figure 2- Terrain above Flash Furnace Building Roofline Monitors (Contours for terrain below Flash Furnace Building Roofline Monitors not Shaded)
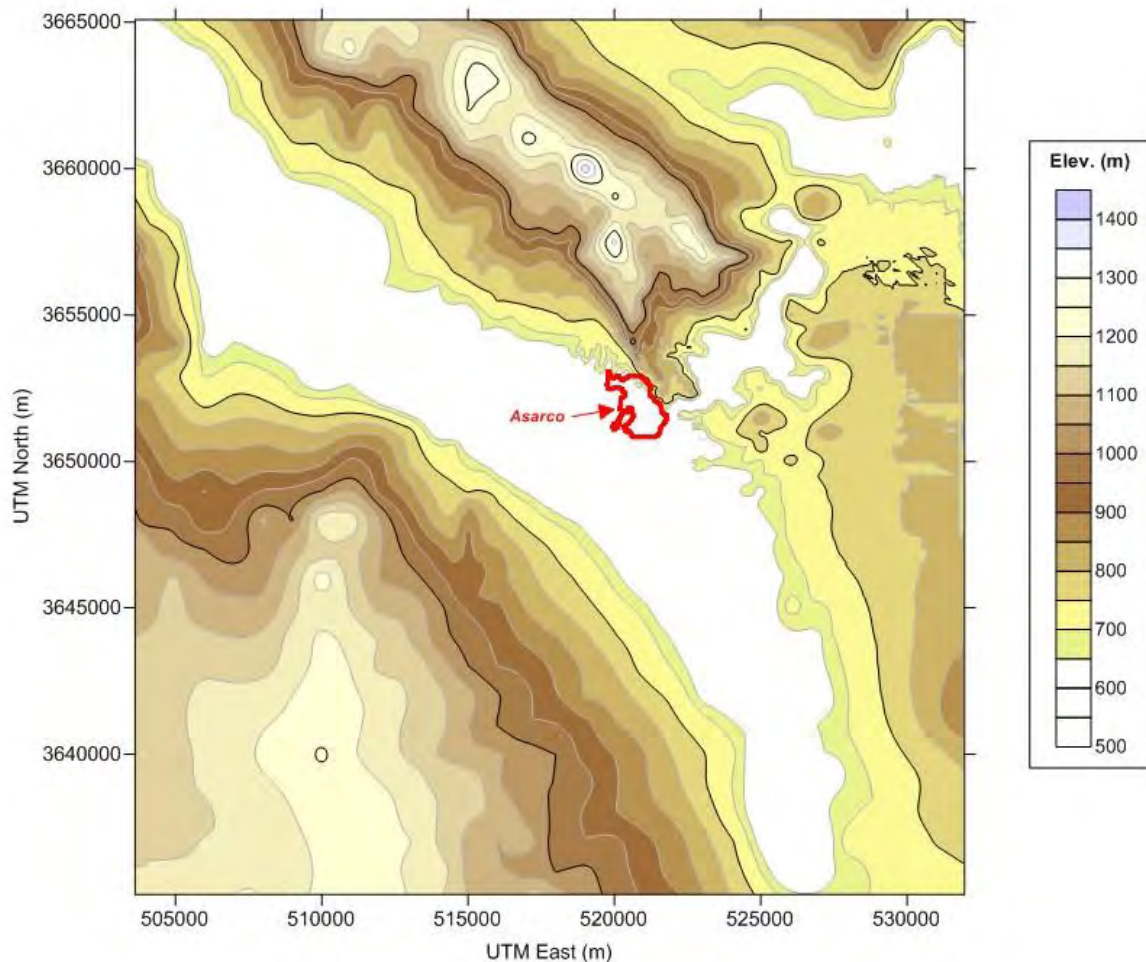
The vast majority of the area modeled in the Asarco SIP modeling is complex terrain for the roofline monitors, and therefore not well-suited for BLP.

Downwash from Roofline Monitors

BLP includes structure downwash algorithms that address the effect that long potline buildings have on plumes from roofline monitors. However, in the case of Asarco, the downwash effects that the Converter Aisle building may have on plumes from the roofline monitors is likely not important, as the distance from that building to the nearest point in the Ambient Air Boundary (AAB) is approximately 1000 ft. In fact, impacts along and near the AAB, particularly in the elevated terrain to the east of Asarco, are likely to be conservatively over-predicted without accounting for downwash effects on plumes from the roofline monitors (i.e., using AERMOD only).

Characterization of Roofline Monitors in AERMOD

The vast majority of SO_2 emissions from Asarco's operations are captured and ultimately emitted through the main stack. Emissions that are not captured are vented through the roofline monitors atop the Converter Aisle and Flash Furnace buildings.

As described earlier, emissions from the roofline monitors are only slightly greater than ambient temperature and therefore are minimally buoyant. In addition, the roof monitors are "capped" such that they vent horizontally. Figure 3 shows the Converter Aisle roofline monitor.

Figure 3-
Converter Aisle Building Roof Monitor

Therefore, because the roofline monitors are not buoyant and vent horizontally, plumes from those roofline monitors have little to no buoyancy or momentum rise. As a result, volume sources were used to represent these sources in AERMOD.

Volume sources were evenly spaced along the roofline monitors for both the Converter Aisle and the Flash Furnace buildings, as shown in Figure 4.

Figure 4- Volume Source Configuration in AERMOD Flash Furnace and Converter Aisle Buildings
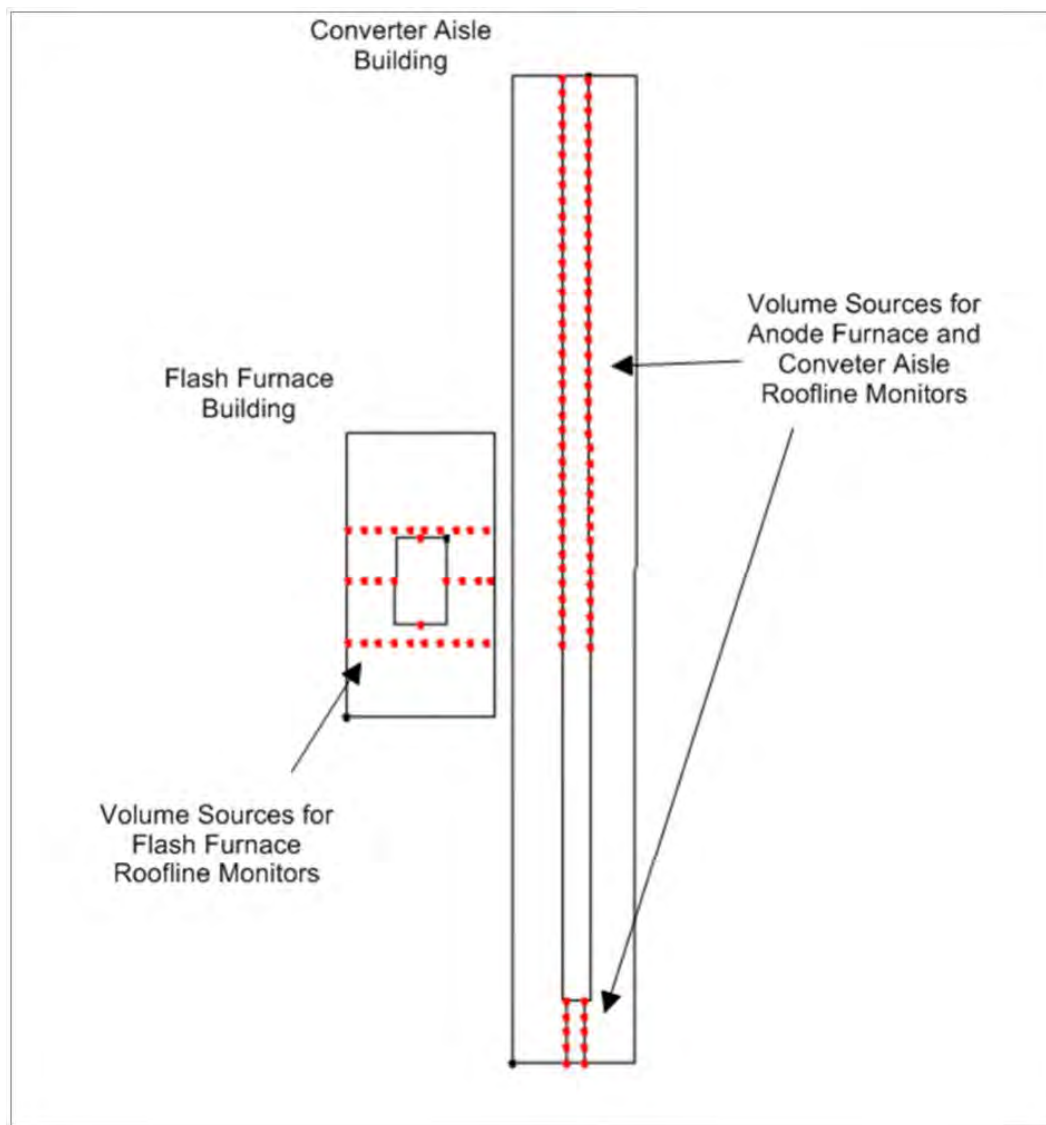
The Flash Furnace building roofline monitors are represented by 32 volume sources, the Anode Furnace roofline monitors (northern end of the Converter Aisle building) are represented by 40 volume sources, and the Converter Aisle building roofline monitors (middle and southern portions of the Converter Aisle building) are represented by 46 volume sources. Initial lateral and horizontal dimensions (σ_{yo} σ_{zo}, respectively) and are calculated based on Table 3-1 of the AERMOD User's Guide[6], with σ_{yo} being calculated assuming the roofline monitors are represented by adjacent volume sources and σ_{zo} being calculated assuming an elevated source on or adjacent to a building. The release heights for the volume sources are placed at the release height on the roofline monitor (i.e., slightly above the top of the respective building).

Model Performance Assessment

While this memorandum to this point has addressed specific aspects of Asarco's facility in relationship to both AERMOD and BLP, the most robust way to address whether or not AERMOD or an AERMOD/BLP

hybrid is a more suitable approach for Asarco is to conduct a model performance assessment. Asarco is in the somewhat unique position of being able to conduct a very specific model performance assessment in that it has onsite meteorological data, hourly continuous emissions monitoring data, and monitoring data from several nearby ambient air quality monitoring stations. Another advantage Asarco has in terms of conducting a model performance assessment is that it is the only meaningful source of SO_2 in the Hayden NAA, thus ensuring that the monitored SO_2 concentrations in the area are nearly completely driven by Asarco's emissions.

Performance assessment modeling was conducted for AERMOD alone as well as the AERMOD/BLP hybrid. This modeling used meteorological data gathered at the Camera Hill meteorological monitoring station for the period of August 16, 2013 through August 15, 2014 (the first full year of onsite meteorological data). Emissions for Asarco sources were defined as follows:

- Main Stack: hourly CEMs data for August 16, 2013 through August 15, 2014
- Flash Furnace fugitives: based on fugitive emissions study (same procedure used for annual emissions inventory)
- Converter Aisle fugitives: based on fugitive emissions study (same procedure used for annual
  emissions inventory)
- Anode Furnace fugitives: based on fugitive emissions study (same procedure used for annual emissions inventory)
- Slag Pouring: maximum hourly emission rate, ratioed by monthly slag pouring
- Anode Furnace Stack: maximum hourly emission rate, assumed to be constant

For each ambient SO_2 monitor, model receptors were placed at 100 m spacing in a 1 km by 1 km grid, with each monitor located at the center of the receptor grid. The five local ambient SO_2 monitors are shown in Figure 5.

To facilitate the comparison of the model output to the monitored concentrations, Q-Q plots were developed. Often used in model validation studies, a Q-Q plot depicts ranked pairings of concentrations, with each pair being two of the same rank (i.e., the highest concentration from a model run is plotted with highest monitored concentration, the second-highest modeled concentration is plotted with second-highest monitored concentration, etc.). If two distributions are similar, points on Q-Q plot will approximately follow line y=x.

Figures 6-10 present the Q-Q plots for the AERMOD and the AERMOD/BLP hybrid performance assessment modeling at each of the ambient SO_2 monitor locations.

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[6] User's Guide for the AMS/EPA Regulatory Model—AERMOD. EPA-454/B-03-001. September 2004.

Figure 5- Ambient SO₂ Monitors near Asarco

Figure 6- Q-Q Plot, Hayden Junction AERMOD and AERMOD/BLP vs. Monitored Concentrations

Q-Q Plot
Modeled vs. Monitored 1-hr SO2 Concentrations
Within 1 km of Hayden Junction
8/16/13 through 8/15/14
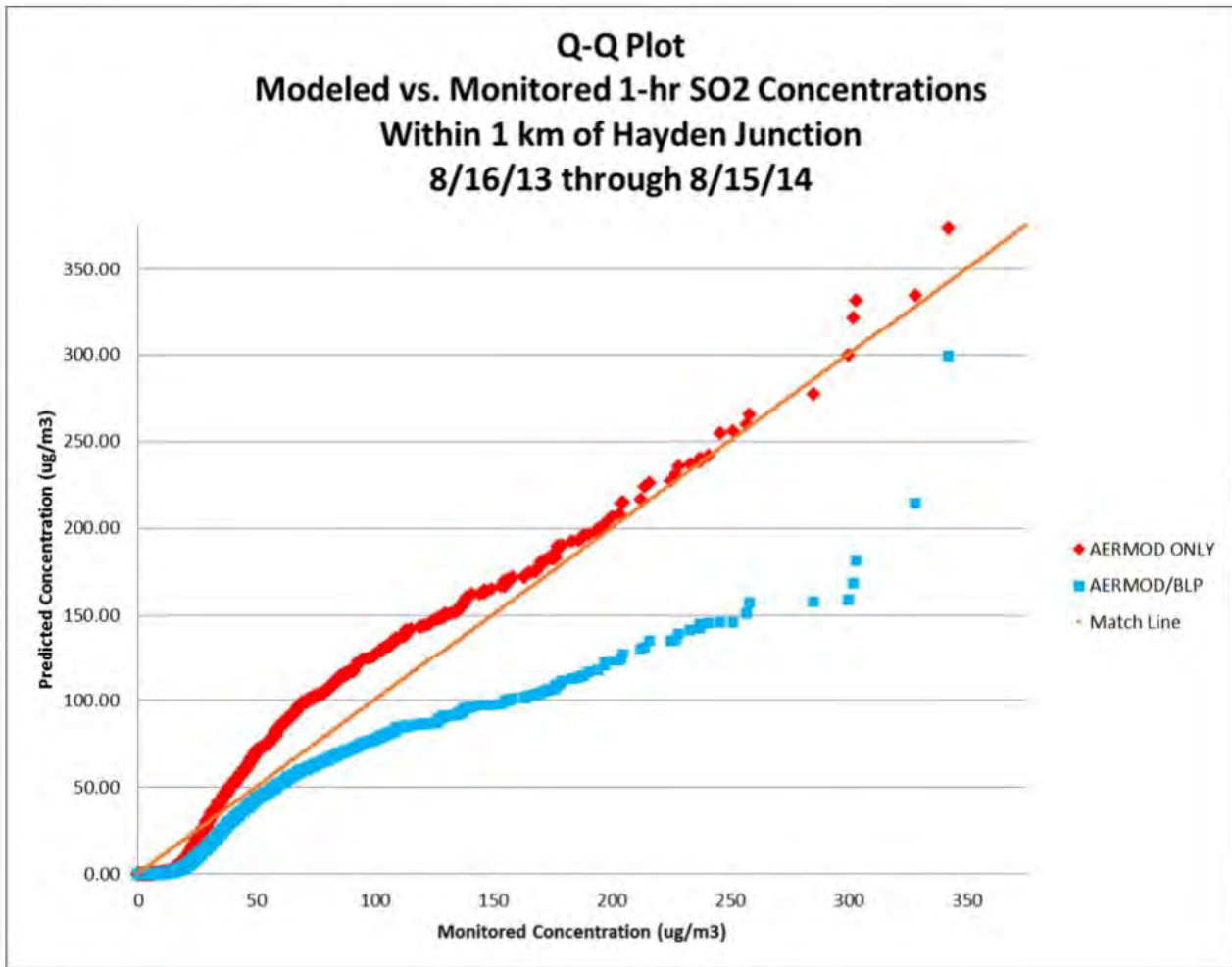
Figure 7- Q-Q Plot, Hayden Jail AERMOD and AERMOD/BLP vs. Monitored Concentrations
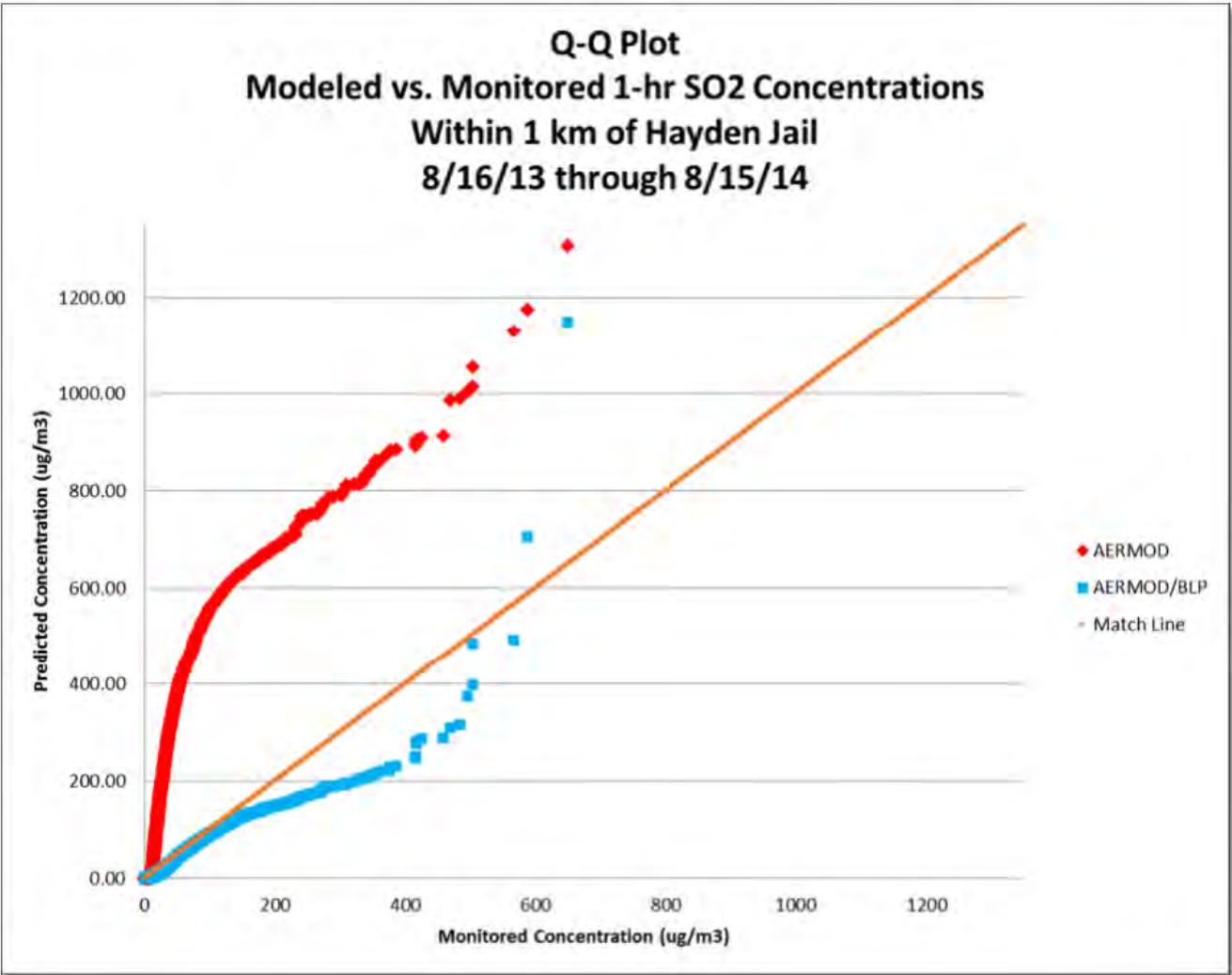
Figure 8- Q-Q Plot, Globe Highway AERMOD and AERMOD/BLP vs. Monitored Concentrations
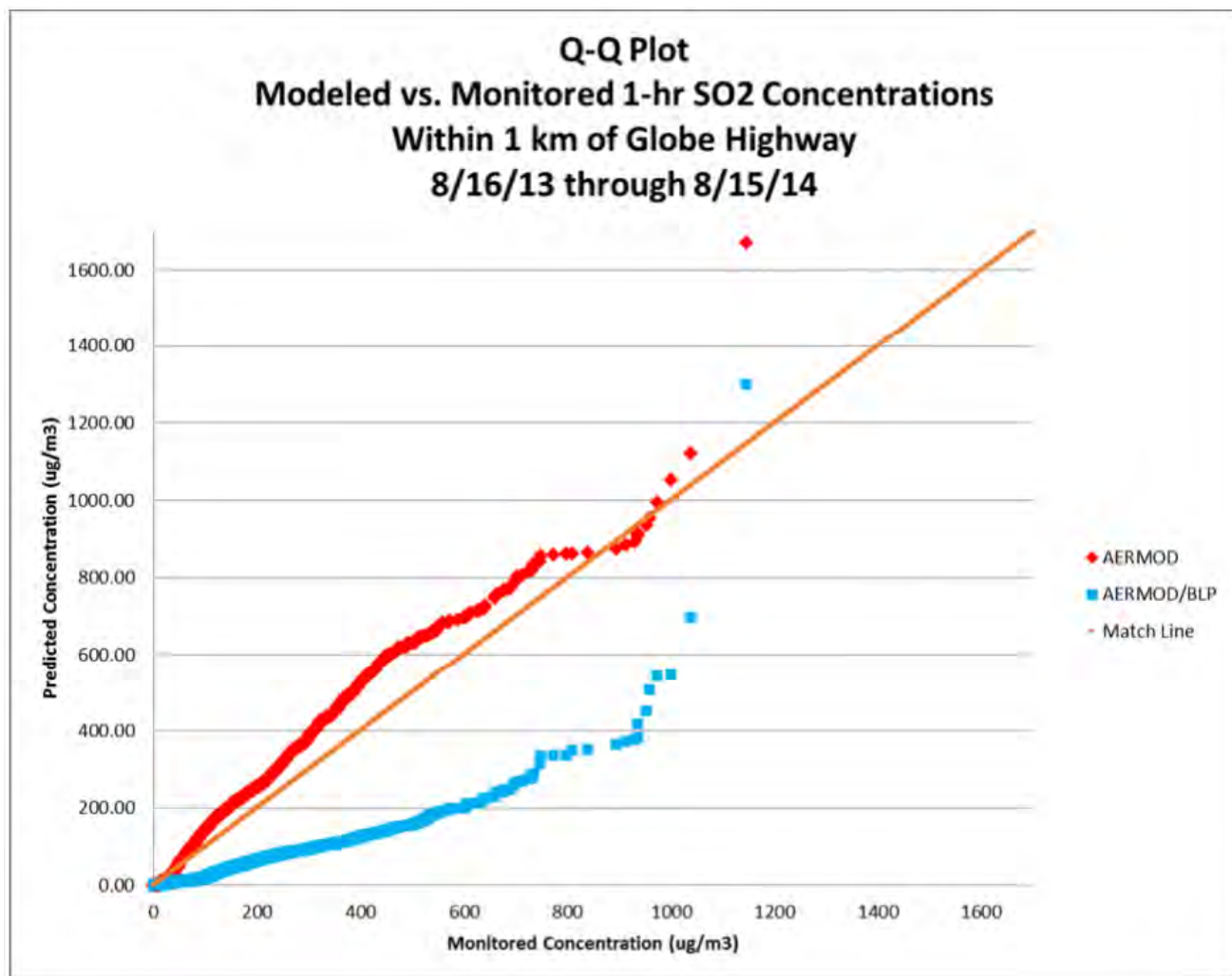
Figure 9- Q-Q Plot, Garfield AERMOD and AERMOD/BLP vs. Monitored Concentration
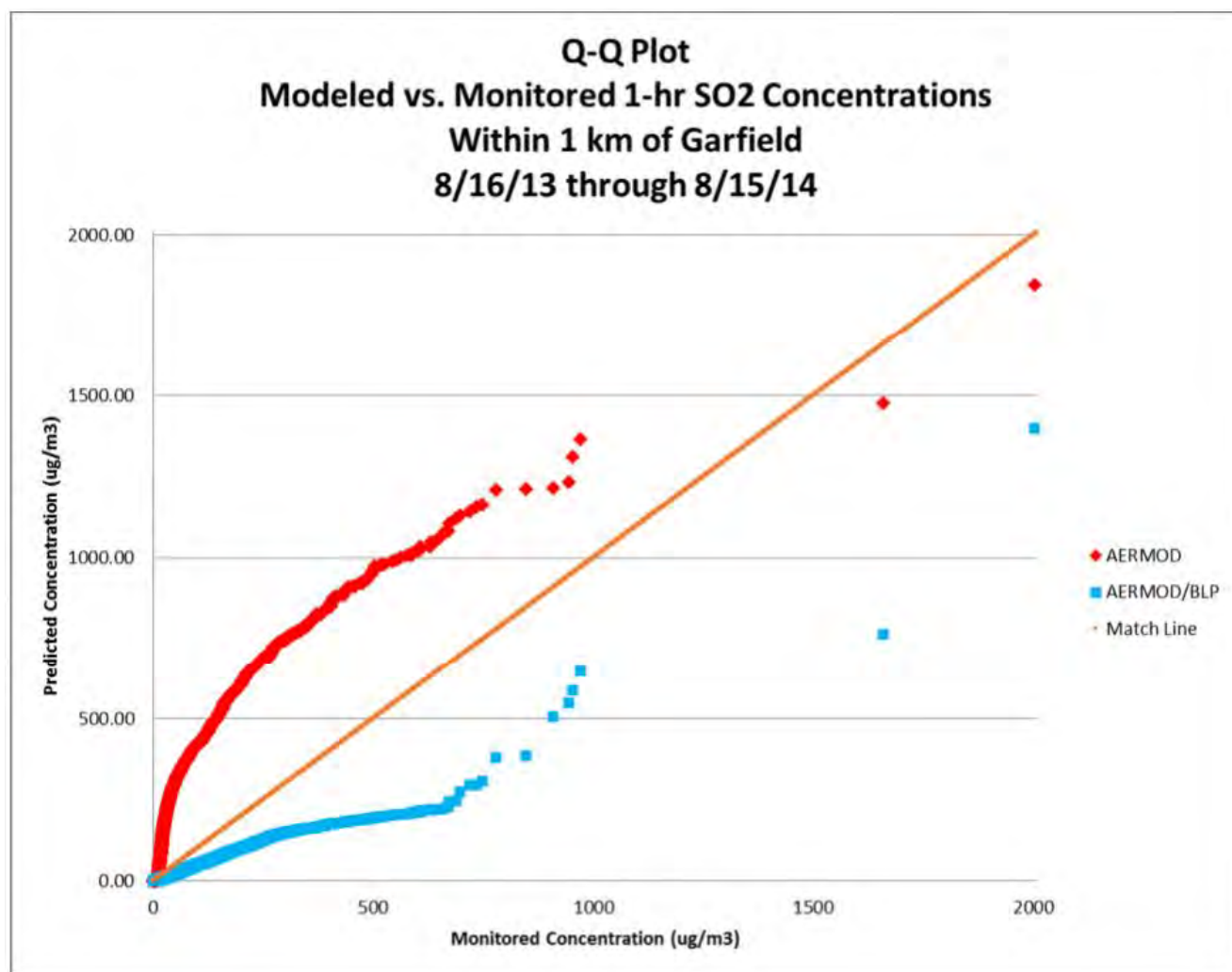
Figure 10- Q-Q Plot, Montgomery Ranch AERMOD and AERMOD/BLP vs. Monitored Concentrations
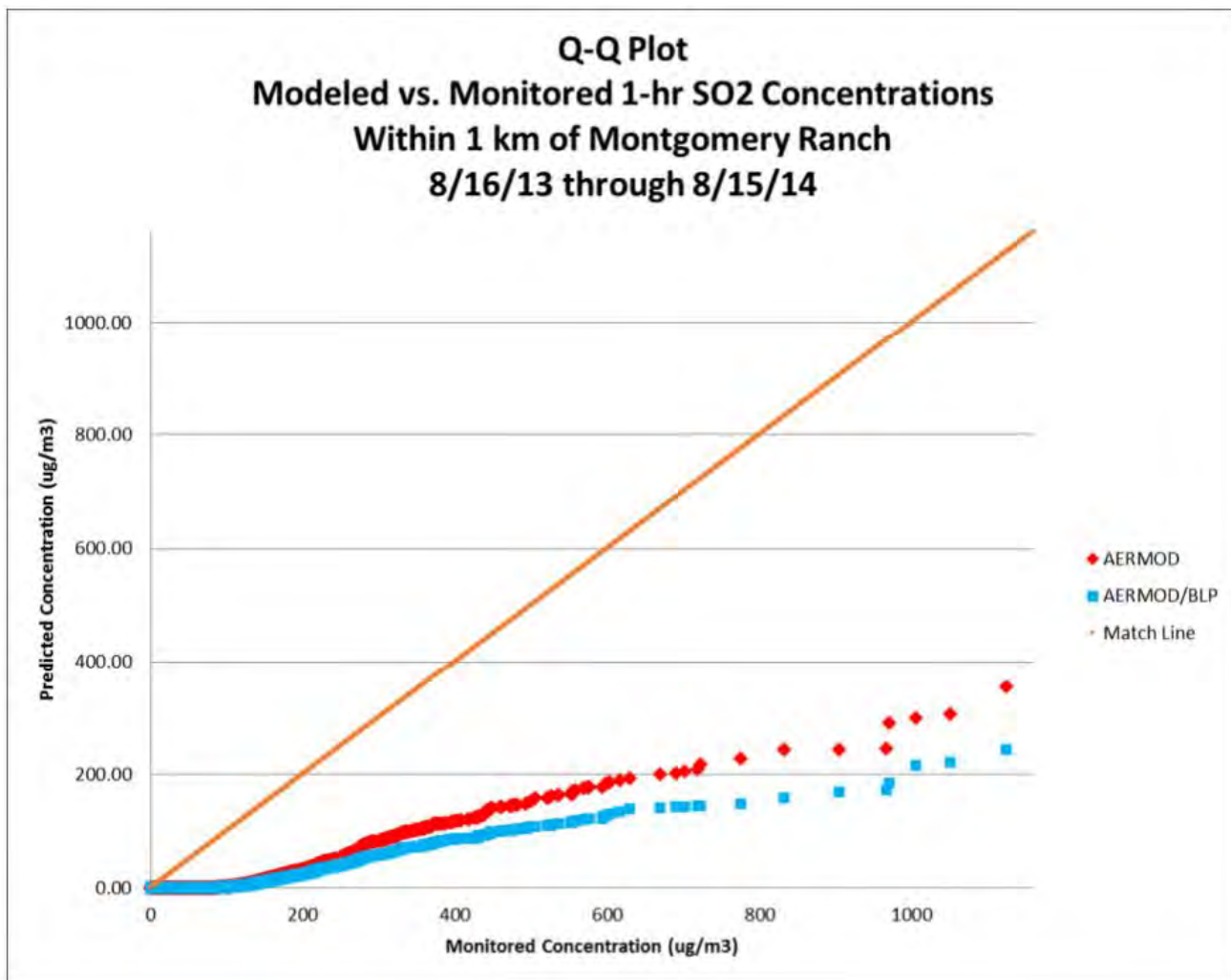
As illustrated by the preceding five figures, AERMOD alone consistently predicts higher concentrations than the combination of AERMOD and BLP. Furthermore, the AERMOD/BLP hybrid nearly always under- predicts relative to the monitored concentrations. Therefore, in the case of Asarco, AERMOD alone performs better than the AERMOD/BLP hybrid (i.e., it is more protective of air quality).

Conclusion

Given Asarco's sources and configuration the incorporation of BLP into the modeling analysis is not appropriate. Specifically,

- Asarco has a single long line source (the Converter Aisle building roofline monitor) and is therefore not consistent with the source for which BLP was developed;
- Emissions from Asarco's roofline monitors are only minimally buoyant and are far less buoyant than the types of sources for which BLP was developed;
- The vast majority of the Hayden NAA is complex terrain relative to Asarco's roofline monitors, and BLP is recommended for simple terrain;

- While BLP includes structure downwash algorithms that address the effect that long buildings have on plumes from roofline monitors, in the case of Asarco the downwash effects that the Converter Aisle building may have on plumes from the roofline monitors is likely not important because of the large distance from the Converter Aisle building to the AAB; and
- Predicted impacts from Asarco are likely to be conservatively over-predicted using AERMOD only without accounting for downwash effects on plumes from the roofline monitors.

Perhaps more important than these specific points, a Model Performance Assessment has clearly demonstrated that not only does AERMOD alone perform quite well in the case of Asarco, the AERMOD/BLP hybrid approach consistently under predicts relative to nearby monitored concentrations. Therefore, the use of AERMOD alone is appropriate in the case of Asarco.

10.5 Appendix E: Calculation of Sources Parameters

Main Stack Source Parameters

Stack Center	
Flow (scfm)	98,500
Temp (F)	400
Diameter (ft)	17.0
Area (ft2)	227
Stack Annulus	
Flow (scfm)	925,000
Temp (F)	139
Diameter (ft)	30.3
Area (ft2)	448
For Combined Annulus and Center	
Equivalent Diameter (ft)	29.3
Flow Rated-Weighted Temperature (F)	164
Total Flow (acfm)	1,388,663
Equivalent Velocity (ft/sec)	34.3

Volume Source Characteristics

Flash Furnace

Roof Monitors

Assumptions
Initial lateral Dimesion (Yo): Line Source Represented by Adjacent Volume Sources
Initial Vertical Dimension (Zo): Elevated Sources (h > 0) on or Adjacent to a Building

Length of side:	1.5	m
Building height:	42.67	m
Sigma Y:	0.70	m
Sigma Z:	19.85	m
Release Height:	43.67	m

Penthouse

Assumptions
Initial lateral dimension (Yo): Line Source Represented by Adjacent Volume Sources
Initial Vertical Dimension (Zo): Elevated Sources (h > 0) on or Adjacent to a Building

Length of side:	16 m
Building height:	44.5 m
Sigma Y:	7.44 m
Sigma Z:	20.70 m
Release Height:	43.59 m

Volume Source Characteristics

Converter Aisle

Assumptions

Initial lateral dimension (Yo): Line Source Represented by Adjacent Volume Sources

Initial vertical dimension (Zo): Elevated Sources (h>0) on or adjacent to a building

Length of side:	1.5 m
Building height, Monitor N:	24.38 m
Building height, Monitor S:	22.86 m
Sigma Y:	0.70 m
Sigma Z, Monitor N:	11.34 m
Sigma Z, Monitor S:	10.63 m
Release Height, Monitor N:	31.35 m
Release Height, Monitor S:	25.40 m

Anode Furnace

Assumptions

Initial lateral dimension (Yo): Line Source Represented by Adjacent Volume Sources

Initial vertical dimension (Zo): Elevated Sources (h>0) on or adjacent to a building

Length of side:	1.5 m
Building height, Monitor N:	24.38 m
Building height, Monitor S:	22.86 m
Sigma Y:	0.70 m
Sigma Z, Monitor N:	11.34 m
Release Height, Monitor N:	31.35 m

Slag Pouring Heat Release Calculations

Assumptions/Inputs

Density of slag (ρ)	132	lb/ft^3
Surface area of poured slag (A)	1500	ft^2
Volume of poured slag (V)	600	ft^3
Temp of slag at start of pour (Ti)	2120	°F Temp
of slag at end of pour (Tf)	1760	°F
Average temp of slag during pour (T)	2400	°R Specific
heat of slag (c$_p$)	0.239	Btu/lb-^{o}F
Time for slag to crust (ΔT)	0.025	hr
Stefan/Boltzmann constant (σ)	1.713E-09	Btu/ft^2-hr-^{o}R^4

Radiative Heat Loss Calculations

*Assuming that slag radiates as a black body and that the radiative heat
loss can be defined by the Stefan Boltzman Law, as follows:*

Radiative heat loss (QR) =	σT^{4}AΔT Btu
Radiative heat loss (QR) =	2.13E+06 Btu

Calculation of Total Heat Release Rate

Total heat release (QT) =	ρVc$_p$(Ti-Tf) Btu
Total heat release (QT) =	6.81E+06 Btu

Calculation of Net Heat Release Rate

Net heat release after radiative heat loss (QN) =	QT - QR Btu
Net heat release after radiative heat loss (QN) =	4.68E+06 Btu
Net heat release after radiative heat loss (QN) =	1.18E+09 cal
Net heat release rate (QN/sec) =	1.31E+07 cal/sec

Slag Pouring Equivalent Stack Parameters Calculations

Assumptions/Inputs

Ambient temperature (T_a)   308 °K Average Temp

of slag and pour gases during pour (T)   1333 °K Acceleration of gravity (g)

9.807 m/s Effective diameter of the poured slag area (D)   13.3 m

Net heat release rate (Q_N/sec)   1.31E+07 cal/sec

Methodology

According to Briggs (1969), the plume rise of a non-stack release can be estimated by
calculating equivalent stack parameters when the buoyancy flux is known.
The buoyancy flux can be described by the following equations"

EQN1: F= $(gvd^2)/4[(T-T_a)/T]$

EQN2: F= 3.7×10^{-5} Q_N/sec

where
v = the effective upward velocity of the release (m/s)

Setting Equations 1 and 2 equal:

Effective upward velocity (v) = (3.7×10^{-5}) (4) (T) (Q_N) / (gd^2(T-T_a))

Effective upward velocity (v) =   1.45

10.6 Appendix F: Memo, Documentation of GEP Stack Height at Asarco Smelter in Hayden, Arizona

WHITE PAPER

DOCUMENTION OF GEP STACK HEIGHT AT ASARCO SMELTER IN HAYDEN, ARIZONA
by
Ron Petersen, PhD, CCM, FASHRAE
CPP, Inc.
2400 Midpoint Drive, Fort Collins, CO, 80525
August 25, 2015

Abstract

In 1983, EPA approved a good engineering practice ("GEP") stack height demonstration for the 1000 foot (305 m) stack at the ASARCO LLC smelter located in Hayden, Arizona based upon a wind tunnel study conducted by Petersen and Cermak (1979). In 1985, EPA revised the GEP stack height regulations that included new definitions for "nearby" terrain and "excessive concentrations." This white paper examines the changes in the 1985 regulations, evaluates the 1979 wind tunnel study results in light of the change in regulations and guidance, and concludes, based on information in the 1979 wind tunnel study and available through current dispersion modeling, that the 1983 GEP stack height determination is consistent with the 1985 regulations and that the 1000 foot (305 m) stack remains an appropriate GEP determination.

Background

Petersen and Cermak (1979) conducted a wind tunnel modeling study to determine whether the 1000 foot (305 m) stack at the ASARCO Hayden smelter is above or below the "good engineering practice" (GEP) stack height established by Congress in Section 123 of the Clean Air Act. The study found that the 1000 foot (305 m) stack is below the GEP stack height and hence, can be used an input for compliance modeling purposes. At the time of the study, the procedures for conducting these wind tunnel modeling studies were in draft form and the 1979 wind tunnel study closely followed the EPA (1979) Draft Guideline.

Based on the results of the 1979 wind tunnel study, EPA proposed that the ASARCO 1000 foot stack be approved as GEP on November 30, 1981 (46 FR 58098-01) after the Arizona Department of Environmental Quality's review and approval in September 1979. EPA then approved the 1000 foot stack as meeting the GEP stack height requirement on January 14, 1983 (48 FR 1717-01). This GEP stack height has been used for all subsequent modeling and compliance purposes through the present date.

This white paper examines the 1979 wind tunnel study that addressed the 1000 foot stack in the context of changes to the GEP regulations in 1985, and demonstrates that the conclusion of that study remains valid today.

Definition of GEP Stack Height According the 1985 Final Rule

In the final (1985) stack height regulation (40 CFR 51.100 (ii)), GEP stack height is defined to be the _greater_ of:

"(1)   65 meters, measured from the ground level elevation at the base of the stack;

(2)   (i) for stacks in existence on January 12, 1979, and for which the owner or operator had obtained all applicable permits or approvals required under 40 CFR Parts 51 and 52,

$$H_g = 2.5H \tag{1}$$

provided that the owner or operator produces evidence that this equation was actually relied on in establishing an emission limitation:

(ii)   for all other stacks,

$$H_g = H + 1.5L \tag{2}$$

where;

H_g =   good engineering practice stack height, measured from the ground-level elevation at the base of the stack,

H =   height of nearby structure(s) measured from the ground-level elevation at the base of the stack,

L =   lesser dimension, height or projected width, of nearby structure(s),

provided that the EPA, State, or local control agency may require the use of a field study or fluid model to verify GEP stack height for the source; or

(3)   The height demonstrated by a fluid model or a field study approved by the EPA, State, or local control agency, which ensures that the emissions from a stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source itself, nearby structures or nearby terrain features."

The ASARCO Hayden smelter is located in the potential downwash zone of a ridge located to the north and east of the smelter. Based on (3), physical modeling is required to determine the GEP stack height for complex terrain situations, such as for the ASARCO Hayden smelter. The demonstration needs to show that excessive concentrations result due to upwind terrain wakes and eddies based on the definition of nearby terrain and excessive concentration.

For the final rule (FR, Vol. 50, No. 130, July 8, 1985), excessive concentration was defined as follows:

"A maximum concentration due to emissions from a stack due in whole or part to downwash, wakes or eddy effects produced by nearby structures or nearby terrain features which individually is at least 40 percent in excess of the maximum concentration experienced in the absence of such downwash, wakes, or eddy effect and which contributes to a total concentration due to emissions from all sources that is greater than an ambient air quality standard."

For conducting demonstrations under 51.1 (ii) (3) "nearby" means:

"not greater than 0.8 km (1/2 mile), except that the portion of a terrain feature may be considered to be nearby which falls within a distance of up to 10 times the maximum height (H_t) of the feature, not to exceed 2 miles if such feature achieves a height (H_t) 0.8 km from the stack that is a least 40 percent of the GEP stack height determined by the formula...."

Based on the definition of excessive concentration, the maximum ground-level concentration from wind-tunnel testing with the terrain present is first compared to NAAQS. For this comparison, the background concentration and impact due to other sources must be added to the impact due to the stack being evaluated. If the total concentration is below NAAQS, a shorter stack must be considered. Once a stack height is found such that a lower stack would result in an exceedance of NAAQS, it is considered GEP if the concentration without nearby terrain present is at least 40 percent less than that with the terrain present (referred to as the 40 percent test). Key in the 40 percent excess concentration demonstration is the method used to model the "terrain-out" test configuration.

The following sections will show that the Petersen and Cermak (1979) study, while conducted following a combination of the 1979 EPA Draft Guideline and 1982 GEP stack height rule (FR, Vol 47, No. 26, 1982), provide results that meet the requirements for demonstrating that the 1000 foot stack is GEP according the final rule (EPA, 1985). The main areas to consider are the definition of an excessive concentration and the definition of "nearby" terrain.

Impact of EPA Guideline Changes Regarding the Definition of an Excessive Concentration

Petersen and Cermak (1979) conducted a wind tunnel modeling study that demonstrated that the 1000 foot stack met the excessive concentration requirements due to adverse upwind terrain wake effects as outlined in the EPA Guideline (1979). The excessive concentration requirement in the 1979 EPA Guideline was:

"Concentrations in the wake of the structure or terrain obstacle are considered excessive if the ground-level concentrations exceed an ambient air quality standard or PSD increment and are at least 40 percent greater than the maximum in the absence of their influences."

This excessive concentration definition is the same as the final 1985 rule definition and both criteria were demonstrated by Petersen and Cermak (1979). Based on that demonstration, EPA approved the 1000 foot stack as GEP and that height was used for all subsequent compliance modeling

studies. That alone should be sufficient justification for allowing the 1000 foot stack to be classified as GEP for future modeling applications.

The EPA 1979 Draft Guideline was finalized in 1981 followed by the first stack height rule that was published in 1982. The 1981 EPA guideline and 1982 rule relaxed the definition of excessive concentration so that only a 40 percent concentration increase due to upwind terrain wake and eddy effects needed to be demonstrated. This change had no effect on the results of the Petersen and Cermak (1979) study.

The conclusion is that the changes to the definition of excessive concentration have no impact on the Petersen and Cermak (1979) study and their determination that the 1000 foot stack is GEP.

Impact of EPA Guideline and Rule Changes Regarding the Definition of Nearby Terrain

The methodology for determining the GEP stack height is to first conduct testing with all relevant upwind and downwind terrain present in the model. The results from this testing are then first used to determine whether a NAAQS exceedance can be demonstrated.

According to EPA (1985), nearby terrain can be considered for determining the GEP stack height with certain constraints. First, for terrain to be considered nearby, the terrain within 0.8 km (0.5 miles) of the stack must rise to at least 40 percent of the formula GEP stack height for the wind directions being evaluated. The formula GEP stack height for the ASARCO Smelter is 65 m which means the terrain must rise by at least 26 m within 0.8 km of the stack. Figure 1 shows that the height of the terrain, H_t, at 0.8 km is 137 m which is well above the 26 m threshold. Hence, the elevation of the nearby terrain is sufficiently high to qualify for a wind tunnel demonstration study and this part of the 1985 "nearby" definition has no impact on the 1979 wind tunnel study results.

The next step for determining the GEP stack height is to conduct testing without the upwind terrain. The maximum concentration from this testing is then compared to the maximum concentration from testing with all terrain present and if the maximum concentration with terrain present is a least 40% greater than that without the upwind terrain present, the stack is creditable as GEP. For this comparison, Petersen and Cermak (1979) removed all of the upwind terrain as illustrated in Figure 2 which was consistent with EPA 1979 and 1981 Guidance and the 1982 rule.

According to the final rule (1985) and EPA Guidance (1985), the amount of terrain that can be considered nearby for fluid modeling purposes extends out to 10 times the maximum height (H_T) of the terrain feature (10 H_T), not to exceed 3.2 km. For this case, the maximum terrain height is 242 m, which means that the maximum distance that can be considered nearby is 2.4 km (242 m * 10). Beyond that distance, the terrain is not nearby and cannot be removed for wind tunnel modeling purposes.

Figure 3 shows the upwind terrain that should be modeled for the "terrain-out" configuration according EPA (1985) guidance. The figure shows that only the nearby terrain is removed while the terrain that is not nearby remains in the model. This configuration is different than the one used by

Petersen and Cermak (1979) where all upwind terrain was removed (Figure 2). If the study had been conducted using EPA (1985) guidance, the concentrations with upwind terrain removed could increase by some factor due to the terrain that remains in the model.

Petersen and Cermak (1979) found that at the 1000 foot stack height the ratio of maximum concentration with and without the upwind terrain present was 1.68 (68% increase due terrain). For that ratio to decrease to 1.4 (40% increase due terrain), the wind tunnel test results for the "terrain-out" configuration using the EPA (1985) procedure would have to increase by 20% or more.

Figure 3 shows that the highest terrain feature remaining for the EPA (1985) "terrain-out" configuration is about 5200 m upwind with a maximum height of 228 m above stack base. A representative hill height is approximately 200 m or less. Thompson and Snyder (1985) found that a source that is 1.5 hill heights tall positioned 20 hill heights downwind of a steep triangular ridge has maximum concentrations with and without the ridge present that are essentially the same (see Figure 4). Since the Main Stack is ~1.5 hill heights tall and is 23 hill heights, or more, downwind of the terrain feature, this research confirms that the EPA (1985) "terrain-out" procedure will have an insignificant impact on the 68% excessive concentration demonstrated by Petersen and Cermak (1979).

In conclusion, the impact of the change in the definition of "nearby" terrain has no impact on the results in Petersen and Cermak (1979) or the 1000 foot GEP stack height determination.

Impact of the New 1-Hr SO$_2$ NAAQS

At the time the study was carried out, the NAAQS exceedance requirement for an excessive concentration was demonstrated using the 3-hr SO$_2$ NAAQS of 1300 ug/m^3. In 2010, a new 1-hr SO$_2$ NAAQS of 75 ppb (196 µg/m^3) was promulgated. Since the new 1-hr NAAQS is lower than the 3-hr NAAQS, an exceedance of the 1-hr NAAQS is also demonstrated based on the emission rate used in Petersen and Cermak (1979).

Existing SO$_2$ Emission Rates and NAAQS Exceedance

Even though there is no logical reason why ASARCO should continue justifying the GEP stack height based on the NAAQS exceedance criteria as ASARCO continues to reduce emissions, this section will assess whether an 1-hr NAAQS exceedance can be demonstrated using NSPS emission rates for NSPS sources, as set forth in the 1985 rule, and current emission rates for other contributing sources. To make this demonstration, the results of the past study were re-analyzed. Table 1 shows the relevant stack operating parameters that were simulated in the wind tunnel and the existing operating parameters.

The past wind tunnel results were converted to a normalized concentration of the form CU_{ref}/Q which is related to the maximum ground level concentration as follows based on the Gaussian dispersion equation that is used in the AERMOD:

$$\frac{CU_{ref}}{Q} = \frac{1}{2\pi\sigma_y\sigma_z} \, exp\left[-0.5\left(\frac{h_p}{\sigma_z}\right)^2\right] \, x \, 10^6$$

where

C	=	SO$_2$ concentration (ug/m3),
U_{ref}	=	Reference wind speed (m/s) at the reference height of 585.6 m,
Q	=	SO$_2$ emission rate (g/s),
σ_y, σ_z	=	Horizontal and vertical dispersion coefficients, and
h_p	=	Plume height above ground level (m).

The equation shows that CU_{ref}/Q will only change with plume height (h_p) for a given meteorological condition (i.e., σ_y and σ_z fixed).

Table 2 shows that the ratio of stack exit velocity to wind speed is about 1.5 (R), or less, for the cases simulated in the wind tunnel and the existing configuration. When R is 1.5 or less, the plume will level off close to stack top for all cases shown in Table 2. With constant plume rise, CU_{ref}/Q is a constant value which is best indicated by the average CU_{ref}/Q over all cases observed in the wind tunnel. The average observed value is provided in Table 2 which was also used for the existing configuration. Next, the 1-hr SO$_2$ concentration was determined by dividing CU_{ref}/Q by U_{ref} and multiplying by Q.

In addition to the Main Stack there are several other sources of SO$_2$ emissions at the ASARCO smelter: Converter Aisle fugitives, Flash Furnace fugitives, Anode Furnace fugitives, the Anode Furnace baghouse stack, and Slag Pouring. To obtain the impact from these sources an air dispersion modeling analysis was conducted in a manner very similar to that which is described in the recent Hayden SIP Modeling Report entitled "SO$_2$ Air Dispersion Modeling Analysis for ASARCO, LLC; Hayden, Arizona" (July 2015). Because these additional sources are not NSPS sources, and therefore do not have an NSPS rate unlike the Main Stack, for the purposes of this analysis nearly all of the emissions modeled were conservatively assumed to be actual emissions (as opposed to allowables).

Key aspects of this analysis are as follows:

- Modeling was conducted using AERMOD
- Meteorological data used were taken from the on-site Camera Hill meteorological station (August 16, 2013 through August 15, 2014)
- Emissions for the scenario were modeled as follows:
  - Flash Furnace fugitives: based on fugitive emissions study (same procedure used for annual emissions inventory)
  - Converter Aisle fugitives: based on fugitive emissions study (same procedure used for annual emissions inventory)

- o   Anode Furnace fugitives: based on anode furnace baghouse permit revision estimated maximum
- o   Anode Furnace Baghouse Stack: anode furnace baghouse permit revision allowable rate
- o   Slag Pouring: maximum hourly emission rate, ratioed by monthly slag pouring

Model receptors were placed at a distance of 2895 m from the Main Stack (the distance at which the maximum Main Stack concentrations were calculated from the Wind Tunnel Study), along and very near the 51 degree radial (i.e., to the southwest of the Main Stack).

Because the maximum Main Stack concentration was calculated for a tower wind speed of 4.3 m/s at a wind direction of 51 degrees, the predicted 1-hr SO_2 concentrations from the other sources were examined to identify those which occurred with both a wind speed and wind direction close to these values. While there were many concentrations predicted to occur under conditions very close to those, the concentration that nearly perfectly matched the meteorological conditions associated with the maximum Main Stack concentration was 28.1 ug/m3, which was predicted to occur with a wind speed of 4.4 m/s and a wind direction of 51 degrees.

Therefore, the total 1-hr SO_2 concentration is the sum of these values:

- •   171.8 ug/m3 from the Main Stack,
- •   28.1 ug/m3 from other sources at the ASARCO smelter, and
- •   6.3 ug/m3 for Background (see Section 5.7 of "SO_2 Air Dispersion Modeling Analysis for ASARCO, LLC; Hayden, Arizona" (July 2015).

The total 1-hr SO_2 concentration for the worst case condition is 206.2 ug/m3, which is greater than the 1-hr SO2 NAAQS of 196 ug/m3.

Table 2 shows the calculated 1-hr SO_2 concentrations and supporting information based on the 1979 wind tunnel study. The above discussion and Table 2 show that even using the NSPS emission rates contemplated under the 1985 rule, an exceedance of NAAQS is demonstrated for the 1000 foot stack under the criteria established by the 1985 rule.

Summary

In summary, the 1000 foot stack at the ASARCO Hayden Smelter is GEP for the following reasons:

- •   It is the taller of 65 m, the formula height or the height determined through physical modeling as prescribed by the 1985 final stack height rule;
- •   It was approved by EPA as the GEP stack height in 1983;
- •   It meets the excessive concentration requirements due to upwind terrain wake effects as defined in EPA (1979, 1981 and 1985) based on NAAQS at the time of the wind tunnel study;
- •   The EPA (1985) change in the definition of "nearby" and how upwind terrain is modeled has no significant effect on the 40% excess concentration demonstration; and
- •   An exceedance of the 1-hr SO_2 NAAQS can be demonstrated based on emission rates used in Petersen and Cermak (1979) or using the NSPS rates specified in the 1985 rule.

References

EPA, "Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulation) Revised," USEPA Office of Air Quality, Planning and Standards, Research Triangle Park, North Carolina, EPA–45014–80–023R, 1985.

EPA, "Guideline for Use of Fluid Modeling to Determine Good Engineering Practice Stack Height," USEPA Office of Air Quality, Planning and Standards, Research Triangle Park, North Carolina, EPA–450/4–81–003, July 1981.

EPA, "Guideline for Use of Fluid Modeling to Determine Good Engineering Practice Stack Height," USEPA Office of Air Quality, Planning and Standards, Research Triangle Park, North Carolina, Draft for Public Comments, EPA–450/4–79–015, June 1979.

Petersen, R.L. and J.E. Cermak, "Evaluation of "Good Engineering Practice" Stack Height at the ASARCO Smelter, Hayden, Arizona – A Physical Modeling Study," Colorado State University Report CER79-80RLP-JEC2, July 1979.

Taylor, G.H., "A Wind Tunnel Investigation of Good Engineering Practice (GEP) Stack Height at the ASARCO Smelter, Hayden, Arizona, North American Weather Consultants Report No. SBAQ-79-10, July 1979.

Thompson, R.S., and W.H. Snyder, "Air Pollution and terrain Aerodynamics: A Review of Fluid Modeling Studies at the EPA Fluid Modeling Facility," Journal of Wind Engineering and Industrial Aerodynamics, Vol 21, 1985
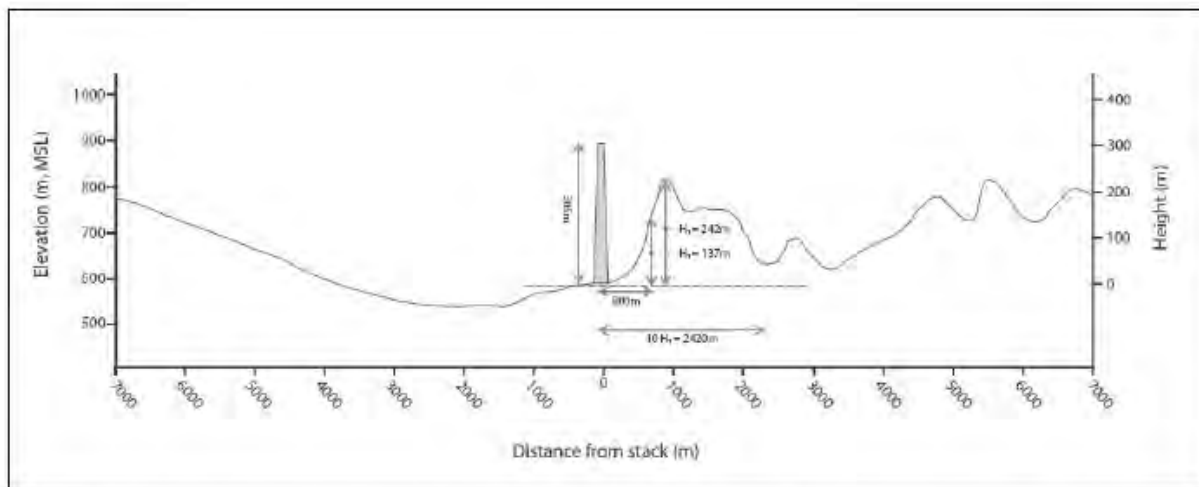
Figure 1. Terrain cross-section (reproduced from Taylor, 1979) for the wind tunnel configuration used for modeling the downwash effect of the upwind hill. Note: a transition ramp was used upwind of the terrain to match the wind tunnel floor to ensure a smooth transition flow.
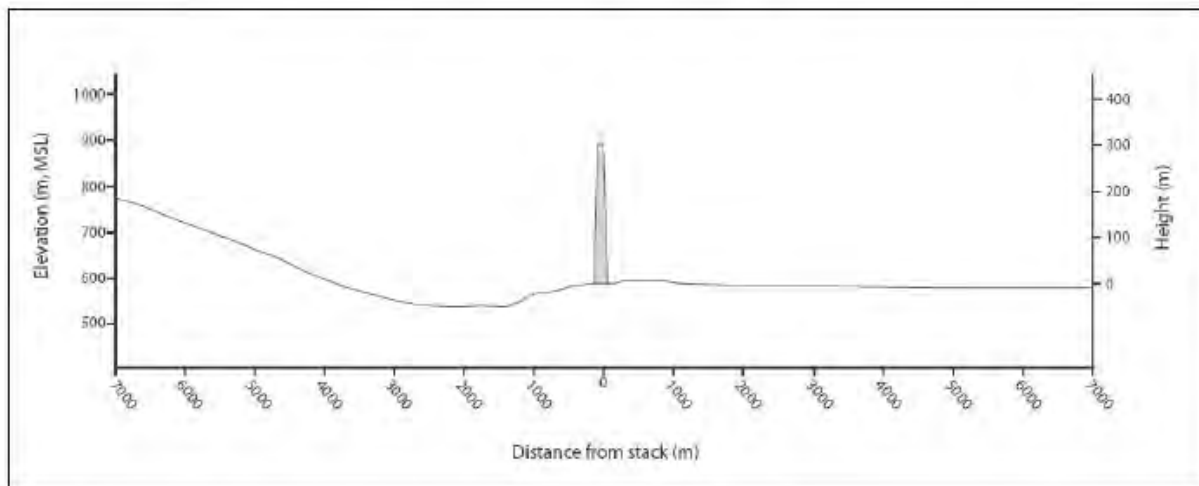
Figure 2. Terrain cross-section (reproduced from Taylor, 1979) for the wind tunnel configuration used for "terrain-out" configuration as defined in the 1979 EPA Guideline document.
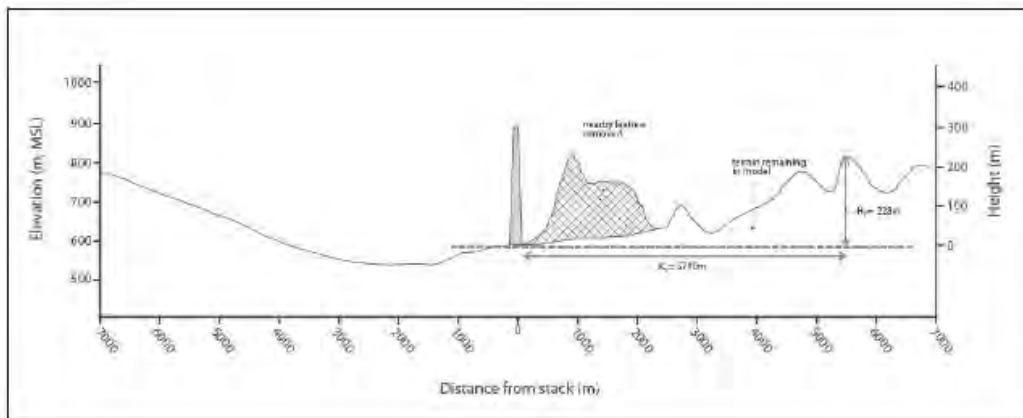
Figure 3. Terrain cross-section (based on Taylor, 1979) for the wind tunnel configuration used for the "terrain-out" configuration as defined in the 1985 EPA Guideline document.
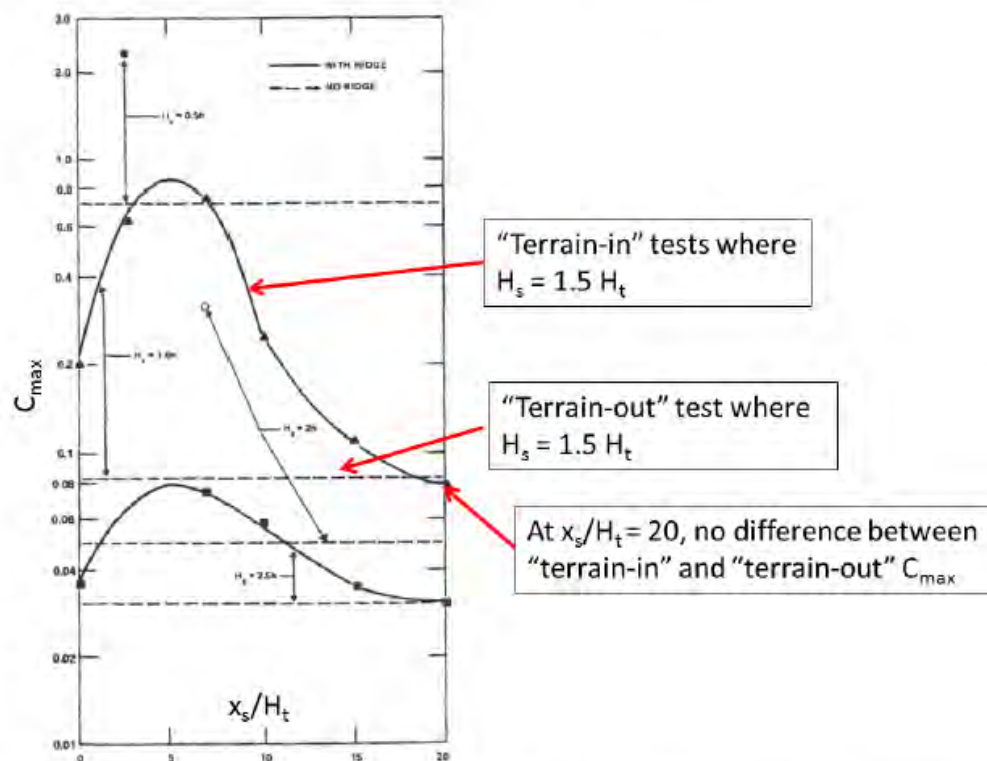
Figure 4. Maximum ground-level concentrations (C_{max}) as a function of source position (x_s) downwind of steep triangular ridge of height H_t (figure copied from Thompson and Snyder, 1985).

Table 1. Source Parameters

Case	Stack Diameter (m)	Stack Temp Ts (K)	Std Volume Flow (m3/s)	Act Volume Flow (m3/s)	Exit Velocity Ve (m/s)	SO$_2$ Emission Rate Q (g/s)	SO$_2$ Emission Rate (lbs/hr)	SO$_2$ Source Concentration Co (ppm)
Wind Tunnel Study	5.18	380.7	252.1	319.9	15.18	7348.0	58318	8834
NSPS Configuration	8.94	374	309.9	448.1	7.14	458.4	3638	551.1

Zref =	585.6 m	Reference Height
HT =	242 m	Terrain Height
n	0.32	Wind power law exponent as measured in wind tunnel
Ta =	300 K	Ambient Temperature

Table 2. Summary of Calculations Documenting a NAAQS Exceedance

1979 Wind Tunnel Study

WD	Xmax/HT	X_{max} (m)	U_{ref} (m/s)	R V_e/U_{ref}	Tower Speed (51.76m) (m/s)	C_{max} (ppm	$C_{max} U_{ref}/Q$ (ug/g/m^2)	Max 1 hr- SO$_2$ C_{max} (ug/m3)
NE (51°)	15	3630	9.30	1.63	4.28	1.01	3.32	2626
NE (51°)	15	3630	15.60	0.97	7.18	0.57	3.15	1482
NE (51°)	15	3630	22.10	0.69	10.17	0.51	3.99	1326
						Average	3.49	

NSPS Configuration

WD	Xmax/HT	X_{max} (m)	U_{ref} (m/s)	R V_e/U_{ref}	Tower Speed (51.76m) (m/s)	$C_{max} U_{ref}/Q$ (ug/g/m^2)	1000 ft Stack Max 1 hr- SO2 C_{max} (ug/m3)	Other Sources+BG Max 1 hr- SO2 C_{max} (ug/m3)	Total Max 1 hr- SO2 C_{max} (ug/m3)
NE (51°)	15	3630	9.30	0.77	4.28	3.49	171.8	34.4	206.2
NE (51°)	15	3630	15.60	0.46	7.18	3.49	102.4	23.3	125.7
NE (51°)	15	3630	22.10	0.32	10.17	3.49	72.3	24.9	97.2

10.7 Appendix G: Load Analysis

GCT

Metallurgical Process Specialists

Gas Cleaning Technologies, LLC
4953 N. O Connor Blvd.
Irving, TX 75062 USA
Telephone   +1 214 613 1785
Facsimile   +1 214 613 1786

January 4, 2016

Jack Garrity
Technical Manager
ASARCO, LLC
P.O. Box 8
Hayden, Arizona 85235

CC: Amy Veek

Re: Minimum Stack Flow Scenario Post-CRP

Dear Jack,

GCT was asked to identify a potential scenario that would result in a minimum smelter stack flow rate. This scenario could then be run in the dispersion model to determine the predicted impact on ambient air SO_2 concentration.

GCT noted that the Consent Decree requires that the acid plant, converter secondary baghouse, and tertiary ventilation system all operate whenever material is being processed in the converter aisle, which greatly limits the potential reduction in stack flow rate. Even if no material is processed in the converter aisle, GCT assumes at least one of the two systems (secondary or tertiary) will be operating at normal flow rate if the furnace is operating in order to provide building ventilation in the aisle.

GCT also noted that the Consent Decree will require high surface area dry lime injection on the secondary baghouse system and on the furnace vent baghouse system (R&R Cottrell Replacement Baghouse) that must achieve at least 50% SO_2 removal efficiency.

GCT therefore identified two potential scenarios that would result in a worst-case minimum stack flow scenario.

Scenario 1 – Furnace and Dryers Off – Furnace Vent Baghouse System Off

In Scenario 1, the furnace vent baghouse system is off. This would require that the flash furnace and dryers not operate. Material processing would continue in the converter aisle, requiring the acid plant, converter secondary system, and tertiary ventilation system to operate at their normal flow conditions. Table 1 below summarizes the emissions streams for this scenario.

Table 1
Scenario 1 Smelter Stack Flow Conditions

Stream	Flow (SCFM)	Average SO$_2$			Maximum 1-hr average SO$_2$		
		Temp. (F)	SO$_2$ (ppmv)	SO$_2$ (lb/hr)	Temp. (F)	SO$_2$ (ppmv)	SO$_2$ (lb/hr)
Conv. Secondary Baghouse	275,000	150	39	107	120	66	180
Converter Tertiary System	375,000	100	15	55	100	24	90
Furnace Vent Baghouse	-	-	-	-	-	-	-
Acid Plant Tail Gas	106,100	400	110	116	400	110	116
Total	756,100	160	37	278	149	51	386

For Scenario 1, the maximum 1-hr average values can be used for the modeling, though this represents a very conservative case. The total stack flow conditions (center plus annulus) for this scenario would be 756,100 SCFM at 149°F and 386 lb/hr SO$_2$.

Scenario 2 – Tertiary System Off - No Material Processing in Converter Aisle

In Scenario 2, the converter tertiary system is off. By the Consent Decree requirements, no material processing can occur in the converter aisle if the tertiary system is off. Therefore, the SO$_2$ to the secondary baghouse system would be negligible, but the system is assumed to still operate at normal flow capacity to help with building ventilation. The acid plant is assumed to continue to operate at normal conditions as well. Table 2 below summarizes the emissions streams for this scenario.

Table 2
Scenario 2 Smelter Stack Flow Conditions

Stream	Flow (SCFM)	Average SO$_2$			Maximum 1-hr average SO$_2$		
		Temp. (F)	SO$_2$ (ppmv)	SO$_2$ (lb/hr)	Temp. (F)	SO$_2$ (ppmv)	SO$_2$ (lb/hr)
Conv. Secondary Baghouse	275,000	100	0	0	100	0	0
Converter Tertiary System	-	-	-	-	-	-	-
Furnace Vent Baghouse	275,000	210	67	183	210	67	183
Acid Plant Tail Gas	106,100	400	110	116	400	110	116
Total	**656,100**	**195**	**46**	**299**	**195**	**46**	**299**

For Scenario 2, the average and maximum 1-hr average values are the same. The total stack flow conditions (center plus annulus) for this scenario would be 656,100 SCFM at 195°F and 299 lb/hr SO$_2$.
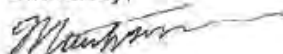
Recommendation

The two scenarios above are believed to be conservative estimates of the potential minimum flow conditions. Scenario 2 has the lowest total stack flow rate at 656,100 SCFM and the lowest SO$_2$ loading at 299 lb/hr. Scenario 1 has 15% higher flow than Scenario 2 (756,100 SCFM vs 656,100 SCFM) but 29% higher SO$_2$ loading (386 lb/hr vs 299 lb/hr). Therefore, Scenario 1 may represent the worst case in terms of the dispersion modeling results.

GCT would recommend that ASARCO evaluate both scenarios in the dispersion model to determine if either presents a concern.

If you have any questions or concerns regarding the analysis, please do not hesitate to contact me.

Sincerely,

Matt Russell
Senior Process Engineer
Gas Cleaning Technologies, LLC

Garfield
Max Daily 1-hr SO2 Concentrations
Asarco Shutdown

	Avg:	3.7		Avg:	2.7		Avg:	7.0
Date		Max Daily 1-hr SO2 (ug/m3)	Date		Max Daily 1-hr SO2 (ug/m3)	Date		Max Daily 1-hr SO2 (ug/m3)
5/20/2009		3	3/10/2011		3	3/26/2013		7
5/21/2009		2	3/11/2011		2	3/27/2013		8
5/22/2009		2	3/12/2011		3	3/28/2013		8
5/23/2009		2	3/13/2011		3	3/29/2013		6
5/24/2009		3	3/14/2011		2	3/30/2013		7
5/25/2009		3	3/15/2011		4	3/31/2013		7
5/26/2009		4	3/16/2011		2	4/1/2013		7
5/27/2009		3	3/17/2011		4	4/2/2013		7
5/28/2009		4	3/18/2011		4	4/3/2013		6
5/29/2009		3	3/19/2011		2	4/4/2013		7
5/30/2009		3	3/20/2011		2	4/5/2013		6
5/31/2009		2	3/21/2011		2	4/6/2013		6
6/1/2009		3	3/22/2011		2	4/7/2013		6
6/2/2009		4	3/23/2011		3	4/8/2013		10
6/3/2009		3	3/24/2011		2	4/9/2013		7
6/4/2009		3				4/10/2013		7
6/5/2009		3				4/11/2013		8
6/6/2009		3				4/12/2013		6
6/7/2009		3						
6/8/2009		3						
6/9/2009		3						
6/10/2009		4						
6/11/2009		4						
6/12/2009		5						
6/13/2009		3						
6/14/2009		3						
6/15/2009		4						
6/16/2009		4						
6/17/2009		4						
6/18/2009		4						
6/19/2009		4						
6/20/2009		4						
6/21/2009		4						
6/22/2009		5						
6/23/2009		5						
6/24/2009		5						
6/25/2009		6						
6/26/2009		6						
6/27/2009		5						

Globe
Max Daily 1-hr SO2 Concentrations
Asarco Shutdown

	Avg:	2.9		Avg:	3.6		Avg:	7.1
Date	**Max Daily 1-hr SO2 (ug/m3)**		**Date**	**Max Daily 1-hr SO2 (ug/m3)**		**Date**	**Max Daily 1-hr SO2 (ug/m3)**	
5/20/2009	4		3/10/2011	8		3/26/2013	7	
5/21/2009	4		3/11/2011	2		3/27/2013	10	
5/22/2009	4		3/12/2011	4		3/28/2013	9	
5/23/2009	4		3/13/2011	3		3/29/2013	9	
5/24/2009	5		3/14/2011	3		3/30/2013	9	
5/25/2009	4		3/15/2011	2		3/31/2013	8	
5/26/2009	5		3/16/2011	2		4/1/2013	3	
5/27/2009	4		3/17/2011	3		4/2/2013	5	
5/28/2009	10		3/18/2011	3		4/3/2013	5	
5/29/2009	1		3/19/2011	3		4/4/2013	6	
5/30/2009	2		3/20/2011	1		4/5/2013	5	
5/31/2009	2		3/21/2011	1		4/6/2013	4	
6/1/2009	3		3/22/2011	3		4/7/2013	10	
6/2/2009	3		3/23/2011	7		4/8/2013	10	
6/3/2009	2		3/24/2011	8		4/9/2013	8	
6/4/2009	3					4/10/2013	9	
6/5/2009	2					4/11/2013	7	
6/6/2009	2					4/12/2013	4	
6/7/2009	2							
6/8/2009	2							
6/9/2009	3							
6/10/2009	2							
6/11/2009	2							
6/12/2009	2							
6/13/2009	2							
6/14/2009	2							
6/15/2009	2							
6/16/2009	3							
6/17/2009	2							
6/18/2009	2							
6/19/2009	2							
6/20/2009	2							
6/21/2009	2							
6/22/2009	2							
6/23/2009	3							
6/24/2009	2							
6/25/2009	2							
6/26/2009	3							
6/27/2009	3							

Hayden Jail
Max Daily 1-hr SO2 Concentrations
Asarco Shutdown

	Avg:	2.1		Avg:	2.4		Avg:	7.2
Date	**Max Daily 1-hr SO2 (ug/m3)**		**Date**	**Max Daily 1-hr SO2 (ug/m3)**		**Date**	**Max Daily 1-hr SO2 (ug/m3)**	
5/20/2009	5		3/10/2011	5		3/26/2013	8	
5/21/2009	5		3/11/2011	2		3/27/2013	8	
5/22/2009	3		3/12/2011	2		3/28/2013	9	
5/23/2009	3		3/13/2011	1		3/29/2013	8	
5/24/2009	4		3/14/2011	1		3/30/2013	6	
5/25/2009	4		3/15/2011	2		3/31/2013	7	
5/26/2009	8		3/16/2011	2		4/1/2013	7	
5/27/2009	4		3/17/2011	5		4/2/2013	7	
5/28/2009	3		3/18/2011	3		4/3/2013	5	
5/29/2009	0		3/19/2011	2		4/4/2013	6	
5/30/2009	0		3/20/2011	2		4/5/2013	6	
5/31/2009	2		3/21/2011	1		4/6/2013	7	
6/1/2009	0		3/22/2011	1		4/7/2013	9	
6/2/2009	4		3/23/2011	2		4/8/2013	9	
6/3/2009	1		3/24/2011	5		4/9/2013	5	
6/4/2009	1					4/10/2013	6	
6/5/2009	1					4/11/2013	7	
6/6/2009	0					4/12/2013	6	
6/7/2009	1							
6/8/2009	1							
6/9/2009	4							
6/10/2009	1							
6/11/2009	1							
6/12/2009	1							
6/13/2009	1							
6/14/2009	1							
6/15/2009	1							
6/16/2009	4							
6/17/2009	1							
6/18/2009	1							
6/19/2009	1							
6/20/2009	1							
6/21/2009	1							
6/22/2009	1							
6/23/2009	4							
6/24/2009	3							
6/25/2009	1							
6/26/2009	1							
6/27/2009	2							

Hayden Junction
Max Daily 1-hr SO2 Concentrations
Asarco Shutdown

	Avg:	4.3		Avg:	4.3		Avg:	5.8
Date	Max Daily 1-hr SO2 (ug/m3)		Date	Max Daily 1-hr SO2 (ug/m3)		Date	Max Daily 1-hr SO2 (ug/m3)	
5/20/2009	3		3/10/2011	4		3/26/2013	5	
5/21/2009	2		3/11/2011	4		3/27/2013	6	
5/22/2009	2		3/12/2011	4		3/28/2013	5	
5/23/2009	2		3/13/2011	4		3/29/2013	7	
5/24/2009	3		3/14/2011	4		3/30/2013	5	
5/25/2009	2		3/15/2011	4		3/31/2013	5	
5/26/2009	5		3/16/2011	4		4/1/2013	8	
5/27/2009	3		3/17/2011	5		4/2/2013	5	
5/28/2009	6		3/18/2011	4		4/3/2013	5	
5/29/2009	3		3/19/2011	5		4/4/2013	5	
5/30/2009	3		3/20/2011	4		4/5/2013	5	
5/31/2009	3		3/21/2011	5		4/6/2013	5	
6/1/2009	4		3/22/2011	4		4/7/2013	11	
6/2/2009	6		3/23/2011	4		4/8/2013	7	
6/3/2009	6		3/24/2011	5		4/9/2013	5	
6/4/2009	7					4/10/2013	5	
6/5/2009	4					4/11/2013	6	
6/6/2009	4					4/12/2013	5	
6/7/2009	4							
6/8/2009	5							
6/9/2009	5							
6/10/2009	3							
6/11/2009	4							
6/12/2009	5							
6/13/2009	5							
6/14/2009	4							
6/15/2009	4							
6/16/2009	6							
6/17/2009	5							
6/18/2009	6							
6/19/2009	5							
6/20/2009	4							
6/21/2009	4							
6/22/2009	6							
6/23/2009	6							
6/24/2009	3							
6/25/2009	4							
6/26/2009	5							
6/27/2009	6							

Introduction

As explained in the "Guidance for 1-Hour SO2 Nonattainment Area SIP Submissions" EPA allows for longer than 1-hour emission limits in order to show attainment with the 2010 SO_2 NAAQS. Appendix C of this guidance document lays out the steps to derive longer than 1-hr limits based on the critical emission value (CEV). These steps involve scaling the CEV downward based on emission variability over various averaging periods, resulting in longer than 1-hr average emission limits with comparable stringency to the 1-hr CEV. These longer than 1-hr average limits allow for hourly emission rates above the CEV, provided that these are offset by periods of emissions below the CEV. The guidance addresses this scenario and states that "a source complying with a longer term average emission limit could possibly have hourly emissions which occasionally exceed the critical emission value." These hourly excursions above the CEV do not necessarily lead to NAAQS violations, as these hourly excursions need to occur during periods when the meteorology is conducive to high ambient SO_2 concentrations. The guidance further states "if periods of hourly emissions above the critical emission value are a rare occurrence at a source, these periods would be unlikely to have a significant impact on air quality, insofar as they would be very unlikely to occur repeatedly at the times when the meteorology is conducive for high ambient concentrations of SO_2."

After following the EPA's guidance methodology the proposed emission limit for the Asarco smelter main stack is a 14-day average of 1,069.12 lbs/hr. This document will provide an overview of projected future emissions from the Asarco Smelter and show that even with this longer than 1-hr limit the hourly emissions above the CEV are predicted to be a rare occurrence and that these high emission rates are very unlikely to occur when the meteorology is conducive for high ambient concentrations of SO_2.

Forecast Emission Rates

Asarco provided historical and forecast SO_2 emission rates for the smelter, including the main stack and fugitive estimates from the flash furnace, converter aisle, and anode furnace. These forecast emissions are the emission rates expected to be achieved under the Converter Retrofit Project (CRP) and were generated by applying the CRP control assumptions to historical CEMS emissions data. Sections 5.3 and 5.4 of the Hayden SO_2 Modeling Technical Support Document details the methodology and assumptions used to create this forecast dataset.

Table shows the distribution of these forecasted emission rates. Forecasted emission rates were calculated from actual CEMS data recorded from 2005 to 2014, which is why the forecast data is presented for these years. This is provided to give examples of what the annual forecast emission distributions will be, not to indicate what emissions actually were during the stated year. The critical emissions value (CEV) is indicated by the red line (1,518 lbs/hr). The forecast emissions data presented in **Table** shows that the majority of emissions are predicted to fall below the CEV.

Table 1: Forecast Emission Rate Distribution

Facility-Wide Emission Rate Bins			# Hours Within Each Bin									
			2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2,000		+	0	0	0	0	3	0	1	0	1	0
1,900	to	2,000	1	0	2	1	2	3	2	0	2	0
1,800	to	1,900	1	0	0	5	9	1	3	4	2	0
1,700	to	1,800	3	0	4	3	23	5	10	1	4	0
1,600	to	1,700	3	1	7	8	37	12	9	7	3	1
1,518	to	1,600	8	2	13	24	34	15	14	2	5	0
1,400	to	1,518	31	10	36	61	114	26	23	16	15	1
1,300	to	1,400	18	9	60	98	155	35	31	36	26	4
1,200	to	1,300	33	9	116	193	271	51	37	61	43	11
1,100	to	1,200	36	37	167	354	362	115	61	143	93	16
1,000	to	1,100	47	46	374	640	447	206	144	196	155	23
900	to	1,000	105	114	623	926	563	356	263	373	202	26
800	to	900	235	285	981	1,223	661	603	492	699	342	47
700	to	800	549	569	1,287	1,326	781	1,037	808	1,013	589	76
600	to	700	940	995	1,383	1,258	861	1,420	1,083	1,325	797	111
500	to	600	1,345	1,510	1,225	1,021	931	1,618	1,425	1,480	1,048	174
400	to	500	1,384	1,710	938	573	940	1,426	1,548	1,395	1,289	232
300	to	400	1,057	1,500	521	268	679	939	1,222	1,015	1,328	202
200	to	300	642	757	231	96	351	413	644	561	1,021	159
100	to	200	287	297	128	87	111	159	241	251	446	72
0	to	100	354	165	184	111	100	193	195	86	605	58

Excursions

As described in the introduction, the term excursion is used in this analysis to describe a 1-hr emission rate that exceeds the CEV. While emission rates above the CEV do not necessarily result in ambient concentrations that exceed the NAAQS, it is important to understand how often these excursion are predicted to occur in order to understand the likely impact they will have on ambient concentrations.

Excursion Rate

Once the dataset of forecasted emissions was established, ADEQ examined the likelihood of excursions (i.e. emission rates above the CEV). **Table 2** and **Table 3** illustrate the predicted level of CRP controls applied to historical data from January 1, 2005 to February 20, 2014 and detail the number and percentage of excursions, respectively. These tables show the number of hours at or above the listed emission rates, starting with 1,518 lbs/hr (the CEV) and extending to include all predicted emission rates.

Table 2: # Hours above CEV

Year	# Hours ≥ Emission Rate (lbs/hr)…													
	1,518	1,567	1,615	1,664	1,712	1,761	1,809	1,858	1,906	1,955	2,003	2,052	2,100	2,240
2005	13	7	5	4	2	2	1	0	0	0	0	0	0	0
2006	2	2	0	0	0	0	0	0	0	0	0	0	0	0
2007	23	12	9	6	3	2	2	1	1	0	0	0	0	0
2008	28	15	10	9	8	4	2	1	0	0	0	0	0	0
2009	85	65	53	38	25	16	7	5	4	3	2	1	1	0
2010	29	21	15	10	6	4	3	3	1	1	0	0	0	0
2011	37	26	20	15	11	7	4	3	1	1	0	0	0	0
2012	13	10	8	7	5	4	2	1	0	0	0	0	0	0
2013	14	11	11	9	7	5	3	3	1	1	1	1	1	0
2014	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Average	24.5	17.0	13.1	9.8	6.7	4.4	2.4	1.7	0.8	0.6	0.3	0.2	0.2	0.0

Table 3: % Hours above CEV

Year	\% Hours ≥ Emission Rate (lbs/hr)...													
	1,518	1,567	1,615	1,664	1,712	1,761	1,809	1,858	1,906	1,955	2,003	2,052	2,100	2,240
2005	0.18%	0.10%	0.07%	0.06%	0.03%	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2006	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2007	0.28%	0.14%	0.11%	0.07%	0.04%	0.02%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
2008	0.34%	0.18%	0.12%	0.11%	0.10%	0.05%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2009	1.14%	0.87%	0.71%	0.51%	0.34%	0.22%	0.09%	0.07%	0.05%	0.04%	0.03%	0.01%	0.01%	0.00%
2010	0.34%	0.24%	0.17%	0.12%	0.07%	0.05%	0.03%	0.03%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%
2011	0.45%	0.31%	0.24%	0.18%	0.13%	0.08%	0.05%	0.04%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%
2012	0.15%	0.12%	0.09%	0.08%	0.06%	0.05%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2013	0.17%	0.14%	0.14%	0.11%	0.09%	0.06%	0.04%	0.04%	0.01%	0.01%	0.01%	0.01%	0.01%	0.00%
2014	0.08%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average	0.32%	0.22%	0.17%	0.12%	0.08%	0.06%	0.03%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%

This data shows that by applying the predicted CRP controls to historical emissions, the Asarco Smelter is expected to have an emission rate above the CEV approximately 0.32% of the time.

Excursion Clustering

In addition to the rate of possible excursions, it's also important to consider how frequently these excursions occur consecutively. Due to the nature of operations at the Asarco Smelter it is common for excursions to occur in clusters of 2 hours or more. ADEQ analyzed the clustering of excursions by grouping them into distinct events. An excursion event is defined by the number of consecutive-hour excursions. **Table 4** below details the number of excursion hours based on event duration.

Table 4: Excursion Clustering

Year	Month	# Consecutive Excursion Hours									
		1	2	3	4	5	6	7	8	9	10+
	1	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	3	2	1	0	0	0	0	0	0	0	0
	4	0	0	0	1	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0
2005	6	0	0	0	0	0	0	0	0	0	0
	7	3	0	0	0	0	0	0	0	0	0
	8	2	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0

Year	Month	# Consecutive Excursion Hours									
		1	2	3	4	5	6	7	8	9	10+
2006	1	0	0	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	1	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0
2007	1	0	0	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	0	0	0
	3	1	0	0	0	0	0	0	0	0	0
	4	1	0	0	0	0	0	0	0	0	0
	5	1	1	0	0	0	0	0	0	0	0
	6	2	0	0	0	0	0	0	0	0	0
	7	1	1	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	0	1	0	0	0	0	0	0	0	0
	10	3	0	0	0	0	0	0	0	0	0
	11	2	0	0	0	0	0	0	0	0	0
	12	3	1	0	0	0	0	0	0	0	0
2008	1	2	0	0	0	0	0	0	0	0	0
	2	1	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	2	1	0	0	0	0	0	0	0	0
	5	2	1	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	3	0	0	0	0	0	0	0	0	0
	8	2	0	0	0	0	0	0	0	0	0
	9	1	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0
	11	3	0	1	0	0	0	0	0	0	0
	12	3	0	0	0	0	0	0	0	0	0

		# Consecutive Excursion Hours									
Year	Month	1	2	3	4	5	6	7	8	9	10+
2009	1	16	4	0	0	0	0	0	0	0	0
	2	4	2	0	0	0	0	0	0	0	0
	3	8	2	0	1	0	0	0	0	0	0
	4	17	0	0	1	0	0	0	0	0	0
	5	0	1	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	1	0	0	0	0	0	0	0	0	0
	8	0	1	0	0	0	0	0	0	0	0
	9	2	0	0	0	0	0	0	0	0	0
	10	0	2	0	0	0	0	0	0	0	0
	11	0	0	1	0	0	0	0	0	0	0
	12	0	1	0	0	0	0	0	0	0	0
2010	1	0	0	0	0	0	0	0	0	0	0
	2	0	0	1	0	0	0	0	0	0	0
	3	1	1	0	0	0	0	0	0	0	0
	4	2	0	0	0	0	0	0	0	0	0
	5	2	1	0	0	0	0	0	0	0	0
	6	1	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
	8	3	0	0	0	0	0	0	0	0	0
	9	3	0	0	0	0	0	0	0	0	0
	10	2	1	0	0	0	0	0	0	0	0
	11	2	0	0	0	0	0	0	0	0	0
	12	2	1	0	0	0	0	0	0	0	0
2011	1	1	0	0	1	0	0	0	0	0	0
	2	2	0	1	0	0	0	0	0	0	0
	3	2	0	0	0	0	0	0	0	0	0
	4	1	0	0	0	0	0	0	0	0	0
	5	1	1	0	0	0	0	0	0	0	0
	6	2	0	0	0	0	0	0	0	0	0
	7	0	1	0	0	0	0	0	0	0	0
	8	0	1	0	0	0	0	0	0	0	0
	9	2	3	0	0	0	0	0	0	0	0
	10	4	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	3	0	0	0	0	0	0	0	0	0

Year	Month	# Consecutive Excursion Hours									
		1	2	3	4	5	6	7	8	9	10+
2012	1	1	0	0	0	0	0	0	0	0	0
	2	2	0	0	0	0	0	0	0	0	0
	3	0	1	0	0	0	0	0	0	0	0
	4	1	0	0	0	0	0	0	0	0	0
	5	1	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	1	0	0	0	0	0	0	0	0	0
	10	1	1	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	2	0	0	0	0	0	0	0	0	0
2013	1	3	3	0	0	0	0	0	0	0	0
	2	3	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	10	1	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	1	0	0	0	0	0	0	0	0	0
2014	1	1	0	0	0	0	0	0	0	0	0
	2	0	0	1	0	0	0	0	0	0	0

On average, 78.38% of excursions at the Asarco Smelter are expected occur as non-consecutive events with 21.62% to occur during longer than 1-hr events. This is important to consider since compliance with the 2010 SO_2 NAAQS is based on maximum daily concentrations. Multi-hour excursion events will therefore likely only contribute to a single daily maximum concentration.

Exceedance Risk

Excursions above the CEV do not necessarily result in ambient SO_2 concentrations that exceed the NAAQS value of 196 µg/m^3. How likely is it that a given emission rate will result in SO_2 concentrations that exceed 196 µg/m^3? ADEQ examined this question by utilizing AERMOD modeling results to derive the likelihood of elevated hourly ambient concentrations. Below is a brief summary of the steps ADEQ took to perform this analysis:

1. Ran AERMOD for the Asarco Smelter with the following parameters:
   a. Full nonattainment area as domain
   b. Unit emission rate (1 g/s) proportioned to the various smelter release points. The unit emission rates were calculated based on the emission rates used in the attainment demonstration modeling.

Emission Source	Attainment Demonstration Emission Rate (lbs/hr)	Scaling Ratio
Main Stack	1518	0.947891
Flash Furnace Fugitives	28.7	0.0180
Converter Aisle Fugitives	10.6	0.0067
Anode Furnace Fugitives	40.1	0.02504
Slag Pouring Fugitives	4.0	0.002529

   c. One year of actual meteorological data (8/16/2013 to 8/15/2014)
2. Took resulting AERMOD post file with all hourly concentrations for all receptors and created a dataset consisting of the single highest modeled concentration for each hour
3. Multiplied these modeled concentrations by 0.947891 to derive the impact from only the main stack (fugitive limits are set at CEV values and so weren't included in this analysis).
4. Finally, multiplied these stack-only modeled concentrations by various emission rates to get predicted ambient SO_2 concentrations

This tool allowed ADEQ to test the predicted effect of various emission rates on modeled concentrations of SO_2. **Table 5** outlines the tested emission rates along with the expected probability of each rate leading to an exceedance (i.e. a modeled 1-hour concentration above 196 µg/m^3).

Table 5: Excursion Risks

Facility-Wide Emission Rate		Emission Rate Probability	Exceedance Probability
lbs/hr	*g/s*		
0.00	0.00	100.000%	0.00%
70.00	8.82	97.680%	0.00%
140.00	17.64	96.209%	0.00%
210.00	26.46	93.423%	0.00%
280.00	35.28	88.488%	0.00%
350.00	44.10	80.615%	0.00%
420.00	52.92	70.177%	0.00%
490.00	61.74	58.446%	0.00%
560.00	70.56	46.773%	0.00%
630.00	79.38	36.186%	0.00%
700.00	88.20	27.033%	0.00%
770.00	97.02	19.728%	0.02%
840.00	105.84	14.089%	0.02%
910.00	114.66	9.812%	0.03%
980.00	123.48	6.945%	0.06%
1050.00	132.30	4.800%	0.06%
1120.00	141.12	3.311%	0.07%
1190.00	149.94	2.231%	0.09%
1260.00	158.76	1.518%	0.11%
1330.00	167.58	1.052%	0.16%
1400.00	176.40	0.682%	0.26%
1470.00	185.22	0.448%	0.33%
1540.00	194.04	0.279%	0.39%
1610.00	202.86	0.184%	0.49%
1680.00	211.68	0.119%	0.59%
1750.00	220.50	0.066%	0.75%
1820.00	229.32	0.031%	1.02%
1890.00	238.14	0.016%	1.31%
1960.00	246.96	0.007%	1.66%
2030.00	255.78	0.003%	2.21%
2100.00	264.60	0.003%	2.95%
2170.00	273.42	0.003%	3.79%
2240.00	282.235	0.000%	4.77%

This data suggests that a single excursion is unlikely to occur during meteorological conditions conducive to high ambient concentrations. For instance, the meteorology in the Hayden area is such that an emission rate of 2,100 lbs/hr has a 2.95% probability of causing ambient SO_2 concentrations to exceed 196 µg/m^3. Based on the forecasted emissions dataset (2005–2014), the highest expected emission rate from the Asarco smelter will be 2,231.65 lbs/hr.

Table 5 tells us how often each emission rate is expected to occur and if it does occur how likely it is to lead to an ambient concentration above 196 µg/m³. With this information we can determine the overall probability of a NAAQS violation for the given emission distribution. In order to qualify as a NAAQS violation there need to be at least 4 exceedances in a given year, therefore the only NAAQS-compliant scenarios are exactly 0, 1, 2 or 3 annual exceedances. Any other scenario (i.e. 4 or more annual exceedances) would be a NAAQS violation. **Table 6** details the probabilities for all of these scenarios.

Table 6: NAAQS Violation Risk

Facility-Wide Emission Rate		Expected Probability of Exactly…				Expected Probability of at Least 4 Exceedances
lbs/hr	g/s	0 Exceedance(s)	1 Exceedance(s)	2 Exceedance(s)	3 Exceedance(s)	
0.00	0.00	100.00%	0.00%	0.00%	0.00%	
70.00	8.82	100.00%	0.00%	0.00%	0.00%	
140.00	17.64	100.00%	0.00%	0.00%	0.00%	
210.00	26.46	100.00%	0.00%	0.00%	0.00%	
280.00	35.28	100.00%	0.00%	0.00%	0.00%	
350.00	44.10	100.00%	0.00%	0.00%	0.00%	
420.00	52.92	100.00%	0.00%	0.00%	0.00%	
490.00	61.74	100.00%	0.00%	0.00%	0.00%	
560.00	70.56	100.00%	0.00%	0.00%	0.00%	
630.00	79.38	100.00%	0.00%	0.00%	0.00%	
700.00	88.20	100.00%	0.00%	0.00%	0.00%	
770.00	97.02	89.33%	10.08%	0.57%	0.02%	
840.00	105.84	91.79%	7.86%	0.34%	0.01%	
910.00	114.66	91.76%	7.89%	0.34%	0.01%	
980.00	123.48	89.82%	9.64%	0.51%	0.02%	
1050.00	132.30	92.85%	6.89%	0.25%	0.01%	
1120.00	141.12	93.70%	6.10%	0.20%	0.00%	
1190.00	149.94	94.41%	5.44%	0.15%	0.00%	
1260.00	158.76	95.53%	4.37%	0.10%	0.00%	
1330.00	167.58	94.86%	5.01%	0.13%	0.00%	
1400.00	176.40	94.88%	5.00%	0.12%	0.00%	
1470.00	185.22	95.15%	4.74%	0.11%	0.00%	
1540.00	194.04	96.94%	3.02%	0.04%	0.00%	
1610.00	202.86	97.09%	2.87%	0.04%	0.00%	
1680.00	211.68	97.07%	2.90%	0.03%	0.00%	
1750.00	220.50	97.76%	2.23%	0.02%	0.00%	
1820.00	229.32	98.98%	1.02%	0.00%	0.00%	
1890.00	238.14	98.69%	1.31%	0.00%	0.00%	
1960.00	246.96	100.00%	0.00%	0.00%	0.00%	
2030.00	255.78	100.00%	0.00%	0.00%	0.00%	
2100.00	264.60	100.00%	0.00%	0.00%	0.00%	
2170.00	273.42	96.21%	3.79%	0.00%	0.00%	
2240.00	282.235	100.00%	0.00%	0.00%	0.00%	
		38.12%	36.82%	17.73%	5.67%	**1.66%**

Conclusion

Based on the available data, ADEQ and Asarco believe that 14-day proposed limit is sufficiently protective of the NAAQS and that additional constrains on the frequency and magnitude of emission rates above the CEV is unnecessary. As shown in Table 2 and Table 3, the hourly emissions above the CEV are predicted to be a rare occurrence as only 0.32% of hourly emissions are expected to exceed the CEV. In addition, these high emission rates are unlikely to occur when the meteorology is conducive for high ambient concentrations of SO_2. Table 6 shows the expected emission rates from the Smelter will have a 1.66% probability of leading to a violation of the NAAQS.

10.10 Appendix J: Ambient Air Boundary Investigation

1. Overview

On Thursday, February 23rd Arizona Department of Environmental Quality (ADEQ) personnel performed an on-site tour of the ambient air boundary (AAB) used for the Hayden SO_2 and Pb nonattainment plans. During this tour ADEQ personnel traveled and documented the portions of the AAB that were reasonably accessible. Figure 1-1 details the approximate locations along the AAB that were visited. Section 2 provides some of the photographs taken during this visit along with descriptive annotations. The location numbers correspond to the locations displayed in Figure 1-1 and indicate the approximate location where the photos were taken. Also, where appropriate ADEQ has included drawings on the photos to indicate the approximate location of the AAB where no fencing is present.

In general, upon visiting the site and inspecting the AAB, ADEQ concurs with the AAB assessment provided by Asarco[20] and agrees that the boundary represents a practical ability to preclude public access. The portions of the AAB that are nearest to the town of Hayden are fenced, and the portions of the AAB that are not fenced are remote and far from any publicly accessed road.

In evaluating the AAB, ADEQ considered the definition of "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access[21]". ADEQ believes that the combination of fencing, terrain, and remoteness is appropriate for delineating the AAB as it precludes access by the general public. Additionally, any individual attempting to gain access would have to scale fences or traverse difficult terrain and open desert. Furthermore, such individual would be intercepted by Asarco security and removed from the site immediately.

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[20] See Hayden SO_2 Modeling Technical Support Document Appendix C.
[21] A.A.C. R18-2-101(14)

Figure 1: Approximate Locations along the AAB that Were Visited

2. Annotated Photos

Figure 2-1: Location #1

Looking north-northeast. Shows general location where fencing ends. Fence continues down slope and terminates at a set of railroad tracks.

AAB runs along fence line.

Looking north. View from location where fencing ends showing railroad tracks and current concentrate storage area in background.

Yellow dotted line added to indicate approximate location of AAB.

Looking south. Typical fencing used along AAB through the town of Hayden.

AAB runs along fence line.

Figure 2-2: Location #2

Looking north. Located just east of Hayden Post Office. Typical fencing used along AAB through the town of Hayden.

AAB runs along fence line.

Figure 2-3: Location #3

Looking east. Fencing runs from left side of image (obscured by bush) and continues downslope into thick vegetation.

Yellow dotted line added to indicate approximate location of fence and AAB.

Figure 2-4: Location #4

Looking west. Fencing and gate leading to secondary crusher.

AAB not visible in this view, as boundary is located further north (right side of image). The AAB runs across a ravine and this location represented the nearest ingress point.

Looking east. Main entrance to the secondary crusher.

AAB not visible in this view, as boundary is located further north (left side of image). The AAB runs across a ravine and this location represented the nearest ingress point.

Figure 2-5: Location #5

Looking northeast. Fencing ends at drainage pipe located at bottom of ravine.

AAB not visible in this view, as boundary is located further north (left side of image). The AAB runs across a ravine and this location represented the nearest ingress point.

Figure 2-6: Location #6

Looking west. View across ravine which runs north-south along road to smelter employee parking lot.

AAB not visible in this view, as boundary is located further north (right side of image).

Figure 2-7: Location #7

Looking south. Fencing along south side of smelter parking lot. In background, fencing can be seen that runs around water retention basin.

AAB runs along fence line.

Figure 2-8: Location #8

Looking south. Looking through barbed wire topped fence. In background fence which runs around water retention basin.

AAB runs along fence line.

Looking east. Barbed wire topped fence continues to location #9.

AAB runs along fence line.

Figure 2-9: Location #9

Looking east. This location is near terminus of barbed wire topped fencing shown at location #8. Steep slope and berm provides significant impedance to access.

Yellow dotted line added to indicate approximate location of AAB.

Figure 2-10: Location #10

Looking southwest. View of contractor access road with slag dump to the right.

Yellow dotted line added to indicate approximate location of AAB.

Looking northeast. Contractor parking area with bolder used to restrict vehicle access. Slag dump and water retention basin in background.

Yellow dotted line added to indicate approximate location of AAB.

Looking west. Image taken from water retention basin with view of slag dump. Asarco employee in background for perspective.

Yellow dotted line added to indicate approximate location of AAB.

Figure 2-11: Location #11

Looking east. This view captures the general area that was added to AAB due to Asarco's land purchase. AAB lies beyond the hills in this image.

Looking north. This view captures the general area that was added to AAB due to Asarco's land purchase. AAB lies beyond the hills in this image.

Figure 2-12: Location #12

Looking south. View from concentrate storage area towards location #1 where fencing ends. Ravine with train tracks visible.

Yellow dotted line added to indicate approximate location of AAB. Line starts where fencing ends.

Looking north. View of concentrate and lime (white substance) storage area.

Yellow dotted line added to indicate approximate location of AAB. AAB runs north from location #1 to approximate location of lime storage then follows roadway (not visible).

Figure 2-13: Location #13

Looking northeast. View of mountain ridge which runs along the northeast and eastern side of AAB.

Yellow dotted line added to indicate approximate location of AAB.

Looking southwest. View of roadway that is used to demarcate the northwestern edge of AAB.

Yellow dotted line added to indicate approximate location of AAB.

•   Introduction

ADEQ has proposed the following emission limit for the Asarco smelter:

> *Emissions from the Main Stack shall not exceed 1069.1 pounds per hour on a 14-operating day average unless 1518 pounds or less is emitted during each hour of the 14-operating day period.*

This "dual limit" has been pursued by Asarco for the operational flexibility it extends, especially considering some uncertainties regarding control efficiencies for Converter Retrofit Project (CRP) controls that haven't been installed. ADEQ proposed this dual limit and after review EPA expressed concerns with it and stated that "[t]his combination does not provide the protection against violations of the NAAQS that either limit by itself provides, nor does this combination provide the protection against NAAQS violations contemplated in EPA's guidance."[22]

ADEQ has previously released an analysis of the expected exceedance risk posed by the Asarco smelter under the proposed control strategy and emissions limit[23]. This exceedance risk analysis examined the probability of a NAAQS violation using a forecasted emission dataset based on historical emissions data. The results showed a 1.66% probability (1 in 62.5 years) of a NAAQS violation. These results provided an indication that the controls put forth in the Hayden SO_2 SIP provided reasonable assurance of NAAQS compliance. The methodology used in the exceedance risk analysis to calculate expected NAAQS violations differs from the methodology presented in this document. While the results of the two analysis are not in complete agreement, they nonetheless both offer insights into the possible risks of NAAQS violations based on the proposed limits and forecasted emissions distribution.

This document serves to further document and analyze the dual SO_2 limits and their impact on the Hayden Nonattainment Area. Specifically, this document will compare the dual limit proposed by ADEQ with EPA's guidance approach as described in the April 2014 memo "Guidance for 1-Hour SO2 Nonattainment Area SIP Submissions". This comparison is based on the analysis described in EPA's SO_2 Guidance Appendix B and involves the use of randomly created datasets and modeling outputs to predict ambient SO_2 impacts. The results of the simulations described in this document show that there is functionally no difference between the expected ambient impacts of the dual limit and the 14-day guidance limit.

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[22] 2/6/2017 Feedback from EPA to ADEQ regarding hybrid limit
[23] Exceedance Risk Analysis, Hayden SO2 Modeling TSD, Appendix I

• Simulator Overview

ADEQ used a Monte Carlo simulator to aide in the comparison of the dual limit and 14-day guidance limit. To perform this comparison, ADEQ used Microsoft Excel to create a simulator to test various emissions scenarios and calculate and record their predicted concentrations and design values. An overview of the steps involved in setting up this simulator are provided below.

• Forecast Emission Rates

Asarco provided historical and forecast SO_2 emission rates for the smelter, including the main stack and fugitive estimates from the flash furnace, converter aisle, and anode furnace. These forecast emissions are the emission rates expected to be achieved under the Converter Retrofit Project (CRP) and were generated by applying the CRP control assumptions to historical CEMS emissions data. Sections 5.3 and 5.4 of the Hayden SO_2 Modeling Technical Support Document details the methodology and assumptions used to create this forecast dataset.

The simulator only considered main stack emission rates when determining compliance with the limits, since the dual limit explicitly applies to those emissions but not fugitives. However, the simulator also accounted for fugitive emissions when estimating ambient concentrations as described in Section A2.3.

• Unit Concentrations

Similar to the methodology used in the Exceedance Risk Analysis, ADEQ ran AERMOD for the Hayden smelter using the modeling parameters from the attainment demonstration, one year of actual MET data (8/16/2013 to 8/15/2014), and unit emission rates for each of the SO_2 sources. Since there are multiple SO_2 sources, ADEQ apportioned the unit emission rate (1 g/s) to the various sources based on the rates for each source in the attainment demonstration.

<div align="center">

Table 9 - Modeled Unit Emission Rates

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Emission Source	Attainment Demonstration Emission Rate (lbs/hr)	Unit Emission Rate (g/s)
Main Stack	1518	0.947891
Flash Furnace Fugitives	28.7	0.017921
Converter Aisle Fugitives	10.6	0.006619
Anode Furnace Fugitives	40.1	0.02504
Slag Pouring Fugitives	4.05	0.002529

The resulting AERMOD POST file was processed to extract each hour's highest observed unit concentration.

- ## Simulator Runs

The simulator is populated with hourly emission rates and unit concentration values, which when multiplied together produce an expected ambient concentration. The main stack emission rate is also recorded for each hour to determine compliance/non-compliance with the limits. Each run of the simulator is populated with three years' worth of randomly selected emission rate and unit concentration values. A design value is calculated for each run by taking the average of the 99th percentile daily maximum concentration for these three years. ADEQ ran the simulator for 50,000 runs (which corresponds to 150,000 years' worth of data).

• Simulator Set-Up

In order to compare the relative protectiveness of the various emission limit schemes, ADEQ established the bins listed in Table 10. Each bin describes one of the four possible combinations of both meeting and exceeding the 1-hr and 14-day guidance limits. While the EPA's guidance allows for the calculation of emission limits up to 30-days, this analysis only looks at a 14-day limit. Each three-year run of the simulator lives in a single bin.

Table 10 - Simulator Bins

Scenario Bin	Description
A	Meeting 1-hr limit, meeting 14-day guidance limit
B	Meeting 1-hr limit, exceeding 14-day guidance limit
C	Exceeding 1-hr limit, meeting 14-day guidance limit
D	Exceeding 1-hr limit, exceeding 14-day guidance limit

ADEQ used these bins to address two objective functions:

What are the chances of a NAAQS violation under the various emission limit schemes

Under what conditions would the dual limit be less protective than the 14-day guidance limit

ADEQ used the simulator described in Section ⍰ to address these two questions. The simulator was set to perform 50,000 runs with the results of each run categorized by scenario bin. For example, if the main stack emission rate exceeded 1518 lbs/hr for one or more hours during a 3-year run, but every 14-day rolling average emission rate was at or below 1069.1 lbs/hr throughout that same run, then it would be counted under bin C." If the design value for that run was above 196 µg/m^3 then it was counted as a violation also under bin C. The frequencies of violations in these bins were used to calculate the probability of a violation under each scenario.

While scenarios A-D describe the four possible compliance results with both the 1-hr and guidance limits, they don't explicitly address the question of how the dual limit compares to both the 1-hr and 14-day guidance limits. To answer this question, the four bins can be grouped to provide information on violation probabilities for the dual limit, 1-hr limit, and guidance limit. This grouping is described below.

A,B,C,D$_{occurance}$ = number of simulations that were categorized as A, B, C, or D bins.

A,B,C,D$_{violation}$ = number of violations that occurred for simulations that were categorized as A, B, C, or D bins.

Probability of Violating NAAQS while Complying with 1-Hr Limit

$$\frac{A_{exceedance} + B_{exceedance}}{A_{occurence} + B_{occurence}}$$

Probability of Violating NAAQS while Complying with 14-Day Limit

$$\frac{A_{exceedance} + C_{exceedance}}{A_{occurence} + C_{occurence}}$$

Probability of Violating NAAQS while Complying with Dual Limit

$$\frac{A_{exceedance} + B_{exceedance} + C_{exceedance}}{A_{occurence} + B_{occurence} + C_{occurance}}$$

• Results

The first objective function ADEQ examined was "What are the chances of a NAAQS violation under the various emission limit schemes?" To answer this question ADEQ performed 50,000 runs of the simulator, in effect simulating 150,000 years' worth of data. The results observed from this simulation are provided below in Table 11.

Table 11 – Real-World Emission Scenario - Violation Probability

Scenario Bin	# Occurrences	# Violations
A	0	0
B	0	0
C	50,000	19
D	0	0

The formulas listed in Section ⍰ were used to derive meaningful comparisons between the various limits and the NAAQS violation probabilities each allows. Table 12 lists the violation probabilities observed during the simulation for the three emission limit schemes; 1-hr (i.e. CEV), 14-day (i.e. guidance limit), and the dual limit proposed by ADEQ.

Table 12 – Real-World Emission Scenario - Limit Violation Probability

Limit	Probability of Violating NAAQS while Complying with Limit	90% Confidence Interval		
1-hr	N/A	N/A	to	N/A
14-day	0.038%	0.024%	to	0.052%
Dual	0.038%	0.024%	to	0.052%

The results of this simulation show that with the real-world emissions distributions there is a 0.0035% chance of violating the NAAQS when complying with either the 14-day or dual limit. With this probability we could say that a violation would be expected once every ~2,600 years. In addition, these results show that there is no difference between the probabilities of violating the NAAQS when the facility is complying with the 14-day limit as compared to complying with the dual limit. The reason these probabilities are identical is that Scenario B (meeting 1-hr limit but exceeding the 14-day limit) did not occur once during the entire simulation. Also, no results are provided for the 1-hr limit as there were no simulation runs during which the 1-hr limit was continuously complied with.

The second objective function was "Under what conditions would the dual limit be less protective than the 14-day guidance limit?" To answer this question ADEQ used the same 50,000 runs of the simulator, however for each run also recorded the results with emissions increased by 40% and decreased by 20%. These simulation results are provided in the following two tables.

Table 13 – 40% Emissions Increase

40% Emissions Increase		
Scenario Bin	**Occurrences**	**Violations**
A	0	0
B	0	0
C	49,708	49,569
D	292	292
Limit	**Probability of Violating NAAQS while Complying with Limit**	**90% Confidence Interval**
1-hr	N/A	N/A to N/A
14-day	99.72%	99.68% to 99.76%
Dual	99.72%	99.68% to 99.76%

These results align with the results observed with the "real-world" emissions data. In this scenario where the smelter's emissions are increased by 40%, both the dual limit and 14-day limit provide equal protection of the NAAQS. As with the "normal" emissions simulations, the reason both limits provide for identical protection is because the scenario that the dual limit allows which the 14-day limit precludes was never observed. Even though there is a higher likelihood of a violation, the takeaway from this analysis is that both violation probabilities for the 14-day limit and dual limit are identical.

Table 14 - 20% Emissions Decrease

20% Emissions Decrease		
Scenario Bin	**Occurrences**	**Violations**
A	2,041	0
B	0	0
C	47,959	0
D	0	0
Limit	**Probability of Violating NAAQS while Complying with Limit**	**90% Confidence Interval**
1-hr	0.00	0.00 to 0.00
14-day	0.00	0.00 to 0.00
Dual	0.00	0.00 to 0.00

These results align with the results observed with the "real-world" emissions data. In this scenario where the smelter's emissions are decreased by 20%, both the dual limit and 14-day limit provide equal protection of the NAAQS. There were no observed NAAQS violations from this scenario, therefore all emission limit schemes have the same NAAQS violation probability of zero.

• **Discussion**

The results of ADEQ's analysis of the expected NAAQS violation probabilities for each of the emission limit schemes shows that for the Hayden smelter there is no functional difference between the 14-day limit prescribed by EPA guidance and the dual limit. In essence, both provide the same level of protection of the NAAQS.

One of the key reasons for this equivalence is the fact that not a single occurrence of Scenario B or D was observed in the simulations based on the expected emissions profile. These two scenarios describe noncompliance with the 14-day limit. In the 150,000 years' worth of simulated data not a single occurrence of the Hayden smelter violating the 14-day average was observed. This suggests that such a scenario is extremely implausible.

Even though the simulator showed the 1-hour limit (i.e. the CEV) would be violated based on the expected emissions profile, the chance of a NAAQS violation is approximately 1 every ~2,600 years. ADEQ believes that this probability is small enough to be considered negligible and that all three limits (1-hour, 14-day, and dual) are sufficiently protective of the NAAQS.

The results of the "what if" simulations where the emission rates were artificially increased and decreased also supports the idea that the dual limit is comparably protective of the NAAQS as the 14-day limit. These simulations provide evidence that both the 14-day limit and dual limit would provide identical protection of the NAAQS.

Exhibit AIV   – Guidance Materials

Technical Support Document

ARIZONA
Nonattainment Area Designations for the
2010 Sulfur Dioxide (SO$_2$) Primary National Ambient Air Quality Standard

Summary

Pursuant to section 107(d) of the Clean Air Act (CAA), EPA must initially designate areas as either "nonattainment," "attainment," or "unclassifiable" for the 2010 1-hour sulfur dioxide (SO$_2$) primary national ambient air quality standard (NAAQS). The CAA defines a nonattainment area as one that does not meet the NAAQS or that contributes to poor air quality in a nearby area that does not meet the NAAQS.

Table 1 below identifies the counties and portions of counties in Arizona that EPA has initially designated "nonattainment" based on monitored violations. EPA is not yet prepared to designate other areas in Arizona, and will address such areas in a subsequent round of final designations.

Table 1. Nonattainment Designations for Arizona

Area (listed alphabetically)	Arizona's Recommendation of Areas/Counties	EPA's Designated Nonattainment Areas/Counties
Hayden		
Gila County (partial)	Nonattainment	Nonattainment
Pinal County (partial)	Nonattainment	Nonattainment
Miami		
Gila County (partial)	Nonattainment	Nonattainment

Background

On June 2, 2010, EPA revised the primary SO$_2$ NAAQS (75 FR 35520, June 22, 2010) by establishing a new 1-hour standard at a level of 75 parts per billion (ppb), which is met at an ambient air quality monitoring site when the 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations is less than or equal to 75 ppb, as determined in accordance with Appendix T of 40 CFR part 50. 40 CFR 50.17(a)-(b). EPA has determined that this is the level necessary to provide protection of public health with an adequate margin of safety, especially for children, the elderly, and those with asthma. These groups are particularly susceptible to the health effects associated with breathing SO$_2$. The Agency is revoking the two prior primary standards of 140 ppb evaluated over 24-hours and 30 ppb evaluated over an entire year because the standards will not add additional public health protection given a 1-hour standard at 75 ppb. Accordingly, EPA has not designated areas in this process on the basis of either of these two prior primary standards. Similarly, the secondary standard for SO$_2$ has not been revised, so EPA has not designated areas in this process on the basis of the secondary standard.

EPA's SO$_2$ Designation Approach

Section 107(d) of the CAA provides that not later than 1 year after promulgation of a new or revised NAAQS, state Governors may submit their recommendations for designations and boundaries to EPA. This deadline was June 3, 2011. Section 107(d) also requires EPA to provide a notification to states of no less than 120 days prior to promulgating an initial area designation that is a modification of a state's recommendation. EPA has reviewed the state's recommendations and has notified the Governor through a letter signed by the Regional Administrator of any intended modifications. While language in section 107 specifically addresses states, we intend to follow the same process for tribes, pursuant to section 301(d) of the CAA and Tribal Authority Rule (40 CFR Part 49). Therefore, we intend to designate tribal areas, in consultation with the tribes, on the same schedule as state designations. If a state or tribe did not submit designation recommendations, EPA will promulgate the designations that it deems appropriate. If a state or tribe disagrees with EPA's intended area designations, it has an opportunity to demonstrate why any proposed modification is inappropriate.

Designations guidance was issued by EPA through a March 24, 2011, memorandum from Stephen D. Page, Director, U.S. EPA, Office of Air Quality Planning and Standards, to Air Division Directors, U.S. EPA Regions I-X. This memorandum identifies factors EPA we are using to evaluate in determining boundaries for areas designated nonattainment. These 5 factors include: 1) air quality data; 2) emissions and emissions-related data (location of sources and potential contribution to ambient SO$_2$ concentrations); 3) meteorology (weather/transport patterns); 4) geography/topography (mountain ranges or other air basin boundaries); and 5) jurisdictional boundaries (e.g., counties, air districts, pre-existing nonattainment areas, reservations, metropolitan planning organization), among any other information deemed relevant to establishing appropriate area designations and boundaries for the 1-hour SO$_2$ NAAQS.

As defined at 18 U.S.C. 1151, "Indian country" refers to: "(a) all land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation, (b) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (c) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same." EPA recognizes the sovereignty of tribal governments, and has attempted to take the desires of the tribes into account in establishing appropriate nonattainment area designation boundaries, in accordance with EPA's December, 2011 *Policy for Establishing Separate Air Quality Designations for Areas of Indian Country[1]*.

The March 24, 2011 designation memo recommended that area boundaries default to the county boundary unless additional provided information justifies a larger or smaller boundary than the county. EPA believes it is appropriate to evaluate each potential area on a case-by-case basis, and to recognize that area-specific analyses conducted by states, tribes and/or EPA may support a different boundary than a default county boundary.

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[1] http://www.epa.gov/ttn/caaa/t1/memoranda/20120117indiancountry.pdf

In this TSD, EPA discusses its review and technical analysis of the nonattainment area recommendations submitted by the state of Arizona for designations of the 1-hour SO_2 standard. Based on our review of information discussed below, EPA agrees with the state's recommendation to designate portions of Gila County and Pinal County nonattainment and has initially designated those areas accordingly. The EPA is not yet reaching conclusions concerning areas in Arizona, and their sources, that are outside of the nonattainment area designations addressed in this TSD. EPA will make final initial designations decisions for the remaining portions of Arizona in the future.

Definition of important terms used in this document:

1) **Designated nonattainment area –** an area which EPA has determined, based on a state recommendation and/or on the technical analysis included in this document, has violated the 2010 SO_2 NAAQS, based on the most recent three years of air quality monitoring data, or contributes to a violation in a nearby area.

2) **Recommended nonattainment area –** an area that a state or tribal government has recommended to EPA to be designated as nonattainment.

3) **Violating monitor –** an ambient air monitor meeting all methods, quality assurance and citing criteria and requirements whose valid design value exceeds 75 ppb, as described in Appendix T of 40 CFR part 50.

4) **2010 SO_2 NAAQS -** 75 ppb, national ambient air quality standard for SO_2 promulgated in 2010. Based on the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations.

5) **Design Value** – a statistic that describes the air quality status of a given area relative to the level of the NAAQS.

Nonattainment Designations

Technical Analysis for Hayden, Arizona

Introduction

This technical analysis for Hayden, Arizona identifies the partial county with a monitor that violates the 2010 SO$_2$ NAAQS, and evaluates that county and nearby counties for contributions to SO$_2$ concentrations in the area. EPA has evaluated this county and nearby counties based on the weight-of-evidence of the factors in EPA's Designation Guidance, issued on March 24, 2011.[2]

Figure 1 shows the Hayden area in Arizona which EPA has initially designated nonattainment. Figure 2 is a map showing the locations of SO$_2$ monitors in Hayden, Arizona and surrounding counties. Violating monitors are shown with a red icon; monitors attaining the standard are shown with green icons. Design values for each monitor are listed in Figure 2, and in Table 2 below.
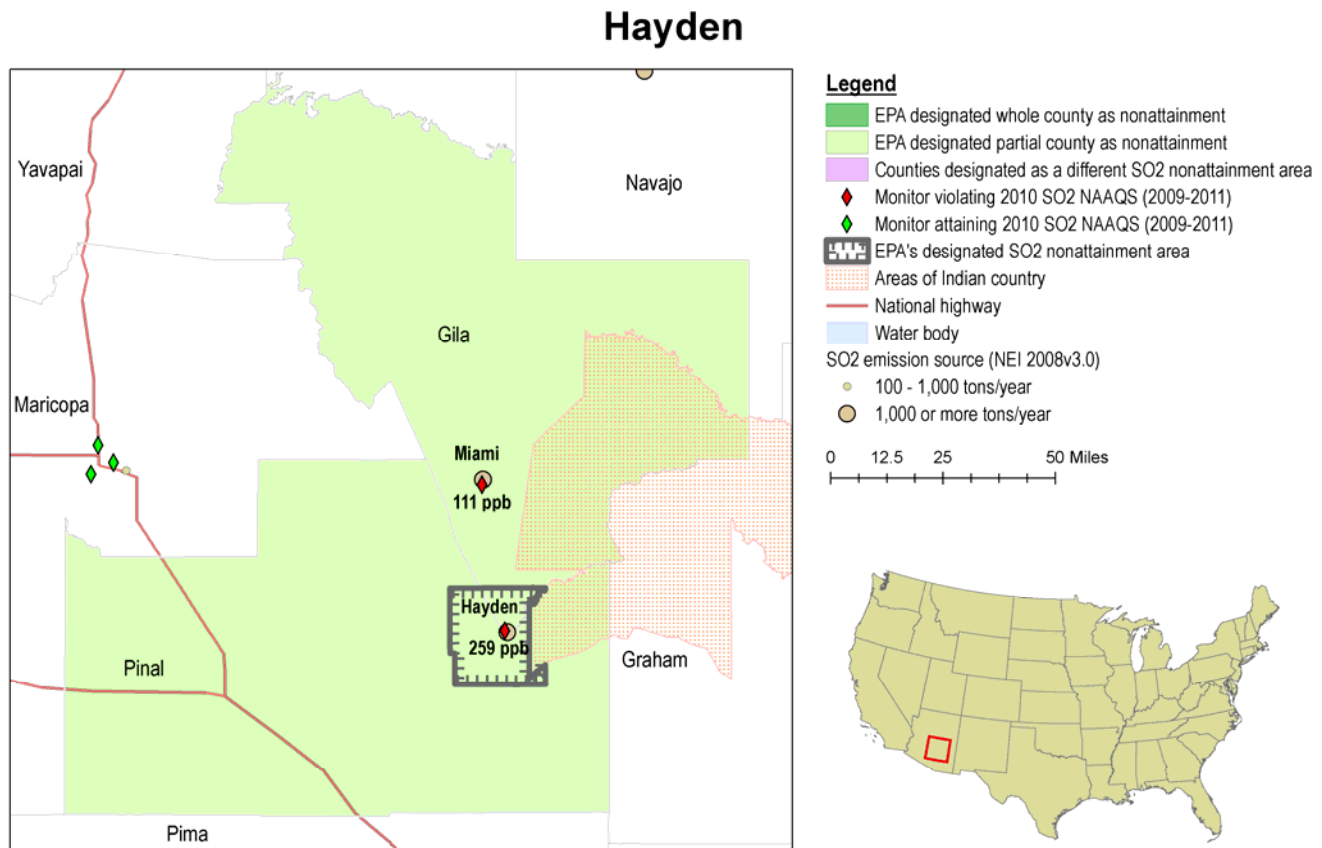

Figure 1

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[2] http://www.epa.gov/air/sulfurdioxide/guidance.html
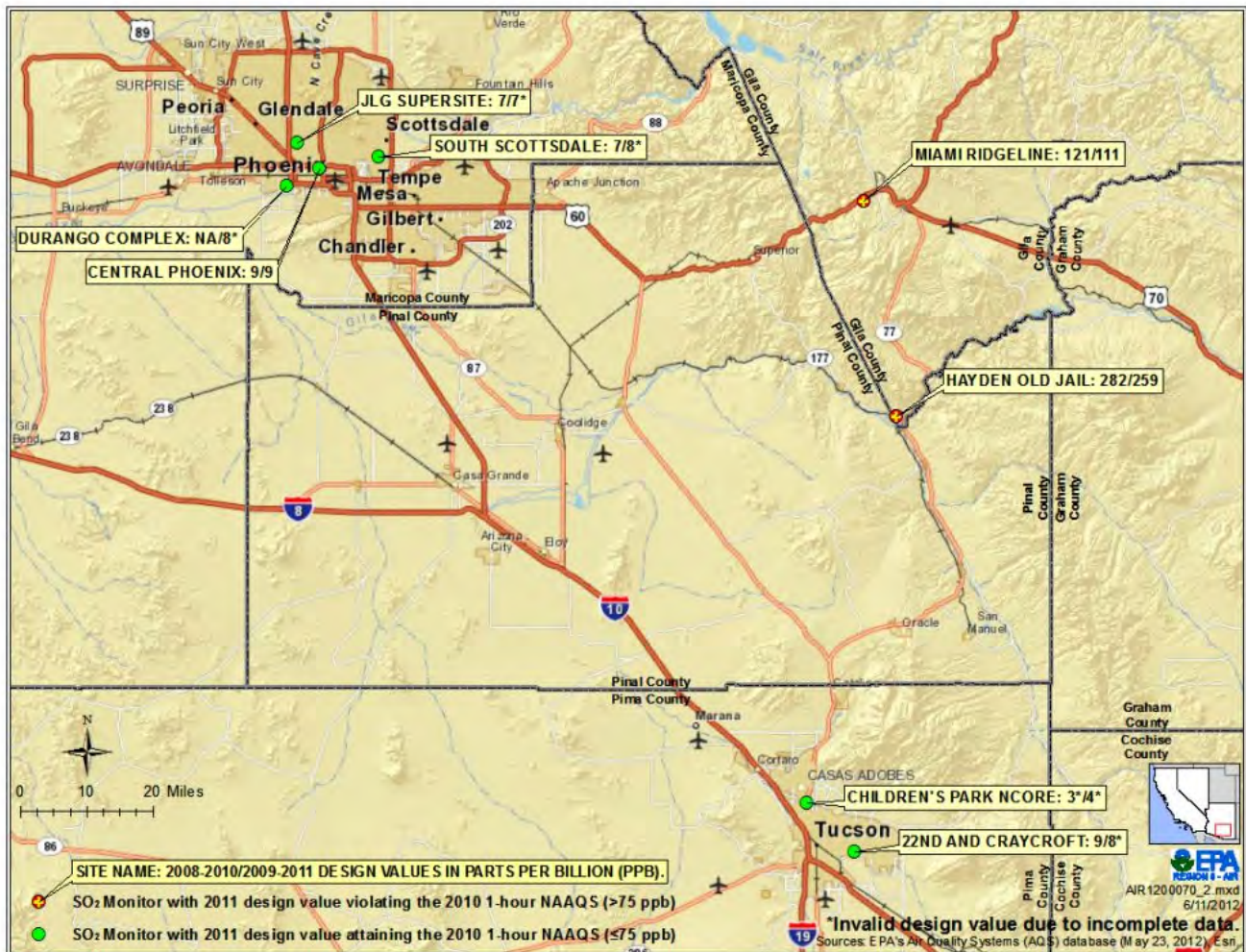
Figure 2

In May 2011, Governor Janice K. Brewer recommended that portions of Gila County and Pinal County be designated as "nonattainment" and the remaining counties and partial counties be designated "unclassifiable" for the 2010 SO_2 NAAQS based on monitored air quality data from 2007-2009 (letter to EPA Region 9 Administrator Jared Blumenfeld from Governor Janice K. Brewer, May 25, 2011). Consistent with the existing Hayden nonattainment area and Miami maintenance area for the 1971 SO_2 NAAQS, the state recommended that the same portions of Gila County and Pinal County (except those portions in Indian country) be designated as the Hayden and Miami nonattainment areas for the 2010 SO_2 NAAQS. The state recommendation was based primarily on monitoring data and consideration of emissions data from the 2005 National Emissions Inventory (NEI).

In February 2013, EPA responded to Governor Brewer's 2011 recommendation ("120-day" letter to Governor Janice K. Brewer from EPA Region 9 Administrator Jared Blumenfeld, February 6, 2013). The February 2013 letter notified the Governor of EPA's intentions regarding designations for the 2010 SO_2 NAAQS. As stated in the letter, EPA intended to agree with the Governor's recommendations for boundaries of the two nonattainment areas the Governor recommended as nonattainment. The Governor replied to EPA's 120-day letter in April 2013 (letter to EPA Region 9 Administrator Jared Blumenfeld

from Governor Janice K. Brewer, April 2, 2013). In the reply letter, the Governor reaffirmed the 2011 recommendations for all areas of the state, but noted that there was a discrepancy with the maps the state provided in 2011 for the Hayden, Arizona area. The 2011 maps were included in a document titled "Arizona Air Quality Designations, Final Proposed Boundary Recommendation for the 2010 Primary National Ambient Air Quality Standard for Sulfur Dioxide" (state technical support document or state TSD).

The state TSD was attached to a letter from the state's environmental agency to the Governor (letter to Governor Janice K. Brewer from Henry R. Darwin, Director, Arizona Department of Environmental Quality, letter dated May 2, 2011). In her April 2013 letter, Governor Brewer indicated that EPA would receive a corrected map. EPA received the corrected map in a letter dated April 5, 2013 (letter to EPA Region 9 Administrator Jared Blumenfeld from Eric Massey, Director, Air Quality Division, Arizona Department of Environmental Quality).

Based on EPA's technical analysis described below, EPA concurs with the state's recommendation to initially designate a portion of Gila County and a portion of Pinal County as nonattainment for the 2010 SO$_2$ NAAQS, as the Hayden nonattainment area. These counties are listed above in Table 1. We note here that the state's corrected map agrees with the maps that are contained in this document.

Detailed Assessment

Air Quality Data

This factor considers the SO$_2$ air quality monitoring data, including the design values (in ppb) calculated for all air quality monitors in Gila County in the Hayden nonattainment area and in the surrounding area based on data for the 2009-2011 period.

The Governor's recommendation was based on 2007-2009 data from Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors provided in the state letter to EPA Region 9 Administrator Jared Blumenfeld from Governor Janice K. Brewer, May 25, 2011.[3]

The 2011 SO$_2$ NAAQS design values for counties in the Hayden nonattainment area and surrounding area are shown in Table 2. Design values are calculated using the 3-year average of the annual 99th percentile of 1-hour daily maximum SO$_2$ concentrations, and compared to the NAAQS of 75 ppb, according to requirements of 40 CFR 50.17.

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[3] Note: Monitors that are eligible for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are sited in accordance with 40 CFR part 58, Appendix D (Section 4.4) and operating with a FRM or FEM monitor that meets the requirements of 40 CFR part 58, Appendix A. All data from a special purpose monitor (SPM) using an FRM or FEM which has operated for more than 24 months are eligible for comparison to the NAAQS unless the monitoring agency demonstrates that the data came from a particular period during which the requirements of Appendix A (quality assurance requirements) or Appendix E (probe and monitoring path siting criteria) were not met.

Table 2. Air Quality Data for Nonattainment Designations in Arizona

County	State Recommended Nonattainment?	Monitor Name	Monitor Air Quality System ID	Monitor Location	SO₂ Design Value, 2009-2011 (ppb)
Gila, Arizona	Yes (partial)	Miami Ridgeline	04-007-0009	4030 Linden Street	111
		Hayden Old Jail	**04-007-1001**	**Jail-Canyon Dr, Hayden**	**259**
Maricopa, Arizona	No	**Central Phoenix**	**04-013-3002**	**1645 E. Roosevelt St, Central Phoenix**	**9**
		South Scottsdale	04-013-3003	2857 N. Miller Road, South Scottsdale	8*
		Durango Complex	04-013-9812	2702 AC Ester Brook Blvd	8**
		JLG Supersite	04-013-9997	4530 N. 17th Ave	7*
Pima, Arizona	No	22nd and Craycroft	04-019-1011	1237 S. Beverly, Tucson	8*
		Children's Park NCore	04-019-1028	400 W. River Road	4**

Monitors in **Bold** have the highest 2009-2011 design value in the respective county. Pinal County, Arizona did not have any SO₂ monitors collecting data from 2009-2011.

*Incomplete data, provided for informational purposes only, not relevant for comparison to the NAAQS. These stations stopped monitoring for comparison to the SO₂ NAAQS after December 2010. The South Scottsdale monitor was moved to the Durango Complex station; JLG Supersite started monitoring for trace levels of SO₂ instead of for comparison to the NAAQS; 22nd and Craycroft SO₂ monitoring was moved to the Children's Park NCore station.

**Incomplete data, provided for informational purposes only, not relevant for comparison to the NAAQS. These stations began monitoring for comparison to the SO₂ NAAQS in late 2010 or 2011.

Gila County shows monitored violations of the 2010 SO₂ NAAQS. No other SO₂ monitors in Arizona show violations of the 2010 SO₂ NAAQS. Therefore, as an analytical starting point, some areas in Gila County and possibly additional areas in surrounding counties must be designated nonattainment. Note that the absence of a violating monitor alone is not a sufficient reason to eliminate nearby counties as candidates for nonattainment status. This is because the Clean Air Act defines a nonattainment area as any area that violates a NAAQS or contributes to a nearby violation.[4] Each area has been evaluated based on the weight-of-evidence of the five factors and other relevant information.

Two SO₂ monitors are violating the standard in Arizona. Both violating monitors are located in Gila County (see Figure 2 and Table 2, above). The Hayden Old Jail monitor (Air Quality System (AQS) ID 04-007-1001) is a source-oriented monitor located approximately 920 meters (0.57 miles) from the ASARCO, LLC – Hayden smelter stack (see Figure 2). Nestled in the southern, V-shaped tip of Gila County, the monitor is about 860 meters (0.54 miles) from the Pinal County border (see Figure 2). The Miami Ridgeline monitor (AQS ID 04-007-0009) is also a source-oriented monitor, located approximately 1,390 meters (0.86 miles) from the Freeport-McMoRan Miami Smelter. The Freeport-McMoRan Miami Smelter is roughly 45.5 kilometers (28 miles) northwest of the ASARCO, LLC – Hayden smelter.

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[4] Section 107(d)(1)(A)(i) of the Clean Air Act defines a nonattainment area as " ... any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant... "

Six additional SO_2 monitors have been operated in recent years in Maricopa and Pima counties. These monitors are not source-oriented and are located in the urban cores of the Phoenix and Tucson metropolitan areas, which are over 50 miles away from the violating monitors located in Gila County (see Figure 2, above). The low concentrations recorded in these locations suggest that their design values are not impacted by the same sources that are impacting the violating monitors.

Figure 3

Emissions and Emissions-Related Data

Evidence of SO_2 emissions sources in the vicinity of a violating monitor is an important factor for determining whether a nearby area is contributing to a monitored violation. For this factor, EPA evaluated county-level emission data for SO_2, as well as emissions from nearby point sources.

Emissions

For this analysis, EPA relied on information from the 2008 National Emissions Inventory (NEI) emissions database (NEI08V3). Arizona did not provide updated emissions information.

Table 3 shows total emissions of SO_2 in 2008 (given in tons) for all 15 counties in Arizona and single sources emitting greater than 100 tons per year of SO_2 according to the 2008 NEI. The counties that contain part of the Hayden nonattainment area for the 2010 SO_2 NAAQS are shown in **bold**.

Table 3. SO₂ Emissions in 2008

County	Facility Located in State Recommended Nonattainment Area?	Facility > 100 tons per year of SO$_2$ emissions	Facility Location	SO$_2$ Air Emissions (2008 NEIV3) (tons)	Total County 2008 SO$_2$ Emissions (tons)
Gila	Yes (Hayden)	ASARCO, LLC - Hayden Smelter	Hayden	21,742	
	Yes (Miami)	Freeport-McMoRan Miami Smelter	Miami	7,091	
	-	Other point, nonpoint, nonroad, onroad	-	343	29,176
Apache	No	Salt River Project (Coronado)	St. Johns	15,900	
	No	Tucson Electric Power Company	Springerville	6,562	
	-	Other point, nonpoint, nonroad, onroad	-	122	22,583
Navajo	No	Arizona Public Service (Cholla)	Joseph City	16,421	
	No	Catalyst Paper (Snowflake) Inc.	Snowflake	2,556	
	-	Other point, nonpoint, nonroad, onroad	-	186	19,163
Pima	No	Tucson Electric Power (Irvington)	Tucson	2,884	
	-	Other point, nonpoint, nonroad, onroad	-	1,834	4,718
Maricopa	No	Phoenix Sky Harbor International Airport	Phoenix	252	
	-	Other point, nonpoint, nonroad, onroad	-	1,389	1,641
Cochise	No	AZ Electric Power (Apache)	Cochise	1,903	
	No	Chemical Lime Company - Douglas	Douglas	1,013	
	-	Other sources (nonpoint, nonroad, onroad)	-	165	3,081
Yavapai	No	Nelson Lime Plant	Peach Springs	1,955	
	-	Other point, nonpoint, nonroad, onroad	-	375	2,330
Pinal	-	Other point, nonpoint, nonroad, onroad	-	381	381
Mohave	-	Other point, nonpoint, nonroad, onroad		345	345
Coconino	-	Other point, nonpoint, nonroad, onroad	-	786	786
Yuma	-	Other point, nonpoint, nonroad, onroad		215	215
La Paz	-	Other point, nonpoint, nonroad, onroad		41	41
Santa Cruz		Other point, nonpoint, nonroad, onroad		105	105
Greenlee	-	Other point, nonpoint, nonroad, onroad		212	212
Graham	-	Other point, nonpoint, nonroad, onroad	-	48	48

Total emissions of SO$_2$ are highest in Gila County. In 2008, the ASARCO, LLC – Hayden Smelter emitted over 20,000 tons of SO$_2$, three times more than the second largest source (Freeport-McMoRan Miami Smelter) of SO$_2$ emissions in Gila County. Both smelters in Gila County are primary copper smelters. Apache and Navajo counties also contain coal-fired electric utility generating units that are large sources of SO$_2$: Coronado Generating Station (15,900 tons in 2008) and Springerville Generating Station (6,562 tons in 2008) in Apache County, and Cholla Power Plant (16,421 tons in 2008) in Navajo County. Total emissions of SO$_2$ from Pinal County are low (381 tons in 2008) compared to Gila, Apache, and Navajo counties. Gila, Apache, and Navajo counties together comprise 84% of total SO$_2$ emissions from the state of Arizona. These five largest stationary sources in the three counties comprised 80% of total SO$_2$ emissions from state lands in Arizona in 2008. See Figure 4 for the geographic distribution of these stationary sources. One additional source emitted over 100 tons per

year - the Navajo Generating Station (3,816 tons in 2008) located on tribal lands near the city of Page in northern Coconino County, Arizona. The Navajo Generating Station is approximately 240 miles north of Freeport-McMoRan Miami Smelter and 270 miles north of the ASARCO LLC – Hayden Smelter.

The state-recommended Hayden nonattainment area for the 2010 SO$_2$ NAAQS includes the ASARCO, LLC – Hayden Smelter. As shown in Figure 4 and Table 3, besides the two largest sources in Gila County, both of which EPA is including in nonattainment areas, there are no other facilities emitting greater than 100 tons per year of SO$_2$ in Gila, Pinal, or Graham County. The San Carlos tribal lands to the east of the state's recommended Hayden nonattainment area also do not have any facilities emitting greater than 100 tons per year of SO$_2$ according to the 2008 NEIV3.

Figure 4

Emissions Controls

The emissions data used by EPA in this technical analysis and provided in Table 3 represent emissions levels taking into account any control strategies implemented on stationary sources in the Hayden, Arizona nonattainment area up to and including 2008. Since 2008, the ASARCO, LLC – Hayden

Smelter has completed two projects, one in 2010 involving addition of a revert screen, and one in 2012 involving additional ventilation and a baghouse to service three existing anode furnaces. Neither of these projects resulted in changes to permitted SO_2 emissions limits for the facility. See the source's Title V federal operating permit renewal and two ADEQ permit actions/revisions that occurred since 2008 (52397-MPR and 54251-MPR).[5]

Population

Gila County's population as of the 2010 census was 53,597. From 2000 to 2010 the county grew by 4.4% and had a population density of 11.3 persons per square mile. Pinal County's population as of the 2010 census was 375,770. From 2000 to 2010 the county grew by 109.1% and had a population density of 70.0 persons per square mile.

Meteorology (weather/transport patterns)

Evidence of source-receptor relationships between specific emissions sources and high SO_2 values at violating monitors is another important factor in determining the appropriate contributing areas and the appropriate extent of the nonattainment area boundary. For this factor, EPA considered meteorological data available for the area. Such data may provide evidence of the potential for SO_2 emissions sources located upwind of a violating monitor to contribute to ambient SO_2 levels at the violation location.

Temperature and precipitation data is available from the nearby Winkelman 6 S station, part of the National Weather Service Cooperative Observer Program. This station typically measures only 14 inches of rain each year, with nearly half of that occurring during the summer months of July through September, coinciding with the Arizona "monsoon" season. There is less than an inch of snow each year.   Daily temperature highs range from 64 to 91 degrees Fahrenheit depending on season, and lows range from 31 to 69 degrees Fahrenheit. See Figure 5 for the location of the Winkleman meteorological station.

The varied elevations in the area cause complex wind flow locally. Within and adjacent to the Gila River and San Pedro River valleys, drainage winds tend to dominate at night under stable conditions. To the west of the smelter, drainage flows toward the west, while east of the smelter the drainage flows to the south. Given the smelter's elevated location and plume buoyancy, some emissions would be expected to rise above these surface flows. However, on sunny days the heated ground warms the air and enhances vertical mixing. Under such convective conditions, the plume could nevertheless be mixed down to the ground to varying degrees. This vertical mixing also causes the flow to be coupled with winds aloft, which generally flow toward the east.

Over the years, wind data has been collected at multiple locations in and around Hayden. Sites include the Hayden Maintenance Yard ("Hayden"), Hayden-Winkelman High School ("Winkelman"), and Globe Highway (data prepared for "Draft Report, Remedial Investigation Report for the ASARCO, LLC Hayden Plant Site, Hayden, Gila County, Arizona", Prepared for U.S. Environmental Protection Agency Region IX, San Francisco, CA., CH2M Hill, August 2008). These stations are shown in Figure 5. Wind roses from these stations are shown in Figure 6. The Winkelman site is nearest the junction of

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the Gila and San Pedro River valleys, and the Globe Highway site is in the northeastern portion of the Gila River valley before it joins the San Pedro. All of the dominant wind directions are consistent with the orientation of the valleys. However, when morning and evening wind frequencies are plotted separately, not all of the directions are consistent with slope flow, e.g., afternoon flow at Hayden is toward the east, but downslope flow in the Gila River valley would be toward the northwest. There is a similar evening component toward the east at Winkelman on some days, but more of a downslope flow on other days. At Globe Highway, flow directions are consistent with slope flows. The differences between sites located relatively close together show the complexity of the flow in the area. Transport of pollutants would be expected to occur mainly along the Gila-San Pedro River valleys (northwest-southeast orientation), somewhat circumscribed by the orientations of the valleys and the surrounding mountains.

Terrain Around Hayden, Arizona:
with SO$_2$ monitor (red circle), cities (purple circles & labels),
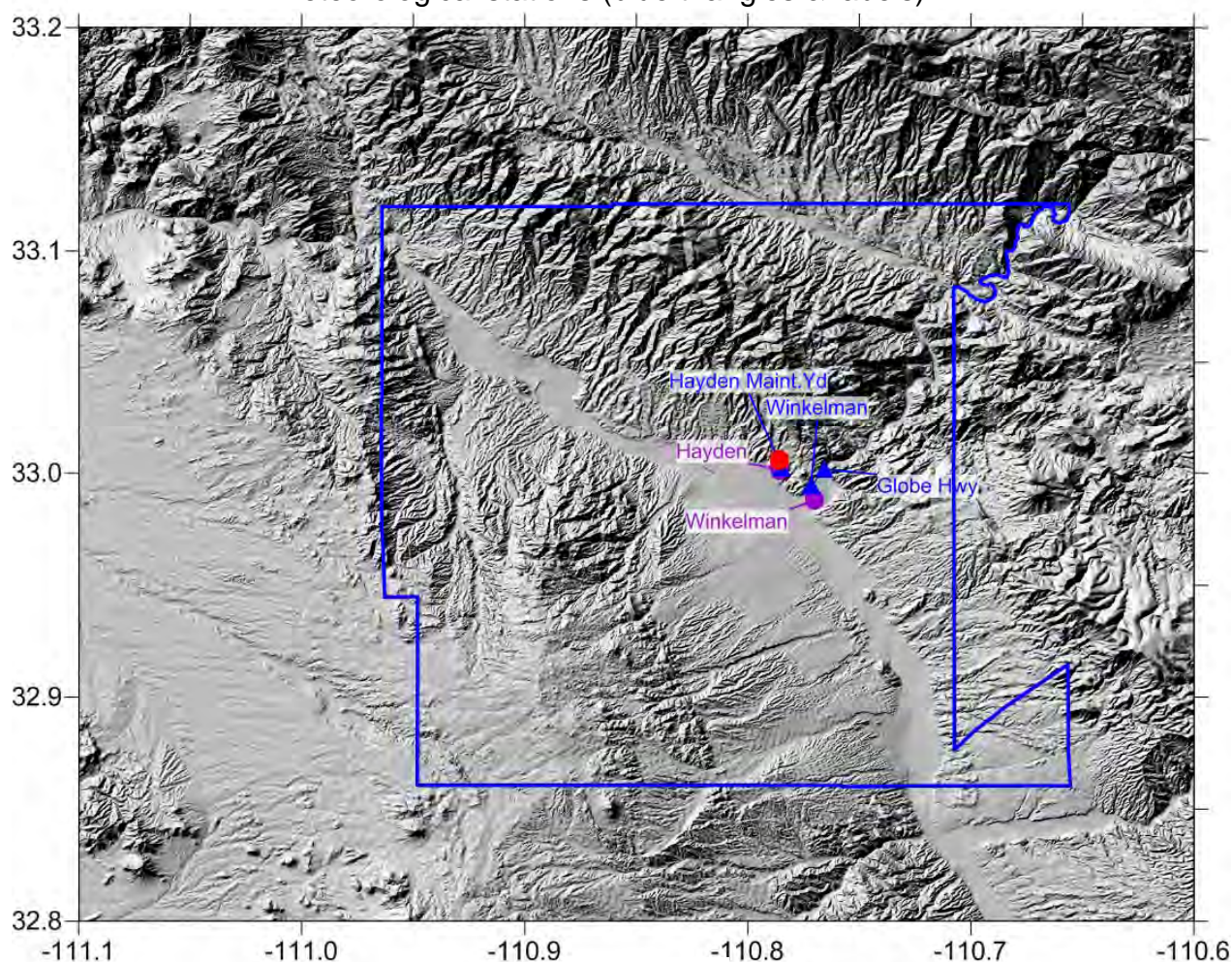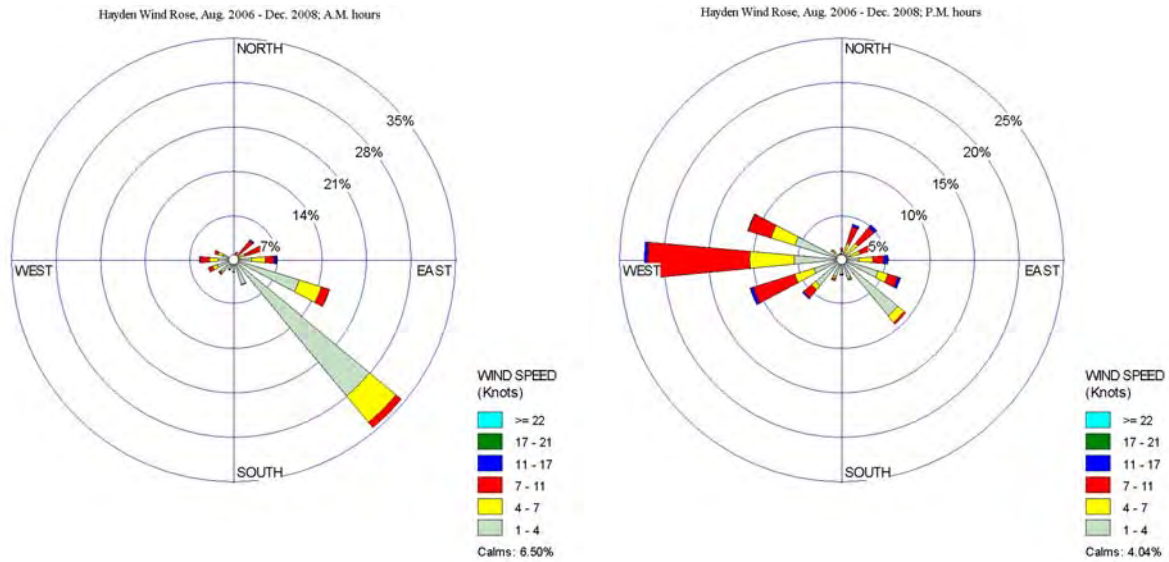meteorological stations (blue triangles & labels).

Figure 5

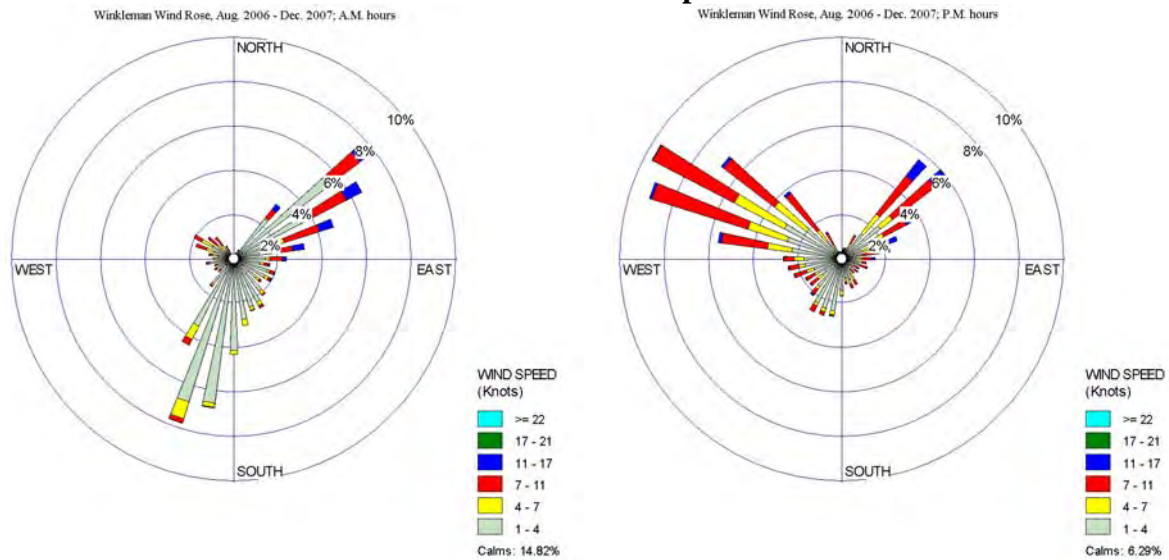# Hayden a.m. and p.m. wind roses

Winkelman a.m. and p.m. wind roses

Figure 6

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Geography/topography (mountain ranges or other air basin boundaries)

As shown in Figure 5 (above) and Figure 7 (below), Hayden and the ASARCO, LLC - Hayden smelter are located in very complex terrain, with the Gila River making a winding semi-circle around the east and south of the facility, and intersected by the San Pedro River valley from the south. The facility itself is elevated relative to the valleys; there is a 200-foot hill just south of the facility. In all directions there is a mountain side. Hayden is at roughly 2,000 feet elevation; the Dripping Springs Mountains to the north rise to 4,000 feet; the Tortilla Mountains on the northwest, west, and south rise 3,300 to 4,000 feet. Terrain rises more gently within the Gila-San Pedro River valleys from the northwest toward the southeast. The nonattainment area encompasses the Gila River valley from where it narrows in the northwest corner of the area, to where it joins with the San Pedro River valley in roughly the center of the area, and to a bend in the San Pedro River in the southeast corner. The surrounding mountains likely limit the extent of the area exceeding the SO$_2$ standard to a relatively small area around the smelter, the main source of SO$_2$ emissions. In light of this, we are not yet prepared to conclude whether locations outside the particular valleys intersecting at Hayden contribute to the violating monitor's design value.
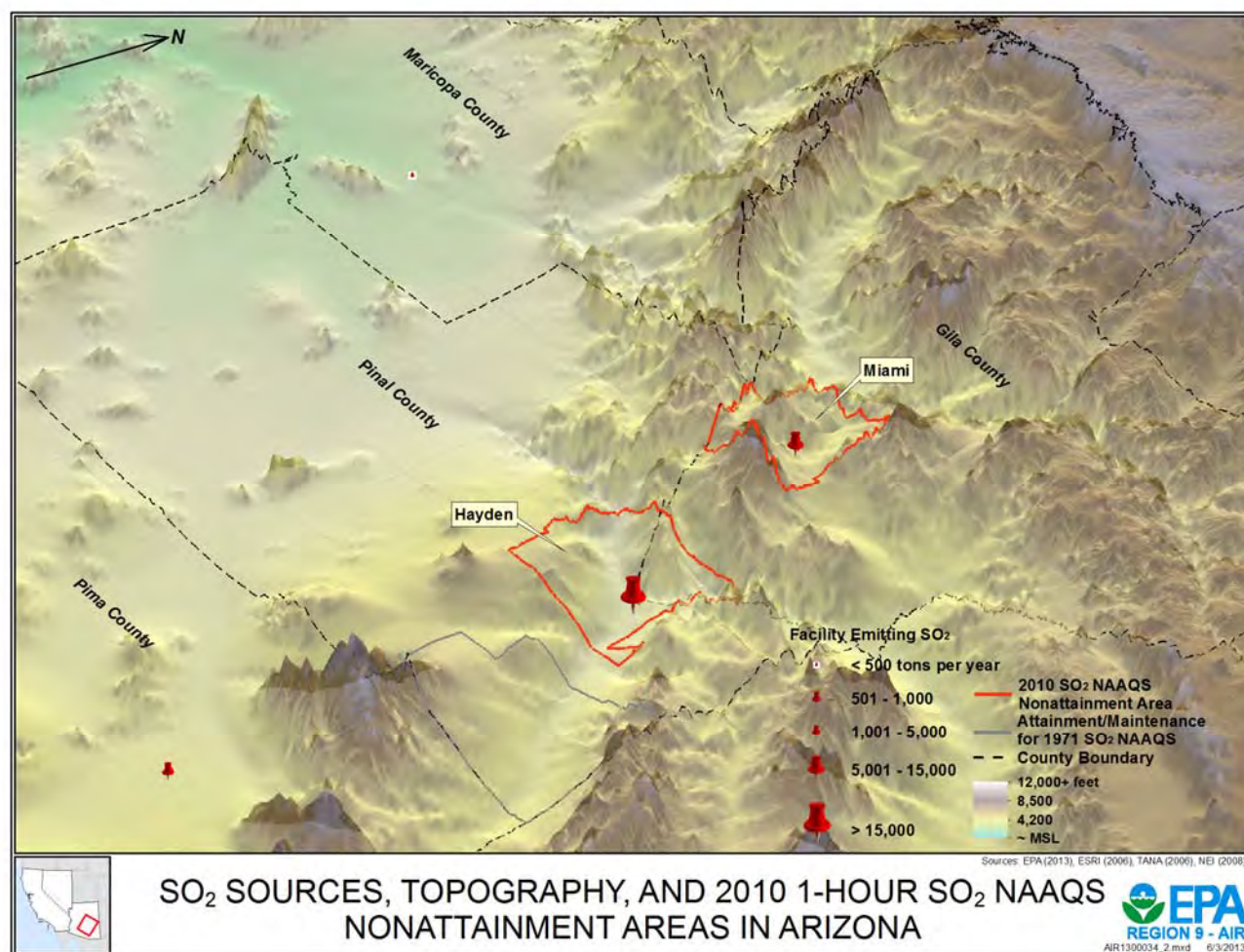

Figure 7

Jurisdictional boundaries

To manage air quality, the state of Arizona has one state agency, the Arizona Department of Environmental Quality (ADEQ), and three local agencies: Maricopa County Air Quality Department, Pima County Department of Environmental Quality, and Pinal County Air Quality Control District. Air quality planning for the existing Hayden nonattainment area under the 1971 SO_2 NAAQS, composed of the same portions of Gila and Pinal counties as the state's recommended nonattainment area for the 2010 SO_2 NAAQS, is under the jurisdiction of ADEQ. Originally, for the 1971 NAAQS, the Hayden area was split between two county-wide SO_2 nonattainment areas for Gila and Pinal counties (see 43 FR 8968, March 3, 1978). At the request of the state of Arizona, the boundary for the Hayden area was reduced to nine townships in and around the town of Hayden (44 FR 21261, April 10, 1979). Section 107(d)(1)(C) of the 1990 Clean Air Act Amendments (CAAA) brought forward, by operation of law, the nonattainment designations for areas, such as the Hayden SO_2 area, that continued to be designated as nonattainment at the time of enactment of the CAAA, i.e., areas that had not been redesignated to ''attainment'' prior to the CAAA's November 15, 1990 enactment date. The then-existing nonattainment area for Hayden under the 1971 SO_2 NAAQS included a portion of Indian country along the eastern boundary. The Hayden nonattainment area for the 2010 SO_2 NAAQS includes the same geographic area as the existing nonattainment area for the 1971 SO_2 NAAQS without the portion of Indian country.

As defined at 18 U.S.C. 1151, "Indian country" refers to: "(a) all land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation, (b) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (c) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same." EPA recognizes the sovereignty of tribal governments, and has attempted to take the desires of the tribes into account in establishing appropriate nonattainment area boundaries. No areas of Indian country are included in the initial Hayden, Arizona nonattainment area. Figures depicting areas of Indian country in this document are intended for illustrative purposes only and are not an EPA determination of Indian country status or of any Indian country boundary.

Other Relevant Information

In its May 25, 2011 letter, ADEQ provided additional information to support its assertion that presumptive use of full county boundaries as the nonattainment area boundary is inappropriate for geographically large counties. The state argued that the use of full county boundaries as the presumptive nonattainment area boundary for a violating monitor results in disparities in the size of nonattainment areas. For example, the state compared the area of Gila County (4,796 square miles) with the area of the entire state of Connecticut (4,845 square miles). A violating monitor in Middlesex County, Connecticut, would result in a presumptive nonattainment area boundary encompassing 369 square miles. Applying this presumption in Arizona would result in a nonattainment area (Gila County) that is 13 times larger than a full Middlesex County nonattainment area in Connecticut. The state further highlighted that the violating monitor in its recommended Hayden nonattainment area is

less than 0.5 miles from the southwest border of Gila and Pinal counties, and more than 100 miles from the northern border of Gila and Coconino counties. Therefore, the state concluded that its consideration of partial counties for the Hayden and Miami nonattainment areas was appropriate.

Conclusion

After considering the factors described above, EPA concurs with the state's recommendation to initially designate a portion of Pinal County and a portion of Gila County as the Hayden, Arizona nonattainment area for the 2010 SO_2 NAAQS, based on the violating monitor in Hayden, Arizona. No areas of Indian country are included in the initial Hayden, Arizona nonattainment area. Areas of Indian country in the state of Arizona will be further addressed in a subsequent round of final initial designations.

The air quality monitor in Hayden, Arizona shows a violation of the 2010 SO_2 NAAQS based on 2009-2011 air quality data. EPA concludes that the state's recommended boundary contains the area violating the standard as well as areas causing or contributing to the monitored violation, as assessed using our five-factor methodology. The monitor is source-oriented, and is located in the southernmost tip of Gila County. Due to constraints imposed by the complex terrain in the Hayden area (see Geography/Topography discussion above), it is expected that the extent of the area exceeding the SO_2 standard is confined to a relatively small area around the main source of SO_2 emissions, the ASARCO, LLC - Hayden smelter. In light of this, we are not yet prepared to conclude whether locations outside the particular valleys intersecting at Hayden contribute to NAAQS exceedances recorded at the Hayden monitor. The meteorology factor is not significant in determining a boundary for the nonattainment area, but available data confirms the importance of the topography in limiting the extent of the nonattainment area to the nearby river valleys and their surroundings. Based on this information, we are not yet prepared to conclude that the emissions from sources located outside the state's recommended boundary contribute to the monitored violation or to other possible violations. We will further address such sources and their areas in a subsequent round of final initial designations. The state's recommended boundary for the Hayden nonattainment area is also consistent with the existing Hayden nonattainment boundary for the 1971 SO_2 NAAQS, without areas of Indian country. All non-Indian country lands in the nonattainment area are under the jurisdiction of ADEQ.

Based on the consideration of all the relevant and available information, as described above, EPA's conclusion is that the boundaries described herein encompass an area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the 2010 SO_2 NAAQS, based on the violating monitor information in the Hayden, Arizona area. Areas and sources that EPA is not yet prepared to conclude are contributing to the monitored violation or to other possible violations are not included in this initial nonattainment area. In the future, we will make final initial designation decisions for areas in Arizona not included in the nonattainment area designations addressed in this TSD.

Technical Analysis for Miami, Arizona

Introduction

This technical analysis for Miami, Arizona identifies the partial county with a monitor that violates the 2010 SO_2 NAAQS and evaluates nearby counties for contributions to SO_2 concentrations in the area. EPA has evaluated this county and nearby counties based on the weight-of-evidence of the factors in EPA's Designation Guidance, issued on March 24, 2011.[6]

Figure 8 shows the Miami area in Arizona which EPA has initially designated nonattainment. Figure 9 is a map of SO_2 monitors in the area and the surrounding counties. Violating monitors are shown with a red icon; monitors attaining the standard are shown with green icons. Design values for each monitor are listed in Figure 9 and in Table 4, below.
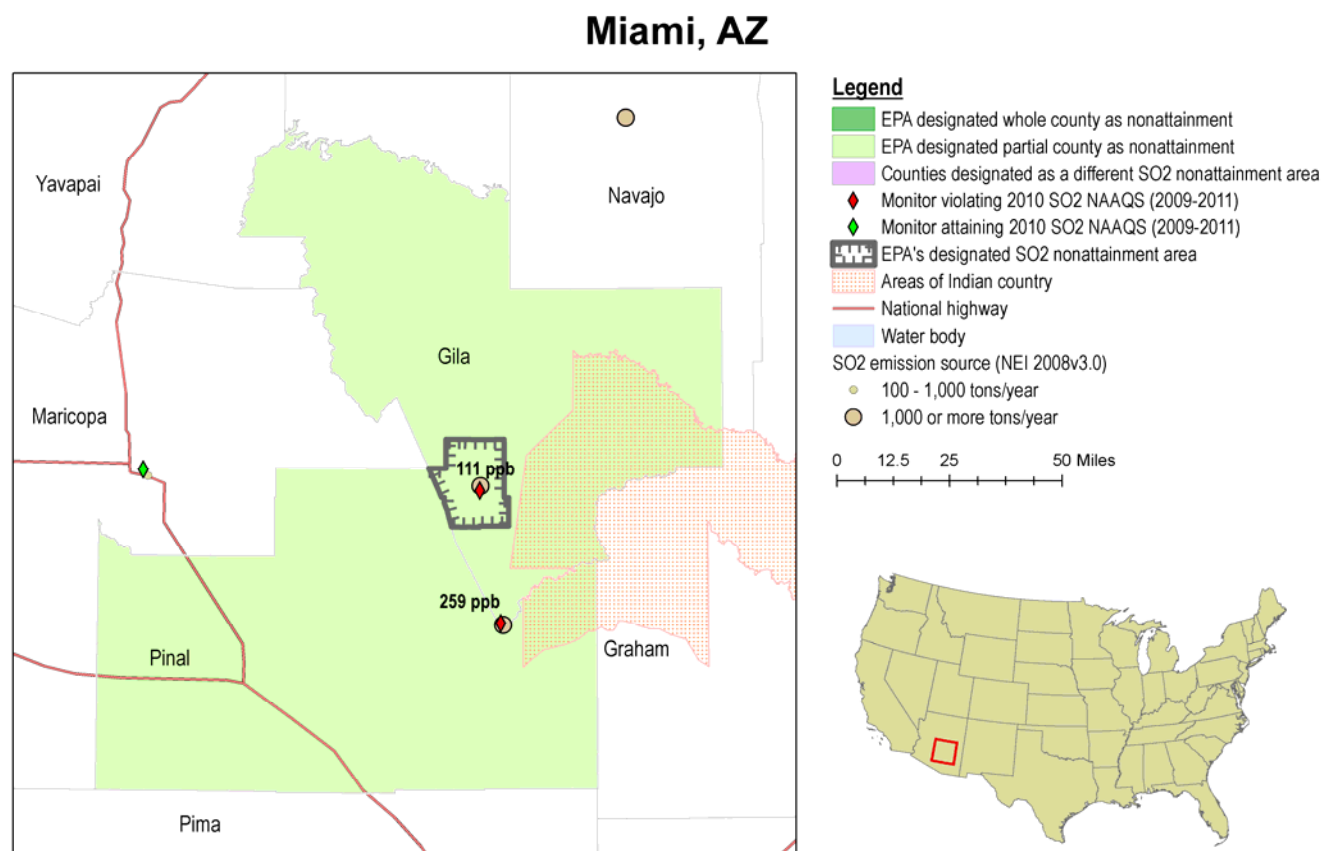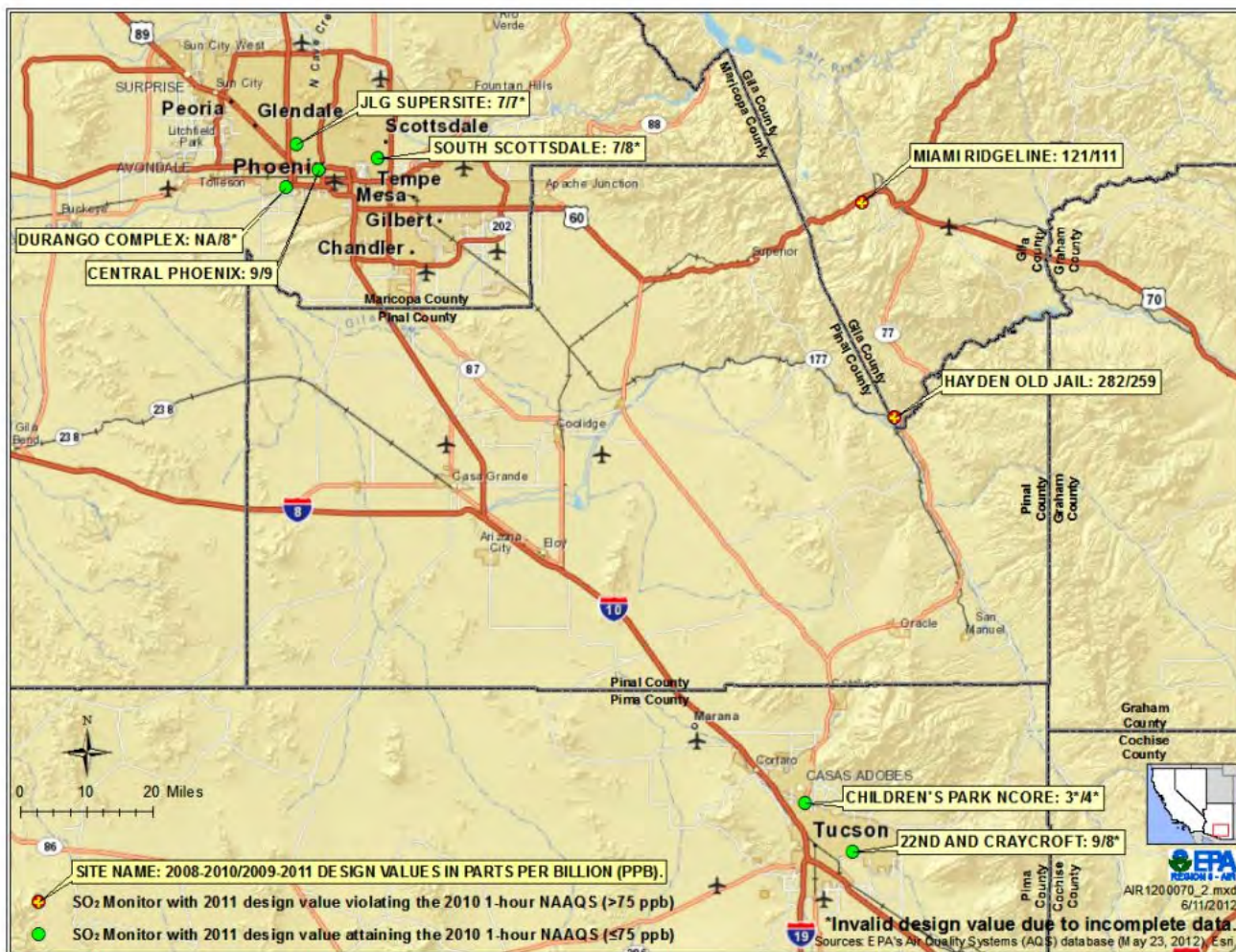

Figure 8

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[6] http://www.epa.gov/air/sulfurdioxide/guidance.html

Figure 9

In May 2011, Governor Janice K. Brewer recommended that portions of Gila County and Pinal County be designated as "nonattainment," and the remaining counties and partial counties be designated "unclassifiable" for the 2010 SO$_2$ NAAQS based on monitored air quality data from 2007-2009 (letter to EPA Region 9 Administrator Jared Blumenfeld from Governor Janice K. Brewer, May 25, 2011). Consistent with the existing Hayden nonattainment area and Miami maintenance area for the 1971 SO$_2$ NAAQS, the state recommended that the same portions of Gila County and Pinal County be designated as the Hayden and Miami nonattainment areas for the 2010 SO$_2$ NAAQS. The state recommendation was based primarily on monitoring data and consideration of emissions data from the 2005 National Emissions Inventory (NEI).

In February 2013, EPA responded to Governor Brewer's 2011 recommendation ("120-day" letter to Governor Janice K. Brewer from EPA Region 9 Administrator Jared Blumenfeld, February 6, 2013). The February 2013 letter notified the Governor of EPA's intentions regarding designations for the 2010 SO$_2$ NAAQS. As stated in the letter, EPA intended to agree with the Governor's recommendations for boundaries of the two nonattainment areas the Governor recommended as nonattainment. The Governor replied to EPA's 120-day letter in April 2013 (letter to EPA Region 9 Administrator Jared Blumenfeld

from Governor Janice K. Brewer, April 2, 2013). In the reply letter, the Governor reaffirmed the 2011 recommendations for all areas of the state.

Based on EPA's technical analysis described below, EPA concurs with the state's recommendation to initially designate a portion of Gila County as nonattainment for the 2010 SO_2 NAAQS, as the Miami nonattainment area. The county is listed above in Table 1.

Detailed Assessment

Air Quality Data

This factor considers the SO_2 air quality monitoring data, including the design values (in ppb) calculated for all air quality monitors in Gila County, in the Miami nonattainment area and the surrounding area based on data for the 2009-2011 period.

The Governor's recommendation was based on 2007-2009 data from Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors provided in the state letter to EPA Region 9 Administrator Jared Blumenfeld from Governor Janice K. Brewer, May 25, 2011.[7]

The 2010 SO_2 NAAQS design values for counties in the Miami nonattainment area and surrounding area are shown in Table 4. Design values are calculated using the 3-year average of the annual 99th percentile of 1-hour daily maximum SO_2 concentrations, and compared to the NAAQS of 75 ppb, according to requirements of 40 CFR 50.17.

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[7] Note: Monitors that are eligible for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are sited in accordance with 40 CFR Part 58, Appendix D (Section 4.4) and operating with a FRM or FEM monitor that meets the requirements of 40 CFR Part 58, Appendix A. All data from a special purpose monitor (SPM) using an FRM or FEM which has operated for more than 24 months are eligible for comparison to the NAAQS unless the monitoring agency demonstrates that the data came from a particular period during which the requirements of Appendix A (quality assurance requirements) or Appendix E (probe and monitoring path siting criteria) were not met.

Table 4. Air Quality Data for Nonattainment Designations in Arizona

County	State Recommended Nonattainment?	Monitor Name	Monitor Air Quality System ID	Monitor Location	SO_2 Design Value, 2009-2011 (ppb)
Gila, Arizona	Yes (partial)	Miami Ridgeline	04-007-0009	4030 Linden Street	111
		Hayden Old Jail	**04-007-1001**	**Jail-Canyon Dr, Hayden**	**259**
Maricopa, Arizona	No	**Central Phoenix**	**04-013-3002**	**1645 E. Roosevelt St, Central Phoenix**	**9**
		South Scottsdale	04-013-3003	2857 N. Miller Road, South Scottsdale	8*
		Durango Complex	04-013-9812	2702 AC Ester Brook Blvd	8**
		JLG Supersite	04-013-9997	4530 N. 17th Ave	7*
Pima, Arizona	No	22nd and Craycroft	04-019-1011	1237 S. Beverly, Tucson	8*
		Children's Park NCore	04-019-1028	400 W. River Road	4**

Monitors in **Bold** have the highest 2009-2011 design value in the respective county.
*Incomplete data, provided for informational purposes only, not relevant for comparison to the NAAQS. These stations stopped monitoring for comparison to the SO_2 NAAQS after December 2010. The South Scottsdale monitor was moved to the Durango Complex station; JLG Supersite started monitoring for trace levels of SO_2 instead of for comparison to the NAAQS; 22nd and Craycroft SO_2 monitoring was moved to the Children's Park NCore station.
**Incomplete data, provided for informational purposes only, not relevant for comparison to the NAAQS. These stations began monitoring for comparison to the SO_2 NAAQS in late 2010 or 2011.

Gila County shows monitored violations of the 2010 SO_2 NAAQS. No other SO_2 monitors in Arizona show violations of the 2010 SO_2 NAAQS. Therefore, as an analytical starting point, some areas in Gila County and possibly additional areas in surrounding counties must be designated nonattainment. Note that the absence of a violating monitor alone is not a sufficient reason to eliminate nearby counties as candidates for nonattainment status. This is because the Clean Air Act defines a nonattainment area as any area that violates a NAAQS or contributes to a nearby violation.[8] Each area has been evaluated based on the weight-of-evidence of the five factors and other relevant information.

Two SO_2 monitors are violating the standard in Arizona. Both violating monitors are located in Gila County (see Table 4 and Figure 9, above). The Miami Ridgeline monitor (AQS ID 04-007-0009) is a source-oriented monitor, located approximately 1,390 meters (0.86 miles) from the Freeport-McMoRan Miami Inc. (FMMI) copper smelter (see Figure 10). The FMMI smelter is roughly 45.5 kilometers (28 miles) northwest of the other violating monitor, Hayden Old Jail, a source-oriented monitor located near the ASARCO, LLC – Hayden smelter.

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[8] Section 107(d)(1)(A)(i) of the Clean Air Act defines a nonattainment area as " ... any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant... "

Figure 10

Six additional SO$_2$ monitors have been operated in Maricopa and Pima counties in recent years. These monitors are not source-oriented and are located in the urban cores of the Phoenix and Tucson metropolitan areas, which are over 50 miles away from the violating monitors located in Gila County (see Figure 9, above). The low recorded concentrations in these locations suggest that their design values are not impacted by the same sources that are impacting the violating monitors.

Emissions and Emissions-Related Data

Evidence of SO$_2$ emissions sources in the vicinity of a violating monitor is an important factor for determining whether a nearby area is contributing to a monitored violation. For this factor, EPA evaluated county level emission data for SO$_2$, as well as emissions from nearby point sources.

Emissions

For this analysis, EPA relied on information from the 2008 National Emissions Inventory (NEI) emissions database (NEI08V3). Arizona did not provide updated emissions information.

Table 5 shows total emissions of SO_2 (given in tons per year) for all 15 counties in Arizona and sources emitting greater than 100 tons per year of SO_2 according to the 2008 NEI. The county that contains all of the Miami nonattainment area for the 2010 SO_2 NAAQS is shown in **bold**.

Table 5. SO_2 Emissions in 2008

County	Facility Located in State Recommended Nonattainment Area?	Facility > 100 tons per year of SO_2 emissions	Facility Location	SO_2 Air Emissions (2008 NEI V3) (tons)	Total County 2008 SO_2 Emissions (tons)
Gila	Yes (Hayden)	ASARCO, LLC - Hayden Smelter	Hayden	21,742	
	Yes (Miami)	Freeport-McMoRan Miami Smelter	Miami	7,091	
	-	Other point, nonpoint, nonroad, onroad	-	343	29,176
Apache	No	Salt River Project (Coronado)	St. Johns	15,900	
	No	Tucson Electric Power Company	Springerville	6,562	
	-	Other point, nonpoint, nonroad, onroad	-	122	22,583
Navajo	No	Arizona Public Service (Cholla)	Joseph City	16,421	
	No	Catalyst Paper (Snowflake) Inc.	Snowflake	2,556	
	-	Other point, nonpoint, nonroad, onroad	-	186	19,163
Pima	No	Tucson Electric Power (Irvington)	Tucson	2,884	
	-	Other point, nonpoint, nonroad, onroad	-	1,834	4,718
Maricopa	No	Phoenix Sky Harbor International Airport	Phoenix	252	
	-	Other point, nonpoint, nonroad, onroad	-	1,389	1,641
Cochise	No	AZ Electric Power (Apache)	Cochise	1,903	
	No	Chemical Lime Company - Douglas	Douglas	1,013	
	-	Other sources (nonpoint, nonroad, onroad)	-	165	3,081
Yavapai	No	Nelson Lime Plant	Peach Springs	1,955	
	-	Other point, nonpoint, nonroad, onroad	-	375	2,330
Pinal	-	Other point, nonpoint, nonroad, onroad	-	381	381
Mohave	-	Other point, nonpoint, nonroad, onroad		345	345
Coconino	-	Other point, nonpoint, nonroad, onroad	-	786	786
Yuma	-	Other point, nonpoint, nonroad, onroad		215	215
La Paz	-	Other point, nonpoint, nonroad, onroad		41	41
Santa Cruz	-	Other point, nonpoint, nonroad, onroad		105	105
Greenlee	-	Other point, nonpoint, nonroad, onroad		212	212
Graham	-	Other point, nonpoint, nonroad, onroad	-	48	48

Total emissions of SO_2 are highest in Gila County. In 2008, the FMMI copper smelter was the second largest source of SO_2 emissions in Gila County, and the fourth largest source in Arizona. Both smelters (FMMI and ASARCO, LLC) in Gila County are primary copper smelters. Apache and Navajo counties also contain coal-fired electric utility generating units that are large sources of SO_2: Coronado Generating Station (15,900 tons in 2008) and Springerville Generating Station (6,562 tons in 2008) in Apache County, and Cholla Power Plant (16,421 tons in 2008) in Navajo County. Total emissions of

SO$_2$ from Pinal County are low (381 tons in 2008) compared to Gila, Apache, and Navajo counties. Gila, Apache, and Navajo counties together comprise 84% of total SO$_2$ emissions from the state of Arizona. The five largest stationary sources in those three counties comprised 80% of total SO$_2$ emissions from Arizona in 2008. The existing Miami maintenance area for the 1971 SO$_2$ NAAQS is identical to the state's recommended Miami nonattainment area for the 2010 SO$_2$ NAAQS and includes the FMMI smelter. See Figure 11.

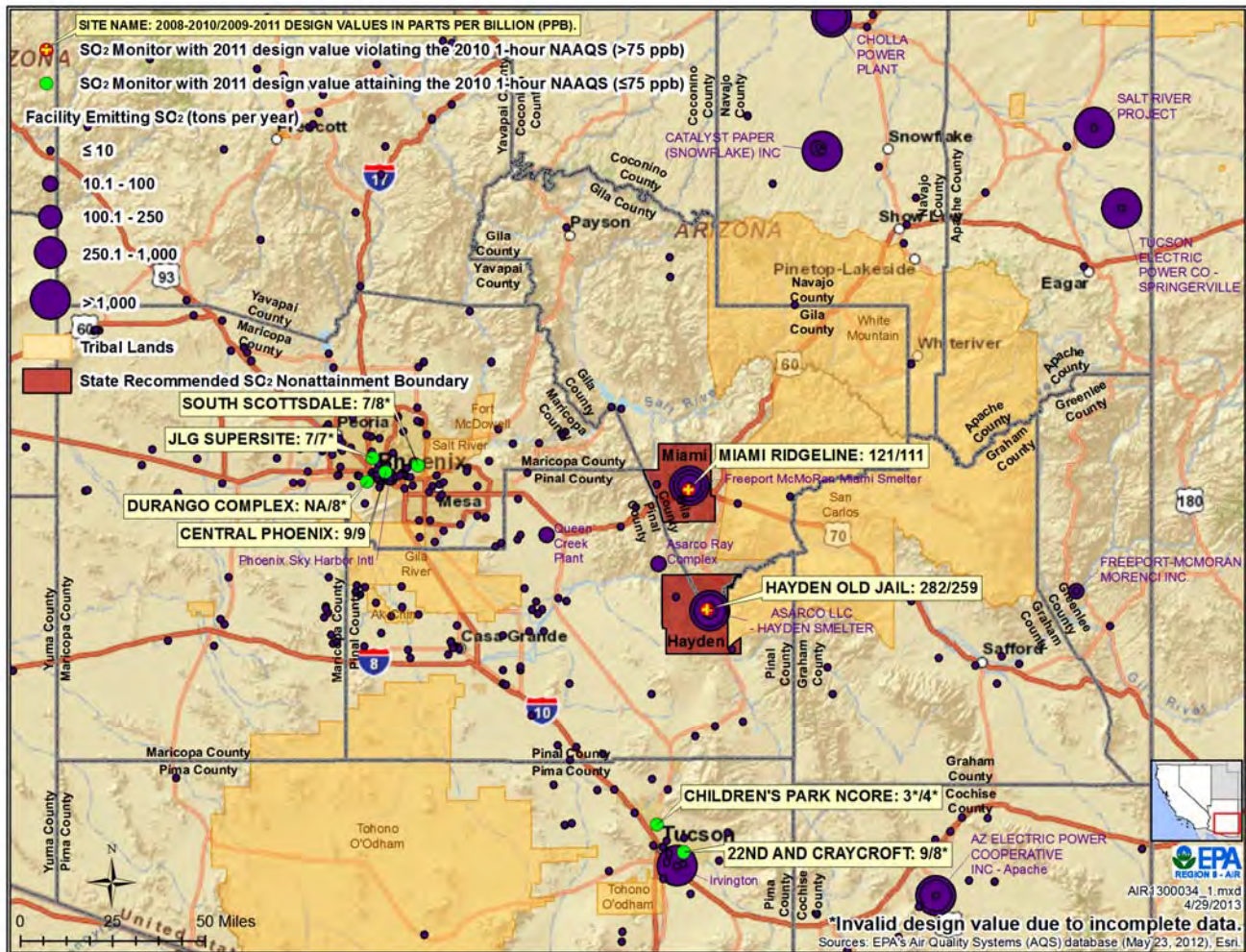
Figure 11

Emissions Controls

The emissions data used by EPA in this technical analysis and provided in Table 5 represent emissions levels taking into account any control strategies implemented on stationary sources in the Miami, Arizona nonattainment area up to and including 2008. Since 2008, FMMI has had several permit revisions, including: installation of a coal injection system with a dust collector system, clarification and/or correction to existing permit conditions, revision to allow additional use of an existing screening machine, update of the sulfur balance methodology to include a gravimetric method, and addition of small internal combustion engines. None of the permit revisions resulted in changes to permitted SO$_2$ emission limits. See seven ADEQ permit actions/revisions from 2008 to the present: 43398-SPR,

45593-MPR, 48448-MPR, 49986-MPR, 54218-MPR, 55226-MPR, and 55691-MPR. These seven permit actions/revisions were included in the Title V Renewal Operating Permit 53592 issued November 26, 2012.[9]

Population

Gila County's population as of the 2010 census was 53,597. From 2000 to 2010 the county grew by 4.4% and had a population density of 11.3 persons per square mile.

Meteorology (weather/transport patterns)

Evidence of source-receptor relationships between specific emissions sources and high SO_2 values at violating monitors is another important factor in determining the appropriate contributing areas and the appropriate extent of the nonattainment area boundary. For this factor, EPA considered meteorological data available for the area. The data may provide evidence of the potential for SO_2 emissions sources located upwind of a violating monitor to contribute to ambient SO_2 levels at the violation location.

Temperature and precipitation data are available from the Miami station, part of the National Weather Service Cooperative Observer Program. Around 20 inches of rain fall each year at the Miami station, roughly evenly distributed between the months, except in April, May, and June, when less than a half inch of rain falls per month. Normal daily temperature highs range from 96 degrees Fahrenheit (°F) in summer to 62 °F in winter, while normal lows are 65 °F in summer to 34 °F in winter.

The closest meteorological station to the violating Miami monitor is Globe station CW1546, part of the National Weather Service Cooperative Observer Program. The city of Globe is about five miles from Miami, roughly to the east. Globe is in the Pinal Creek Valley, oriented at right angles to the valley where Miami is located, with a more west-east orientation. The 2010 wind data shows flows consistent with the valley orientation (see Figure 12). Flow toward the west is the most frequent, but flow toward the east-southeast also occurs. Some, but not all of the flows are consistent with diurnal slope flows; the complexity of the surrounding terrain means there are multiple influences controlling the flow. Because of the complex terrain, and the spatial separation from Miami, this data is of limited usefulness for drawing conclusions about the Miami nonattainment area boundary, except to illustrate that flows largely conform to valley orientation, with slope flow being an important phenomenon.

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[9] Further information about Arizona federal Title V air permits can be found on EPA's website at:
http://www.epa.gov/region9/air/permit/title-v-permits.html

Globe a.m. and p.m wind roses
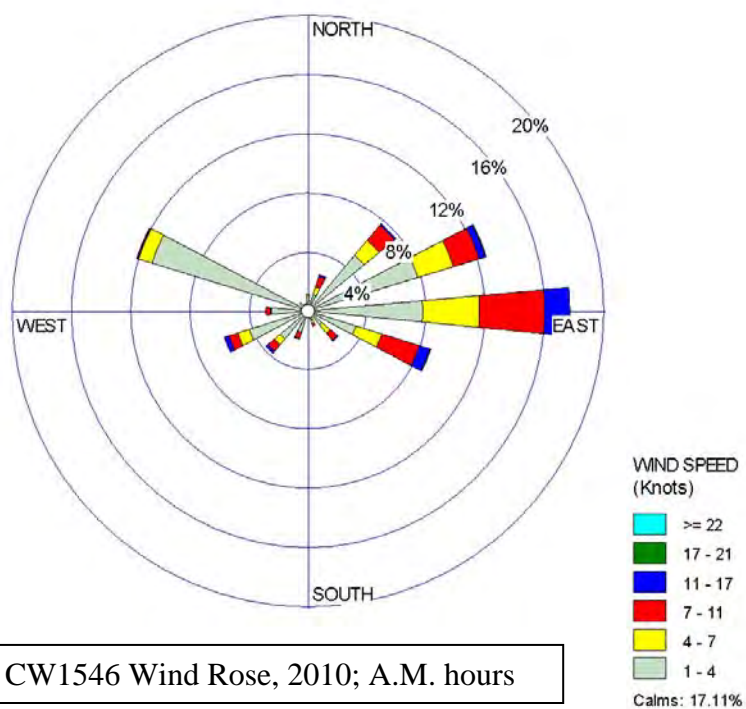
Globe CW1546 Wind Rose, 2010; A.M. hours
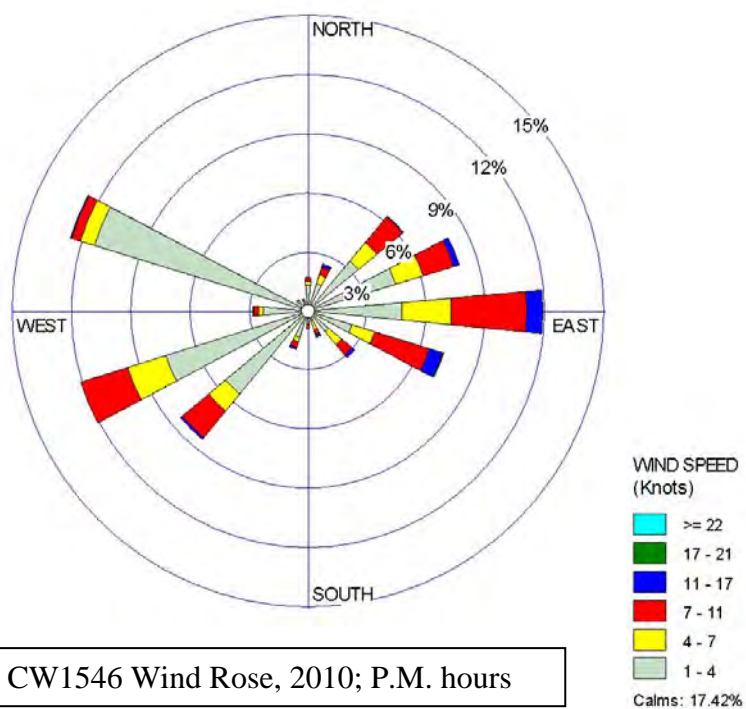
Globe CW1546 Wind Rose, 2010; P.M. hours

Figure 12

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Geography/topography (mountain ranges or other air basin boundaries)

As shown in Figures 13 and 14, Miami and the FMMI smelter are located in complex terrain. Miami is at roughly 3,500 feet elevation, located in the southwest-northeast tending river valley of the Bloody Tanks Wash. To the northeast, this valley joins the Pinal Wash at a right angle; the Wash then tends northwest and merges with the Pinal Creek Valley. Northeast beyond this juncture, the Apache Peaks rise to 4,300 feet, and to 6,200 feet a bit outside of the nonattainment area. To the northwest, Webster Mountain rises to 5,000 feet; the Pinal and other mountain ranges to the south and southwest rise to 6,500 feet; there are various other ridges to the southeast. Thus, Miami is essentially surrounded by mountains in all directions; its immediate valley makes a right-angle turn into the Pinal Creek Valley, which is all within the nonattainment area except for a short narrow portion in the north. The existing nonattainment boundaries contain all the areas topographically connected with Miami.
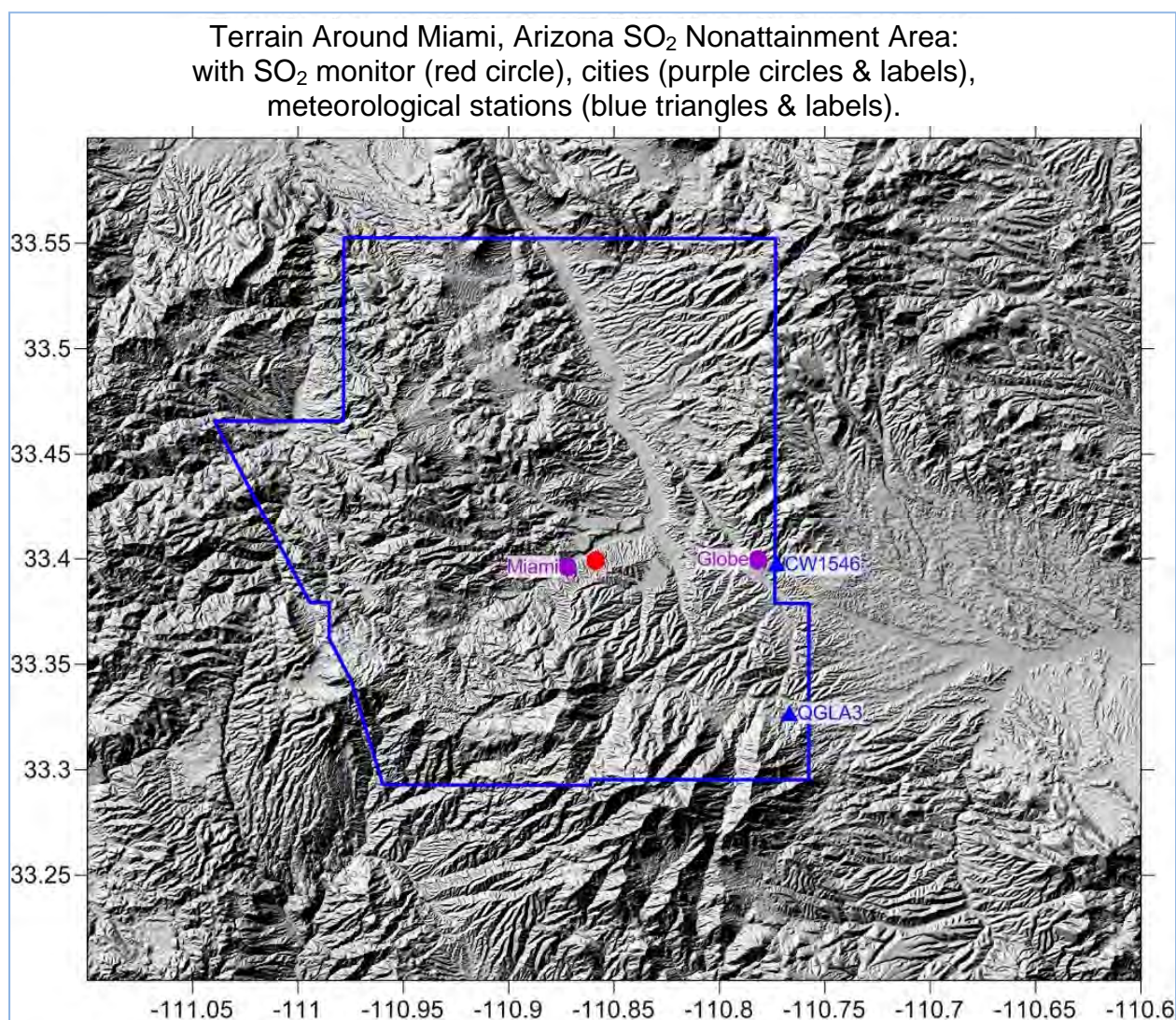

Terrain Around Miami, Arizona SO$_2$ Nonattainment Area: with SO$_2$ monitor (red circle), cities (purple circles & labels), meteorological stations (blue triangles & labels).
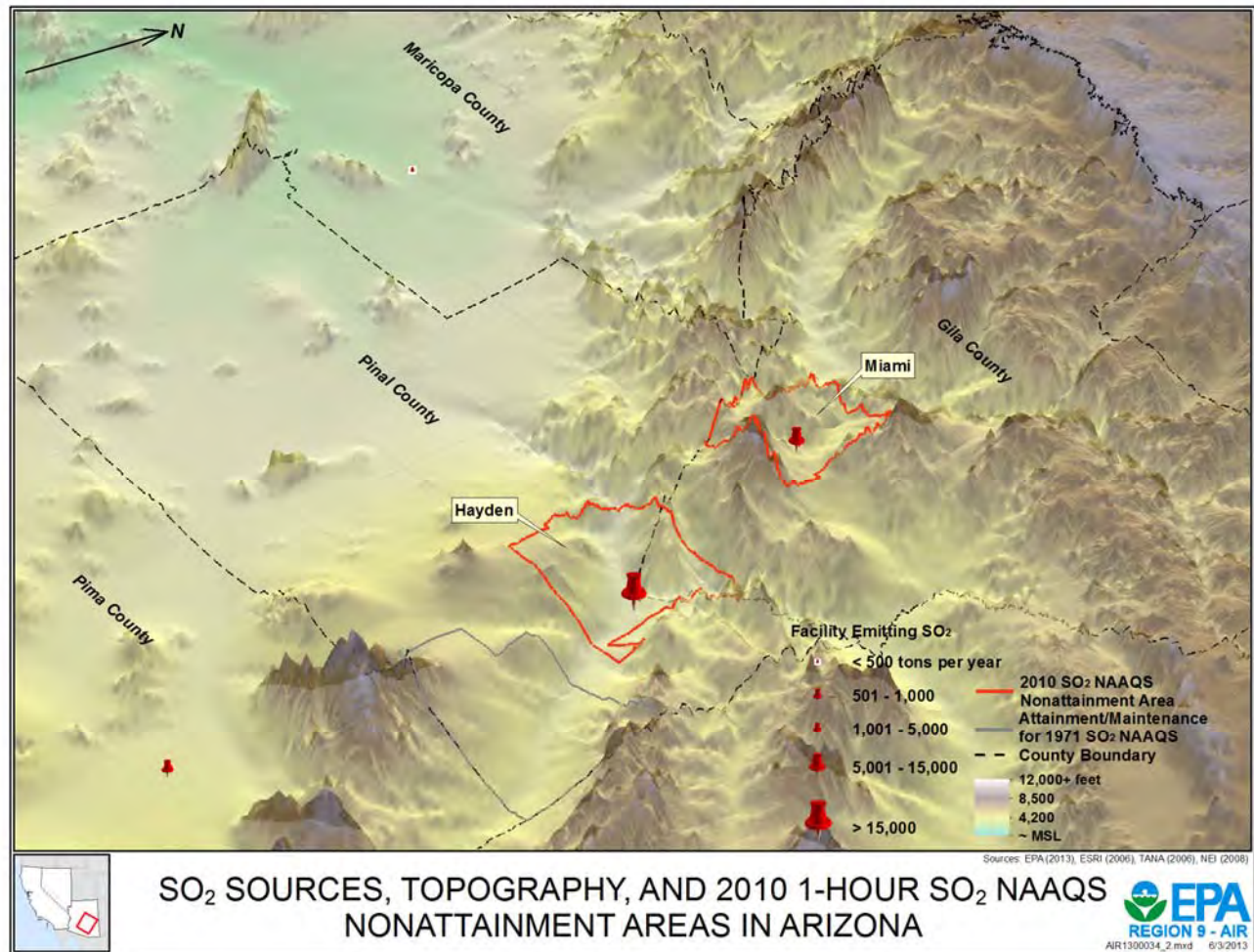
Figure 13

Figure 14

Jurisdictional boundaries

As discussed in the preceding technical analysis for the Hayden nonattainment area, for air quality management purposes, Gila County falls under the jurisdiction of ADEQ. For the 1971 SO_2 NAAQS, the Miami SO_2 nonattainment area was not separately defined but rather that geographic area was included in a county-wide SO_2 nonattainment area (see 43 FR 8968, March 3, 1978). At the request of the state of Arizona, EPA reduced the area's boundaries to include nine townships in and around the city of Miami (44 FR 21261, April 10, 1979). See also, 40 CFR section 81.303. Section 107(d)(1)(C) of the 1990 Clean Air Act Amendments (CAAA) brought forward, by operation of law, the nonattainment designations for areas, such as the Miami SO_2 nonattainment area, that continued to be designated as nonattainment at the time of enactment of the CAAA, i.e., areas that had not been redesignated to ''attainment'' prior to the CAAA's November 15, 1990 enactment date. The area achieved attainment with the 1971 SO_2 NAAQS in 1984, and ADEQ submitted a maintenance plan to EPA in 2002. In January 2007, EPA redesignated the Miami nonattainment area to attainment (72 FR 3061, January 24, 2007). In this redesignation and maintenance plan approval, EPA also corrected the boundary of the Miami SO_2 nonattainment area to exclude a noncontiguous township that was

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erroneously included in the description of the area and to fix a transcription error in the listing of one of the other townships (see 72 FR 3061, January 24, 2007 and 40 CFR section 81.303). The Miami nonattainment area for the 2010 SO$_2$ NAAQS has the same boundaries as the 1971 SO$_2$ NAAQS maintenance area.

Other Relevant Information

In its May 25, 2011 letter, ADEQ provided additional information to support its assertion that presumptive use of full county boundaries as the nonattainment area boundary is inappropriate for geographically large counties. The state argued that the use of full county boundaries as the presumptive nonattainment area boundary for a violating monitor results in regional disparities in the size of nonattainment areas. For example, the state compared the area of Gila County (4,796 square miles) with the area of the entire state of Connecticut (4,845 square miles). A violating monitor in Middlesex County, Connecticut, would result in a presumptive nonattainment area boundary encompassing 369 square miles. Applying this presumption in Arizona would result in a nonattainment area (Gila County) that is 13 times larger than a full-county nonattainment area in Connecticut. Therefore, the state concluded that its consideration of partial counties for the Hayden and Miami nonattainment areas was appropriate.

Conclusion

After considering the factors described above, EPA concurs with the state's recommendation to initially designate a portion of Gila County listed in Table 1 as the Miami, Arizona nonattainment area for the 2010 SO$_2$ NAAQS, based on the violating monitor in Miami, Arizona.

The air quality monitor in Miami, Arizona shows a violation of the 2010 SO$_2$ NAAQS, based on 2009-2011 air quality data. The Freeport-McMoRan Miami Inc. (FMMI) copper smelter located less than 1,400 meters (less than 0.86 mile) away from the violating monitor is expected to be the source of the emissions causing the monitored violation. Miami is essentially surrounded by mountains in all directions. Due to the constraints imposed by the complex terrain in the Miami area (see Geography/Topography discussion above), the extent of the area exceeding the SO$_2$ standard is expected to be confined to a relatively small area around the main source of SO$_2$ emissions, the FMMI copper smelter. In light of this, we are not yet prepared to conclude whether locations outside the particular valley containing Miami contribute to the Miami monitor's recorded exceedances. The meteorology factor did not play a significant role in determining a boundary for the nonattainment area, but available data confirms the relevance of the topography in limiting the extent of the nonattainment area to the nearby river valleys and their surroundings. The nonattainment boundaries recommended by the state are therefore expected to contain areas topographically connected with Miami and causing or contributing to the monitored violation. We are not yet prepared to conclude that the emissions from sources located outside the state's recommended boundary contribute to the monitored violation or to other possible violations, and will further address such sources and their areas in a subsequent round of final initial designations.

Based on the consideration of all the relevant and available information, as described above, EPA's conclusion is that the boundaries described herein for the Miami, Arizona nonattainment area encompass an area that does not meet (or that contributes to ambient air quality in a nearby area that

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does not meet) the 2010 SO_2 NAAQS, based on the violating monitor information. No areas of Indian country are included in the Miami, Arizona nonattainment area. Areas and sources that EPA is not yet prepared to conclude are contributing to the monitored violation or to other possible violations are not included in this initial nonattainment area. In the future, we will make final designation decisions for areas in Arizona not included in the nonattainment area designations addressed in this TSD.

Appendix B

Regulatory Materials

Air Quality Division
August 2, 2022 Final

Exhibit BI – Authorizing Statutes

A.R.S. § 49-104. Powers and duties of the department and director

A. The department shall:

1. Formulate policies, plans and programs to implement this title to protect the environment.

2. Stimulate and encourage all local, state, regional and federal governmental agencies and all private persons and enterprises that have similar and related objectives and purposes, cooperate with those agencies, persons and enterprises and correlate department plans, programs and operations with those of the agencies, persons and enterprises.

3. Conduct research on its own initiative or at the request of the governor, the legislature or state or local agencies pertaining to any department objectives.

4. Provide information and advice on request of any local, state or federal agencies and private persons and business enterprises on matters within the scope of the department.

5. Consult with and make recommendations to the governor and the legislature on all matters concerning department objectives.

6. Promote and coordinate the management of air resources to ensure their protection, enhancement and balanced utilization consistent with the environmental policy of this state.

7. Promote and coordinate the protection and enhancement of the quality of water resources consistent with the environmental policy of this state.

8. Encourage industrial, commercial, residential and community development that maximizes environmental benefits and minimizes the effects of less desirable environmental conditions.

9. Ensure the preservation and enhancement of natural beauty and man-made scenic qualities.

10. Provide for the prevention and abatement of all water and air pollution including that related to particulates, gases, dust, vapors, noise, radiation, odor, nutrients and heated liquids in accordance with article 3 of this chapter and chapters 2 and 3 of this title.

11. Promote and recommend methods for the recovery, recycling and reuse or, if recycling is not possible, the disposal of solid wastes consistent with sound health, scenic and environmental quality policies. The department shall report annually on its revenues and expenditures relating to the solid and hazardous waste programs overseen or administered by the department.

12. Prevent pollution through the regulation of the storage, handling and transportation of solids, liquids and gases that may cause or contribute to pollution.

13. Promote the restoration and reclamation of degraded or despoiled areas and natural resources.

14. Participate in the state civil defense program and develop the necessary organization and facilities to meet wartime or other disasters.

15. Cooperate with the Arizona-Mexico commission in the governor's office and with researchers at universities in this state to collect data and conduct projects in the United States and Mexico on issues that are within the scope of the department's duties and that relate to quality of life, trade and economic development in this state in a manner that will help the Arizona-Mexico commission to assess and enhance the economic

competitiveness of this state and of the Arizona-Mexico region.

16. Unless specifically authorized by the legislature, ensure that state laws, rules, standards, permits, variances and orders are adopted and construed to be consistent with and no more stringent than the corresponding federal law that addresses the same subject matter. This paragraph does not adversely affect standards adopted by an Indian tribe under federal law.

17. Provide administrative and staff support for the oil and gas conservation commission.

B. The department, through the director, shall:

1. Contract for the services of outside advisers, consultants and aides reasonably necessary or desirable to enable the department to adequately perform its duties.

2. Contract and incur obligations reasonably necessary or desirable within the general scope of department activities and operations to enable the department to adequately perform its duties.

3. Utilize any medium of communication, publication and exhibition when disseminating information, advertising and publicity in any field of its purposes, objectives or duties.

4. Adopt procedural rules that are necessary to implement the authority granted under this title, but that are not inconsistent with other provisions of this title.

5. Contract with other agencies, including laboratories, in furthering any department program.

6. Use monies, facilities or services to provide matching contributions under federal or other programs that further the objectives and programs of the department.

7. Accept gifts, grants, matching monies or direct payments from public or private agencies or private persons and enterprises for department services and publications and to conduct programs that are consistent with the general purposes and objectives of this chapter. Monies received pursuant to this paragraph shall be deposited in the department fund corresponding to the service, publication or program provided.

8. Provide for the examination of any premises if the director has reasonable cause to believe that a violation of any environmental law or rule exists or is being committed on the premises. The director shall give the owner or operator the opportunity for its representative to accompany the director on an examination of those premises. Within forty-five days after the date of the examination, the department shall provide to the owner or operator a copy of any report produced as a result of any examination of the premises.

9. Supervise sanitary engineering facilities and projects in this state, authority for which is vested in the department, and own or lease land on which sanitary engineering facilities are located, and operate the facilities, if the director determines that owning, leasing or operating is necessary for the public health, safety or welfare.

10. Adopt and enforce rules relating to approving design documents for constructing, improving and operating sanitary engineering and other facilities for disposing of solid, liquid or gaseous deleterious matter.

11. Define and prescribe reasonably necessary rules regarding the water supply, sewage disposal and garbage collection and disposal for subdivisions. The rules shall:

    (a) Provide for minimum sanitary facilities to be installed in the subdivision and may require that water systems plan for future needs and be of adequate size and capacity to deliver specified minimum quantities of drinking water and to treat all sewage.

(b) Provide that the design documents showing or describing the water supply, sewage disposal and garbage collection facilities be submitted with a fee to the department for review and that no lots in any subdivision be offered for sale before compliance with the standards and rules has been demonstrated by approval of the design documents by the department.

12. Prescribe reasonably necessary measures to prevent pollution of water used in public or semipublic swimming pools and bathing places and to prevent deleterious conditions at those places. The rules shall prescribe minimum standards for the design of and for sanitary conditions at any public or semipublic swimming pool or bathing place and provide for abatement as public nuisances of premises and facilities that do not comply with the minimum standards. The rules shall be developed in cooperation with the director of the department of health services and shall be consistent with the rules adopted by the director of the department of health services pursuant to section 36-136, subsection I, paragraph 10.

13. Prescribe reasonable rules regarding sewage collection, treatment, disposal and reclamation systems to prevent the transmission of sewage borne or insect borne diseases. The rules shall:

(a) Prescribe minimum standards for the design of sewage collection systems and treatment, disposal and reclamation systems and for operating the systems.

(b) Provide for inspecting the premises, systems and installations and for abating as a public nuisance any collection system, process, treatment plant, disposal system or reclamation system that does not comply with the minimum standards.

(c) Require that design documents for all sewage collection systems, sewage collection system extensions, treatment plants, processes, devices, equipment, disposal systems, on-site wastewater treatment facilities and reclamation systems be submitted with a fee for review to the department and may require that the design documents anticipate and provide for future sewage treatment needs.

(d) Require that construction, reconstruction, installation or initiation of any sewage collection system, sewage collection system extension, treatment plant, process, device, equipment, disposal system, on-site wastewater treatment facility or reclamation system conform with applicable requirements.

14. Prescribe reasonably necessary rules regarding excreta storage, handling, treatment, transportation and disposal. The rules may:

(a) Prescribe minimum standards for human excreta storage, handling, treatment, transportation and disposal and shall provide for inspection of premises, processes and vehicles and for abating as public nuisances any premises, processes or vehicles that do not comply with the minimum standards.

(b) Provide that vehicles transporting human excreta from privies, septic tanks, cesspools and other treatment processes shall be licensed by the department subject to compliance with the rules. The department may require payment of a fee as a condition of licensure. The department may establish by rule a fee as a condition of licensure, including a maximum fee. As part of the rulemaking process, there must be public notice and comment and a review of the rule by the joint legislative budget committee. The department shall not increase that fee by rule without specific statutory authority for the increase. The fees shall be deposited, pursuant to

sections 35-146 and 35-147, in the solid waste fee fund established by section 49-881.

15. Perform the responsibilities of implementing and maintaining a data automation management system to support the reporting requirements of title III of the superfund amendments and reauthorization act of 1986 (P.L. 99-499) and article 2 of this chapter.

16. Approve remediation levels pursuant to article 4 of this chapter.

17. Establish or revise fees by rule pursuant to the authority granted under title 44, chapter 9, article 8 and chapters 4 and 5 of this title for the department to adequately perform its duties. All fees shall be fairly assessed and impose the least burden and cost to the parties subject to the fees. In establishing or revising fees, the department shall base the fees on:

(a) The direct and indirect costs of the department's relevant duties, including employee salaries and benefits, professional and outside services, equipment, in-state travel and other necessary operational expenses directly related to issuing licenses as defined in title 41, chapter 6 and enforcing the requirements of the applicable regulatory program.

(b) The availability of other funds for the duties performed.

(c) The impact of the fees on the parties subject to the fees.

(d) The fees charged for similar duties performed by the department, other agencies and the private sector.

18. Appoint a person with a background in oil and gas conservation to act on behalf of the oil and gas conservation commission and administer and enforce the applicable provisions of title 27, chapter 4 relating to the oil and gas conservation commission.

C. The department may:

1. Charge fees to cover the costs of all permits and inspections it performs to ensure compliance with rules adopted under section 49- 203, except that state agencies are exempt from paying those fees that are not associated with the dredge and fill permit program established pursuant to chapter 2, article 3.2 of this title. For services provided under the dredge and fill permit program, a state agency shall pay either:

(a) The fees established by the department under the dredge and fill permit program.

(b) The reasonable cost of services provided by the department pursuant to an interagency service agreement.

2. Monies collected pursuant to this subsection shall be deposited, pursuant to sections 35-146 and 35-147, in the water quality fee fund established by section 49-210.

3. Contract with private consultants for the purposes of assisting the department in reviewing applications for licenses, permits or other authorizations to determine whether an applicant meets the criteria for issuance of the license, permit or other authorization. If the department contracts with a consultant under this paragraph, an applicant may request that the department expedite the application review by requesting that the department use the services of the consultant and by agreeing to pay the department the costs of the consultant's services. Notwithstanding any other law, monies paid by applicants for expedited reviews pursuant to this paragraph are appropriated to the department for use in paying consultants for services.

D. The director may:

ADEQ
Arizona Department of Environmental Quality

Authorizing Statute
A.R.S. § 49-104

1. If the director has reasonable cause to believe that a violation of any environmental law or rule exists or is being committed, inspect any person or property in transit through this state and any vehicle in which the person or property is being transported and detain or disinfect the person, property or vehicle as reasonably necessary to protect the environment if a violation exists.

2. Authorize in writing any qualified officer or employee in the department to perform any act that the director is authorized or required to do by law.

A.R.S. § 49-106. *Statewide application of rules*

The rules adopted by the department apply and shall be observed throughout this state, or as provided by their terms, and the appropriate local officer, council or board shall enforce them. This section does not limit the authority of local governing bodies to adopt ordinances and rules within their respective jurisdictions if those ordinances and rules do not conflict with state law and are equal to or more restrictive than the rules of the department, but this section does not grant local governing bodies any authority not otherwise provided by separate state law.

A.R.S. § 49-404. *State implementation plan*

A. The director shall maintain a state implementation plan that provides for implementation, maintenance and enforcement of national ambient air quality standards and protection of visibility as required by the clean air act.

B. The director may adopt rules that describe procedures for adoption of revisions to the state implementation plan.

C. The state implementation plan and all revisions adopted before September 30, 1992 remain in effect according to their terms, except to the extent otherwise provided by the clean air act, inconsistent with any provision of the clean air act, or revised by the administrator. No control requirement in effect, or required to be adopted by an order, settlement agreement or plan in effect, before the enactment of the clean air act in any area which is a nonattainment or maintenance area for any air pollutant may be modified after enactment in any manner unless the modification insures equivalent or greater emission reductions of the air pollutant. The director shall evaluate and adopt revisions to the plan in conformity with federal regulations and guidelines promulgated by the administrator for those purposes until the rules required by subsection B are effective.

A.R.S. § 49-406. *Nonattainment area plan*

A. For any ozone, carbon monoxide or particulate nonattainment or maintenance area the governor shall certify the metropolitan planning organization designated to conduct the continuing, cooperative and comprehensive transportation planning process for that area under 23 United States Code section 134 as the agency responsible for the development of a nonattainment or maintenance area plan for that area.

B. For any ozone, carbon monoxide or particulate nonattainment or maintenance area for which no metropolitan planning organization exists, the department shall be certified as the agency responsible for development of a nonattainment or maintenance area plan for that area.

C. For any ozone, carbon monoxide or particulate nonattainment or maintenance area, the department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall, by November 15, 1992, and from time to time as necessary, jointly review and update planning procedures or develop new procedures.

D. In preparing the procedures described in subsection C of this section, the department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall determine which elements of each revised implementation plan will be developed, adopted, and implemented, through means including enforcement, by the state and which by local governments or regional agencies, or any combination of local governments, regional agencies or the state.

E. The department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall enter into a memorandum of agreement for the purpose of coordinating the implementation of the procedures described in subsection C and D of this section.

F. At a minimum, the memorandum of agreement shall contain:
    1. The relevant responsibilities and authorities of each of the coordinating agencies.
    2. As appropriate, procedures, schedules and responsibilities for development of nonattainment or maintenance area plans or plan revisions and for determining reasonable further progress.
    3. Assurances for adequate plan implementation.
    4. Procedures and responsibilities for tracking plan implementation.
    5. Responsibilities for preparing demographic projections including land use, housing, and employment.
    6. Coordination with transportation programs.
    7. Procedures and responsibilities for adoption of control measures and emissions limitations.
    8. Responsibilities for collecting air quality, transportation and emissions data.
    9. Responsibility for conducting air quality modeling.
    10. Responsibility for administering and enforcing stationary source controls.
    11. Provisions for the timely and periodic sharing of all data and information among the signatories relating to:

(a) Demographics.

(b) Transportation.

(c) Emissions inventories.

(d) Assumptions used in developing the model.

(e) Results of modeling done in support of the plan.

(f) Monitoring data.

G. Each agency that commits to implement any emission limitation or other control measure, means or technique contained in the implementation plan shall describe that commitment in a resolution adopted by the appropriate governing body of the agency. The resolution shall specify the following:

1. Its authority for implementing the limitation or measure as provided in statute, ordinance or rule.

2. A program for the enforcement of the limitation or measure.

3. The level of personnel and funding allocated to the implementation of the measure.

H. The state, in accordance with the rules adopted pursuant to section 49-404, and the governing body of the metropolitan planning organization shall adopt each nonattainment or maintenance area plan developed by a certified metropolitan planning organization. The adopted nonattainment or maintenance area plan shall be transmitted to the department for inclusion in the state implementation plan provided for under section 49-404.

I. After adoption of a nonattainment or maintenance area plan, if on the basis of the reasonable further progress determination described in subsection F of this section or other information, the control officer determines that any person has failed to implement an emission limitation or other control measure, means or technique as described in the resolution adopted pursuant to subsection G of this section, the control officer shall issue a written finding to the person, and shall provide an opportunity to confer. If the control officer subsequently determines that the failure has not been corrected, the county attorney, at the request of the control officer, shall file an action in superior court for a preliminary injunction, a permanent injunction, or any other relief provided by law.

J. After adoption of a nonattainment or maintenance area plan, if, on the basis of the reasonable further progress determination described in subsection F of this section or other information, the director determines that any person has failed to implement an emission limitation or other control measure, means or technique as described in the resolution adopted pursuant to subsection G of this section, and that the control officer has failed to act pursuant to subsection I of this section, the director shall issue a written finding to the person and shall provide an opportunity to confer. If the director subsequently determines that the failure has not been corrected, the attorney general, at the request of the director, shall file an action in superior court for a preliminary injunction, a permanent injunction, or any other relief provided by law.

K. Notwithstanding subsections A and B of this section, in any metropolitan area with a metropolitan statistical area population of less than two hundred fifty thousand persons, the governor shall designate an agency that meets the criteria of section 174 of the clean air act and that is recommended by the city that causes the metropolitan area to exist and the affected county. That agency shall prepare and adopt

the nonattainment or maintenance area plan. If the governor does not designate an agency, the department shall be certified as the agency responsible for the development of a nonattainment or maintenance area plan for that area.

A.R.S. § 49-425. *Rules; hearing*

A. The director shall adopt such rules as he determines are necessary and feasible to reduce the release into the atmosphere of air contaminants originating within the territorial limits of the state or any portion thereof and shall adopt, modify, and amend reasonable standards for the quality of, and emissions into, the ambient air of the state for the prevention, control and abatement of air pollution. Additional standards shall be established for particulate matter emissions, sulfur dioxide emissions, and other air contaminant emissions determined to be necessary and feasible for the prevention, control and abatement of air pollution. In fixing such ambient air quality standards, emission standards or standards of performance, the director shall give consideration but shall not be limited to the relevant factors prescribed by the clean air act.

B. No rule may be enacted or amended except after the director first holds a public hearing after twenty days' notice of such hearing. The proposed rule, or any proposed amendment of a rule, shall be made available to the public at the time of notice of such hearing.

C. The department shall enforce the rules adopted by the director.

D. All rules enacted pursuant to this section shall be made available to the public at a reasonable charge upon request.