State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

UTAH AIR QUALITY BOARD MEETING

DRAFT AGENDA

Wednesday, March 6, 2019 - 1:30 p.m.
195 North 1950 West, Room 1015
Salt Lake City, Utah 84116

I. Call-to-Order

II. Date of the Next Air Quality Board Meeting: May 1, 2019

III. Approval of the Minutes for February 6, 2019, Board Meeting.

IV. Propose for Public Comment: Revisions to SIP Section XX. Regional Haze, Parts A and D. Presented by Jay Baker.

V. Propose for Public Comment: Amend R307-110-28. Regional Haze. Presented by Thomas Gunter.

VI. Propose For Public Comment: Amend R307-150-3. Applicability. Presented by Thomas Gunter.

VII. Propose for Public Comment: Amend R307-401-10. Source Category Exemptions. Presented by Thomas Gunter.

VIII. HJG Utah, LLC - Final Settlement Agreement. Presented by Jay Morris and Jason Krebs.

IX. Informational Items.
   A. Air Toxics. Presented by Robert Ford.
   B. Compliance. Presented by Jay Morris and Harold Burge.
   C. Monitoring. Presented by Bo Call.
   D. Other Items to be Brought Before the Board.
   E. Board Meeting Follow-up Items.

In compliance with the Americans with Disabilities Act, individuals with special needs (including auxiliary communicative aids and services) should contact Larene Wyss, Office of Human Resources at (801) 536-4281, TDD (801) 536-4284 or by email at lwyss@utah.gov.

ITEM 3

UTAH AIR QUALITY BOARD MEETING
February 6, 2019 – 1:30 p.m.
195 North 1950 West, Four Corners Conference Rooms
Salt Lake City, Utah 84116

DRAFT MINUTES

I. Call-to-Order

Erin Mendenhall called the meeting to order at 1:33 p.m.

Board members present: Kevin Cromar, Randal Martin, Alan Matheson, Arnold Reitze, Erin Mendenhall (attendance by phone), Cassady Kristensen (attendance by phone), Michael Smith (attendance by phone), and William Stringer (attendance by phone).

Excused: Mitra Kashanchi

Executive Secretary: Bryce Bird

II. Date of the Next Air Quality Board Meeting: March 6, 2019

III. Approval of the Minutes for January 2, 2019, Working Lunch and Board Meeting.

- Arnold Reitze motioned to approve. Randal Martin seconded. The Board approved unanimously.

Kevin Cromar enters the meeting.

IV. Final Adoption: Amend R307-101-2. Definitions. Presented by Thomas Gunter.

Thomas Gunter, Rules Coordinator at DAQ, stated that during the 2014 Legislative General Session, House Bill 31 (HB31) removed the definition of “facility” from Utah Code §19-2-102. In November 2018, the Board proposed for public comment an amendment to R307-101-2 that removed the definition of “facility” from the Utah Air Quality rules. This change was made to bring the rules in line with the changes made in HB31. In that November 2018 meeting, DAQ identified 269 times when the term “facility” was used throughout R307, yet none of those uses aligned with the definition. A public comment period was held from December 1, 2018, to January 2, 2019. No comments were received and no hearing was requested. Staff recommends that the Board adopt rule R307-101-2 as amended.

- Arnold Reitze motioned to approve final adoption of R307-101-2. Cassady Kristensen seconded. The Board approved unanimously.

V. Informational Items.

A. Inland Port. Presented by Dr. Brian Moench, Utah Physicians for a Healthy Environment.

Brian Moench of Utah Physicians for a Healthy Environment (UPHE) stated that medical research has established that not all particulate matter is equally toxic, and yet EPA does not have differential air quality standards for different types of PM2.5. Those differences also are not taken into account in the state implementation plan. The state should take these four characteristics into account in its mitigation strategy: “ultra fines” within the PM2.5, diesel engine exhaust particles, primary versus secondary particle which have more biologic potency than secondary particles, and intake fraction. UPHE suggests that the overall mitigation strategy prioritize maximizing public health. Some suggested ideas include approving a change of permitted vehicles and speed limit on the Legacy Highway, wood burning oven permits, eliminate sources of diesel exhaust, and re-evaluate the propriety of an inland port. State law allows the state to make different stricter rules than the EPA. The Board has the authority to restore multiple rules that would protect air quality, the environment, and public health in Utah that the current federal administration has withdrawn, and the Board should pro-actively exercise its authority in the face of the newly regressive actions and policies pursued at the federal level.

B. Legislative Update. Presented by Bryce Bird.

Bryce Bird gave a brief update of legislative bills that DEQ is tracking, in particular bills related to air quality. A summary has been prepared and posted on DEQ’s main web page titled, “Utah Legislative 2019 Environmental Bill Tracker.”

C. Air Toxics. Presented by Robert Ford.

D. Compliance. Presented by Jay Morris and Harold Burge.

E. Monitoring. Presented by Bo Call.

Bo Call, Air Monitoring Section Manager at DAQ, stated that the particulate data for 2018 has been certified with EPA. Except for the Rose Park monitor, the data shows attainment of the standard. EPA has two exceptional events documentation for 2017, which they could act upon. The Rose Park 3-year average for 2016, 2017, and 2018 is at 36.0 right now. If EPA concurs with the two exceptional events, Rose Park could drop to 34.9.

The ozone data has not been certified. With the ozone data, as soon as you get to the 4th value, that is the regulatory number. The current 4th high for the Uinta Basin is 72. The 3-year average for ozone for 2017, 2018, through 2019 would at 80.7. The standard is 70.

F. Other Items to be Brought Before the Board.

G. Board Meeting Follow-up Items.

- No pre-working meeting planned for March at this time.

Meeting adjourned at 2:51 p.m.

ITEM 4

State of Utah
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DAQ-032-19

M E M O R A N D U M

TO: Air Quality Board

THROUGH: Bryce C. Bird, Executive Secretary

FROM: Jay Baker, Environmental Scientist

DATE: February 21, 2019

SUBJECT: PROPOSE FOR PUBLIC COMMENT: Amend Utah State Implementation Plan Section XX.A. Regional Haze. Executive Summary; and Section XX.D(6). Regional Haze. Long-Term Strategy for Stationary Sources. Best Available Retrofit Technology (BART) Assessment for NOx
and PM.

In June 2015, the Air Quality Board approved Regional Haze State Implementation Plan (SIP) sections addressing best available retrofit technology for PM and a BART alternative for NO_x. EPA approved the BART for PM on July 5, 2016, but disapproved the BART alternative for NO_x. The purpose of this SIP revision is to provide additional analysis to support the BART alternative for NO_x and to demonstrate that the alternative will provide greater visibility improvement than would be achieved through the installation of the most stringent NO_x controls on the four electrical generating units (EGU) that are subject to BART.

In the previous submittal, Utah used a weight-of-evidence analysis to show that the alternative was better than BART. One of their reasons for disapproving the BART alternative was that the weight-of-evidence analysis did not show that the alternative was “clearly” better than BART. EPA also acknowledged that the weight-of-evidence analysis is a subjective test. In this submittal, Utah is using dispersion modeling and the two prong test prescribed by the Regional Haze rule in 40 CFR 51.308(e)(3). The two prongs are: (1) Visibility does not decline in any Class I area, and (2) There is an overall improvement in visibility, determined by comparing the average differences between BART and the alternative over all affected Class I areas. The two-prong test is a simple, objective pass-fail test.

1. The SIP keeps in place the current NO_x emission limits for PacifiCorp Hunter 1 and 2 and PacifiCorp Huntington 1 and 2 that are more stringent than EPA’s presumptive BART limits; makes enforceable the closure of PacifiCorp Carbon 1 and 2; and takes credit for the installation of low- NO_x burners at PacifiCorp Hunter 3 in 2008.

2. A demonstration that the alternative to BART will achieve greater reasonable progress than BART is attached and will be included in the technical support documentation for the SIP. The new visibility modeling shows that visibility will not decline in any Class I area under the alternative and that the alternative will improve overall visibility compared to the most stringent NO_x controls.

Recommendation: Staff recommends that the Board propose revisions to SIP Sections XX, Part A and Part D.6 for public comment.

Utah State Implementation Plan
Section XX

Regional Haze

Addressing Regional Haze Visibility Protection for the Mandatory Federal Class I Areas Required Under 40 CFR 51.308 and 309

Adopted by the Air Quality Board

[DATE]

A. EXECUTIVE SUMMARY

This document comprises the State of Utah's State Implementation Plan (SIP) submittal to the U.S. Environmental Protection Agency (EPA) under the Regional Haze Rule in Sections 308 and 309 of Title 40 of the Code of Federal Regulations, Part 51 (40 CFR 51.308 and 309). Part B includes introductory and background information. The remaining parts identify the SIP requirements under Sections 308 and 309 and detail how Utah is addressing those requirements, and appendices include more detail about certain parts. Table 1 is a brief summary of each of the 308 and 309 SIP requirements along with Utah's approach in addressing those requirements.

Table 1 - Executive Summary of Long-Term Strategies

Clean Air Corridors *309(d)(3)*	Part C documents that emission growth inside and outside of the Clean Air Corridor is not shown to be contributing currently to impairment within the Clean Air Corridor.
Stationary Sources *308(e) and 309(d)(4)*	Part D includes proof of a 13% reduction in sulfur dioxide emissions between 1990 and 2000, Best Available Retrofit Technology (BART) Alternative for NO_x and PM, geographic enhancement provisions, and other stationary source materials.
Sulfur Dioxide Milestones and Backstop Trading Program *309(d)(4)*	Part E includes milestones for sulfur dioxide emissions along with a backstop market cap and trade program for sulfur dioxide emissions from specific sources.
Mobile Sources *309(d)(5)*	Part F demonstrates that federal programs (such as low sulfur diesel, vehicle emission standards, etc.) lead to decreasing mobile source emissions throughout the planning period.
Programs Related to Fire *309(d)(6)*	Part G demonstrates that Utah has developed a smoke management regulation (R307-204) that implements the Western Regional Air Partnership (WRAP) *Enhanced Smoke Management Programs for Visibility Policy*.
Paved and Unpaved Road Dust *309(d)(7)*	Part H discusses the WRAP finding that dust emissions are not now a significant regional contributor to visibility impairment within the Colorado Plateau 16 Class I areas.

Pollution Prevention *309(d)(8)*	Part I describes programs and policies within Utah related to renewable energy and energy efficiency. Utah's anticipated contribution to the pollution prevention goals is outlined.
Additional Recommendations *309(d)(9)*	Part J summarizes that Utah has not identified any other recommendations in the Grand Canyon Visibility Transport Commission Report to implement in Utah at this time. A report on each recommendation is included in the Utah Technical Support Document Supplement.
Projection of Visibility Improvement *309(d)(2)*	Part K projects visibility improvement for the 20% best and worst days for each of the Class I areas on the Colorado Plateau (Arches, Bryce, Canyonlands, Capitol Reef, and Zion National Parks in Utah and the other 11 Class I areas in adjacent states that were addressed by the Grand Canyon Visibility Transport Commission)
Periodic Revisions *309(d)(10)*	Part L commits the State of Utah to submit periodic revisions to this SIP every five years.
State Planning and Interstate Coordination *309(d)(11)*	Part M describes Utah's participation in the Western Regional Air Partnership.
Reasonable Progress for Additional Class I Areas *309(g)*	Utah has no additional Class I areas.

Technical Support Documents

Accompanying this implementation plan and associated appendices are ~~two~~ other supporting documents. The first is a Technical Support Document (TSD) developed by the Western Regional Air Partnership (WRAP) that contains the results of numerous collaborative studies by the WRAP members on which the State of Utah relied in the development of the 2003 SIP. In the implementation plan, this is referred to as the “WRAP TSD.” The WRAP TSD also includes appendices. In addition, there are other supplemental materials that are state-specific technical support information, including staff reviews and modeling information. In the implementation plan, these are referred to as the “Utah TSD Supplement.”

In 2008, the Regional Haze SIP was updated to address changes in the regional haze rule and EPA's BART Guidelines. The WRAP developed a new TSD, a Technical Support System (TSS) that contains the results of updated modeling, and an Emission Data Management System (EDMS). In the implementation plan these combined materials are referred to as the 2008 WRAP TSD and updated state-specific materials are referred to as the 2008 Utah TSD supplement.

In 2011 the SO_2 milestones in Part E of the SIP were revised to address a reduced number of states participating in the regional backstop trading program, and changes in growth projections for electric utilities in the west.

B. BACKGROUND ON THE REGIONAL HAZE RULE

[No revisions]

C. LONG-TERM STRATEGY FOR THE CLEAN-AIR CORRIDOR

[No revisions]

D. LONG-TERM STRATEGY FOR STATIONARY SOURCES

1. Regulatory History and Requirements

2. Achievement of a 13% or Greater Reduction of Sulfur Dioxide Emissions by 2000

3. Strategy for Stationary Sources of Sulfur Dioxide

4. Geographic Enhancement Program

5. Report on Assessment of NO_x/PM Strategies

6. Best Available Retrofit Technology (BART) Assessment for NO_x and PM

a. Regional Haze Rule BART Requirements

Pursuant to 40 CFR 51.308(e) and 40 CFR 51.309(d)(4)(vii), certain major stationary sources are required to evaluate, install, operate and maintain BART technology or an approved BART alternative for NO_x and PM emissions. The State of Utah has chosen to evaluate BART for PM under the case-by-case provisions of 40 CFR 51.308(e)(1) and BART for NO_x through alternative measures under 40 CFR 51.308(e)(2) and (3). BART for SO_2 is addressed through an alternative program under 40 CFR 51.309 that is described in Part E of this plan.

b. BART for Particulate Matter

[No revisions]

c. BART for NO_x

BART for NO_x is addressed through alternative measures as provided under 40 CFR 51.308(e)(2). The following emission reduction measures, which include both BART and non-BART sources, are required, and are made enforceable through emission limits established in Section IX, Part H.21 and H.22 of the State Implementation Plan.

- PacifiCorp Hunter Units 1 and 2 and Huntington Units 1 and 2: The replacement of first generation low-NO_x burners with Alstom TSF 2000TM low-NO_x firing system and installation of two elevations of separated overfire air with an emission limit of 0.26 lb/MMBtu.
- PacifiCorp Hunter Unit 3 (not subject-to-BART): The replacement of first generation low-NOx burners with improved low-NOx burners with overfire air with an emission limit of 0.34 lb/MMBtu.

- PacifiCorp Carbon Units 1 and 2 (not subject-to-BART): PacifiCorp shall permanently retire Carbon Units 1 and 2 by August 15, 2015.

40 CFR 51.308(e)(2) requires an analysis to demonstrate that the alternative measures achieve greater reasonable progress than would be achieved through the installation and operation of BART. This demonstration is included in the TSD.[1] Combined emissions of NOx, SO_2, and PM_{10} will be 1,879 tons/yr lower under the alternative than the most-stringent BART scenario for NOx. Dispersion modeling and related analysis done according to 40 CFR 51.308(e)(3), demonstrates that the alternative achieves "greater reasonable progress" by meeting both of the following two prongs: (i) visibility does not decline in any Class I area, and (ii) there is an overall improvement in visibility, determined by comparing the average differences between BART and the alternative over all affected Class I areas.visibility will improve on a greater number of days under the alternative, and the average deciview impairment and 90th percentile deciview impairment will be better under the alternative.

d. BART Summary

The BART emission limits for NO_x and PM are summarized in Table 5. While Utah has chosen to meet the NO_x BART requirement through alternative measures established in Section XX Part D.6 of the SIP, and the SO_2 BART requirement through an alternative to BART program established in Section XX Part E of the SIP, the enforceable emission limits for both NO_x and SO_2 established in the approval orders and in the SIP for the four EGUs also meet the presumptive emission rates for both NO_x and SO_2 established in Appendix Y independently of the alternative programs.

Table 2 - Emission Limits for the Retrofitted Hunter and Huntington Units

Units	Utah Permitted Limits			Presumptive BART Rates[2]	
	SO_2 lb/MMBtu	NOx lb/MMBtu	PM lb/MMBtu	SO_2 lb/MMBtu	NO_x lb/MMBtu
Hunter 1	0.12	0.26	0.015	0.15	0.28
Hunter 2	0.12	0.26	0.015	0.15	0.28
Hunter 3		0.34			
Huntington 1	0.12	0.26	0.015	0.15	0.28
Huntington 2	0.12	0.26	0.015	0.15	0.28

[1] Review of 2008 BART Determination and Recommended Alternative to BART for NOx, Utah Division of Air Quality, February 13, 2015

[2] 40 CFR Part 51 Appendix Y Guidelines for BART Determinations under the Regional Haze Rule (70 Federal Register 39135)

e. Schedule for Installation of Controls

Pursuant to 51.308(e)(1)(C)(iv) each source subject to BART is required to install and operate BART no later than 5 years after approval of the implementation plan, and pursuant to 51.308(e)(2)(E)(3) all alternative measures must take place within the first planning period. Table 6 shows that the required schedule ~~will be~~has been met for all units.

Table 3 - Installation Schedule

Source	Notice of Intent Submitted	Permit Issued	In Service Date
Hunter 1	June 2006	March 2008	Spring 2014
Hunter 2	June 2006	March 2008	Spring 2011
Hunter 3			Summer 2008
Huntington 1	April 2008	August 2009	Fall 2010
Huntington 2	October 2004	April 2005	Dec 2006
Carbon 1			Shut down August 2015
Carbon 2			Shut down August 2015

Utah's long-standing Prevention of Significant Deterioration (PSD) permitting program (SIP Section VII and R307-405), New Source Review permitting program (SIP Section II and R307-401) and Visibility program (SIP section XVII and R307-406) will continue to protect Class I area visibility by ensuring that the BART emission limits established in Part H.21 and H.22 of this plan are maintained, requiring best available control technology for new sources, and assuring that there is not a significant degradation in visibility at Class I areas due to new or modified major sources.

E. SULFUR DIOXIDE MILESTONES AND BACKSTOP TRADING PROGRAM

[No revisions]

F. LONG-TERM STRATEGY FOR MOBILE SOURCES

[No revisions]

G. LONG-TERM STRATEGY FOR FIRE PROGRAMS

[No revisions]

H. ASSESSMENT OF EMISSIONS FROM PAVED AND UNPAVED ROAD DUST

[No revisions]

I. POLLUTION PREVENTION AND RENEWABLE ENERGY PROGRAMS

[No revisions]

J. OTHER GCVTC RECOMMENDATIONS

[No revisions]

K. PROJECTION OF VISIBILITY IMPROVEMENT ANTICIPATED FROM LONG-TERM STRATEGY

[No revisions]

L. PERIODIC IMPLEMENTATION PLAN REVISIONS

[No revisions]

M. STATE PLANNING/INTERSTATE COORDINATION AND TRIBAL IMPLEMENTATION

[No revisions]

N. ENFORCEABLE COMMITMENTS FOR THE UTAH REGIONAL HAZE SIP

[No revisions]

Staff Review
Recommended Alternative to BART for NO_x

Utah Division of Air Quality

January 14, 2019

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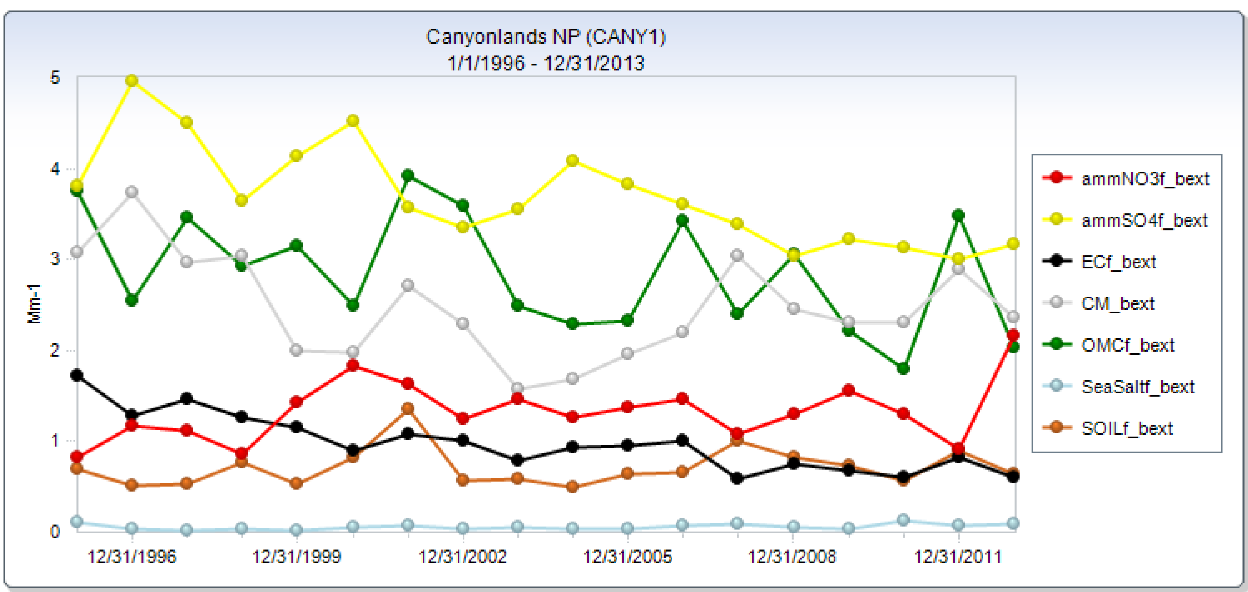
Purpose

On December 14, 2012, the Environmental Protection Agency (EPA) disapproved the Best Available Retrofit Technology (BART) determination for nitrogen oxides (NO_x) and particulate matter (PM) that was adopted in Utah's 2008 Regional Haze State Implementation Plan (RH SIP). On June 4, 2015, Utah submitted PM BART and BART alternative for NO_x. EPA approved the BART for PM on July 5, 2016 but disapproved the BART alternative for NO_x. The purpose of this analysis is to provide additional documentation and support to the BART alternative for NO_x and to demonstrate that the alternative will provide greater visibility improvement than would be achieved through the installation of the most stringent NO_x controls on the four electrical generating units (EGU) that are subject to BART.

History

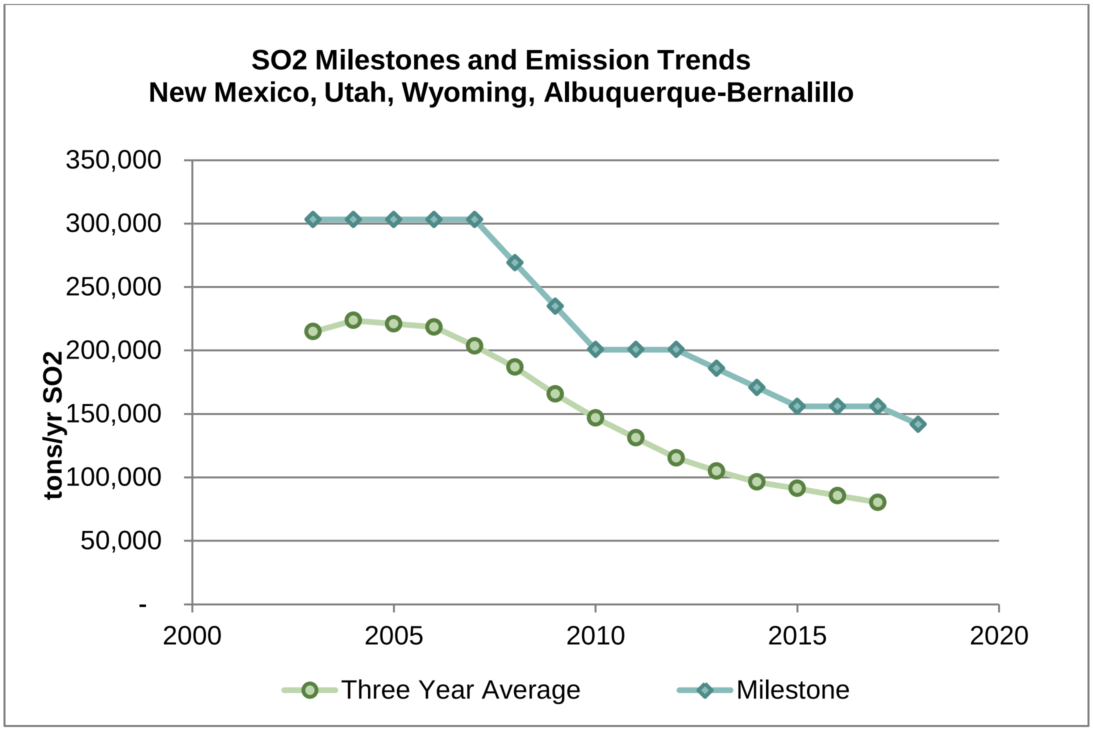
Utah's RH SIP, originally adopted in 2003, was based on the recommendations of the Grand Canyon Visibility Transport Commission (GCVTC). The GCVTC evaluated haze at Class I areas on the Colorado Plateau, and determined that stationary source reductions should be focused on sulfur dioxide (SO_2) because it is the pollutant that has the most significant impact on haze on the Colorado Plateau. Utah's 2008 BART determination was developed within the context of the overall SIP and reflected this focus on SO_2. Figure 1 shows the contributions of various species to visibility impairment at Canyonlands National Park. As can be seen, sulfate (ammSO4) is the most significant contributor to haze. Fire (OMC) and dust (CM) are also significant components, but their impact is variable from year to year.

Figure 1 Speciated Annual Average Light Extinction at Canyonlands



Utah's 2003 RH SIP included SO_2 emission milestones with a backstop regulatory trading program to ensure that SO_2 emissions in the transport region decreased substantially between 2003 and 2018. The milestones were adjusted in 2008 and 2011 to reflect changes in the number of states participating in the regional program. In the current three-state region, actual SO_2 emissions decreased by 64% between 2003 and 2017. In 2017, emissions were significantly below the 2018 milestone in Utah's RH SIP (See Figure 2).

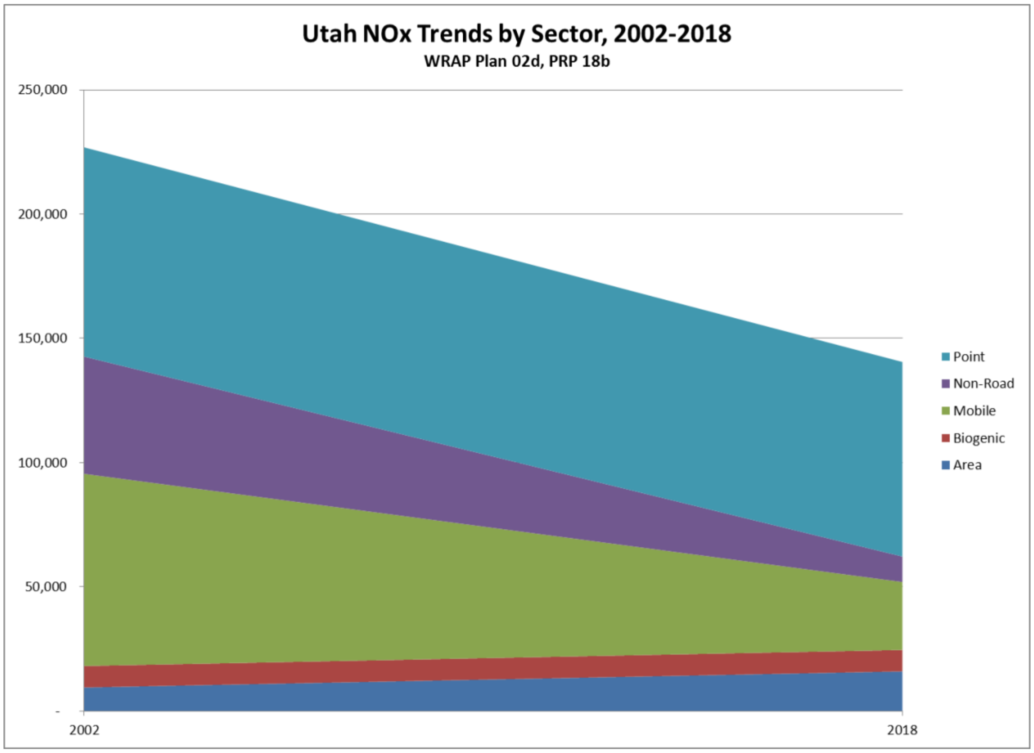
Figure 2 SO2 Milestones and Emission Trends



While Utah's RH SIP is focused on achieving SO_2 reductions from stationary sources, substantial reductions in nitrogen oxide (NO_x) emissions will also occur from stationary sources as well as mobile and non-road sources. Figure 3 shows the projected decrease in NO_x emissions between 2002 and 2018 as documented in Section K of Utah's 2008 RH SIP.[1]

[1] WRAP Plan 02d and PRP 18b inventory (PRP 18a mobile) http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx

Figure 3 Utah RH SIP Expected NOx Reductions 2002-2018



BART Determination in 2008 RH SIP

On September 3, 2008, the Utah Air Quality Board adopted a revision to Utah's RH SIP to include Best Available Retrofit Technology (BART) requirements for NO_x and particulate matter (PM) as required by 40 CFR 51.309(d)(4)(vii). PacifiCorp's Hunter Unit 1, Hunter Unit 2, Huntington Unit 1, and Huntington Unit 2 fossil fuel fired electric generating units (EGUs) were determined to be subject to BART. The 2008 RH SIP required PacifiCorp to install the following BART controls at these EGUs:

Hunter Units 1 and 2:

- Conversion of electrostatic precipitators to pulse jet fabric filter bag-houses.
- The replacement of first generation low-NO_x burners with Alstom TSF 2000TM low-NO_x firing system and installation of two elevations of separated overfire air.
- Upgrade of flue gas desulfurization system to > 90% sulfur dioxide removal.

Huntington Units 1 and 2:

- Conversion of electrostatic precipitators to pulse jet fabric filter bag-houses.
- The replacement of first generation low-NO_x burners with Alstom TSF 2000TM low-NO_x firing system and installation of two elevations of separated overfire air.
- Installation of a new wet-lime, flue gas de-sulfurization system at Unit 2 (FGD).
- Upgrade of flue gas desulfurization system to > 90% sulfur dioxide removal at Unit 1.

The emission rates established in the 2008 RH SIP for Hunter Units 1 and 2 and Huntington Units 1 and 2 were more stringent than the presumptive BART emission rates for SO_2 and NO_x established in 40 CFR Part 51 Appendix Y, Guidelines for BART Determinations under the Regional Haze Rule as shown in Table 1.

Table 1 BART Emission Rates in Utah's 2008 SIP

Units	Utah Permitted Rates[2] (lb/MMBtu)			Presumptive BART Limits[3] (lb/MMBtu)		Year of Installation
	SO_2[a]	NOx[a]	PM	SO_2	NOx	
Hunter 1	0.12	0.26	0.015	0.15	0.28	2014
Hunter 2	0.12	0.26	0.015	0.15	0.28	2011
Huntington 1	0.12	0.26	0.015	0.15	0.28	2010
Huntington 2	0.12	0.26	0.015	0.15	0.28	2006

[a]30-day rolling average

Partial Approval, Partial Disapproval of Utah's Regional Haze SIP

On December 14, 2012, EPA approved the majority of Utah's Regional Haze SIP but disapproved Utah's BART determinations for NO_x and PM for PacifiCorp's Hunter Unit 1, Hunter Unit 2, Huntington Unit 1, and Huntington Unit 2[4]. EPA determined that the SIP did not comply with regulations under 40 C.F.R. 51.308(e)(1) and did not contain the necessary provisions to make BART limits practically enforceable as required by section 110(a)(2) of the Clean Air Act and Appendix V to 40 C.F.R. Part 51.[5] The imposed controls themselves were not disapproved by EPA. Prior to EPA's disapproval, Utah's BART determination was in place and enforceable under state law and state permits. The required controls were installed and operating on three of the four EGUs prior to EPA's proposed disapproval and were installed on the 4th EGU in 2014 as required by Utah's SIP under state law.

On June 4, 2015, Utah re-proposed its SIP for PM BART and submitted a BART Alternative for NO_x for the same PacifiCorp's Electrical Generating Units.[6] On January 14, 2016, EPA issued a proposed rule containing a proposal to approve the PM BART and a co-proposal to either approve or disapprove the BART Alternative for NO_x and to impose a FIP requiring BART for NO_x in the event of the disapproval.[7] On July 5, 2016, EPA issued the final rule disapproving the

[2] Utah Division of Air Quality Approval Orders: Huntington Unit 2 - AN0238012-05, Huntington Unit 1 - DAQE-AN0102380019-09 (note – on January 19, 2010 an administrative amendment was made to the 2009 AO), Hunter Units I and 2 - DAQE-AN0102370012-08.

[3] 40 CFR Part 51 Appendix Y Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations, 70 Fed. Reg. 39104, 39135 (July 6, 2005).

[4] 77 Fed. Reg. 74,355 (Dec. 14, 2012).

[5] *Id*. at 74,357.

[6] 81 Fed. Reg. 43,894 (July 5, 2016).

[7] 81 Fed. Reg. 2,004, 2,007 (Jan. 14, 2016).

BART alternative for NO_x and approving the BART for PM portion of the June 4, 2015 SIP.[8] To replace the disapproved BART alternative, EPA promulgated a FIP, requiring installation of Selective Catalytic Reduction (SCR) controls on the subject EGUs by August of 2021.[9]

Utah filed a lawsuit against EPA challenging the July 5, 2016 disapproval of BART Alternative for NO_x in the Tenth Circuit on September 1, 2106.[10] This litigation has been in abeyance since September 11, 2017, and the final rule requiring SCR installation is stayed.[11]

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[8] 81 Fed. Reg. 43,894 (July 5, 2016).

[9] *Id*. at 43,907.

[10] *See Utah v. EPA*, No. 16-9541, Petition for Review (Sept. 1, 2016).

[11] *See id*., Order (Sept. 11, 2017); *see also id*., Order Filed by the Clerk of the Court (Dec. 11, 2018) (continuing to hold appeal in abeyance).

Alternative to BART for NOx

40 CFR 51.308(e)(2) A State may opt to implement or require participation in an emissions trading program or other alternative measure rather than to require sources subject to BART to install, operate, and maintain BART. Such an emissions trading program or other alternative measure must achieve greater reasonable progress than would be achieved through the installation and operation of BART. For all such emission trading programs or other alternative measures, the State must submit an implementation plan containing the following plan elements and include documentation for all required analyses:

Utah has opted to establish an alternative measure for NO_x as provided in 40 CFR 51.308(e)(2).[12] The alternative measure requires the installation of low-NO_x burners with overfire air with an emission limit more stringent than the presumptive BART emission limit at the four EGUs that are subject-to-BART, and additional reductions of visibility impairing pollutants from three EGUs that are not subject to BART: PacifiCorp Hunter Unit 3, PacifiCorp Carbon Unit 1, and PacifiCorp Carbon Unit 2. All controls required under the BART alternative have been accomplished. Specifically, the BART NO_x alternative requires:

PacifiCorp Hunter Units 1 and 2 and PacifiCorp Huntington Units 1 and 2: the replacement of first generation low-NO_x burners with Alstom TSF 2000TM low-NO_x firing system and installation of two elevations of separated overfire air.

PacifiCorp Hunter Unit 3 (not subject-to-BART): the replacement of first generation low-NOx burners with upgraded low-NO_x burners with overfire air.

PacifiCorp Carbon Units 1 and 2 (not subject-to-BART): permanent closure of both units by August 15, 2015 and rescission of the plant's operating permit by December 31, 2015.

PacifiCorp shut down the Carbon Power Plant in 2015 due to the high cost of controlling mercury to meet the requirements of EPA's Mercury and Air Toxics Standards (MATS). The MATS rule was finalized in 2011, well after the 2002 base year for Utah's RH SIP; therefore, any reductions required to meet the MATS rule may be considered as part of an alternative strategy under 40 CFR 51.308(e)(2)(vi). This plant is located about 30 miles northeast of the Huntington

[12] Greater reasonable progress can be demonstrated using one of three methods: (i) "greater emission reductions" than under BART; (ii) "conduct dispersion modeling" for the "worst and best 20 percent days" to "demonstrate 'greater reasonable progress;'" (40 C.F.R. §51.308(e)(3)); or (iii) "based on the clear weight of evidence" (40 C.F.R. §51.308(e)(2)(E)). As the U.S. Circuit Court of Appeals for the 10th Circuit recently observed, the state is free to choose one method or the other. *WildEarth Guardians v. E.P.A.*, 770 F.3d 919, 935-37 (10th Cir. 2014). The court characterized the former approaches as a "quantitative" and the later as "qualitative," and specifically sanctioned the use of qualitative factors under the clear weight of evidence. The State believes that the NOx BART Alternative would qualify under either the "dispersion modeling" or "weight of evidence" test, but has focused here on the "quantitative" approach using "dispersion modeling."

Plant and about 40 miles northeast of the Hunter Plant and its emissions impact the same general area as the Hunter and Huntington Plants. Average SO_2 emissions from the Carbon Plant in 2012-13 were 8,005 tons/yr, and average NO_x emissions were 3,342 tons/yr. PacifiCorp and ultimately Utah rate payers must pay the cost to replace the electricity generated by this plant, but there will also be a visibility benefit due to the emission reductions. Overall emission reductions of SO_2 and NO_x due to the closure of this plant and the other NO_x controls installed on Hunter Units 1 , 2, and 3, and Huntington Units 1 and 2, are greater than the NO_x reductions that could be achieved by installing the most stringent NO_x control, SCR, on the four subject-to-BART EGUs and the emission reductions will occur close to the location of the Hunter and Huntington plants.

While PacifiCorp had plans to shut down the Carbon Plant, the decision was not enforceable, and PacifiCorp could have chosen to meet the MATS requirements through other measures. An enforceable requirement in the RH SIP to permanently close the Carbon Plant as part of an alternative to BART locks in substantial emission reductions.

BART-eligible Sources Covered by Alternative Measure for NOx

> *40 CFR 51.308(e)(2)(i)(A) A list of all BART-eligible sources within the state. 40 CFR 51.308(e)(2)(i)(B) A list of all BART-eligible sources and all BART source categories covered by the alternative program. The state is not required to include every BART source category or every BART-eligible source with a BART source category in an alternative program, but each BART-eligible source in the state must be subject to the requirements of the alternative program, have a federally enforceable emission limitation determined by the state and approved by EPA as meeting BART in accordance with section 302(c) or paragraph (e)(1) of this section, or otherwise addressed under paragraphs (e)(1) or (e)(4) of this section.*

Four EGUs were the only BART-eligible sources identified in Utah's 2008 RH SIP. All four of these EGUs are covered by the alternative program.

- PacifiCorp Hunter, Unit 1
- PacifiCorp Hunter, Unit 2
- PacifiCorp Huntington, Unit 1
- PacifiCorp Huntington, Unit 2

The Alternative Measure also includes "non-BART sources" (i.e., Carbon Unit 1 and Unit 2 (PM, NO_X and SO_2) and Hunter Unit 3 (NO_X)).

NOx emission reductions achievable

> *40 CFR 51.308(e)(2)(i)(C) An analysis of the best system of continuous emission control technology available and associated emission reductions achievable for each source within the state subject to BART and covered by the alternative program. This analysis must be conducted by making a determination of BART for each source subject to BART and covered by the alternative program as provided for in paragraph (e)(1) of this section, unless the emissions trading program or other alternative measure has been designed to meet a requirement other than BART (such as the core requirement to have a long-term strategy to achieve the reasonable progress goals established by the states). In this case, the state may determine the best system of continuous emission control technology and associated emission reductions for similar types of sources within a source category based on both source-specific and category-wide information, as appropriate.*

In June 2012, PacifiCorp prepared a new 5-factor BART analysis to satisfy the requirements of the BART rule. PacifiCorp submitted an update to that analysis on August 5, 2014 to address issues that EPA had raised with other regional haze SIPs. The technologies identified in the analysis range from the currently required low NO_x burners with overfire air (presumptive BART) to the most-stringent NOx technology (SCR + low NO_x burners with overfire air). DAQ reviewed PacifiCorp's analysis and agreed that SCR + low NO_x burners with overfire air with an annual emission rate of 0.05 lb/MMBtu was the most stringent technology available to reduce NOx emissions from the four subject-to-BART EGUs.[13] This technology is very expensive to install on the subject-to-BART EGUs considering their current configuration and the unique characteristics of Utah's coal and would require careful consideration through a case-by-case 5-factor analysis before determining if it was cost effective. However, this technology can be used as a stringent benchmark for comparison with an alternative program. DAQ's use of this technology as a benchmark is not a determination that this technology is BART; it is merely a conservative approach to evaluate the effectiveness of the alternative program (see Table 2).

[13] EPA has used a 0.05 lb/MMBtu NO_x emissions rate for SCR for other regional haze SIP analyses, recently in New Mexico and Arizona. *See e.g.*, 79 Fed. Reg. 60,978, 60, 984 (New Mexico, Oct. 9 2014)("In promulgating the FIP, we evaluated the performance of both new and retrofit SCRs and determined that 0.05 lb/MMBtu on a 30-boiler-operating-day average was the appropriate emission limit for SCR at the San Juan Generating Station units. *See* 76 Fed. Reg. 491 and 76 Fed. Reg. 52,388. New Mexico appropriately used this same rate in their cost and visibility analyses for the four-SCR scenario as part of its BART evaluation."); 79 Fed. Reg. 52,420, 52,431 (Arizona, Sept. 3, 2014)("We agree that our use of a 0.05 lb/MMBtu annual average design value for SCR is consistent with other BART determinations for coal-fired power plants."). EPA has agreed that even higher NO_x emission rates can qualify as the most stringent emission rate for modeling visibility impacts. For example, EPA accepted state-mandated SCR emission rates of 0.07 and 0.08 in Colorado, as well as its SCR related analyses based on 0.07. *See* 77 Fed. Reg. 76,871 (Colorado, Dec. 21, 2012). EPA also used 0.083 to 0.098 for the Reid Gardner Station in Nevada. 77 Fed. Reg. 50,936, 50,942 (Nevada, Aug. 23, 2012).

Projected Emission Reductions from Alternative Measures

40 CFR 51.308(e)(2)(i)(D) An analysis of the projected emissions reductions achievable through the trading program or other alternative measure.

Table 2 shows the estimated annual emissions in 2025 for NO_x and SO_2 for the baseline, the most stringent NO_x scenario, and the alternative measure. The Baseline modeling scenario represents the emission values in the future year (2025) before any additional control technology (other than controls that were in operation during the PacifiCorp power plants baseline period of 2001-2003) was placed on any of the PacifiCorp units to reduce emissions. EPA's FIP issued on July 5, 2016 required the same controls as the most stringent technology. These controls are described in the previous section of this staff review. Annual emissions of other haze causing pollutants can be found in Appendix A. While NO_x emissions are higher under the alternative measure, emissions of SO_2 lower under the alternative measure. Combined emissions of both pollutants are 1,576 tons/yr lower under the alternative measure.[14]

Table 2 Estimated emissions under the 2025 Baseline Scenario, EPA FIP (most stringent NOx scenario), and the Alternative scenario

Units	NOx (tpy)			SO_2 (tpy)			Combined		
	2025 Baseline	EPA FIP	Alternative	2025 Baseline	EPA FIP	Alternative	2025 Baseline	EPA FIP	Alternative
Carbon 1	1,312	1,312	0	2,286	2,286	0	3,598	3,598	0
Carbon 2	1,977	1,977	0	3,528	3,528	0	5,505	5,505	0
Hunter 1	6,380	796	3,166	2,535	1,153	1,153	8,915	1,949	4,319
Hunter 2	6,092	798	3,028	2,531	1,408	1,408	8,623	2,206	4,436
Hunter 3	6,530	6,530	4,490	1,204	1,230	1,230	7,734	7,760	5,720
Huntington 1	5,944	793	3,147	2,380	1,254	1,254	8,324	2,047	4,401
Huntington 2	5,816	753	3,366	12,308	1,201	1,201	18,124	1,954	4,567
Total	*34,051*	*12,959*	*17,197*	*26,772*	*12,060*	*6,246*	*60,823*	*25,019*	*23,443*

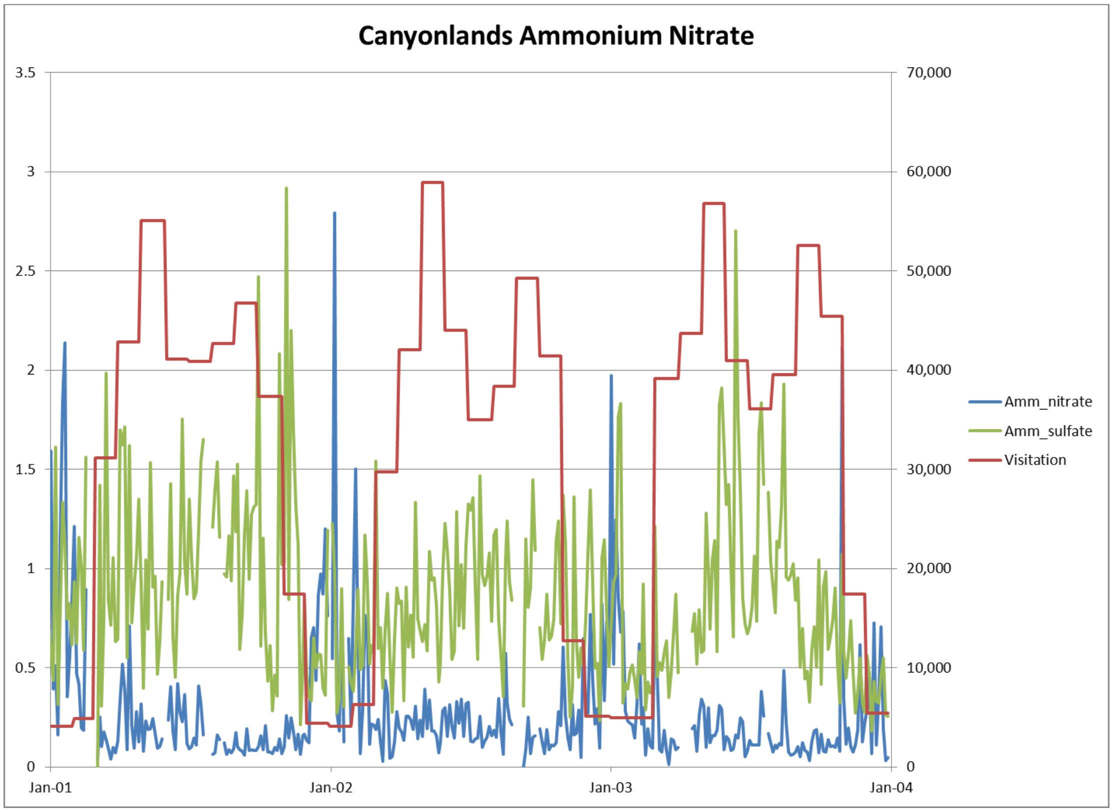
Continued Focus on SO_2 Reductions

Utah's 2003 RH SIP focused on SO_2 reductions because SO_2 has the greatest overall impact at Class I areas on the Colorado Plateau and revisions in 2008 and 2011 continued this focus. The alternative measures enhance that approach through additional, significant emission reductions of over 8,000 tons/yr SO_2 due to the closure of the Carbon Plant. Figure 1 shows that sulfates are the dominant visibility impairing pollutant at Canyonlands, the Class I area with the greatest

[14] EPA has approved, or proposed approval, of other BART alternatives that included "inter-pollutant trading" when SO_2 levels were lowered. 79 Fed. Reg. 33,438, 33,440-41 (Washington, June 11, 2014); 79 Fed. Reg. 56,322, 56,328 (Arizona, Sept. 19, 2014).

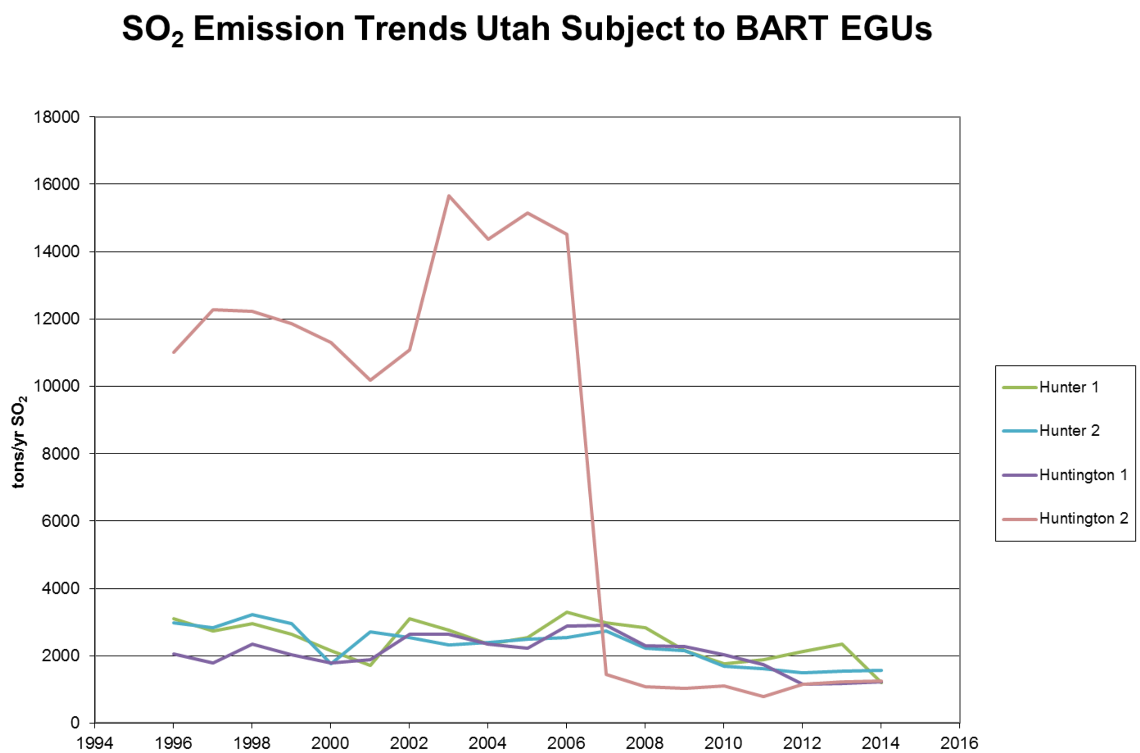
overall impact from the four subject-to-BART sources. Figure 4 shows that sulfates affect visibility throughout the year and are the dominant visibility impairing pollutant from anthropogenic sources during the high visitation period of March through November. Similar results are seen at the other Class I areas and are documented in the TSD.

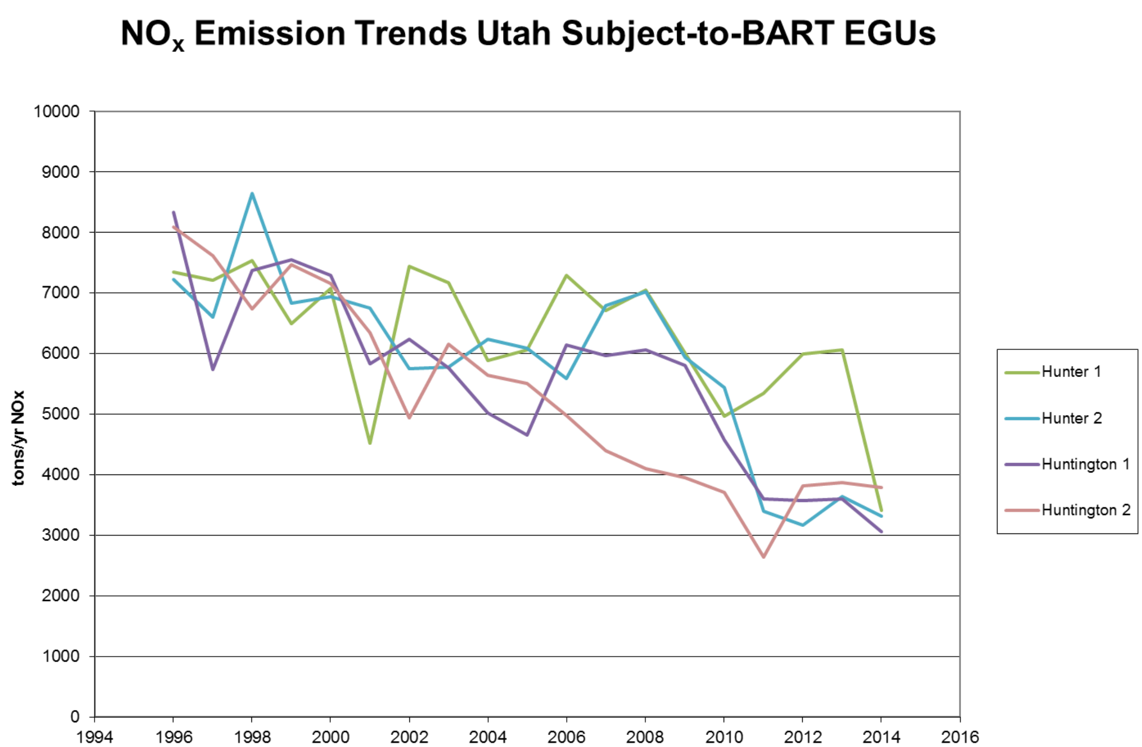
Figure 4 Canyonlands ammonium sulfate and ammonium nitrate



DAQ has confidence that SO_2 reductions will achieve meaningful visibility improvement. The visibility improvement during the winter months due to NO_x reductions is much more uncertain. Figure 5 shows the significant emission reductions of both SO_2 and NO_x that have occurred from the four subject-to-BART EGUs over the last 15 years.

Figure 5 SO2 and NOx Emissions Trends





Greater Reasonable Progress than BART

40 CFR 51.308(e)(2)(i) A demonstration that the emissions trading program or other alternative measure will achieve greater reasonable progress than would have resulted from the installation and operation of BART at all sources subject to BART in the State and covered by the alternative program. This demonstration must be based on the following:

> *(E) A determination under paragraph (e)(3) of this section or otherwise based on the clear weight of evidence that the trading program or other alternative measure achieves greater reasonable progress than would be achieved through the installation and operation of BART at the covered sources.*

40 CFR 51.308(e)(3) A State which opts under 40 CFR 51.308(e)(2) to implement an emissions trading program or other alternative measure rather than to require sources subject to BART to install, operate, and maintain BART may satisfy the final step of the demonstration required by that section as follows: If the distribution of emissions is not substantially different than under BART, and the alternative measure results in greater emission reductions, then the alternative measure may be deemed to achieve greater reasonable progress. If the distribution of emissions is significantly different, the State must conduct dispersion modeling to determine differences in visibility between BART and the trading program for each impacted Class I area, for the worst and best 20 percent of days. The modeling would demonstrate "greater reasonable progress" if both of the following two criteria are met:

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

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

The Hunter, Huntington, and Carbon plants are all located within 40 miles of each other in Central Utah. Because of the close proximity of the three plants, the distribution of emissions will not be substantially different under the alternative program. The combined emissions of NO_x and SO_2 are 1,576 tons/yr lower under the alternative measure. Therefore, the alternative measure may be deemed to achieve greater reasonable progress than BART.

However, because the emission reductions under the BART alternative included reductions of SO_2 in addition to reductions of NO_x, visibility improvement under the two scenarios could occur during different episodes and during different times of the year. For this reason, Utah chose to treat the distribution of emissions as significantly different than under BART. Utah chose to demonstrate greater reasonable progress by conducting dispersion modeling that shows the alternative to BART meets the two prong test required by 40 CFR 51.308(e)(3).

The two prong test requires an assessment of degradation of each Class I area in the modeling domain relative to the baseline (prong 1) and average visibility improvement across all Class I areas relative to BART (prong 2). Both prongs are assessed for the 20% best days and 20% worst days.

PacifiCorp, at DAQ's direction and supervision, conducted dispersion modeling in 2018 using the Comprehensive Air Quality Model with extensions (CAMx) to compare the visibility improvement anticipated under the alternative measure with the visibility improvement under the most stringent NO_x technology. CAMx is a photochemical grid model (PGM) with the capabilities to estimate the concentrations of pollutants that contribute to regional haze. It has a technical formulation that is considered more realistic than that of CALPUFF, and CAMx predicts more accurate changes in light extinction as a result to changes in emissions from EGUs. A full description of the CAMx modeling platform used and the modeling results are included in Appendix A.

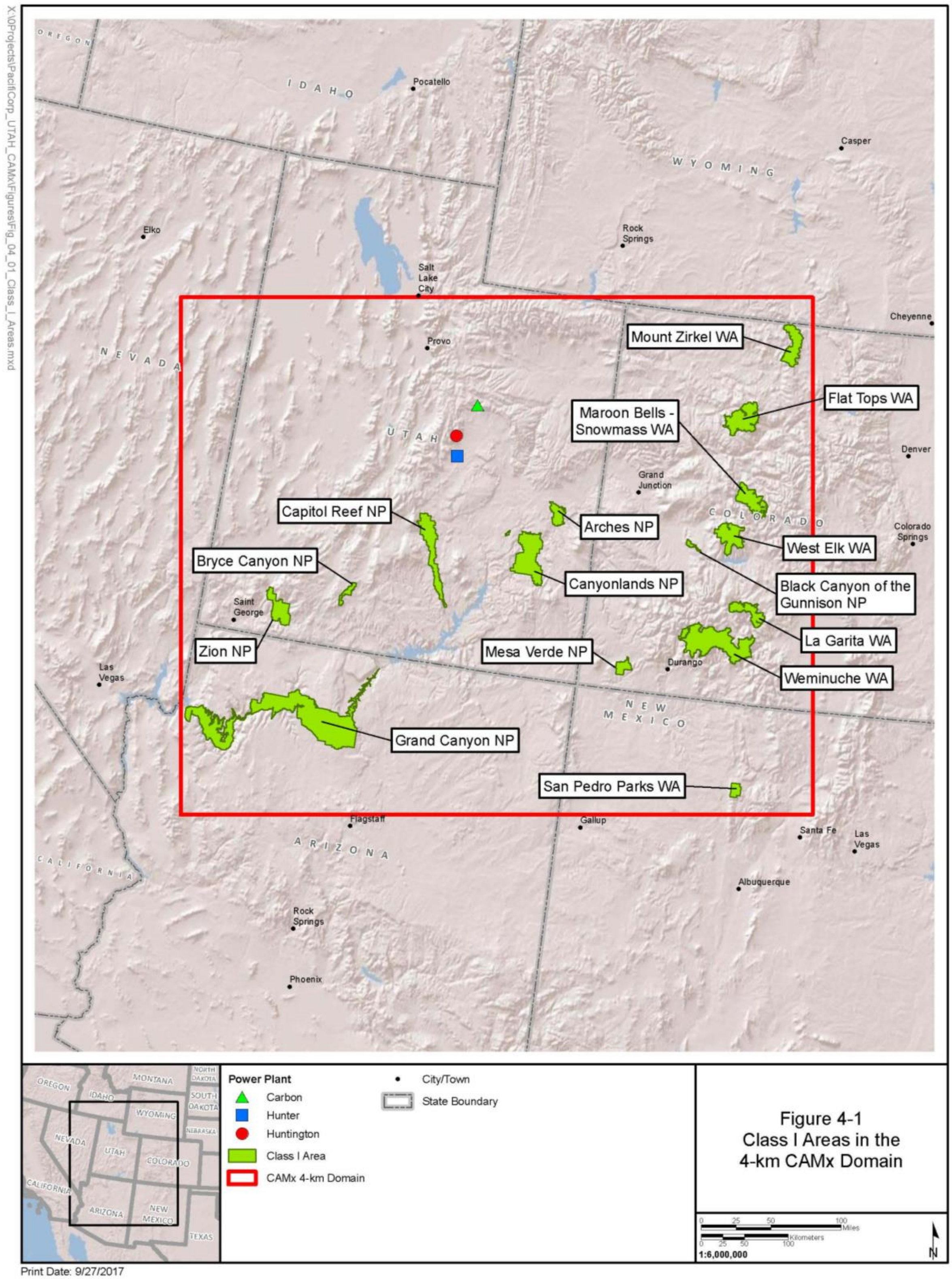
The seven EGUs shown in Table 3 EGUs analyzed with CAMxTable 3 were included in the modeling. The following 15 Class I areas, shown graphically in Figure 6, were included in the modeling domain:

1. Grand Canyon National Park (NP)
2. Arches NP
3. Black Canyon of the Gunnison NP
4. Bryce Canyon NP
5. Canyonlands NP
6. Capitol Reef NP
7. Mesa Verde NP
8. Zion NP
9. Flat Tops Wilderness Area (WA)
10. Mount Zirkel WA
11. Maroon Bells-Snowmass WA
12. West Elk WA
13. La Garita WA
14. Weminuche WA
15. San Pedro Parks WA

Table 3 EGUs analyzed with CAMx

Company Name	Plant Name	Units
PacifiCorp	Hunter	Boilers #1,2,3
PacifiCorp	Huntington	Boilers #1,2
PacifiCorp	Carbon	Boilers #1,2

Figure 6 Class I areas within the CAMx modeling domain



Prong 1: Visibility does not decline in any Class I area

The visibility impacts derived from the 2018 CAMx modeling results are summarized in Tables 4 and 5. The tables show the projected contribution to visibility on the 20 percent best days and worst days respectively for the Baseline, the EPA FIP, and the proposed BART alternative scenarios at each of the Class I areas analyzed. The last two columns show the predicted visibility benefits from the BART alternative scenario relative to both the baseline and the FIP. At the bottom of each table are the average visibility values from all the Class I areas. Negative values in the last two columns indicate that the BART alternative has smaller contributions to visibility impairment relative to the baseline and the FIP.

Column D in Table 4 shows that emissions from the seven EGUs under the BART alternative will not result in degradation of visibility on the 20 percent best days compared to the Baseline at any one of the 15 Class I areas. In general, the BART alternative scenario shows an average improvement in visibility of 0.00494 dv relative to the EPA FIP for the 20 percent best days. Table 5 shows that, on the 20 percent worst days, visibility impairment is less under the BART alternative than the baseline in each of the Class I areas. Therefore, the BART alternative meets prong 1 of the “greater reasonable progress using dispersion modeling” test found in 40 CFR 51.308(e)(3).

Table 4 Visibility Impacts for the, EPA FIP and BART alternative Scenarios on the 20 Percent Best Days

Class I area	[A] Baseline (dv)	[B] EPA FIP (dv)	[C] BART alternative (dv)	[D] BART alternative - Baseline	[E] BART alternative - EPA FIP
Arches NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Black Canyon of the Gunnison NM	0.02769	0.01611	0.01162	-0.01607	-0.00449
Bryce Canyon NP	0.00528	0.00254	0.00228	-0.00300	-0.00026
Canyonlands NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Capitol Reef NP	0.14218	0.07222	0.07140	-0.07078	-0.00082
Flat Tops WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Grand Canyon NP	0.07136	0.03567	0.03611	-0.03525	0.00044
La Garita WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
Maroon Bells-Snowmass WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Mesa Verde NP	0.06356	0.03381	0.02749	-0.03607	-0.00632
Mount Zirkel WA	0.04209	0.02060	0.01471	-0.02738	-0.00589
San Pedro Parks WA	0.03627	0.01742	0.01593	-0.02034	-0.00149
Weminuche WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
West Elk WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Zion NP[1]	0.00612	0.00291	0.00300	-0.00312	0.00009
All Class I area Average	**0.04940**	**0.02602**	**0.02108**	**N/A**	**-0.00494**

[1] Results based on incomplete dataset. Zion NP monitor did not meet the 75% data completion SMAT requirement for year 2011.

Prong 2: An overall improvement in visibility

A determination of whether the BART alternative meets prong 2 of the "greater reasonable progress using dispersion modeling" test found in 40 CFR 51.308(e)(3) is made by comparing the average difference between the alternative and BART. As explained previously, Utah considers the EPA July 5, 2016 FIP requirements as the most stringent control technology but used them in this analysis as a substitute for BART. The last row of column E in Tables 4 and 5 show the average difference in visibility between the BART alternative and the FIP for the 20 percent best and worst days respectively. The negative number indicates that the average visibility impact of the BART alternative is less than the FIP in both cases. Therefore, the BART alternative meets prong 2 of 40 CFR 51.308(e)(3).

Table 5 Visibility Impacts for the EPA FIP and BART alternative Scenarios on the 20 Percent Worst Days

Class I area	[A] Baseline (dv)	[B] EPA FIP (dv)	[C] BART alternative (dv)	[D] BART alternative - Baseline	[E] BART alternative - EPA FIP
Arches NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Black Canyon of the Gunnison NM	0.01265	0.00682	0.00540	-0.00725	-0.00142
Bryce Canyon NP	0.04945	0.02184	0.02470	-0.02475	0.00286
Canyonlands NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Capitol Reef NP	0.26010	0.11672	0.14568	-0.11442	0.02896
Flat Tops WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Grand Canyon NP	0.00186	0.00089	0.00056	-0.00130	-0.00033
La Garita WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
Maroon Bells-Snowmass WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Mesa Verde NP	0.06203	0.02524	0.02959	-0.03244	0.00435
Mount Zirkel WA	0.03312	0.01705	0.01198	-0.02114	-0.00507
San Pedro Parks WA	0.00154	0.00074	0.00073	-0.00081	-0.00001
Weminuche WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
West Elk WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Zion NP[1]	0.00155	0.00051	0.00051	-0.00104	0.00000
All Class I area Average	**0.06957**	**0.03471**	**0.03413**	**N/A**	**-0.00058**

[1] Results based on incomplete dataset. Zion NP monitor did not meet the 75% data completion SMAT requirement for year 2011.

The language in 40 CFR 51.308(e)(3)(i) and (ii) indicate allowance of a straight numerical test. The regulation does not specify that a minimum difference in deciview between the scenarios must be achieved to determine that a BART alternative achieves greater reasonable progress. Because the modeling results show that visibility under the BART alternative does not decline at any of the 15 affected Class I areas compared to the baseline (prong 1) and will result in improved visibility, on average, across all 15 Class I areas compared to the EPA FIP (prong 2), Utah finds that the BART alternative will achieve greater reasonable progress than the EPA FIP under the two-prong modeling test in 40 CFR 51.308(e)(3).

Timing of NO_x Emission Reductions under Alternative Measure and Monitoring, Recordkeeping, and Reporting

> *40 CFR 51.308(e)(2)(iii) A requirement that all necessary emission reductions take place during the period of the first long-term strategy for regional haze. To meet this requirement, the State must provide a detailed description of the emissions trading program or other alternative measure, including schedules for implementation, the emission reductions required by the program, all necessary administrative and technical procedures for implementing the program, rules for accounting and monitoring emissions, and procedures for enforcement.*

The schedule for installation of the NO_x controls required by the alternative measure is shown in Table 4. The alternative measure has been fully implemented prior to 2018, the end of the first long term strategy for regional haze.

Table 6 Implementation Schedule

Unit	Year Installed or Required
PacifiCorp Hunter Unit 1	2014
PacifiCorp Hunter Unit 2	2011
PacifiCorp Hunter Unit 3	2008
PacifiCorp Huntington Unit 1	2010
PacifiCorp Huntington Unit 2	2006
PacifiCorp Carbon Unit 1	2015
PacifiCorp Carbon Unit 2	2015

The enforceable emission limits, administrative and technical procedures for implementing the program, rules for accounting and monitoring emissions, and procedures for enforcement are addressed in SIP Section IX, Parts H.21 and 22.

Emission Reductions are Surplus

> *40 CFR 51.308(e)(2)(iv) A demonstration that the emission reductions resulting from the emissions trading program or other alternative measure will be surplus to those reductions resulting from measures adopted to meet requirements of the CAA as of the baseline date of the SIP.*

Baseline Date of the SIP

When the regional haze rule was promulgated in 1999, EPA explained that the "baseline date of the SIP" in this context means "the date of the emissions inventories on which the SIP relies."[15] The baseline inventory for the regional SO_2 milestones and backstop trading program in Utah's 2003 SIP was 1990 while the inventory for the remaining elements in the 2003 SIP, including enhanced smoke management, mobile sources, and pollution prevention, was 1996. When the RH SIP was updated in 2008, a new baseline inventory of 2002 was established for regional modeling, evaluating the impact on Class I areas outside of the Colorado Plateau, and BART as outlined in EPA Guidance[16] and the July 6, 2005 BART Rule.[17] For purposes of evaluating an alternative to BART, the later baseline date of 2002 is therefore most appropriate. 2002 is the baseline inventory that was used by other states throughout the country when evaluating BART under the provisions of 40 CFR 51.308. Any measure adopted after 2002 is considered "surplus" under 40 CFR 51.308(e)(2)(iv)[18]. To make a valid comparison that the "alternative measure will be surplus to those reductions resulting from measures adopted to meet requirements of the Regional Haze Rule as of the baseline date of the SIP" as required by 40 CFR 51.308(e)(2)(iv), the Most Stringent NO_x scenario includes measures required before the baseline date of the SIP but does not include later measures that are credited as part of the alternative scenario.

SO_2 and NOx Reductions from the Closure of the PacifiCorp Carbon Plant

Utah met the BART requirement for SO_2 as provided under 40 CFR 51.309(d)(4) through the establishment of SO_2 emission milestones with a backstop regulatory trading program to ensure that SO_2 emissions in the 3-state region of Utah, Wyoming, and New Mexico decreased substantially between 2003 and 2018. The final SO_2 milestone in 2018 was determined to provide greater reasonable progress than BART and the overall RH SIP was deemed to meet the reasonable progress requirements for Class I areas on the Colorado Plateau and for other Class I areas[19]. The modeling supporting the RH SIP included regional SO_2 emissions based on the 2018 SO_2 milestone and also included NO_x emissions from the Carbon Plant. Actual emissions in the 3-state region are calculated each year and compared to the milestones. As can be seen in

[15] 64 Fed. Reg. 35,742 (July 1, 1999).

[16] Memorandum from Lydia Wegman and Peter Tsirigotis, 2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, PM2.5, and Regional Haze Programs, November 8, 2002.

[17] 70 Fed. Reg. 39,143 (July 6, 2005).

[18] Utah's actions here are consistent with EPA's actions in other states. *See e.g.,* 79 Fed. Reg. at 33,441-42; 79 Fed. Reg. at 56,328.

[19] 77 Fed. Reg. 74,355 (Dec. 14, 2012).

Table 5, the 2018 milestone was met seven years early in 2011, and SO_2 emissions have continued to decline. The most recent milestone report for 2016 demonstrates that SO_2 emissions are currently 36% lower than the 2018 milestone. The Carbon Plant was fully operational in the years 2011-2013 when the 2018 milestone was initially achieved for those years. Therefore, the SO_2 emission reductions from the closure of the Carbon Plant are surplus to what is needed to meet the 2018 milestone established in Utah's RH SIP.

Table 7 SO_2 Milestone Trends

Year	Milestone	Three Year Average SO_2 Emissions (tons/yr)	Carbon Plant SO_2 Emissions (tons/yr)
2003	303,264	214,780	5,488
2004	303,264	223,584	5,642
2005	303,264	220,987	5,410
2006	303,264	218,499	6,779
2007	303,264	203,569	6,511
2008	269,083	186,837	5,057
2009	234,903	165,633	5,494
2010	200,722	146,808	7,462
2011	200,722	131,074	7,740
2012	200,722	115,316	8,307
2013	185,795	105,006	7,702
2014	170,868	96,302	9,241
2015	155,940	91,310	2,816
2016	155,940	90,591	0
2017	155,940		
2018	141,849		

The Carbon Plant was built in the 1950s and is therefore grandfathered under Utah's permitting rules. The plant was equipped with an electrostatic precipitator for PM control and had no SO_2 or NO_x controls. PacifiCorp shut down the Carbon Power Plant on April 14, 2015 due to the high cost of controlling mercury to meet the requirements of EPA's new Mercury and Air Toxics Standards (MATS) rule. The MATS rule was finalized in 2011, well after the 2002 base year for Utah's RH SIP, and therefore any reductions required to meet the MATS rule are clearly surplus and may be considered as part of an alternative strategy under 40 CFR 51.308(e)(2)(vi). An enforceable requirement is included in Section IX.H.22 of the SIP that made the permanent closure of the Carbon Plant enforceable by August 15, 2015.

In October 2015, the Utah Air Quality Board approved an Enforceable Commitment whereby Utah committed to amend SIP sections and rules so that emissions reductions from the closure of the Carbon plant would not be counted under 308 and 309. As part of this SIP amendment, the DAQ is amending State Rule R307-150 so that the Carbon Plant will continue to report

8,005 tons of SO_2 emissions each year as part of the SO2 Milestone report. This allows credit for those emissions reductions to be used as part of the State's BART alternative.

PacifiCorp Hunter Unit 3

PacifiCorp upgraded the low-NO_x burners on Hunter Unit 3 in 2008. This upgrade was not required under the requirements of the Clean Air Act as of the 2002 baseline date of the SIP and is therefore clearly considered surplus and may be credited in the alternative program under 40 CFR 51.308(e)(2)(vi). Prior to the 2008 upgrade, the emission rate for Hunter Unit 2 was 0.46 lb/MMBtu heat input for a 30-day rolling average as required by Phase II of the Acid Rain Program.

Future Planning

The regional haze program is designed to achieve a long-term goal and updated SIPs are required every 10 years to ensure continued progress. The DAQ is beginning work on a RH SIP that will address the next planning period of 2021 – 2028. This next RH SIP is due in 2021, and the DAQ anticipates that this SIP will be completed in parallel with planning efforts to meet the 2015 ozone NAAQS. Both regional haze and ozone are affected by regional NOx emissions, and the DAQ anticipates that common emission strategies will lead to improvements in both areas. Significant technical work must be completed before these common benefits can be quantified in the next RH SIP.

Appendix A

CAMx Visibility Assessment for Utah Power Plants: Hunter, Huntington and Carbon

AECOM
Ramboll
Fort Collins, Colorado
September 2018

CAMx Visibility Assessment for Utah Power Plants: Hunter, Huntington and Carbon

Final Report

List of Acronyms

AGL	above ground level
BART	Best Available Retrofit Technology
BC	boundary conditions
CAIR	Clean Air Interstate Rule
CAMD	Clean Air Market Division
CAMx	Comprehensive Air Quality Model with Extensions
CB0r2	Carbon Bond version 6
CBNG	Coalbed Natural Gas
CEM	continuous emissions monitoring
CEMPD	Center for Environmental Modeling for Policy Development
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality
CO	carbon monoxide
CSAPR	Cross-State Air Pollution Rule
dv	Deciview
DVC	Current Design Value
DVF	Future-Year Design Value
EGU	Electric Generating Unit
EIS	Environmental Impact Statement
FIP	Federal Implementation Plan
FLAG	Federal Land Manager's Air Quality Guidance
ft	feet
ft/s	feet per second
HONO	nitrous acid
IC	initial conditions
IE	Institute for the Environment
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISORROPIA	inorganic aerosol thermodynamics/partitioning model
K	Kelvin
km	kilometer
K_v	coefficient of vertical eddy diffusion
LCC	Lambert Conformal Conic
LNB	Low-NO_x Burners controls
m	meters
m/s	meters per second
m^2/s	square meters per second
mb	millibar
MCIP	Meteorology-chemistry interface processor
MEGAN	Model of Emissions of Gases and Aerosols from Nature

MOVES	Motor Vehicle Emission Simulator
MOZART	Model for Ozone and Related chemical Tracers
MPE	model performance evaluation
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NCAR	National Center for Atmospheric Research
NCL	NCAR Command Language
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NH_3	ammonia
NH_4	ammonium
NO_3	Nitrate
NO	nitric oxide
NO_2	nitrogen dioxide
NONROAD	Non-road mobile emissions model
NO_X	oxides of nitrogen
NP	National Park
NPRI	National Pollutant Release Inventory
O_3	ozone
OC	Organic Carbon
OFA	Over-fire Air controls
PAVE	Package for Analysis and Visualization of Environmental data
PBL	planetary boundary layer
PFT	plant functional types
PGM	photochemical grid model
PiG	Plume-in-Grid
PM	particulate matter
PM_{10}	PM with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$	PM with an aerodynamic diameter less than or equal to 2.5 microns
PPM	piecewise parabolic method
PSAT	Particulate Source Apportionment Technology
PSD	Prevention of Significant Deterioration
QA	quality assurance
RADM	Regional Acid Deposition Model
RPO	Regional Planning Organization
RRF	Relative Response Factors
SCC	Source Classification Code
SCR	Selective Catalytic Reduction controls
SIP	State Implementation Plan
SMAT-CE	Software for Model Attainment Test – Community Edition
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	sulfur dioxide
SO_4	sulfate

tpy	tons per year
TUV	total ultraviolet
U.S.	United States
UNC	University of North Carolina
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VMT	vehicle miles traveled
VOC	volatile organic compound
WA	Wilderness Area
WAQS	Western Air Quality Modeling Study
WBD	wind-blown dust
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecast

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Executive Summary

The United States Environmental Protection Agency (USEPA) issued a Regional Haze Rule to protect visibility in over 150 national parks and wilderness areas in 1999. The Regional Haze Rule requires states to establish Best Available Retrofit Technology requirements (BART) and Reasonable Progress Goals for improving visibility, with the overall goal of attaining natural background visibility conditions by 2064. On June 4, 2015, the State of Utah submitted to the USEPA a revised Regional Haze State Implementation Plan (SIP). The SIP addressed requirements of the Clean Air Act specifically related to the Regional Haze Rule. On July 5, 2015, USEPA approved some parts and disapproved other parts of Utah's regional haze SIP. Specifically, USEPA disapproved the State's nitrogen oxides (NOx) BART determinations for four units at two PacifiCorp power plants: Hunter units 1 and 2 and Huntington units 1 and 2. To address the portions of Utah's SIP that USEPA disapproved, USEPA finalized a Federal Implementation Plan (FIP) that determined NOx BART controls for Hunter and Huntington power plants require the application of selective catalytic reduction (SCR) controls with low NOx burners and separated overfire air (SCR + LNB/SOFA). The State of Utah and PacifiCorp disagreed with the FIP determination and challenged it in court. The USEPA relied, in large part, on the CALPUFF computer model to reject Utah's SIP BART alternative; however, the State of Utah and PacifiCorp believe the CALPUFF model results used by EPA had several limitations.

To address these concerns, PacifiCorp retained AECOM to perform additional modeling of Utah's SIP and EPA's FIP using the Comprehensive Air Quality Model with extensions (CAMx). CAMx is a photochemical grid model (PGM) with the capabilities to estimate the concentrations of pollutants that contribute to regional haze. It has a technical formulation that is considered more realistic than that of CALPUFF, and CAMx predicts more accurate changes in light extinction as a result to changes in emissions from PacifiCorp power plants. Identified below are a description of the CAMx modeling and the results from the model runs involving the EPA's FIP and Utah's SIP.

Modeling Approach

A modeling protocol (AECOM, 2018) for the CAMx analysis was negotiated with and agreed to by EPA in February 2018. The CAMx modeling analysis uses the Western Air Quality Modeling Study (WAQS) modeling platform, which is a publicly available platform intended to facilitate air resource analyses in the western United States.

The CAMx system was configured using the WAQS configuration settings to simulate future-year 2025 visibility conditions for different modeling scenarios. The only differences among scenarios are the emission rates for PacifiCorp's power plants in Utah. The three modeling scenarios were:

- Baseline Scenario. This scenario simulates representative emissions from Carbon, Hunter and Huntington power plants during the Regional Haze Rule baseline period of 2001 to 2003.
- USEPA FIP Scenario. This scenario simulates the emission control strategy for Hunter and Huntington units stipulated by the USEPA in the FIP. The Carbon power plant is modeled with the same level of emissions as the Baseline scenario.
- Utah SIP Scenario. This scenario includes the BART Alternative strategy identified in Utah's SIP. It simulates representative emissions from Hunter and Huntington units during the period 2014 to 2016, which included emissions controls required by the SIP. For this scenario, the Carbon power plant emissions also were zero since the power plant was decommissioned in April 2015, a requirement contained in the SIP.

Table ES-1 summarizes the total emissions modeled for Hunter, Huntington and Carbon combined in each scenario. The values represent the final emissions that were modeled.

Table ES-2: Total Modeled Emissions for PacifiCorp Power Plants by Scenario

Scenario	NO_x (tpy*)	SO_2 (tpy)	VOC (tpy)	CO (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	NH_3 (tpy)
Baseline	34,053	26,772	225	1,877	3,834	2,663	41
USEPA FIP	12,959	12,060	225	1,877	3,834	2,663	41
Utah SIP	17,197	6,246	207	1,721	3,531	2,443	37

*tpy = short tons per year

Other than the emissions for the PacifiCorp power plants, all other model inputs, including other regional emissions sources, are identical for each of the emission scenarios modeled with CAMx. Maintaining consistent model inputs enables comparison of the effects of different emissions scenarios. The Particulate Source Apportionment Technology (PSAT) tool was applied in the CAMx simulations to track and account for the particulate mass concentrations that originate from or are formed by PacifiCorp power plant emissions.

Once all the scenarios above were simulated with the PGM, model results were processed to isolate the changes to visibility conditions. To assess compliance with Regional Haze Rule requirements, visibility impacts were assessed for the 20 percent best visibility days and the 20 percent worst visibility days at each potentially affected, federally-regulated Class I area in the modeling domain (see below). The visibility estimates are provided as deciview (dv) contributions from PacifiCorp's power plants. A deciview is a measure of visibility derived from light extinction that is designed so that incremental changes in the measurement of haze correspond to uniform incremental changes in visual perception, across the entire range of conditions from pristine to highly impaired. Model-predicted visibility impacts at these fifteen Class I areas in the 4-km modeling domain were estimated for each of the three modeling scenarios.

- Grand Canyon National Park (NP)
- Arches NP
- Black Canyon of the Gunnison NP
- Bryce Canyon NP
- Canyonlands NP
- Capitol Reef NP
- Mesa Verde NP
- Zion NP
- Flat Tops Wilderness Area (WA)
- Mount Zirkel WA
- Maroon Bells-Snowmass WA
- West Elk WA
- La Garita WA
- Weminuche WA
- San Pedro Parks WA

To convert model concentrations to visibility estimates and account for quantifiable model bias, the USEPA's Software for Model Attainment Test – Community Edition (SMAT-CE) was used. All models are affected by biases; i.e., model results are a simplification of natural phenomena and, as such, model results over- or under-estimate true conditions. The use of SMAT-CE helps mitigate model bias by pairing model estimates with actual measured conditions. By using the Particulate Source Apportionment Technology tool in conjunction with SMAT-CE, this modeling effort estimates PacifiCorp's power plants' visibility impacts for each model scenario in a realistic manner. The Utah SIP scenario SMAT-CE visibility estimates are compared to the Baseline and USEPA FIP scenarios to determine which has the least impact on visibility.

Assessment Method

Potential visibility improvements from two emissions strategies (e.g., the USEPA FIP and the Utah SIP BART Alternative) can be compared using a two-pronged test. Under the first prong, visibility must not decline at any Class I area for the Utah SIP scenario when compared to baseline visibility conditions (i.e., the Baseline scenario). This prong is satisfied if the difference between the Utah SIP scenario and the Baseline scenario is negative or zero at each Class I area. Under the second prong, the average visibility over all Class I areas is compared between the Utah SIP scenario and the USEPA FIP scenario. For the second prong, if the average visibility impact is negative or zero this indicates that the Utah SIP scenario is predicted to have lower visibility impacts on average than the USEPA FIP scenario. For the second prong, it is acceptable if some Class I areas show greater improvement under the USEPA FIP scenario provided that the overall impacts are equivalent or greater for the Utah SIP (i.e., the average over all areas analyzed). The objective of the two-pronged test is to evaluate the visibility impacts under the Utah SIP scenario and determine if the predicted visibility will be better than the baseline and better than the USEPA FIP. This analysis is conducted for two sets of data: the 20 percent best visibility days and the 20 percent worst visibility days. This assessment method is similar to the one used in the Cross-State Air Pollution Rule (CSAPR) (USEPA 2011) and the Clean Air Interstate Rule (CAIR) (USEPA 2005a).

The modeling results are presented in a tabular format below to easily evaluate visibility impacts relative to the two-pronged test for the 20 percent best and worst days. The table presents the model-predicted visibility impacts at each analyzed Class I area for the following scenarios: Baseline (Column A), USEPA FIP (Column B) and Utah SIP (Column C). The last two columns of tables show the predicted visibility benefits from Utah SIP scenario relative to both the Baseline (Column D) and the USEPA FIP (Column E). Negative values for individual Class I areas in Column D indicate that the Utah SIP scenario has smaller contributions to visibility relative to the Baseline and therefore it improves visibility over the Baseline at every Class I area. When Column D results are negative, the Utah SIP scenario meets the requirements of the first prong of the test. The last row of the table shows the average visibility results. When the bottom row of Column E has negative values, the Utah SIP scenario improves the average visibility relative to the USEPA FIP and meets the requirements of the second prong of the test.

Results

Visibility impacts derived from modeling results are summarized in **Tables ES-2** and **ES-3**. The tables show the model-estimated contribution from PacifiCorp's power plants in Utah to visibility on the 20 percent best days and worst days, respectively. **Table ES-2** shows that the emissions for the Utah SIP scenario will not result in degradation of visibility on the 20 percent best days compared to the Baseline conditions at any of the analyzed Class I areas. In each individual area, visibility is predicted to improve compared to the Baseline visibility, since all the values shown in Column D are negative. The Utah SIP meets the requirements of the first prong of the test for the 20 percent best days. As shown in Column E, the Utah SIP scenario shows an average improvement in visibility of 0.00494 dv relative to the USEPA FIP for the best 20 percent days. The Utah SIP meets the requirements of the second prong of the test for the 20 percent best days by showing an overall improvement in visibility over the USEPA FIP as the average visibility change across all Class I areas is negative.

Table ES-3 shows that the emissions for the Utah SIP scenario would not result in degradation of visibility on the 20 percent worst days compared to the Baseline conditions at any of the analyzed Class I areas. In each individual area, visibility is predicted to improve compared to the Baseline visibility, since all values in Column D are negative. The Utah SIP meets the requirements of the first prong of the test for the 20 percent worst days. Also, as shown in Column E, the Utah SIP scenario shows an average improvement in visibility of 0.00058 dv relative to the USEPA FIP for the 20 percent worst days. The Utah SIP meets the requirements of the second prong of the test for the 20 percent worst days.

In summary, the Utah SIP meets the requirements of both prongs of the two-prong test for both the 20 percent best and 20 percent worst visibility days. CAMx modeling results predict that Utah SIP proposal improves visibility relative to the Baseline scenario at each of the analyzed Class I areas during both the 20 percent best and 20 percent worst visibility days. Furthermore, modeling results show that, on average, visibility improvement at the analyzed Class I areas is greater for the Utah SIP scenario than for the USEPA FIP scenario during both the 20 percent best and 20 percent worst visibility days.

Table ES-3: Visibility Impacts for the 2025 Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Best Days

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Black Canyon of the Gunnison NM	0.02769	0.01611	0.01162	-0.01607	-0.00449
Bryce Canyon NP	0.00528	0.00254	0.00228	-0.00300	-0.00026
Canyonlands NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Capitol Reef NP	0.14218	0.07222	0.07140	-0.07078	-0.00082
Flat Tops WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Grand Canyon NP	0.07136	0.03567	0.03611	-0.03525	0.00044
La Garita WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
Maroon Bells-Snowmass WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Mesa Verde NP	0.06356	0.03381	0.02749	-0.03607	-0.00632
Mount Zirkel WA	0.04209	0.02060	0.01471	-0.02738	-0.00589
San Pedro Parks WA	0.03627	0.01742	0.01593	-0.02034	-0.00149
Weminuche WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
West Elk WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Zion NP[1]	0.00612	0.00291	0.00300	-0.00312	0.00009
All Class I Area Average	**0.04940**	**0.02602**	**0.02108**	**N/A**	**-0.00494**

Table ES-4: Visibility Impacts for the 2025 Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Worst Days

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Black Canyon of the Gunnison NM	0.01265	0.00682	0.00540	-0.00725	-0.00142
Bryce Canyon NP	0.04945	0.02184	0.02470	-0.02475	0.00286
Canyonlands NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Capitol Reef NP	0.26010	0.11672	0.14568	-0.11442	0.02896
Flat Tops WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Grand Canyon NP	0.00186	0.00089	0.00056	-0.00130	-0.00033
La Garita WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
Maroon Bells-Snowmass WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Mesa Verde NP	0.06203	0.02524	0.02959	-0.03244	0.00435
Mount Zirkel WA	0.03312	0.01705	0.01198	-0.02114	-0.00507
San Pedro Parks WA	0.00154	0.00074	0.00073	-0.00081	-0.00001
Weminuche WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
West Elk WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Zion NP[1]	0.00155	0.00051	0.00051	-0.00104	0.00000
All Class I Area Average	**0.06957**	**0.03471**	**0.03413**	**N/A**	**-0.00058**

1.0 Introduction

The USEPA issued a Regional Haze Rule to protect visibility in over 150 national parks and wilderness areas in 1999. The Regional Haze Rule requires states to establish Best Available Retrofit Technology requirements (BART) and Reasonable Progress Goals for improving visibility, with the overall goal of attaining natural background visibility conditions by 2064. On June 4, 2015, the State of Utah submitted to the USEPA a revised Regional Haze State Implementation Plan (SIP). The SIP addressed requirements of the Clean Air Act specifically related to the Regional Haze Rule. On July 5, 2015, USEPA approved some parts and disapproved other parts of Utah's regional haze SIP. Specifically, USEPA disapproved the State's nitrogen oxides (NO_x) BART determinations for four units at two PacifiCorp power plants: Hunter units 1 and 2 and Huntington units 1 and 2. To address the portions of Utah's SIP that USEPA disapproved, USEPA finalized a Federal Implementation Plan (FIP) that determined NOx BART controls for Hunter and Huntington power plants require the application of selective catalytic reduction (SCR) controls with low NOx burners and separated overfire air (SCR + LNB/SOFA). The State of Utah and PacifiCorp disagreed with the FIP determination and challenged it in court. The USEPA relied, in large part, on the CALPUFF model to reject Utah's SIP BART Alternative; however, the State of Utah and PacifiCorp assert that USEPA's CALPUFF model results are ultimately of limited value and should be viewed in light of all of the evidence and information.

To address these concerns, a new modeling analysis with an advanced photochemical grid model (PGM) was conducted to assess the visibility benefits associated with the Utah SIP's BART Alternative NOx emissions controls at Hunter and Huntington power plants combined with the retirement of the Carbon Power Plant. This report, relying on the advanced modeling analysis and results, provides an assessment of the BART Alternative compared to the visibility benefits predicted by USEPA's FIP NOx BART limits. This assessment was conducted at fifteen Class I areas in Utah, Arizona, New Mexico and Colorado.

The PGM used for this report was the Comprehensive Air Quality Model with extensions (CAMx). CAMx (Ramboll 2014) can estimate the formation, transport, and removal of pollutants that contribute to regional haze. CAMx has a technical formulation that is considered state-of-science, so it is more realistic and is expected to predict more accurate changes in light extinction due to changes in emissions from PacifiCorp power plants than the CALPUFF model used in the USEPA FIP. This project utilized an available CAMx modeling platform already reviewed by the USEPA that covers the area where the power plants and Class I areas are located.

1.1 Model Description Overview

The use of the CAMx model for analyzing potential cumulative air quality impacts has been well established: the model has been used for many previous visibility modeling studies in the western U.S., including SIPs and Environmental Impact Statements (EISs). CAMx is a photochemical modeling system developed and updated regularly by Ramboll. The Western Air Quality Study (WAQS) modeling platform (IWDW 2016a and 2016b) was used as the starting point to assess visibility impacts from different emissions scenarios from PacifiCorp's Utah power plants. The WAQS is a modeling platform intended to facilitate air resource analyses for federal and state stakeholders as part of the National Environmental Policy Act (NEPA) process and for other studies. The WAQS provides a framework for performing air quality analyses in the three states of Wyoming, Colorado, and Utah.

The Intermountain West Data Warehouse (IWDW) developed an updated air quality model platform for WAQS year 2011 (referred to as "2011b") (IWDW 2016a and 2016b). The 2011b model platform includes updates to the emissions, boundary conditions and model configuration relative to its predecessor, the 2011a modeling platform. The 2011b model platform has been reviewed and approved by the IWDW-WAQS Cooperating Agencies, including USEPA (Region 8), and Utah Department of Environmental Quality among other state and federal agencies such as the BLM (in Colorado, Wyoming, Utah and New Mexico offices), the FS (in Rocky Mountain, Intermountain, and Southwestern Regions), the NPS (Intermountain Region), and the FWS (Region 6), Colorado Department of Public Health and Environment, Wyoming Department of Environmental and New Mexico Environment Department. The 2011b modeling platform and its individual components as described in this report were leveraged to perform this alternative visibility assessment.

The Weather Research and Forecast (WRF) Model and the Sparse Matrix Operator Kernel Emissions (SMOKE) model provide meteorological and emissions inputs respectively to the CAMx photochemical grid model. Collectively, these three models will be referred to hereafter as the “CAMx modeling system.” The CAMx modeling system used for this project was selected for consistency with the WAQS and includes:

- WRF (version 3.5.1): State-of-science mesoscale numerical weather prediction system capable of supporting urban- and regional-scale photochemical, fine particulate and regional haze regulatory modeling studies.
- SMOKE (version 3.5.1): Emissions modeling system that generates hourly, gridded, and speciated emissions inputs of on-road, non-road, area, point, fire, and biogenic emissions sources for photochemical grid models.
- CAMx (versions 6.10 and 6.40): State-of-science ‘One-Atmosphere’ photochemical grid model capable of addressing ozone and other criteria pollutants, visibility, and atmospheric deposition at the regional and urban scale.

The CAMx system was configured to simulate the following modeling scenarios which are described in more detail in Chapter 2:

- <u>Typical Year Modeling Scenario</u>. The Typical scenario is used only to aid in the calculation of relative response factors that will be used for the visibility assessment impacts, as described in more detail in Chapter 4.0. This modeling scenario includes emissions for all the units of Carbon, Hunter and Huntington power plants at levels representative of the period 2001 to 2003, while all other sources remain at the levels of the 2011 WAQS base year simulation. This period was chosen to keep consistency with the modeling performed by the USEPA in support of the FIP (2015a, 2016a).
- <u>Baseline Modeling Scenario</u>. This scenario simulates representative emissions from Carbon, Hunter and Huntington power plants during the period 2001 to 2003. Emissions from Carbon, Hunter and Huntington are identical to the Typical Year Modeling Scenario. All other emissions sources remain at the levels of the 2025 WAQS future-year simulation.
- <u>USEPA FIP Modeling Scenario</u>. This scenario simulates the emission control strategy for Hunter and Huntington units stipulated by the USEPA in the FIP. The scenario also includes the Carbon power plant using the same level of emissions as the Baseline scenario. All other emissions sources remain at the levels of the 2025 WAQS future-year simulation.
- <u>Utah SIP Modeling Scenario</u>. This scenario simulates the emission control strategy for Carbon, Hunter and Huntington units required by Utah’s SIP. This scenario simulates representative emissions from Hunter and Huntington units during the period 2014 to 2016, which include the emissions controls required by the SIP. For this scenario, the Carbon power plant emissions were zero since the power plant was decommissioned in April 2015, as required by the SIP. All other emissions sources remain at the levels of the 2025 WAQS future-year simulation.

Notice that the only changes between the Baseline, USEPA FIP, and Utah SIP scenarios are due to different emission rates for PacifiCorp power plants. All other regional sources remain unchanged among all emission scenarios. Note that the temporal profile of all the PacifiCorp power plants emissions is normalized for all model scenarios to prevent periods of down time experienced by any of the units historically from artificially affecting the analysis of future impacts.

1.2 Visibility Impact Assessment

The modeling methodology followed established regional PGM modeling procedures and guidelines, specifically:

- "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone (O_3), $PM_{2.5}$, and Regional Haze" (USEPA 2014b).
- "Regional Haze Regulations and Guidelines for Best Available Retrofit Determinations" (USEPA 2005b).
- "Demonstration that the Clean Air InterState Rule (CAIR) Satisfies the 'Better-than-BART' Test as proposed in the Guidelines for Making BART Determinations" (USEPA 2005a).
- "Cross-State Air Pollution (CSAPR) Air Quality Modeling" (USEPA 2011).

Visibility impacts were evaluated using the following three-step process:

1. Develop project emissions for all scenarios;
2. Model the impacts resulting from the changes in these emissions; and
3. Compare the modeled impacts among different scenarios.

The first step in the process is the emissions development. Chapter 2.0 identifies PacifiCorp power plants emissions, provides information on the regional emissions inventory and shows the agreed-upon modeling domains for this project. Chapter 3.0 details the modeling procedures. Chapter 4.0 outlines the procedures for reporting model results and comparing the resulting impacts among the different scenarios. Chapter 5.0 provides a summary of the results.

2.0 Emissions Inventories and Modeling Domains

Regional photochemical grid models need information from all emissions sources in the modeling domain, in addition to those associated with the PacifiCorp power plants alone. This typically requires a comprehensive emissions inventory, which is processed in combination with the project-specific emissions.

This chapter provides information about both the emissions for each control scenario specific to PacifiCorp's power plants and all other regional emissions included in the model simulations. It describes the sources of the emissions data, the processing steps, the purpose of each emissions scenario, and the final modeled emissions.

2.1 PacifiCorp Power Plants Emissions

This section provides a description of the emission rates and parameters associated with the following PacifiCorp power plants located in Utah: Carbon, Hunter and Huntington. The modeling for this study considers three different scenarios for the future year (2025) and an additional scenario for the typical year (2011). Each of the modeling scenarios' emissions are described in more detail in the following sections. However, emissions associated with PacifiCorp power plants were modeled using the same stack parameter information for all modeling scenarios. The stack parameters associated to each of PacifiCorp power plants units is summarized in **Table 2-1**. This information was provided by PacifiCorp and is identical to the information available in for the 2011 EPA National Emissions Inventory (NEI) version 6 (USEPA 2016b), which was used in the WAQS.

Table 2-1: Stack Parameters by Unit

Plant	Unit	Stack Height		Stack Diameter		Stack Exit Velocity		Stack Exit Temperature
		M	Ft	m	ft	m/s	ft/s	K
Carbon	1	61.0	200.0	3.1	10.3	10.8	35.3	382.0
	2	52.4	172.0	3.8	12.5	12.1	39.8	412.6
Hunter	1	183.0	600.4	7.3	24.0	17.3	56.8	317.0
	2	183.0	600.4	7.3	24.0	17.3	56.8	317.0
	3	182.9	600.0	7.3	24.0	13.4	44.0	322.0
Huntington	1	183.0	600.4	7.3	24.0	19.6	64.3	317.0
	2	183.0	600.4	7.3	24.0	19.6	64.3	317.0

In addition to the stack parameters, all the scenarios used identical values for the emissions speciation profile and the temporal profile for the PacifiCorp power plants. The speciation profile is based on the Carbon Bond version 6 (CB6r2) chemical mechanism with profiles for volatile organic compounds (VOCs), nitrogen monoxide (NO), nitrogen dioxide (NO2), and particulate matter (PM) with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$) that uses source-specific speciation developed with the SPECIATE 4.3 database. A detailed description of the temporal profile is presented in the Typical Year scenario section (2.1.1).

2.1.1 Typical Year (2011) Modeling Scenario

The main goal of the Typical Year modeling is to aid in the calculation of relative response factors used in the visibility assessment as described in Chapter 4.0. In general, the regional emissions and configuration for the Typical Year modeling scenario are based on the WAQS 2011 platform with the exception that the PacifiCorp power plants emissions are representative of the period 2001 to 2003 instead of the emissions that correspond to the year 2011. The annual emissions for PacifiCorp's power plants in tons per year (tpy) for the Typical Year Modeling Scenario are shown in **Table 2-2**.

The NO_x and sulfur dioxide (SO_2) total annual emissions presented in **Table 2-2** are calculated from the three-year average (2001 to 2003) of emission rates found in the USEPA Clean Air Market Division (CAMD) emissions system for the PacifiCorp power plants (USEPA 2017a). In addition to NO_X and SO_2 emissions from CAMD, **Table 2-2** includes emissions for VOCs, carbon monoxide (CO), PM with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), and ammonia (NH_3). The annual emissions for pollutants not included in CAMD datasets are calculated from the 3-year average of years 2000 to 2002 from the USEPA's National Emissions Inventory (NEI) (USEPA 2017b). The year 2003 was not included on this estimate because there is no NEI data for this year. However, the NEI did provide values for 2000 emissions which were similar in magnitude to those for years 2001 and 2002 and therefore are included in the final 3-year average estimate.

Table 2-2: PacifiCorp Power Plants' Emissions for the Typical Year Modeling Scenario by Unit

Plant	Unit	NO_x tpy	SO_2 tpy	VOC tpy	CO Tpy	PM_{10} tpy	$PM_{2.5}$ tpy	NH_3 tpy
Carbon	1	1,312.4	2,285.7	7.4	61.6	119.9	86.9	1.3
	2	1,977.3	3,527.5	11.3	93.9	182.9	132.5	1.9
Hunter	1	6,379.7	2,535.1	45.1	375.4	733.0	537.0	8.4
	2	6,092.1	2,531.4	44.1	367.5	717.4	525.5	8.2
	3	6,530.2	1,204.0	32.6	271.8	530.6	388.7	6.1
Huntington	1	5,944.3	2,380.4	28.3	235.8	517.2	331.1	4.9
	2	5,816.5	12,308.0	56.5	470.7	1,032.6	661.0	9.7

The total annual emissions must be temporally allocated throughout the year so that CAMx modeling can be performed. This allocation is referred as the emissions temporal profile. The temporal profile used for this and all other modeling scenarios was estimated to represent a "typical" level of operations for all the units from the PacifiCorp power plants during the 2001 to 2003 period (USEPA 2017a). The temporal profile was derived by taking the average of the CAMD daily SO_2 and NOx emissions from 2001 to 2012 for each power plant. This period covers the entire time span of the emissions used for the various modeling scenarios considered. Using the average from eleven years provides a temporal profile that retains a realistic day-to-day variability without fluctuations attributable to temporary shutdowns or restarts at each unit. The daily percentage contribution was then calculated by determining the percentage the 3-year daily contributes to the annual total. The resulting temporal profile for each power plant is shown in **Figure 2-1** as the daily percentage contribution for SO_2, NO_x and all the other pollutants. The SO_2 and NOx profiles are then applied to the SO_2 and NOx, emissions, respectively for each power plant's units. Notice that the temporal profile for all the other pollutants was determined through the average of the SO_2 and NO_x profiles and is applied to the power plant's emissions for VOC, CO, PM_{10}, $PM_{2.5}$ and NH_3. In general, the profiles show a constant level of operations without a strong seasonality. For comparison a constant profile that allocates emissions equally throughout the year would represent a flat line at 0.27% every day.

A description of the regional emissions included in the modeling is presented in Section 2.2. It is important to note that for this scenario the remaining Electric Generating Units (EGUs) emissions and temporal profiles in the computational domain remain unchanged from the data provided by the 2011 WQAS modeling platform. In other words, the only changes to the emission inventory in this scenario are those described above for PacifiCorp power plants.

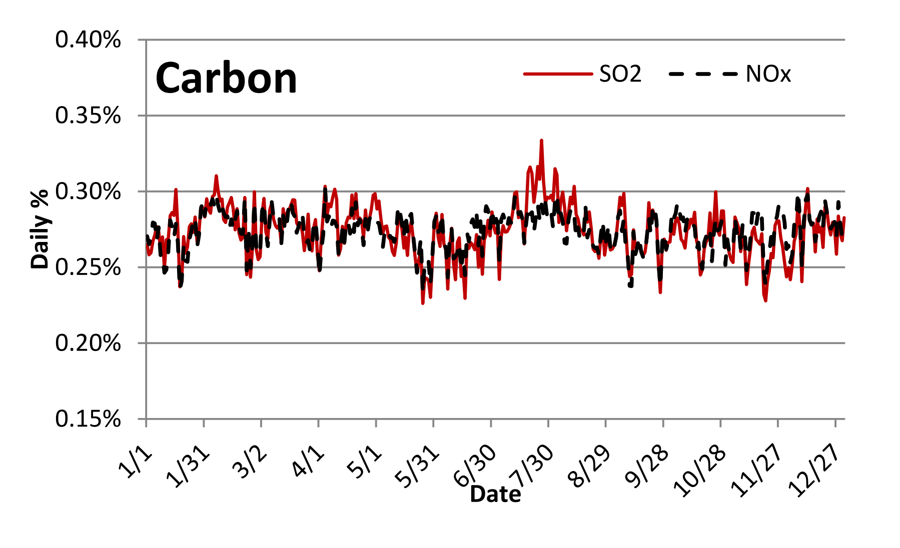
2.1.2 Baseline (2025) Modeling Scenario

The Baseline modeling scenario represents the emission values in the future year (2025) before any additional control technology (other than controls that were in operation during the PacifiCorp power plants baseline period of 2001-2003) was placed on any of the PacifiCorp units to reduce emissions. This scenario provides a baseline to compare the relative visibility improvement of the USEPA FIP and Utah SIP modeling scenarios. In general, the Baseline modeling scenario is based on the dataset provided by the 2025 WAQS modeling platform. However, the emissions of PacifiCorp power plants are representative of the period 2001 to 2003 and are identical to those described in the Typical Year (2011) scenario above. The temporal profile used for PacifiCorp power plants emissions is described in Section 2.1.1. The annual emissions for the Baseline scenario are shown in **Table 2-3**.

Table 2-3: PacifiCorp Power Plants Emissions for the Baseline Modeling Scenario by Unit

Plant	Unit	NO_x tpy	SO_2 Tpy	VOC tpy	CO Tpy	PM_{10} tpy	$PM_{2.5}$ tpy	NH_3 Tpy
Carbon	1	1,312	2,286	7.4	61.6	119.9	86.9	1.3
	2	1,977	3,528	11.3	93.9	182.9	132.5	1.9
Hunter	1	6,380	2,535	45.1	375.4	733.0	537.0	8.4
	2	6,092	2,531	44.1	367.5	717.4	525.5	8.2
	3	6,530	1,204	32.6	271.8	530.6	388.7	6.1
Huntington	1	5,944	2,380	28.3	235.8	517.2	331.1	4.9
	2	5,816	12,308	56.5	470.7	1,032.6	661.0	9.7

Like the Typical Year Scenario, all remaining EGUs emissions and temporal profiles remain unchanged from the data provided by the 2025 WAQS modeling platform.


Carbon
SO2
NOx
Daily %
0.40%
0.35%
0.30%
0.25%
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1/1
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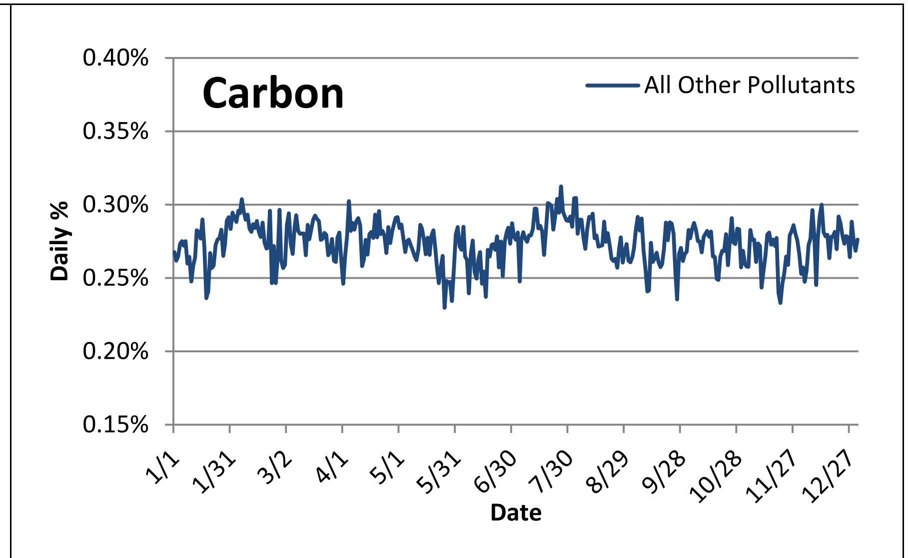
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date


Carbon
All Other Pollutants
Daily %
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
1/1
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4/1
5/1
5/31
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8/29
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10/28
11/27
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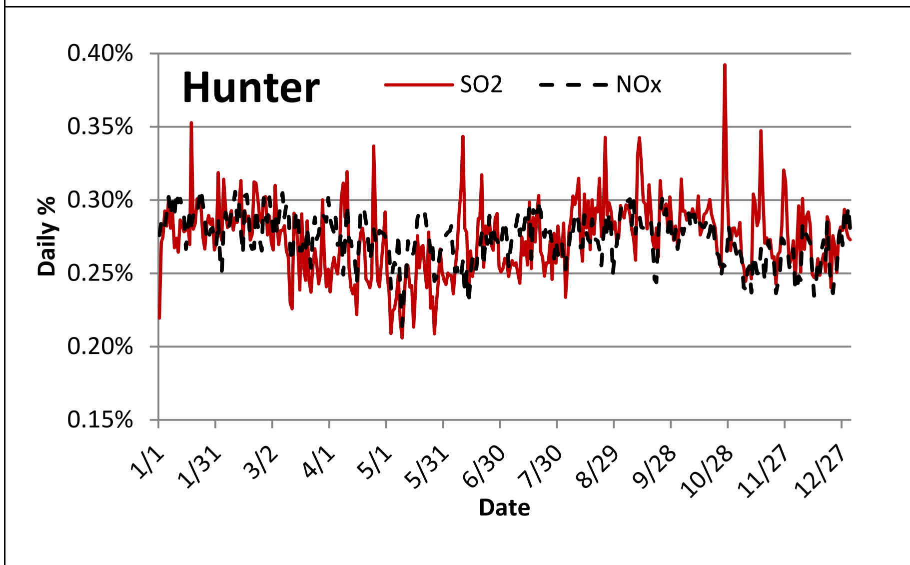
Date


Hunter
SO2
NOx
Daily %
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
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Date

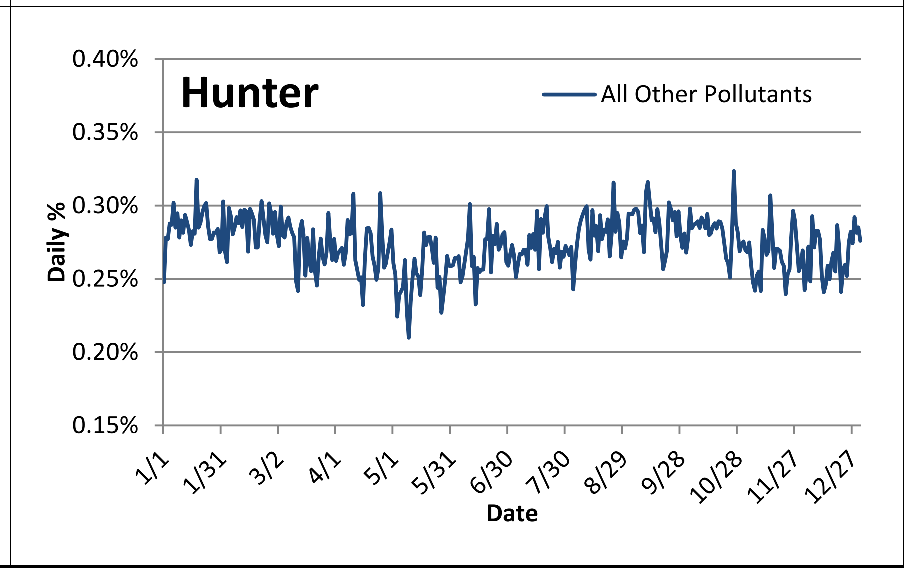
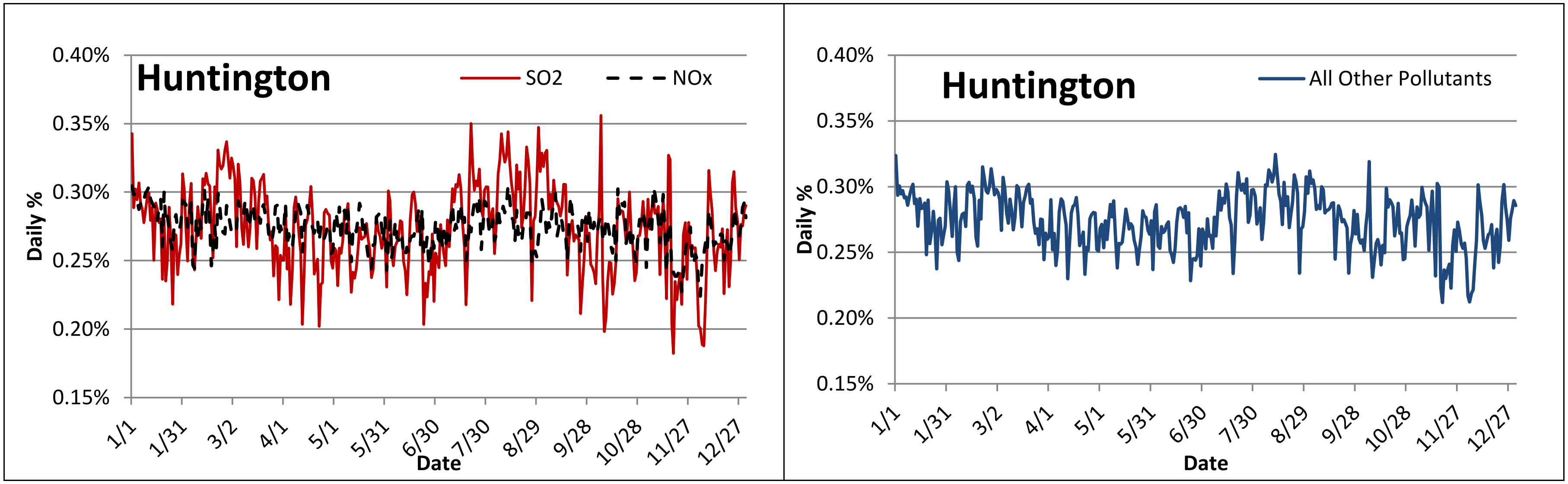

Hunter
All Other Pollutants
Daily %
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

Figure 2-1: Emissions Temporal Profiles for NO_x and SO_2 (left) and all other Pollutants (right)



2.1.3 USEPA FIP (2025) Modeling Scenario

The USEPA FIP modeling scenario is based on emission reductions that would take place as required by the FIP promulgated by the USEPA. The annual emissions for this modeling scenario are shown in **Table 2-4**. The values presented here represent the USEPA FIP for PacifiCorp Hunter Units 1 and 2 and Huntington Units 1 and 2 that includes Low-NO_x Burners (LNB) with Separate Over-fire Air (SOFA) controls and Selective Catalytic Reduction (SCR) controls. NO_x emissions are reduced from the baseline using information presented in the FIP. The NOx emission reduction values for LNB with SOFA and SCR control option found in Tables 2 through 5 of the FIP for each unit were subtracted from the baseline emissions. The resulting total controlled annual emission rate is 0.05 lb/MMBtu consistent with USEPA's BART analysis. All other pollutant emissions, except SO_2, are the same as the baseline. The NOx emissions from Carbon Units 1 and 2 and Hunter Unit 3 are the same as the baseline as these are non-BART sources according to the FIP (USEPA 2015a, 2016a)

Table 2-4: PacifiCorp Power Plants Emissions for USEPA FIP Modeling Scenario by Unit

Plant	Unit	NO_x tpy	SO_2 tpy	VOC tpy	CO Tpy	PM_{10} tpy	$PM_{2.5}$ Tpy	NH_3 tpy
Carbon	1	1,312	2,286	7.4	61.6	119.9	86.9	1.3
	2	1,977	3,528	11.3	93.9	182.9	132.5	1.9
Hunter	1	796	1,153	45.1	375.4	733	537	8.4
	2	798	1,408	44.1	367.5	717.4	525.5	8.2
	3	6,530	1,230	32.6	271.8	530.6	388.7	6.1
Huntington	1	793	1,254	28.3	235.8	517.2	331.1	4.9
	2	753	1,201	56.5	470.7	1,032.6	661	9.7

2.1.4 Utah SIP (2025) Modeling Scenario

The Utah SIP scenario consists of emission reductions due to the emission control strategy proposed by PacifiCorp. The Utah SIP BART Alternative scenario includes all the units of Hunter and Huntington that correspond to emissions levels representative of the period 2014 to 2016. Notice that this BART alternative also requires decommissioning the Carbon plant in April 2015 and thus the emissions related to this facility for all pollutants are set to zero. The annual emissions for this modeling scenario are shown in **Table 2-5**. The temporal profile is the same as the one described in Section 2.1.1 and like all other future-year emissions scenarios the remaining EGUs emissions (except for PacifiCorp power plants) remain unchanged from the 2025 WAQS modeling platform.

Table 2-5: PacifiCorp Power Plants Emissions for the Utah SIP Modeling Scenario by Unit

Plant	Unit	NO_x tpy	SO_2 Tpy	VOC tpy	CO Tpy	PM_{10} tpy	$PM_{2.5}$ tpy	NH_3 tpy
Carbon	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0
Hunter	1	3,166	1,153	45.1	375.4	733	537	8.4
	2	3,028	1,408	44.1	367.5	717.4	525.5	8.2
	3	4,490	1,230	32.6	271.8	530.6	388.7	6.1
Huntington	1	3,147	1,254	28.3	235.8	517.2	331.1	4.9
	2	3,366	1,201	56.5	470.7	1,032.6	661	9.7

2.2 Regional Emissions Inventories and Modeling Domains

The regional photochemical model's skill to estimate air quality and visibility impacts depends on its ability to simulate the complex interactions that occur between primary emissions sources (i.e., input emissions inventory) and meteorological conditions (i.e., output data from the WRF model). An important step is the gathering and processing of the emissions inventory for all sources within the modeling domain. The emissions inventory development process is described in detail within the context of the modeling domain.

2.2.1 Description of the Modeling Domains

A common strategy for regional photochemical modeling is to develop several nested modeling domains with finer grid resolution surrounding the areas of primary interest. In this case, the area of interest centers in the state of Utah where PacifiCorp power plants are located as shown in **Figure 2-2**. The largest domain has a 36-km horizontal grid resolution (i.e., each grid cell is 36-km on a side), a smaller domain with a 12-km grid resolution, and the finest domain with a 4-km grid resolution centered on Utah and the Class I areas of interest. The modeling domains are described in further detail below and shown in **Figure 2-2**. For this study, the WAQS 36-km and 12-km modeling results were used to provide pollutant concentrations entering the 4-km domain, referred to as lateral boundary conditions (BC) for the 4-km grid domain, and only the 4-km grid was used to conduct the modeling and corresponding visibility analysis.

2.2.1.1 Horizontal Modeling Domain

The CAMx modeling domain used in this assessment is based on the Regional Planning Organizations' (RPO) unified grid map projection, which has been used by both the Western Regional Air Partnership (WRAP) and USEPA. The RPO unified grid consists of a Lambert Conformal Conic (LCC) map projection with the parameters listed in **Table 2-6**. **Table 2-7** lists the size and dimensions of the WAQS 36-km and 12-km modeling domains along with the 4-km modeling domain defined for the visibility assessment of PacifiCorp's power plants. Notice that the coordinates for the 12-km and 4-km domains include the buffer cells required for performing two-way nested simulations. The WAQS performed 36-km and 12-km two-way nesting CAMx simulations for year 2011 and 2025 using the domains shown in **Figure 2-2**. The 12-km domain concentrations were used to establish the lateral boundary conditions of the 4-km domain when modeling both the base and future years for this analysis.

Table 2-6: RPO Unified Grid Definition

Parameter	Value
Projection	Lambert-Conformal Conic
Datum	World Geodetic System 1984
Standard Parallel 1	33° latitude N
Standard Parallel 2	45° latitude N
Central Meridian	97° longitude W
Latitude of Origin	40° latitude N

Table 2-7: CAMx Model Domain Dimensions

Domain	Number of Grid Cells	Coordinates of Southwestern Corner of Grid (km)
36-km	148 x 112	-2736, -2088
12-km	227 x 230	-2388, -1236
This study 4-km	182 x 149	-1516, -412

2.2.1.2 Vertical Modeling Domain

The CAMx vertical domain structure depends on the definition of the WRF vertical layers structure with thinner (more) layers within the planetary boundary layer (PBL). The PBL is the lowest part of the atmosphere where the physical properties of the air are directly influenced by its contact with the ground surface. Within the PBL, the wind is affected by surface drag, influencing the wind speed, wind direction, and turbulence. The atmosphere above the PBL typically is referred to as the “free atmosphere” where the wind is usually non-turbulent, or only intermittently turbulent. Due to the different physical characteristics between the free atmosphere and the PBL, it is important to have the PBL well resolved in meteorological models. The vertical extent of the PBL changes throughout the day and season.

The altitudes above sea level were estimated according to standard atmosphere assumptions used in the WRF model.[1] The WAQS used WRF with 37 vertical layer interfaces from the surface up to 50 millibar (mb) (~19 km above ground level [AGL]). A layer averaging scheme is adopted for the CAMx simulations whereby multiple WRF layers are combined into one CAMx layer to reduce the air quality model computational time. The WAQS (IWDW 2016a) indicates that the lowest layers of WRF were mapped directly into CAMx with no layer collapsing; the WRF layer 1 thickness, at 12 m was found to be too shallow and may trap emissions in a too shallow layer resulting in overstated surface concentrations. Also, the WAQS mentioned that several previous studies, like the 2008 Denver ozone SIP, have shown that collapsing layers that are higher aloft, results in thick vertical layers near the top of the modeling domain that contribute to the too rapid transport of high ozone concentrations of stratospheric ozone origin to the ground. The layer structure used in the modeling is summarized in **Table 2-8**, which displays the approach for collapsing the WRF 37 vertical layers to 25 vertical layers in CAMx.

[1] Standard equations and assumptions include: surface pressure of 1,000 mb, model top at 100 mb, surface temperature of 275 degrees Kelvin (°K), and lapse rate of 50°K/ natural log-pressure (ln[p]).

Figure 2-2: CAMx Modeling Domains

Table 2-8: Vertical Layer Structure Used for WRF and CAMx Modeling Simulations

WRF Meteorological Model					CAMx Air Quality Model		
WRF Layer	Sigma	Pressure (mb)	Height (m)	Thickness (m)	CAMx Layer	Height (m)	Thickness (m)
37	0	50	19,260	2,055	25	19,260	3,904.9
36	0.027	75.65	17,205	1,850			
35	0.06	107	15,355	1,725	24	15,355.1	3,425.4
34	0.1	145	13,630	1,701			
33	0.15	192.5	11,930	1,389	23	11,929.7	2,569.6
32	0.2	240	10,541	1,181			
31	0.25	287.5	9,360	1,032	22	9,360.1	1,952.2
30	0.3	335	8,328	920			
29	0.35	382.5	7,408	832	21	7,407.9	1,591.8
28	0.4	430	6,576	760			
27	0.45	477.5	5,816	701	20	5,816.1	1,352.9
26	0.5	525	5,115	652			
25	0.55	572.5	4,463	609	19	4,463.3	609.2
24	0.6	620	3,854	461	18	3,854.1	460.7
23	0.64	658	3,393	440	17	3,393.4	439.6
22	0.68	696	2,954	421	16	2,953.7	420.6
21	0.72	734	2,533	403	15	2,533.1	403.3
20	0.76	772	2,130	388	14	2,129.7	387.6
19	0.8	810	1,742	373	13	1,742.2	373.1
18	0.84	848	1,369	271	12	1,369.1	271.1
17	0.87	876.5	1,098	177	11	1,098	176.8
16	0.89	895.5	921	174	10	921.2	173.8
15	0.91	914.5	747	171	9	747.5	170.9
14	0.93	933.5	577	84	8	576.6	168.1
13	0.94	943	492	84			
12	0.95	952.5	409	83	7	408.6	83
11	0.96	962	326	82	6	325.6	82.4
10	0.97	971.5	243	82	5	243.2	81.7
9	0.98	981	162	41	4	161.5	64.9
8	0.985	985.75	121	24			
7	0.988	988.6	97	24	3	96.6	40.4
6	0.991	991.45	72	16			
5	0.993	993.35	56	16	2	56.2	32.2
4	0.995	995.25	40	16			
3	0.997	997.15	24	12	1	24.1	24.1
2	0.9985	998.58	12	12			
1	1	1000	0	0			

2.2.2 Regional Emissions Inventory Data

This section provides a description of the regional emissions inventory used for both the 2011 Typical Year, and the three 2025 future-year scenarios.

The Typical Year inventory produced for the 4-km simulation used emission inputs developed for the WAQS (IWDW 2016a and 2016b) as shown in **Table 2-9**. **Table 2-10** shows the data sources for the future-year emissions inventory. Other than the PacifiCorp power plants' emissions, all other emission datasets remain constant among the three future-year modeling scenarios. Maintaining consistent model inputs enables comparison of the effects of different emissions scenarios.

A complete emissions inventory for photochemical modeling includes point sources, area sources, non-road and on-road mobile sources, as well as ammonia emissions, windblown dust, biogenic emissions, and fire emissions. Ammonia emissions include agriculture, fertilizer, and livestock emission sources. Regional emissions sources that are identical for all modeling scenarios include: windblown dust, biogenic, lightning, and fire emissions.

<u>Emissions Sources Held Constant for all Scenarios</u>

Windblown dust emissions can be a significant source of PM. For the WAQS study, the WRAP windblown dust model was run with 2011 meteorological data to provide an estimate of windblown coarse and fine soil dust emissions for each modeling domain.

The most current version of the Model of Emissions of Gases and Aerosols for Nature (MEGAN version 2.1), as developed by National Center for Atmospheric Research (NCAR), was used to estimate biogenic emissions for the WAQS. MEGAN requires several types of input data, including: vegetation input data (Leaf area indices); emissions factors; classification of a grid cell's plant functional types (PFT); and wilting point for each PFT. MEGAN also requires as input hourly, gridded temperature and solar radiation data to estimate biogenic emissions. These data were derived from the WAQS and WRF model output.

Important sources of PM and ozone precursors in the fire emissions inventory include wildfires, prescribed burning and agricultural burning. The WAQS used the 2011 fire emissions inventory generated by the Particulate Matter Deterministic and Empirical Tagging and Assessment of Impacts on Levels (PMDETAIL) study.

2.2.2.1 2011 Typical year Emissions Inventory

As stated previously, the typical year modeling used the WAQS emissions inventory with no additional modifications, other than those for PacifiCorp power plants described above. The typical year emissions inventory processed for WAQS is shown in **Table 2-9**. Most of the emissions modeling is based on version 6.2 of the 2011 NEI from the USEPA with additional enhancements as described in the WAQS Modeling Protocol (IWDW 2016a and 2016b).

Table 2-9: Typical Year 2011 Emissions Inventory Data Sources from WAQS

Component	Configuration	Details
PacifiCorp power plants: Carbon, Hunter, and Huntington	See Section 2.1.1	See Section 2.1.1
Oil and Gas Emissions	WAQS 2011p1 and 2011 NEIv6	Used the WAQS 2011 Phase I inventory and the NEI 2011v6 inventory for all areas outside of the WAQS inventory coverage area
Non-point Source	2011 NEIv6	County-level emissions for sources that individually are too small in magnitude or too numerous to inventory as individual point sources.
On-road Mobile	2011 NEIv6 via MOVES20110414a	County specific emissions run for monthly weekday and weekend days. California and Texas MOVES estimates were normalized to emission values provided by these states
Point Sources	2011 Continuous Emissions Monitoring (CEM) and 2011 NEIv6	Use 2011 day-specific hourly measured CEM from the CAMD for SO_2 and NO_X emissions for CEM sources, 2011 NEIv6 for other pollutants and non-CEM sources
Off-road Mobile Sources	2011 NEIv6	Based on USEPA NONROAD2008a model
Biogenic Sources	MEGAN	Enhanced version of MEGAN Version 2.1
Wind Blown Dust Emissions	WRAP Wind Blown Dust (WBD)	WRAP WBD Model with 2011 WRF meteorology
Fires	PMDETAIL	Hourly agricultural, prescribed, and wildfire sources with pre-computed plume parameters and speciated PM
Mexico Sources	MNEI2012	Mexican NEI 2012
Canada Sources	NPRI2006	Canadian 2006 National Pollutant Release Inventory
Lightning NO_X	2011 WRF	Gridded hourly nitric oxide (NO) emissions tied to WRF convective rainfall
Sea salt	2011 WRF	Surf zone and open ocean PM emissions tied to WRF

The USEPA NEI database contains information relative to sources that emit criteria air pollutants and their precursors. The database includes estimates of annual air pollutant emissions from point, nonpoint, and mobile sources in the 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. The USEPA collects information about sources and releases an updated version of the NEI database every 3 years.

The USEPA compiles the NEI database from these primary sources:

- Emissions inventories compiled by state and local environmental agencies;
- Databases related to the USEPA Maximum Achievable Control Technology programs to reduce emissions of hazardous air pollutants;
- Toxic Release Inventory data;
- Emission Tracking System CEM data and Department of Energy fuel use data (for electric generating units);
- Federal Highway Administration estimate of vehicle miles traveled (VMT) and emissions factors from the USEPA motor vehicle emission simulator (MOVES) computer model (for on-road sources);

- NONROAD computer model (for non-road sources); and
- Previous emissions inventories (if states do not submit current data).

2.2.2.2 Future Year Modeling Scenarios

The future-year emissions inventory is based on the future-year projected inventory from the WAQS as outlined in **Table 2-10**. The main data sources are the 2025 Projections from the 20011 NEIv6 inventory. The 2011 emissions of windblown dust, biogenic, lightning, sea salt, and fire sources categories are used in the future-year modeling scenarios, which is consistent with the 2025 Projections from the 2011 NEIv6 development approach whereby the non-anthropogenic emissions do not change between the typical year and future-year modeling scenarios.

Table 2-10: Future-Year Modeling Scenarios Emissions Inventory Data Sources

Major Source Type	Location	Projection Method
Point Sources	PacifiCorp power plants	See Sections 2.1.2 to 2.1.4
	Whole Domain	2025 Projections from the 2011 NEI v6
Area Sources	Whole Domain	2025 Projections from the 2011 NEI v6
Oil and Gas	Whole Domain	2025 Projections from the 2011 NEI v6
On-road Mobile sources	Whole Domain	2025 Projected MOVES lookup tables from MOVES2010b
Off-road Mobile Sources	Whole Domain	2025 Projections from the 2011 NEI v6 inventory
Ammonia Emissions	Whole Domain	2025 Projections from the 2011 NEI v6 inventory
Biogenic	Whole Domain	Hold typical year 2011 emissions constant.
Wind Blown Dust Emissions	Whole Domain	Hold typical year 2011 emissions constant.
Fires	Whole Domain	Hold typical year 2011 emissions constant.
Non-US sources	Outside US	Hold typical year 2011 emissions constant.
Lightning NO_X	Whole Domain	Hold typical year 2011 emissions constant.
Sea salt	Whole Domain	Hold typical year 2011 emissions constant.

3.0 Photochemical Model Configuration

This chapter provides a detailed description of the CAMx model configuration and other inputs used in this analysis. Required configuration and input data includes a defined modeling domain, gridded meteorological data, emissions data, and a set of ancillary files required for the physical and chemical reaction calculations. The CAMx model configurations and input data were identical for all scenarios, except for emissions that have already been described in Chapter 2 for each model scenario.

3.1 Approach Overview

The CAMx modeling system includes both meteorological (WRF model) and emissions processing models (SMOKE), in addition to the photochemical grid model. This chapter provides a detailed description of the CAMx modeling system setup and configuration used in this analysis. The CAMx modeling system was used to simulate the typical year and three modeling scenarios as described in Chapters 1.0 and 2.0.

The 2011 Three-State Air Quality Study (WAQS) WRF modeling has been used to provide the meteorological input to the WAQS and Western Air Quality Study (WAQS) (IWDW 2016a and 2016b). The same gridded meteorological data is used in the CAMx modeling simulations described in this report. The emissions inventory was processed in a similar and consistent manner, with the emissions specific to PacifiCorp power plants changing accordingly for each modeling simulation. The CAMx model configurations, 4-km domain boundary conditions and other ancillary data are identical in all modeling cases.

The modeling methodology follows USEPA's established guidance on the use of regional PGM modeling procedures for demonstrating the achievement of air quality goals for PM, and regional haze (USEPA 2007, 2014). Finally, the CAMx modeling results were post-processed to derive model estimates of light extinction coefficients for inter-comparison among all the scenarios considered in this analysis.

3.2 Meteorological Input

Photochemical grid models require meteorological data to simulate air quality conditions. A prognostic meteorology model such as the WRF model (Skamarock et al. 2008; NCAR 2009) is generally used to provide gridded meteorological data at the same grid resolutions and spatial extent of the PGM computational domains.

This study relies on the WRF meteorological modeling conducted for the 2011 WAQS platform. The WRF modeling results for the 2011 annual period were evaluated against surface meteorological observations of wind speed, wind direction, temperature and humidity. The complete description of both the WRF configuration and the results of the model performance evaluation are detailed in the WRF Final Report (UNC and Ramboll Environ 2015).

The WAQS processed the WRF model output files using the WRFCAMx and Meteorology-chemistry interface processor (MCIP) processors to generate meteorological fields that drive both the CAMx air quality simulations and emission processing. Air quality models require certain meteorological input data including wind fields, estimates of turbulent eddy dispersion, humidity, temperature, clouds, and solar radiation. Additionally, the WRF meteorological parameters are used to solve the transport and chemical reaction equations in the air quality model.

The WAQS provided both the WRF model output and the CAMx-ready meteorology derived with WRFCAMx. This assessment leverages the CAMx-ready meteorological inputs from the original 4-km WAQS domain, but they were extracted to match the horizontal domain defined in **Table 2-7**.

3.3 Emissions Processing using SMOKE

The SMOKE emissions processing system was developed by MCNC (Coats 1995; Houyoux and Vukovich 1999) and has continued to be developed and maintained through the Center for Environmental Modeling for Policy Development (CEMPD) of the University of North Carolina (UNC) at Chapel Hill Institute for the Environment (IE). SMOKE is an emissions processing system that converts emissions inventory data into the formatted emissions files required by an air quality simulation model. SMOKE supports area, fire, and point source emissions processing and can run emissions models that require meteorological data, such as biogenic models or mobile source models. SMOKE has been available since 1996 and has been used for emissions processing in numerous regional air quality modeling applications, such as WRAP visibility studies and O_3 modeling for SIPs, and it is the preferred emissions processing system by USEPA. SMOKE contains several major features that make it a useful component of the CAMx modeling system and it supports a variety of input formats from other emissions processing systems and models.

SMOKE originally was designed to allow emissions data processing methods to utilize emergent high-performance-computing as it is applied to sparse-matrix algorithms. The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of the less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing.

3.3.1 SMOKE Processing

SMOKE was configured to generate emissions files in a format compatible with CAMx. There are several different types of emissions processed by SMOKE, including point, area, non-road, on-road, fire, and biogenic emissions. These source types can be processed separately to prepare emission inventories for modeling with a PGM. SMOKE consists of several processing routines:

- <u>Spatial Allocation</u>. The spatial resolution of the emissions must match the CAMx grid cells for each domain. Initial area, non-road mobile, and on-road mobile emission inventories are spatially resolved at the county level, an area that is much too coarse for the CAMx grid resolution. Therefore, county-level emissions are allocated to the grid cells within each county based on spatial surrogates (e.g., population, land use categories, and economic activity).
- <u>Chemical Speciation</u>. Emission inventories do not routinely include estimates of each chemical species, rather total VOC, total PM, and NO_X are reported. Emissions of total VOC are converted to estimates of number of carbon bond types required for use of the Carbon Bond version 6 release 2 (CB6r2) (Yarwood et al. 2010) chemical mechanism in CAMx. Total unspeciated NO_X emissions are allocated to NO and nitrogen dioxide (NO_2) components (and nitrous acid (HONO) in some emissions sectors). PM is allocated to coarse PM, nitrate, sulfate, organic carbon, elemental carbon, and other fine particulates. Speciation profiles for each emissions source classification code (SCC) are consistent with the profiles from the WAQS.
- <u>Temporal Allocation</u>. Emissions are provided for different averaging periods for each source type. Those source types with annual or short-term emission rates are adjusted to seasonal or monthly profiles accounting for day-of-week and hour-of-day differences. Area sources, including non-road mobile and dust emissions are allocated by monthly, daily, and hourly profiles provided by the USEPA. Biogenic and on-road mobile emissions are modeled using hourly meteorological data. Point sources, including CEM data and fire emissions, are modeled with available day-specific, or hour specific emissions and meteorology.

- Elevated Sources. For point sources with plume rise of greater than 20m, those point sources are treated as elevated sources. Except for PacifiCorp power plants, no Plume-in-Grid (PiG) treatment is be applied to any other elevated point sources.
- Quality Assurance. SMOKE includes quality assurance (QA) and reporting features to keep track of the adjustments at each processing stage and ensure that data integrity is not compromised.

All ancillary files used for SMOKE processing were obtained from the WAQS, except for the PacifiCorp power plants-specific emissions data that has already been detailed in Chapter 2.

In general, all emissions are processed by SMOKE in a manner consistent with the WAQS. As stated in Chapter 2.0, the typical year emission inventories for all domains are directly taken from the WAQS, which were processed using the SMOKE model. Since the 4-km domain used in this study is a subdomain of the original 4-km WAQS, the final emissions from the 4-km WAQS domain have been extracted to match the horizontal domain defined in **Table 2-7**. Regional emissions have been reprocessed and combined with the modified PacifiCorp power plant emissions through SMOKE in a manner consistent with the WAQS.

3.3.2 Emissions Inventory Quality Assurance

In addition to the CAMx-ready input files generated by SMOKE for each hour of each modeled day, several QA files were prepared and used to check for errors in the emissions inputs.

Importing the model-ready emissions into the Package for Analysis and Visualization of Environmental data (PAVE) or the NCAR Command Language (NCL) for visualization and looking at both the spatial and temporal distribution of the emissions, provides insight into the quality and accuracy of the emissions inputs. The QA procedures for the processed emissions data included the following:

- Visualization of the model-ready emissions with the scale of the plots set to a low value. This shows whether there are areas omitted from the raw inventory or if emissions sources are erroneously located in cells over water.
- State inventory summaries prepared prior to the emissions processing are compared against SMOKE output report totals generated after each major step of the emissions generation process.

To check the chemical speciation of the emissions to CB6r2 terms and the vertical allocation of the emissions, automatically generated reports are compared with SMOKE reports to target specific areas of the processing. For speciation, the inventory state totals are compared to the same state totals with the speciation matrix applied.

The quantitative QA review did not reveal any specific deficiencies in the input data or the model setup. Special care was given to the PacifiCorp power plants emissions for the various scenarios. SMOKE reports were generated to review that the correct elevated source have been selected as elevated and plume-in-grid has been included.

3.4 CAMx Model Inputs

In addition to meteorological and emissions data, CAMx requires other ancillary data to configure each simulation. The purpose of the CAMx ancillary data is to set initial conditions (IC) and boundary conditions (BC), define the chemical mechanism, describe the photochemical conditions, and describe surface characteristics. CAMx modeling inputs include:

- CAMx-ready three-dimensional (3-D) hourly meteorological fields generated by WRFCAMx, the processor used to prepare input meteorology files from the WRF output;

- Two-dimensional low-level (surface layer) emissions and elevated point source emissions generated by the SMOKE emissions processor;
- Initial conditions (IC) and boundary conditions (BC) generated by the CAMx IC/BC processors. The 36-km domain lateral boundaries concentrations in the WAQS are based on the Model for Ozone and Related chemical Tracers (MOZART) global chemistry model;
- Albedo/Haze/O_3 Column input file;
- Photolysis rates look up table; and
- Land use and topography data.

Table 3-1 summarizes the CAMx configuration used for this study. This assessment leverages the three-dimensional 12-km 2025 future-year outputs provided by the WAQS to set ancillary files such as the boundary and initial conditions of the computational domain defined in Chapter 2. This approach ensures consistency with the original modeling platform. The CAMx simulations use the vertical layers described in **Table 2-8**. The Piecewise Parabolic Method (PPM) advection solver is used along with the spatially varying horizontal diffusion approach. Vertical diffusion in CAMx is modeled by K-theory. This study is consistent with the original WAQS modeling platform that used a specific meteorology and CAMx version for the winter period (defined as January 1 to March 31).

Table 3-1: CAMx Air Quality Model Configurations

Science Options	Configuration	Details
Model Version	CAMx V6.10 CAMx V6.40	V6.10 used for April to December V6.40 used for January to March
Vertical Grid Mesh	25 vertical layers collapsed from WRF's 37 vertical layers structure	Layer 1 thickness ~24- m. Model top at ~19-km (AGL)
Grid Interaction	One-way nesting for the 4-km domain.	This assessment relies on the modeling output for the WAQS 12-km domain.
Plume-in-Grid (PiG)	Invoke PiG for all the units for the three PacifiCorp power plants	Subgrid-scale plume chemistry and dynamics module used for PacifiCorp power plants
Initial Conditions	7 day spin-up for 4-km domain simulations	4-km IC derived from 12-km modeling results
Boundary Conditions	36-km from MOZART global chemistry model	4-km boundary conditions derived from 12-km modeling results. Increased ammonia concentrations along northern boundary by a factor of 7.51 for January, February and December
Chemistry		
Gas Phase Chemistry	CB6r2	Carbon Bond 6 version 2 for the entire year
Aerosol Chemistry	Inorganic aerosol thermodynamics/partitioning model (ISORROPIA) equilibrium	
Cloud Chemistry	Regional Acid Deposition Model (RADM)-type aqueous chemistry	
Meteorological Processor	WRFCAMx	Compatible with CAMx v6.10
Horizontal Transport	K-theory with grid size dependent coefficient of horizontal eddy diffusion	

Table 3-1: CAMx Air Quality Model Configurations

Science Options	Configuration	Details
Vertical Transport	K-theory (CMAQ-like in WRFCAMx)	Lower limit of vertical eddy diffusivity = 0.1 m^2/s or 2.0 m^2/s. Land use dependent
Deposition Scheme	Zhang dry deposition and CAMx-specific formulation for wet deposition	Ammonia deposition velocity rates are decreased by setting the parameter RSCALE to 1 for January, February and December
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI)	
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Integration Time Step	Wind speed dependent	~0.1-1 min (4-km), 1-5 min (12-km), 5-15 min (36-km)

As described above, meteorological inputs for CAMx are generated with the WRFCAMx processor and the emissions inputs are generated with the SMOKE model. In addition to the meteorology and emissions inputs, CAMx requires ancillary data, including initial and boundary concentrations for all chemical species, and O_3 column data for calculating photolysis rates. The sources of these ancillary data are described below.

After the model is configured, PGM applications typically require a model performance evaluation (MPE) that compares model results with available observations. The MPE provides valuable information on the ability of the model to reproduce the processes that lead to the formation of pollutants. Detailed information on the MPE for this application is presented in Section 3.5. However, is important to note here that at the suggestion of the USEPA, a separate analysis presented in **Appendix A**, was conducted to evaluate the ammonia concentrations along the lateral boundaries of the 4-km computational domain. This analysis has led to two changes from the original WAQS modeling:

1. Increased ammonia through the northern lateral boundary conditions of the 4-km domain
2. Reduction of ammonia deposition velocity rates by setting the RSCALE parameter to 1

The changes are intended to improve the model performance for ammonia ambient concentrations in this study. Both modifications were performed for the months of January, February and December which are more representative of the climatological winter period in Utah.

3.4.1 Initial and Boundary Concentration Data

Additional input data required for photochemical grid model simulations include the three-dimensional concentration fields of chemical species to initialize the model, and concentrations of chemical species at the lateral boundaries of the 4-km domain.

Typically, initial concentration values are created by performing a model spin-up simulation. The CAMx spin-up simulation is initialized using initial concentrations meant to represent clean atmospheric conditions and then continues using emissions and meteorological data for a pre-determined period. The three-dimensional initial concentrations generated from a spin-up simulation are more representative of actual ambient concentrations than default initial values. The results of the CAMx spin-up simulation are then used to initialize the CAMx modeling simulations, thereby eliminating the influence of the default initial concentration values.

The boundary concentration data for the WAQS 36-km modeling domain were derived from average concentrations of a 2011 MOZART global simulation. The MOZART horizontal and vertical coordinate systems were interpolated to the CAMx Lambert-Conformal Conic Projection. The MOZART chemical species also are mapped to the CB6r2 chemical mechanism used in CAMx. It should be noted that because adverse model performance impacts were observed from excessive dust and sea salt particle concentrations entering the modeling domains from the outer boundary using MOZART in the WAQS 2011 base year simulation (IWDW 2016a and 2016b), both the dust and sea salt concentration were ultimately zeroed out for the CAMx boundary conditions.

For the 4-km computational domain used in this assessment, both the lateral boundary conditions and initial conditions have been derived from the three-dimensional concentrations available for the 12-km domain WAQS modeling results. The 4-km modeling for all scenarios were initialized with this data and the spin-up simulations performed for 7 days. To reduce the time required for annual model simulations, these were performed in separate runs of 3 months, each with their corresponding spin-up period. For this assessment all the vertical layers along the northern lateral boundary conditions were modified to increase the ammonia concentrations by a factor of 7.51 which is consistent with the analysis presented on **Table A-4** (**Appendix A**).

3.4.2 Photolysis Rates

Several chemical reactions in the atmosphere are initiated by the photo-dissociation of various trace gases. Accurate estimates of these photo-dissociation rates should be made to represent the complex chemical transformations in the atmosphere. The CAMx model AHOMAP processor prepares albedo/haze/O_3 column input files for CAMx. The CAMx total ultraviolet (TUV) preprocessor then calculates a table of clear-sky photolysis rates for each grid cell for a specific date. TUV accounts for environmental parameters that influence photolysis rates including solar zenith angle, altitude above the ground, surface ultraviolet albedo, aerosols (haze), and stratospheric O_3 column. Photolysis rates are derived for each grid cell assuming clear sky conditions as a function of five parameters including solar zenith angle, altitude, total O_3 column, surface reflectivity, and atmospheric turbidity. The CAMx version of TUV is modified to output information in a format directly compatible with CAMx for the CB6r2 chemical mechanism.

The surface ultraviolet albedo is calculated based on the gridded land use data using land use-specific ultraviolet (UV) albedo values. The albedo varies spatially according to the land cover distribution, but typically does not vary with time.

3.5 Model Performance Evaluation

This section provides a summary of the Model Performance Evaluations (MPE) for both the meteorological and photochemical models that conform the 2011b WAQS modeling platform. The MPE results help to understand and evaluate the biases, errors and limitations of the modeling platform and therefore the limitations of any subsequent analysis derived from the 2011b WAQS. Additionally, this section provides a summary of limited MPE that focuses only on the effects of changing ammonia concentrations discussed in Section 3.4 above and fully detailed in **Appendix B**.

3.5.1 Meteorological Model Performance Evaluation

Both qualitative and quantitative MPEs were performed to evaluate the WRF model for the 2011 base year annual simulation. The goal of this type of evaluation was to determine whether the meteorological fields are sufficiently accurate for the air quality model to properly characterize the transport, chemistry, and removal processes. Also, to provide a reasonable meteorological characterization, the WRF model should reproduce the large-scale patterns; mesoscale and regional wind, temperature, PBL height, humidity, cloud and precipitation patterns; mesoscale circulations such as sea breezes and mountain-drainage circulations; and diurnal cycles in PBL depth, temperature, and humidity. The details of the model performance can be found in 3SAQS Weather Research Forecast 2011 Meteorological Model Application/Evaluation Report (UNC and Ramboll Environ 2015). While the WRF model performance statistics showed good overall performance benchmarks for surface winds, temperature, and mixing ratios across the 4-km WAQS and 12-km domains on a domain-wide and state-by-state basis, it showed some limitations:

- WRF exhibited some difficulties simulating the nighttime temperature inversion in regions with mountainous terrain. It was found that warm bias at night in Utah during the winter months and cool bias during nighttime hours in other areas.
- WRF consistently under-predicted wind speed by about 0.5 m/s throughout the entire year across much of the modeling domains.
- A distinct seasonal pattern in mixing ratio bias was observed, in which WRF generally over-predicted the mixing ratio in the cooler months and under-predicted during the warmer months across much of the modeling domain.

In general, WRF reproduced well the spatial distribution and magnitudes of the Parameter-elevation Relationships on Independent Slopes Model (PRISM) monthly precipitation analysis fields during all seasons except summer when WRF monthly precipitations showed greater differences from the PRISM analysis fields during monsoon conditions.

3.5.2 Air Quality Model Performance Evaluation

As stated in Chapter 1, the WAQS performed photochemical grid modeling for the year 2011 using CAMx version 6.10. The WAQS also conducted a model performance evaluation for the WAQS 2011 base year simulation version B (Adelman et al 2016) for a wide range of air pollutants and air quality related values, including ozone, $PM_{2.5}$, wet deposition, and light extinction. Since the focus of this assessment is the evaluation of visibility impacts, we summarize here the MPE results for $PM_{2.5,}$ as well as the light extinction MPE to disclose any limitations of the model for this study.

The WAQS MPE showed that on an annual and domain-wide basis, total $PM_{2.5}$ and all its components except nitrate (NO_3), were within both performance criteria for bias (≤±60%) and error (≤±75%). CAMx showed significant under-prediction or NO_3 when comparing ambient monitoring data. The MPE indicates that nitrate is underestimated in all seasons, which could be due in part the result of overestimation of NO_3 deposition. However, it is more likely that the sources underestimate urban NO_x emissions. For the state of Utah, the WAQS MPE indicates that the model shows good agreement for total $PM_{2.5}$. The compositional differences relative to IMPROVE observations state-wide in Utah show large underestimates in organic carbon (OC), ammonium (NH_4) and NO_3, and overestimates in other-PM and sulfate (SO_4).

In general, when comparing reconstructed light extinction to the IMPROVE estimates, CAMx slightly under-estimates total light extinction across the 4-km domain and in Colorado, Wyoming, and Utah, despite some the differences that exist between species in different parts of the modeling domain. The CAMx annual average light extinction showed that the model underestimates the SO_4 contribution, which is offset by over-estimates of the sea salt contribution at many of the IMPROVE sites. CAMx also under-estimated the contribution of soil to light extinction, which is likely due to the over-correction of the boundary condition dust in simulation Base 11b.

The MPE results presented in Adelman et al. (2016) for the 2011b WAQS modeling platform indicate that the performance for ambient ammonia could be improved. This species is relevant since it is a precursor with an important effect in the formation of both particulate sulfate and nitrate. At the suggestion of the USEPA, we evaluated the differences in ammonia concentrations along the lateral boundaries of the 4-km computational domain. This analysis can be found in **Appendix A**. The analysis suggests that two changes in the modeling could have an impact to address the modeled ammonia under-prediction with the original 2011b platform.

The combined changes to the boundary concentrations and the ammonia deposition velocity required a characterization of the effect on the formation of secondary particulate formation. A revised MPE was performed using the 4-km domain definition and provided in detail in **Appendix B**. The model performance was assessed for a select subset of ambient air particle-phase pollutants for a three-month period that represents winter conditions, namely January, February and December. The MPE results showed that:

1) Model performance for sulfate between the original WAQS and the revised modeling with ammonia adjustments is extremely similar for all the months analyzed. The original WAQS results showed a consistent over-prediction of model-predicted sulfate concentrations. The adjusted model performance for sulfate shows that the changes to ammonia have almost no noticeable effect in the formation of sulfate in the Class I areas within the computational domain.
2) The WAQS performance shows systematic under-prediction of nitrate, ammonia and ammonium concentrations for all the months analyzed. The adjusted model simulations show that the ammonia configuration adjustments lead to significantly higher concentrations these species. Some species such as nitrate and ammonium now show slight over-predictions for certain months.
3) For ammonia, the adjusted model simulations still show under-predict concentrations relative to the observations. However, for all months the magnitude of negative biases gets reduced, which indicates better model performance.

In summary, the ammonia adjustments performed over the original 2011b WAQS modeling platform and explicitly simulated for this study's 4-km computational domain showed significant improvements in the model-predicted concentrations of sulfate, nitrate, ammonium and ammonia during the months of January, February and December when higher contributions of nitrate are expected to affect visibility in Class I areas.

3.6 PM Source Apportionment Technique

The CAMx Particulate Source Apportionment Technology (PSAT) (Yarwood et al. 2004) was used to obtain an estimate of the contributions to PM and the corresponding visibility impairment in the future-year modeling analyses from each of the PacifiCorp power plants. PSAT provides source-category apportionment of modeled PM by individual species. PSAT has been developed to retain the advantage of using a grid model to describe the chemistry of secondary PM formation and provide an estimate of the contribution from individual sources, or groups of sources, to the total modeled concentration. PSAT was invoked to explicitly tag and track the contributions to PM from each PacifiCorp Power Plant within the modeling domain. The PSAT configuration in CAMx was setup to include the following tracers: Sulfur (Sulfate tracers), nitrogen (nitrate and ammonium tracers) and primary particulate matter (elemental carbon, organic aerosol, crustal PM tracers). Due to the relatively small modeled concentrations of secondary organic aerosols (SOA) from the power plants emissions, and the relatively large runtime penalty of the SOA PSAT mechanism, SOA was not selected to be part of the PSAT tracers for this study.

4.0 Visibility Impacts

This chapter describes the methodology used to assess the potential visibility impacts of the PacifiCorp's power plants, detailing how CAMx modeling results were post-processed into visibility estimates. In addition, this chapter compares the visibility impacts between the USEPA FIP and the Utah SIP modeling scenarios.

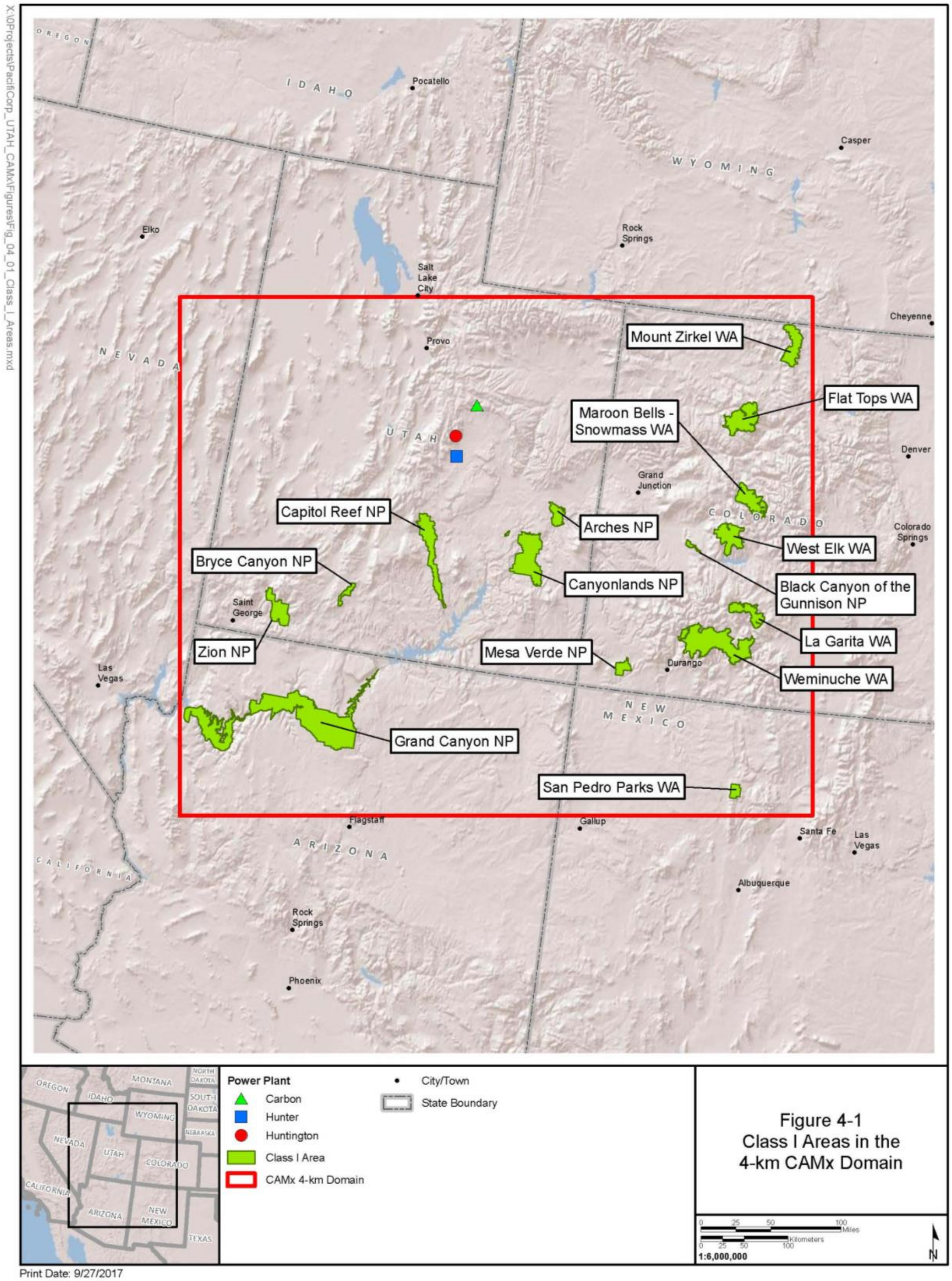
4.1. Visibility Impact Assessment Method

The CAMx configuration described in Chapter 3.0 was used to run the modeling scenarios described in Chapter 2.0. As configured, the CAMx model produces hourly results of both cumulative air quality concentrations and PacifiCorp's power plant contribution to PM species at every grid cell. The ultimate objective is to isolate the changes in visibility due to the different emissions scenarios described here. To assess compliance with Regional Haze Rule requirements, visibility changes are assessed during the 20 percent best visibility days and the 20 percent worst visibility days at each potentially affected, federally regulated Class I area. The following Class I areas were identified as having a potential to be affected by PacifiCorp's power plants. **Figure 4-1** shows the locations of these areas, the extent of the 4-km modeling domain, and the location of the power plants:

1. Grand Canyon National Park (NP)
2. Arches NP
3. Black Canyon of the Gunnison NP
4. Bryce Canyon NP
5. Canyonlands NP
6. Capitol Reef NP
7. Mesa Verde NP
8. Zion NP
9. Flat Tops Wilderness Area (WA)
10. Mount Zirkel WA
11. Maroon Bells-Snowmass WA
12. West Elk WA
13. La Garita WA
14. Weminuche WA
15. San Pedro Parks WA

Future visibility conditions at the Class I areas listed above are estimated for all three future-year modeling scenarios. To convert model concentrations into visibility conditions and account for quantifiable model bias, the most recent version (v1.2) of USEPA's Software for Model Attainment Test – Community Edition (SMAT-CE) (USEPA 2015b) is used. More information about the SMAT-CE tool, its purpose, and how it is configured for this analysis is provided in the section below. Once visibility estimates are calculated using SMAT-CE for each model scenario, the process is repeated modifying the inputs to isolate PacifiCorp units' visibility impacts for each model scenario. As a final step, results from the Utah SIP scenario are compared to the Baseline and USEPA FIP scenarios to determine which has the least impact on visibility.

Figure 4-1: Class I Areas in the 4-km CAMx Domain



The following steps were performed to generate visibility impacts estimates:[2]

1. Apply SMAT-CE. Repeat this process three times, once for each of the three modeling scenarios relative to the Typical Year. This step provides the 'cumulative' visibility conditions from all the regional sources, including PacifiCorp's power plants, for each model scenario.
2. Subtract PacifiCorp's power plants concentrations estimated with PSAT from the cumulative air quality concentrations. Repeat this process three times, once for each of the three modeling scenarios and the associated PacifiCorp's power plants contributions to those scenarios. This step provides estimates of cumulative air quality concentrations, excluding PacifiCorp's power plants, for each of the three modeling scenarios.
3. Apply SMAT-CE using the regional concentrations derived in Step 2 which exclude PacifiCorp's power plants contributions. Repeat this process three times, once for each of the three modeling scenarios. This step provides the 'cumulative' visibility conditions from all regional sources, excluding PacifiCorp's power plants, for each modeling scenario.
4. Subtract the cumulative visibility estimates without PacifiCorp's power plants (derived in Step 3) from the cumulative visibility estimates with PacifiCorp's power plants (derived in Step 1). Repeat this process three times, once for each of the three modeling scenarios. This step provides estimates of PacifiCorp's power plants contributions to visibility impacts for each modeling scenario.
5. Subtract the results of Step 4 for the Baseline scenario from Utah SIP scenario. This step provides the predicted visibility benefits from the Utah SIP scenario relative to the Baseline.
6. Subtract the results of Step 4 for the USEPA FIP scenario from the Utah SIP scenario. This step provides the predicted visibility benefits from the Utah SIP scenario relative to USEPA FIP.

Results from the steps above are evaluated in a similar manner to the Cross-State Air Pollution Rule (CSAPR) (USEPA 2011) and the Clean Air Interstate Rule (CAIR) (USEPA 2005a). The visibility improvements from two emissions strategies can be compared using a "better-than-USEPA FIP" assessment that consists of a two-pronged test. Under the first prong, visibility must not decline at any Class I area for the Utah SIP scenario when compared to baseline visibility conditions (i.e., the Baseline scenario). This prong is satisfied if the difference between the Utah SIP scenario and the Baseline scenario is negative or zero at each Class I area. Under the second prong, the average visibility over all Class I areas must be better under the Utah SIP scenario than under the USEPA FIP scenario. For the second prong, the average visibility improvement over all affected Class I areas must be negative or zero. It is acceptable if some Class I areas show greater improvement under the USEPA FIP scenario, if the average improvement is larger under the Utah SIP scenario. The objective of these tests is to evaluate the visibility impacts under the Utah SIP scenario and determine if the predicted visibility will be better than the USEPA FIP.

4.2. The SMAT-CE Tool, Visibility Calculation Method, and SMAT-CE Configuration Options

For this analysis, visibility impacts are assessed using SMAT-CE version 1.2 (USEPA 2015b). SMAT-CE provides model-adjusted impacts that are consistent with USEPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of the Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" (USEPA 2014b). All models are affected by biases, i.e. model results are a simplification of natural

[2] Steps 1 through 4 are necessary to isolate PacifiCorp's power plant visibility contribution because SMAT-CE requires cumulative air quality concentrations, rather than single source concentrations from PSAT.

phenomena and, as such, model results tend to over- or under-estimate true impacts. The use of SMAT-CE aids in mitigating model bias by pairing model estimates with actual measured conditions.

SMAT-CE calculates baseline and future-year visibility levels for both the 20 percent best and 20 percent worst days for each Class I Area. To do this, SMAT-CE adjusts the modeled air quality concentrations based on measured air quality concentrations to account for possible model bias utilizing the relative response factor approach described below. Within SMAT-CE, model-predicted concentrations of chemical compounds that scatter or absorb light are converted to estimates of light extinction using the IMPROVE equation (Hand and Malm 2006). The IMPROVE equation reflects empirical relationships derived between measured mass of PM components and measurements of light extinction at IMPROVE monitoring sites in Class I areas. The IMPROVE equation calculates light extinction as a function of relative humidity for large and small particulate matter. As a final step in SMAT-CE, light extinction values are converted into deciviews (dv), a measure for describing the ability for the human eye to perceive changes in visibility.

The USEPA guidance for estimating future-year visibility levels recommends using the photochemical grid model results in a relative sense to scale the visibility current design values (DVC). The visibility DVCs are based on a 5-year average of monitored IMPROVE data centered on the typical modeling year. For this analysis, the Typical Year is 2011, so the 5-year period centered on 2011 is 2009 through 2013.

Scaling factors, called relative response factors (RRFs), are calculated from the modeling results. RRFs are applied to the DVC to predict future-year design values (DVF) at a given monitoring location using the following equation:

$$DVF = DVC \times RRF$$

RRFs are the ratio between the model-predicted concentrations in the future-year modeling scenario and the Typical Year modeling scenario. RRFs are calculated for each individual chemical component that contributes to light extinction based on the model grid cells surrounding a monitoring site.

SMAT-CE depends on IMPROVE monitors to assess visibility impacts. Notice that of the Class I areas selected for analysis, the following do not have an IMPROVE monitor within their boundaries:

- Arches NP
- Black Canyon of the Gunnison NP
- La Garita WA
- Maroon Bells-Snowmass WA
- West Elk WA
- Flat Tops WA

However, SMAT-CE can estimate visibility impacts at areas without a monitor by assigning a representative IMPROVE monitor following the **Appendix A**, **Table A-2** of “Guidance for tracking Progress Under the Regional Haze Rule”[3]. Representative monitors are generally close to the Class I area.

SMAT-CE was configured using the settings provided in **Table 4-1** and was run with the modeling results for each of the future-year 2025 modeling scenarios. Cells highlighted in **Table 4-1** represent the values recommended for this study that are different from SMAT-CE defaults. Highlighted changes are necessary

[3] “Guidance for Tracking Progress Under the Regional Haze Rule”
http://www.epa.gov/ttn/oarpg/t1/memoranda/rh_tpurhr_gd.pdf

to accurately incorporate the model year selected for the Typical Year and other data that is dependent on the Typical Year.

Table 4-1: SMAT-CE Configuration Settings

Option	Main category	Setting	Default	This Study
Desired Output	Scenario Name	Name		
	Forecast	Temporally-adjust visibility levels at class 1 area	Yes	Yes
		Improve algorithm	use new version	use new version
		Use model grid cells at monitors	Yes	Yes
		Use model grid cells at class 1 area centroid	No	No
	Actions on run completion	Automatically extract all selected output files	Yes	Yes
Data Input	Monitor data	File name	ClassIareas_NEWIMPROVEALG_2000to2015_2017feb13_TOTAL.csv	ClassIareas_NEWIMPROVEALG_2000to2015_2017april27_TOTAL.csv
	Model data	Baseline file	SMAT.PM.Large.12.SE_US2.2011eh.camx.grid.csv	Typical Year 2011 4-km model results[1]
		Forecast file	SMAT.PM.Large.12.SE_US2.2017eh.camx.grid.csv	Future-year 2025 4-km model results[2]
	Using model data	Temporal adjustment at monitor	3x3	3x3
Filtering	Choose visibility data years	Start monitor year	2009	2009[3]
		End monitor year	2013	2013[3]
		Base model year	2011	2011[3]
	Valid visibility monitors	Minimum years required for valid monitor	3	3

[1] Baseline file changed from default (2011) to the Typical Year (2011) modeling results.

[2] Forecast file changed from default (2020) to the modeling results of the future-year (2025) scenarios for this analysis. SMAT-CE was run three times changing this setting as there are three modeling scenarios: USEPA FIP, PacifiCorp and Baseline.

[3] The values for the Start, End and Base model years are set to reflect a base year centered on the Typical Year (2011) and to perform the current design value calculation with the 5-year period surrounding this year (2009 to 2013).

4.3. Assessment Results

Tables 4-2 and **4-3** show the projected contribution to visibility on the 20 percent best days and worst days due to PacifiCorp's power plants in Utah. Both tables present the estimates for the Baseline (Column A), USEPA FIP (Column B) and Utah SIP (Column C) scenarios at each of the 15 Class I areas. The last two columns show the predicted visibility benefits from Utah SIP scenario relative to both the Baseline (Column D) and the FIP (Column E). Also shown at the bottom row are the average visibility values from all the areas. Negative values in Column D indicate that the Utah SIP scenario has smaller contributions to visibility relative to the baseline and therefore it improves visibility over the baseline. Similarly, negative values in Column E indicate that the Utah SIP scenario improves visibility relative to the USEPA FIP.

Table 4-2: Visibility Impacts for the 2025 Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Best Days

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Black Canyon of the Gunnison NM	0.02769	0.01611	0.01162	-0.01607	-0.00449
Bryce Canyon NP	0.00528	0.00254	0.00228	-0.00300	-0.00026
Canyonlands NP	0.10300	0.05607	0.03851	-0.06449	-0.01756
Capitol Reef NP	0.14218	0.07222	0.07140	-0.07078	-0.00082
Flat Tops WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Grand Canyon NP	0.07136	0.03567	0.03611	-0.03525	0.00044
La Garita WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
Maroon Bells-Snowmass WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Mesa Verde NP	0.06356	0.03381	0.02749	-0.03607	-0.00632
Mount Zirkel WA	0.04209	0.02060	0.01471	-0.02738	-0.00589
San Pedro Parks WA	0.03627	0.01742	0.01593	-0.02034	-0.00149
Weminuche WA	0.02769	0.01611	0.01162	-0.01607	-0.00449
West Elk WA	0.02834	0.01488	0.01115	-0.01719	-0.00373
Zion NP[1]	0.00612	0.00291	0.00300	-0.00312	0.00009
All Class I Area Average	**0.04940**	**0.02602**	**0.02108**	**N/A**	**-0.00494**

[1] Results based on incomplete dataset. Zion NP monitor did not meet the 75% data completion SMAT requirement for year 2011.

Table 4-2 shows that the PacifiCorp's emissions for the Utah SIP scenario will not result in degradation of visibility on the 20 percent best days compared to the Baseline conditions at any of the analyzed 15 Class I areas. In each individual area, visibility is predicted to improve compared to the Baseline visibility, since all the values shown in Column D are negative.

In general, the Utah SIP scenario shows an average improvement in visibility of 0.00494 dv relative to the USEPA FIP for the best 20 percent days. **Table 4-2** also shows that for the Utah SIP scenario, visibility during the best days improves at all Class I areas compared to the USEPA FIP except for Grand Canyon NP and Zion NP.

Table 4-3 shows that PacifiCorp's emissions will not result in degradation of visibility on the 20 percent worst days compared to the Baseline conditions at any of the analyzed 15 Class I areas. In each individual area, visibility is predicted to improve compared to the Baseline visibility, since all values in Column D are negative.

Table 4-3 indicates that for the Utah SIP scenario, visibility during the 20 percent worst days improves at all Class I areas compared to the USEPA FIP scenario except at Bryce Canyon NP, Capitol Reef NP and Mesa Verde NP. An additional analysis that compares the modeled nitrate and sulfate concentrations at these three parks for both the Utah SIP and USEPA FIP scenarios is provided in **Appendix C**. This analysis in Appendix C shows that the impacts, particularly at Capitol Reef NP, are mostly due to high nitrate concentrations during a few days during the winter, while the benefits of reduced sulfate concentrations occur over the entire period of the 20 percent worst days. The modeling results in **Table 4-3** indicate that the Utah SIP scenario passes the second-prong test since it shows an average improvement in visibility of 0.00058 dv relative to the USEPA FIP for the 20 percent worst days.

Table 4-3: Visibility Impacts for the 2025 Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Worst Days

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Black Canyon of the Gunnison NM	0.01265	0.00682	0.00540	-0.00725	-0.00142
Bryce Canyon NP	0.04945	0.02184	0.02470	-0.02475	0.00286
Canyonlands NP	0.25740	0.13780	0.12584	-0.13156	-0.01196
Capitol Reef NP	0.26010	0.11672	0.14568	-0.11442	0.02896
Flat Tops WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Grand Canyon NP	0.00186	0.00089	0.00056	-0.00130	-0.00033
La Garita WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
Maroon Bells-Snowmass WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Mesa Verde NP	0.06203	0.02524	0.02959	-0.03244	0.00435
Mount Zirkel WA	0.03312	0.01705	0.01198	-0.02114	-0.00507
San Pedro Parks WA	0.00154	0.00074	0.00073	-0.00081	-0.00001
Weminuche WA	0.01265	0.00682	0.00540	-0.00725	-0.00142
West Elk WA	0.02703	0.01387	0.01011	-0.01692	-0.00376
Zion NP[1]	0.00155	0.00051	0.00051	-0.00104	0.00000
All Class I Area Average	**0.06957**	**0.03471**	**0.03413**	**N/A**	**-0.00058**

[1] Results based on incomplete dataset. Zion NP monitor did not meet the 75% data completion SMAT requirement for year 2011.

The results presented in this assessment focused on the five-year period 2009 to 2013 centered on year 2011 as indicated in **Table 4-1**. Visibility impacts obtained with SMAT-CE for two additional periods are detailed in **Appendix D**. As noted in this chapter the results for Zion NP are based on an incomplete monitoring dataset, and **Appendix D**, provides an assessment for Zion NP when the data is over 75% complete. The visibility assessment for the additional periods also indicate that for both the 20 percent and 20 percent worst the Utah SIP will lead to better visibility improvements over the USEPA FIP.

In summary, modeling results indicate that the Utah SIP scenario will not cause degradation of visibility relative to the Baseline at any of the analyzed Class I areas during either the 20 percent best or 20 percent worst visibility days. Furthermore, modeling results show that, on average, visibility improvement at the analyzed Class I areas is greater for the Utah SIP than for the USEPA FIP scenario during both the 20 percent best and worst visibility days.

5.0 Summary

The photochemical grid model Comprehensive Air Quality Model with Extensions (CAMx) was used to estimate and compare the potential visibility impacts at selected Class I areas for different emissions scenarios considered for PacifiCorp's Hunter, Huntington and Carbon power plants in Utah. The CAMx modeling system was used in this analysis because its technical formulation is considered state-of-the-science and accounts for complex processes such as the chemistry, transport and deposition of particulate pollutants responsible for regional haze.

This analysis uses the Western Air Quality Modeling Study (WAQS) modeling platform, which is a publicly available platform intended to facilitate air resource analyses in the western United States.

The CAMx system was configured using the WAQS configuration settings to simulate future-year 2025 visibility conditions for different modeling scenarios. The only differences among scenarios are the emission rates for PacifiCorp's power plants in Utah. The three modeling scenarios include:

- Baseline Scenario. This scenario simulates representative emissions from Carbon, Hunter and Huntington power plants during the period 2001 to 2003.
- USEPA FIP Scenario. This scenario simulates the emission control strategy for Hunter and Huntington units stipulated by the USEPA in the FIP. The Carbon power plant is modeled with the same level of emissions as the Baseline scenario.
- Utah SIP Scenario. This scenario simulates the emission control strategy from Utah's SIP, using representative emissions from Hunter and Huntington units during the period 2014 to 2016 when the SIP controls were installed. For the SIP scenario, the Carbon power plant emissions were zero since the power plant was decommissioned in April 2015, as required by the SIP.

Other than the emissions for the PacifiCorp power plants, all other model inputs, including other regional emissions sources, are identical for all future-year scenarios. Maintaining consistent model inputs enables comparison of the effects of different emissions scenarios. The Particulate Source Apportionment Technology (PSAT) tool was applied in the CAMx simulations to track and account for the particulate mass concentrations that originate from or are formed by PacifiCorp power plant emissions.

Once all the scenarios above were simulated with the PGM, model results were processed to isolate the changes to visibility conditions. To assess compliance with Regional Haze Rule requirements, visibility impacts were assessed for the 20 percent best visibility days and the 20 percent worst visibility days at each potentially affected, federally-regulated Class I area. Model-predicted visibility impacts at the fifteen Class I areas listed in Chapter 4 in the 4-km modeling domain were estimated for each of the three modeling scenarios.

To convert model concentrations into visibility estimates and account for quantifiable model bias, the USEPA's Software for Model Attainment Test – Community Edition (SMAT-CE) was used. Numerical models are often affected by biases, i.e. model results are a simplification of natural phenomena and, as such, model results over- or under-estimate true conditions. Using SMAT-CE in this assessment helped to mitigate model bias by pairing model estimates with actual measured conditions. Using PSAT two sets of model results were processed by SMAT-CE: the first was the total cumulative air quality concentrations, including PacifiCorp's units; the second is the total cumulative air quality concentrations excluding the target power plant. The difference between these two SMAT-CE runs was used to estimate the visibility impacts of PacifiCorp's power plants for each modeling scenario in a realistic manner.

As a final step, visibility impacts were compared between the Utah SIP, the Baseline and the USEPA FIP scenarios to determine which scenario has the least impacts on visibility. The model results (detailed in Chapter 4.0) indicate that the emissions modeled under the Utah SIP will not degrade visibility conditions relative to the Baseline scenario at any of the analyzed Class I areas during either the 20 percent best or 20 percent worst visibility days. The modeling results also show that, on average, visibility improvement at the analyzed Class I areas is greater under the Utah SIP than the USEPA FIP scenarios during both the 20 percent best and 20 percent worst visibility days.

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Appendix A Analysis of Ammonia Concentrations along Computational Domain's Lateral Boundaries

The visibility assessment of PacifiCorp's power plants presented in this document relies on the 2011b WAQS modeling platform. The 2011b WAQS photochemical model performance evaluation indicates that for the State of Utah during the fall and winter particulate nitrate is systematically under-predicted relative to available observations. The WAQS MPE also indicates that CAMx systematically under-predicts ammonia concentrations throughout the year. In consultation with EPA Region 8 and the Utah Division of Air Quality (UDAQ), it was determined that to improve particulates and ammonia performance in Utah, ammonia concentrations in the model could be increased by reducing the deposition velocity of this species (setting the parameter RSCALE to 1 in the CAMx chemistry parameter input) and by allowing increased ammonia concentrations to enter the modeling through the northern boundary to reflect the elevated ammonia emissions in northern Utah. This appendix provides a detailed analysis of the ammonia concentrations along the northern boundary of the computational domain defined in Chapter 2. The analysis compares the modeling results for ammonia concentrations from:

1) The 2011 modeling performed in support of the State Implementation Plan (SIP) by the Utah Division of Air Quality (UDAQ); and
2) The 2011b modeling performed for the Western Air Quality Study (WAQS).

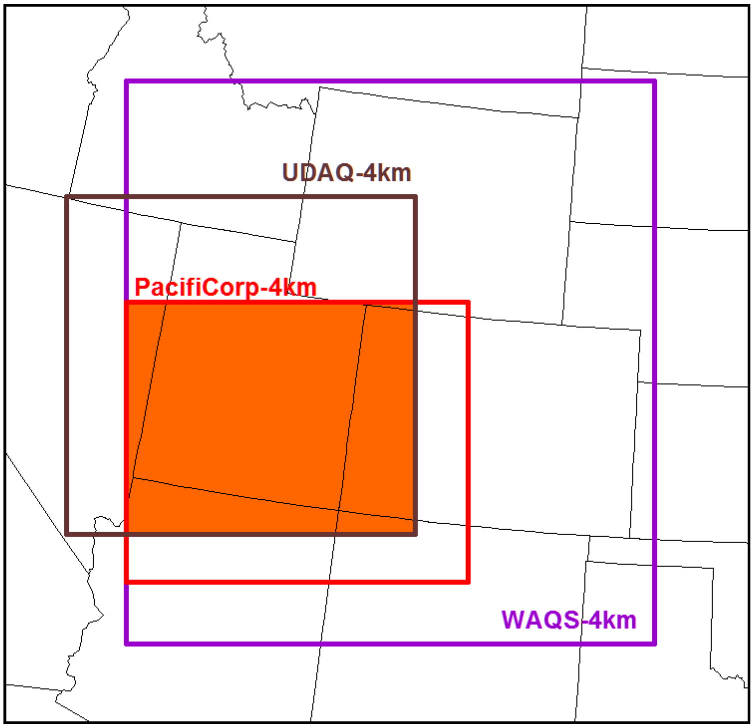
Table A-1 below identifies some of the differences relevant for this comparison.

Table A-2: Relevant Differences between UDAQ and WAQS Modeling

Category	UDAQ Modeling	WAQS Modeling
Period of simulation	January 1 - January 10	January 1 – December 31
Horizontal computational domain definition (4km grid)	Southwestern corner coordinate: (-1644km, -312km) Number of grid cells: 186x180	Southwestern corner coordinate: (-1516km, -544km) Number of grid cells: 281x299
Vertical Domain definition	41 vertical layers	25 vertical layers
Meteorology	Specific WRF simulation for the 10-day period performed by University of Utah (41 eta levels)	WRF simulation performed for the WAQS (37 eta levels)
Deposition Velocity	Modified to decrease ammonia deposition velocity (RSCALE = 1)	Default values for ammonia deposition velocity (RSCALE = 0)
Ammonia Surface Emissions	Modified to add additional emissions through ammonia injection for counties within Wasatch Front and Cache Valley	2011b WAQS ammonia emissions

Figure A-1 below compares the extent of horizontal 4-km computational domains for the original WAQS, UDAQ and this study. Notice that UDAQ's domain is not large enough to the east to encompass the entire northern boundary of this study's domain. Furthermore, there are approximately 28 cells (112 kilometers) along the northern boundary of this study's domain that are not part of UDAQ's modeling domain and therefore it is not possible to compare the concentrations in this region. The ammonia concentrations are compared for only those grid cells that are on the edges of the area that includes both this study's and UDAQ's modeling domains, which are indicated by the orange rectangle in **Figure A-1**. Only the edges of the domain are compared since the emissions inputs are different for the two studies.

Figure A-1: Comparison among 4-km Horizontal Computational Domains.



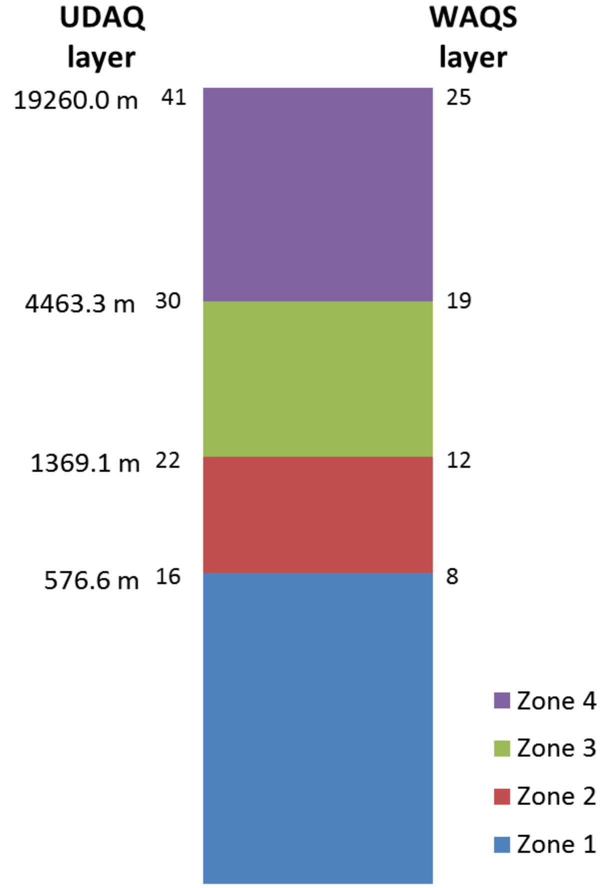
While in the main body of this report, the air quality concentrations for the only the surface layer were analyzed and reported consistent with similar analyses, the assessment of ammonia concentrations in this appendix compares modeled concentrations for various levels above the surface to have a more complete understanding of the ammonia concentration differences. As indicated in **Table A-1,** both modeling efforts used different WRF input data to drive the corresponding simulations. In addition to the differences on the meteorology, the definition of the vertical domains is different between the UDAQ's and WAQS simulations. This is an important difference that needs to be considered when comparing the concentrations along the northern boundaries. **Table A-2** provides the vertical layer interface definition for both WRF simulations and the vertical layers used in both CAMx simulations. Notice that the WAQS CAMx modeling used an approach that collapses multiple WRF layers into one layer. The table also provides the approximate height above surface in meters for the WAQS CAMx layers. We have confirmed that the base pressure at the top (1000 mbar) and at the bottom (50 mbar) of both WRF simulations are the same. Therefore, the rows and layers that have the same sigma values identically match between both modeling simulations. **Table A-2** illustrates the difficulties in matching the UDAQ's vertical structure to the WAQS. There are multiple ranges of vertical layers that would require further post-processing and averaging to make a one-to-one comparison of the ammonia concentrations. For efficiency in this analysis, the ammonia concentrations for every layer in each modeling simulation are plotted using **Table A-2** to visually guide the layer ranges that would be of comparable thickness.

Table A-2: Vertical Layer Interface Definition for UDAQ and WAQS WRF Simulations and Corresponding CAMx Layers.

UDAQ		WAQS		
WRF sigma	**CAMx Layer**	**WRF sigma**	**CAMx Layer**	**Approximate Height (m)**
0.0000	41	0.0000	25	19260.0
		0.0270		
		0.0600	24	15355.1
0.0500	40			
0.1000	39	0.1000		
0.1500	38	0.1500	23	11929.7
0.2000	37	0.2000		
0.2500	36	0.2500	22	9360.1
0.3000	35	0.3000		
0.3500	34	0.3500	21	7407.9
0.4000	33	0.4000		
0.4500	32	0.4500	20	5816.1
0.5000	31	0.5000		
0.5500	30	0.5500	19	4463.3
0.6000	29	0.6000	18	3854.1
		0.6400	17	3393.4
0.6500	28			
		0.6800	16	2953.7
0.7000	27			
		0.7200	15	2533.1
0.7400	26			
		0.7600	14	2129.7
0.7700	25			
0.8000	24	0.8000	13	1742.2
0.8200	23			
0.8400	22	0.8400	12	1369.1
0.8600	21			
		0.8700	11	1098.0
0.8800	20			
		0.8900	10	921.2
0.9000	19			
0.9100	18	0.9100	9	747.5
0.9200	17			
0.9300	16	0.9300	8	576.6
0.9400	15	0.9400		
0.9500	14	0.9500	7	408.6
0.9550	13			
0.9600	12	0.9600	6	325.6
0.9650	11			
0.9700	10	0.9700	5	243.2
0.9750	9			
0.9800	8	0.9800	4	161.5
0.9825	7			
0.9850	6	0.9850		
0.9875	5			
		0.9880	3	96.6
		0.9910		
0.9900	4			
		0.9930	2	56.2
0.9929	3			
0.9950	2	0.9950		
		0.9970	1	24.1
0.9976	1			
		0.9985		
1.0000		1.0000		0.0

Table A-2 shows selected rows highlighted in orange that correspond to identical sigma layers between both modeling simulations. A graphic representation of the range of CAMx layers in UDAQ's modeling that are comparable to the WAQS's is shown in **Figure A-2**. Subsequently, in this document we refer to each specific layer's range as zone 1 to zone 4, with zone 1 (blue in **Figure A-2**) directly above the surface followed by zone 2, zone 3 and zone 4 representing the very top layers of the model. **Figure A-2** provides a visual aid reference for the vertical concentrations comparisons in the next sections.

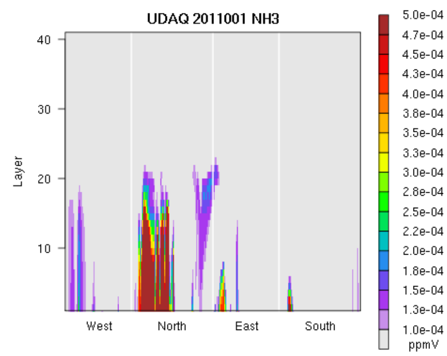
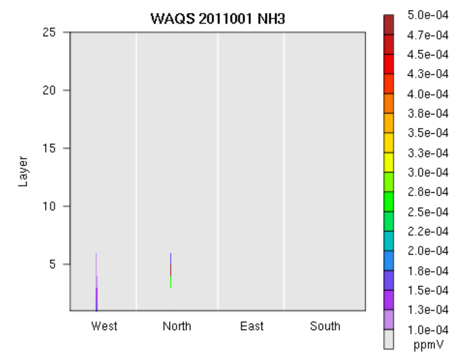
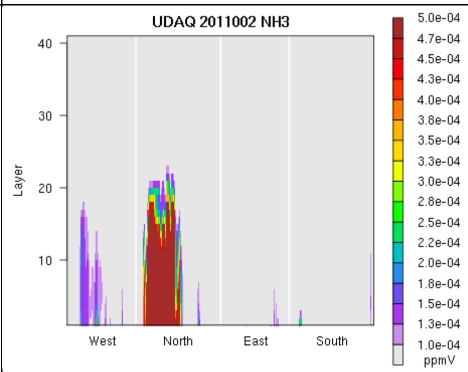
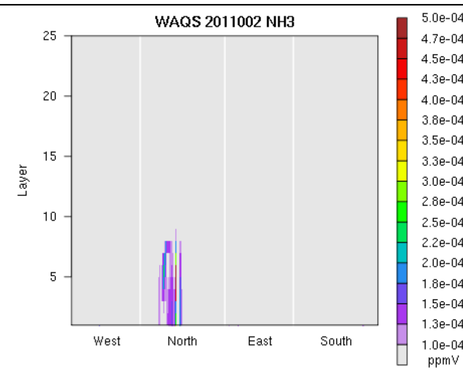
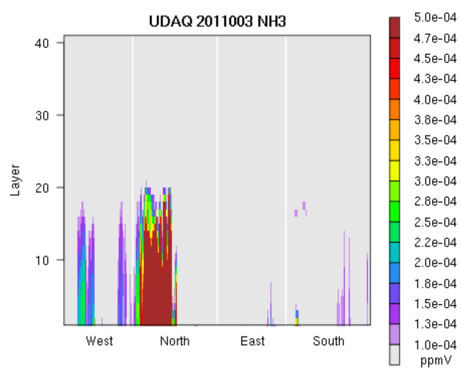
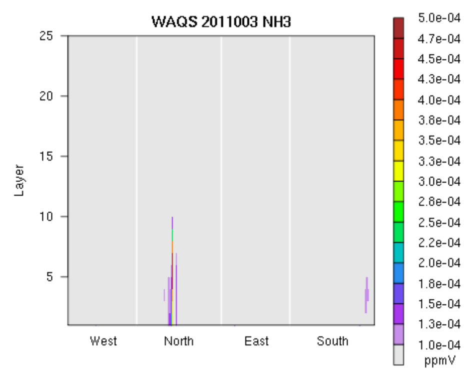
Figure A-2: Equivalent CAMx Layer Ranges between UDAQ and WAQS



<u>Graphical Comparison of Ammonia Concentrations along the Northern Boundary</u>

The modeling output for both UDAQ's and WAQS simulations was post-processed to compare the ammonia concentrations along the edges of the domain indicated in orange in **Figure A-1**. As a first step, daily average concentrations were produced for each of the 10 available days in January along all the boundaries as shown in **Figure A-3**. Ammonia concentrations along the northern boundary exhibit a spatial gradient with the largest values, generally, closer to the surface. The comparison between UDAQ's and WAQS modeling results illustrate that UDAQ's ammonia concentrations are consistently higher than those estimated from the WAQS for every single day.

Figure A-3: Comparison of Daily Average Ammonia Concentrations along the all the Boundaries between UDAQ and WAQS

Day	UDAQ	WAQS
Jan 1		
Jan 2		
Jan 3		

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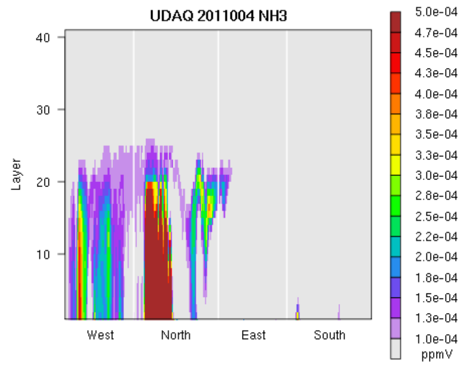
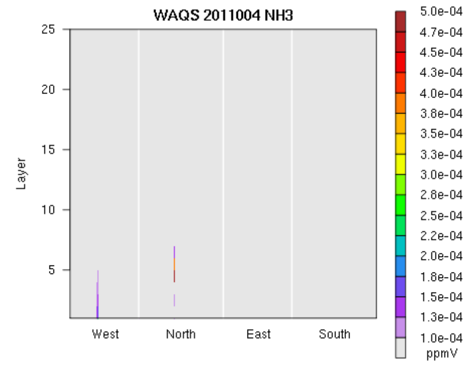
<tr><td>Jan 4</td><td>
</td><td>
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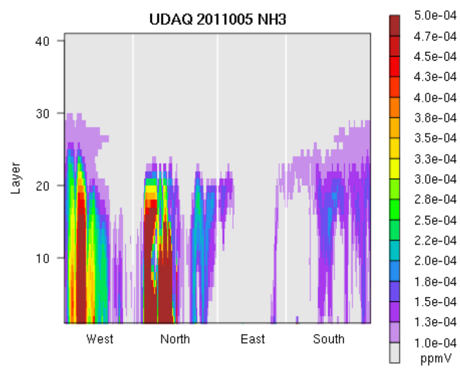
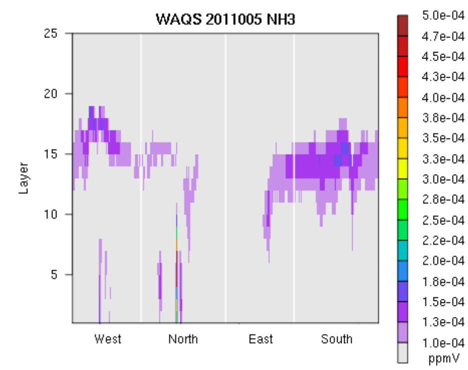
<tr><td>Jan 5</td><td>
</td><td>
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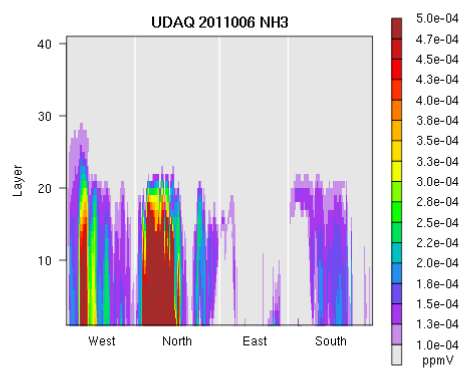
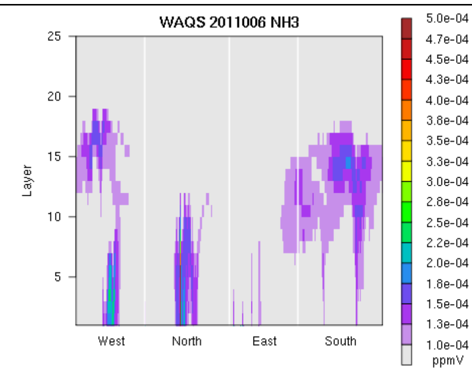
<tr><td>Jan 6</td><td>
</td><td>
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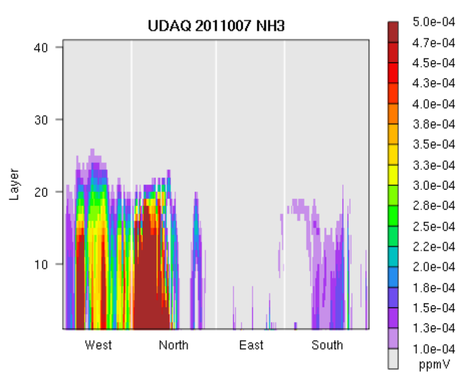
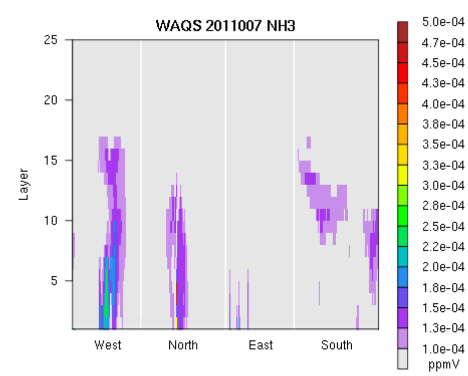
<tr><td>Jan 7</td><td>
</td><td>
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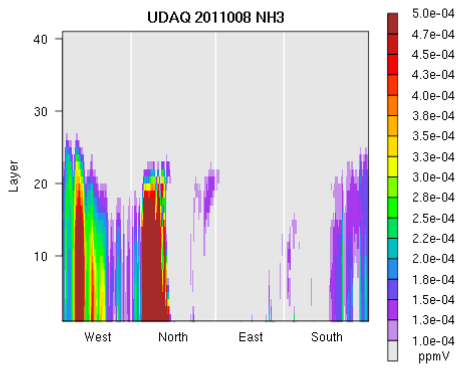
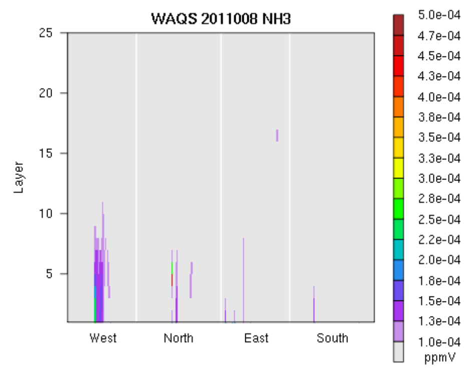
<table>
<tr><th>Day</th><th>UDAQ</th><th>WAQS</th></tr>
<tr><td>Jan 8</td><td>
</td><td>
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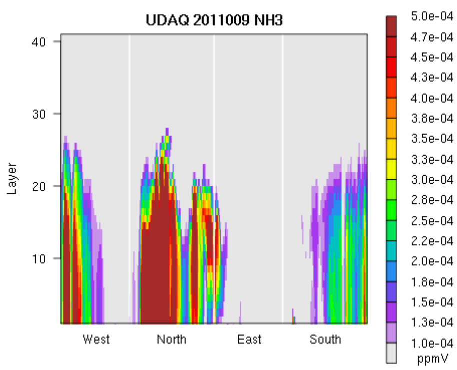
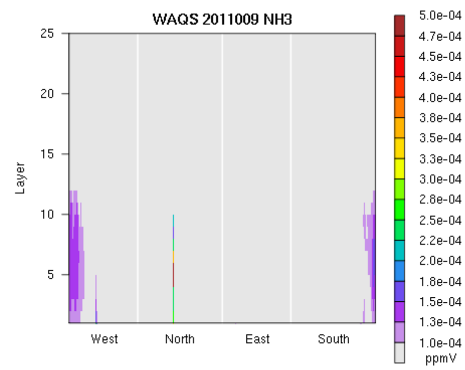
<tr><td>Jan 9</td><td>
</td><td>
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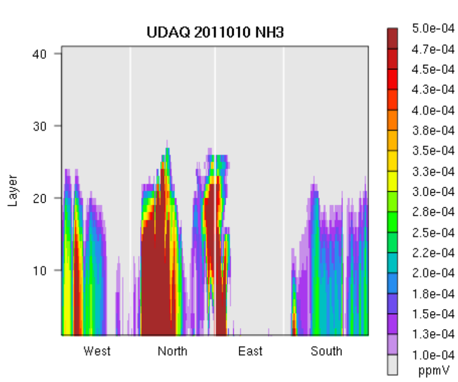
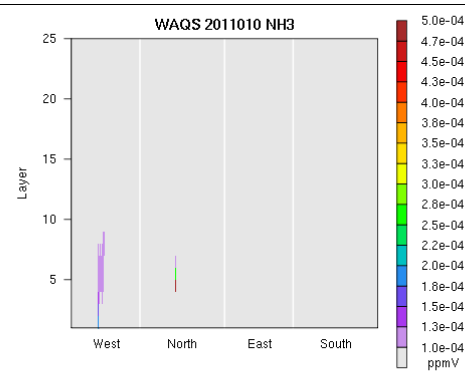
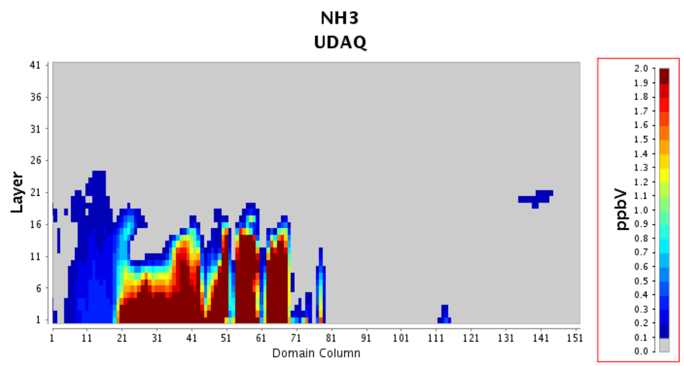
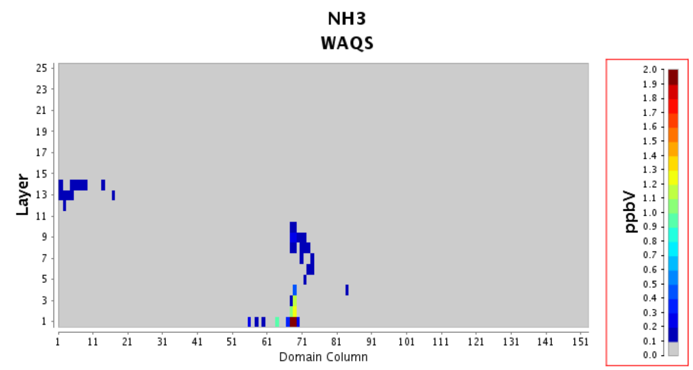
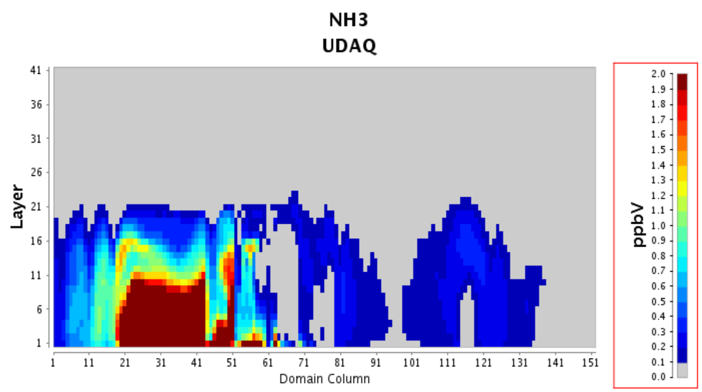
<tr><td>Jan 10</td><td>
</td><td>
</td></tr>
</table>

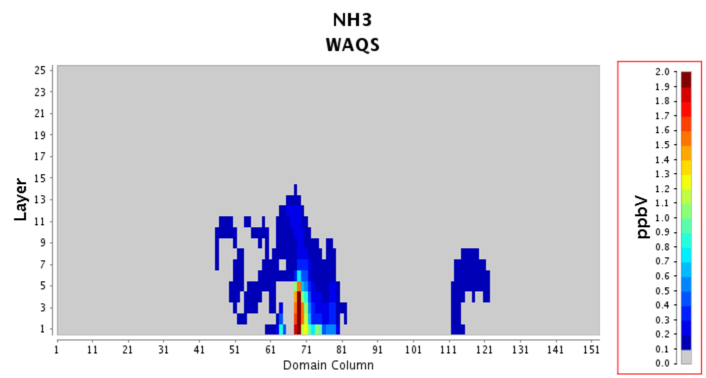
Based on this comparison and further evaluation of UDAQ's modeling data, the ammonia concentrations were plotted for the hours with the largest values, as shown in **Figure A-4**. The figure also shows the corresponding concentrations for the WAQS modeling. **Figure A-4** indicates that the UDAQ's modeling data has systematically higher concentrations and appears to have a larger spatial extent than the WAQS for the concentrations that extend from the surface up to about 1360 m, which encompasses Zones 1 and 2.

Figure A-4: Comparison of Selected Hourly Average Ammonia Concentrations along the Northern Boundary between UDAQ and WAQS

<table>
<tr><th>Day-Time</th><th>UDAQ</th><th>WAQS</th></tr>
<tr><td>1-4-2011
01:00 MST</td><td>

Min= 9.871 E-7, Max= 15.617</td><td>

Min= 1.0 E-6, Max= 2.603</td></tr>
<tr><td>1-7-2011
11:00 MST</td><td>

Min= 9.871 E-7, Max= 18.22</td><td>

Min= 1.0 E-6, Max= 4.25</td></tr>
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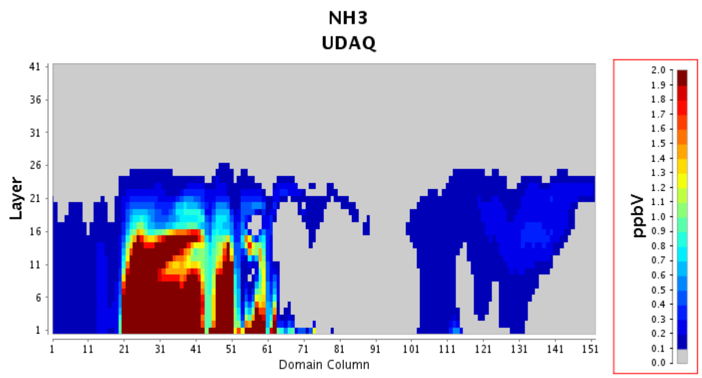
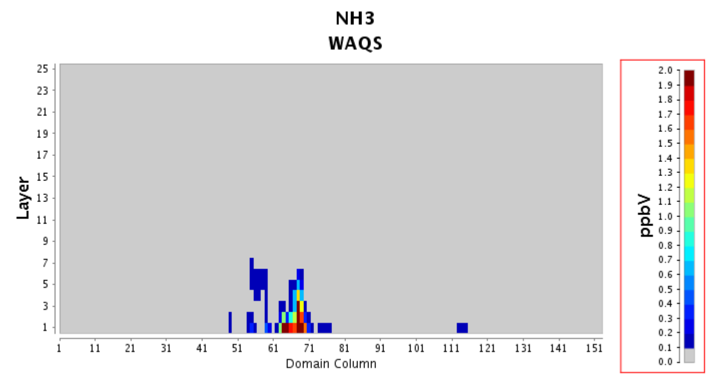
Day-Time	UDAQ	WAQS
1-8-2011 16:00 MST	 Min= 9.8087 E-7, Max= 15.531	 Min= 1.0 E-6, Max= 5.131

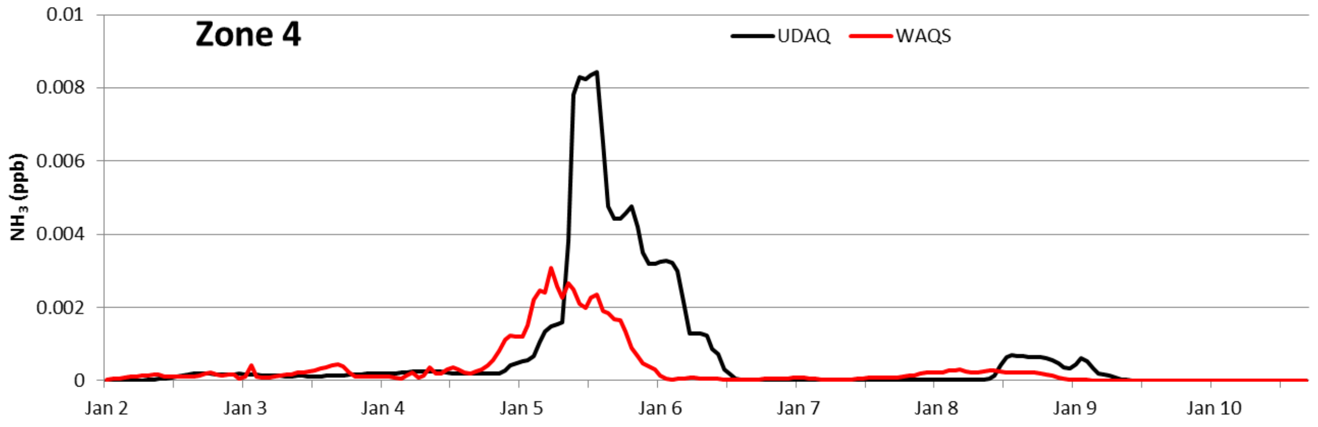
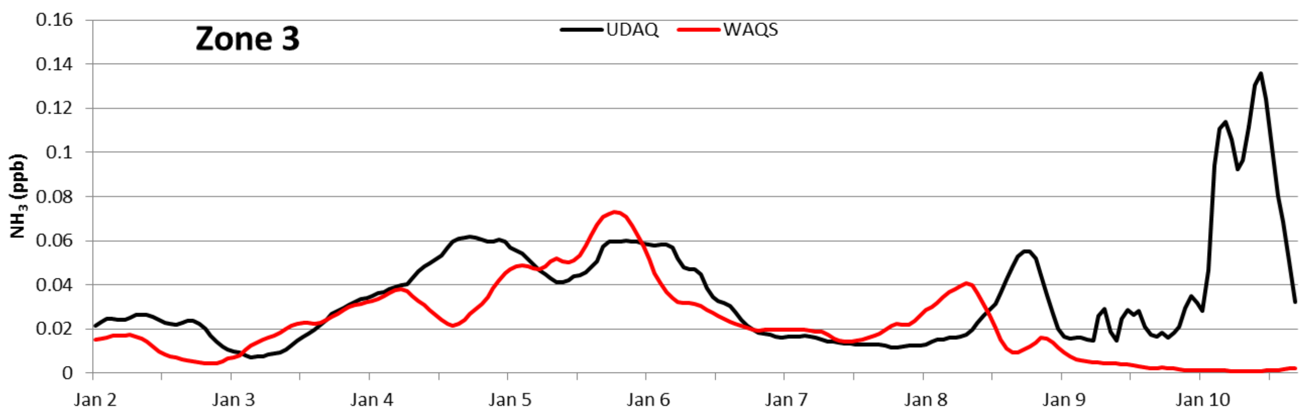
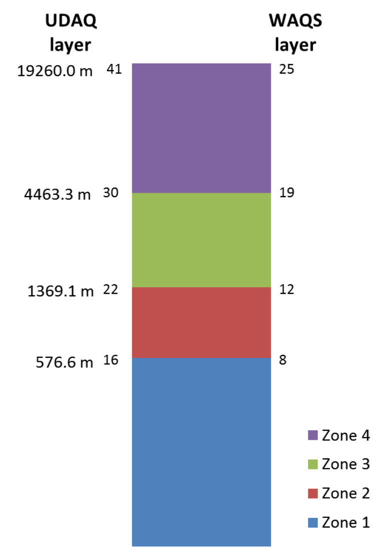
Zonal Mean Time Series along the Northern Boundary

Figures A-3 and **A-4** confirm that UDAQ's ammonia concentrations along the northern boundary are significantly higher than those predicted by the WAQS. To quantify how much larger UDAQ's concentrations are relative to the WAQS's, hourly time series comparisons of the zonal means are presented in **Figure A-5**. The zonal means are calculated by averaging all the ammonia concentrations within the CAMx zones specified in **Figure A-2**. Notice the scale for the concentrations on each zone is different, which is consistent with the spatial distribution of ammonia. The largest concentrations occur in zones 1 and 2, closer to the surface, while the smallest concentrations occur at higher altitudes closer to the top of the modeling domain in zones 3 and 4. As ammonia concentrations dilute into the top of the atmosphere, the differences between UDAQ and WAQS become smaller. However, for the largest concentrations in zone 1 and 2, UDAQ's model concentrations are systematically higher than the WAQS concentrations. Given that both simulations are driven by different meteorological inputs, it is expected that the temporal correlations would be low, in general, which is illustrated in most of the zonal mean comparisons. **Table A-3** shows a comparison of both UDAQ's and WAQS daily average concentrations for each zone. The values for zone 1 indicate that UDAQ's concentrations are systematically larger than those predicted by the WAQS and on specific days, such as January 9 and 10, the UDAQ's model concentrations are more than a factor of 10 larger than the WAQS's concentrations.

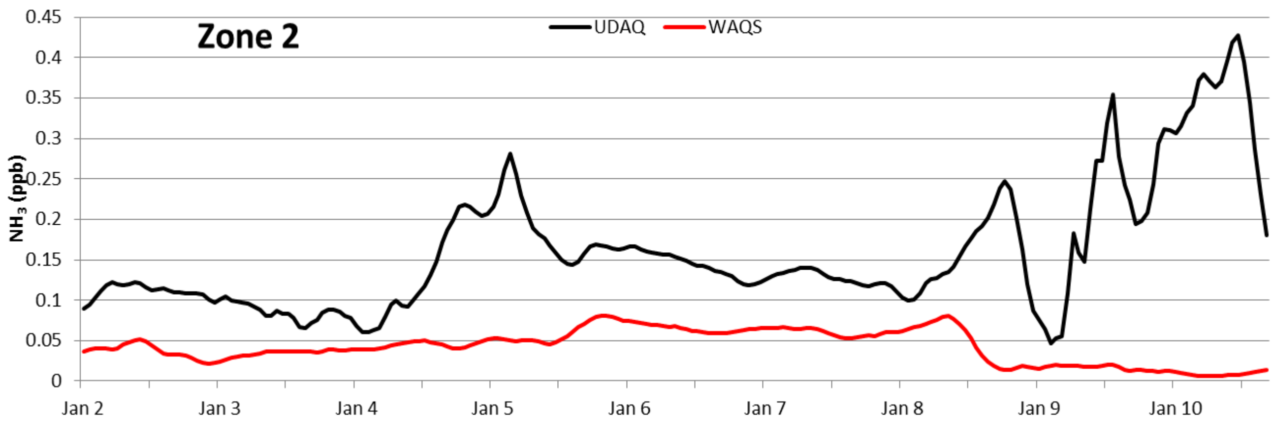
Table A-3: Daily Average Zonal Mean Concentrations for Ten Day Period

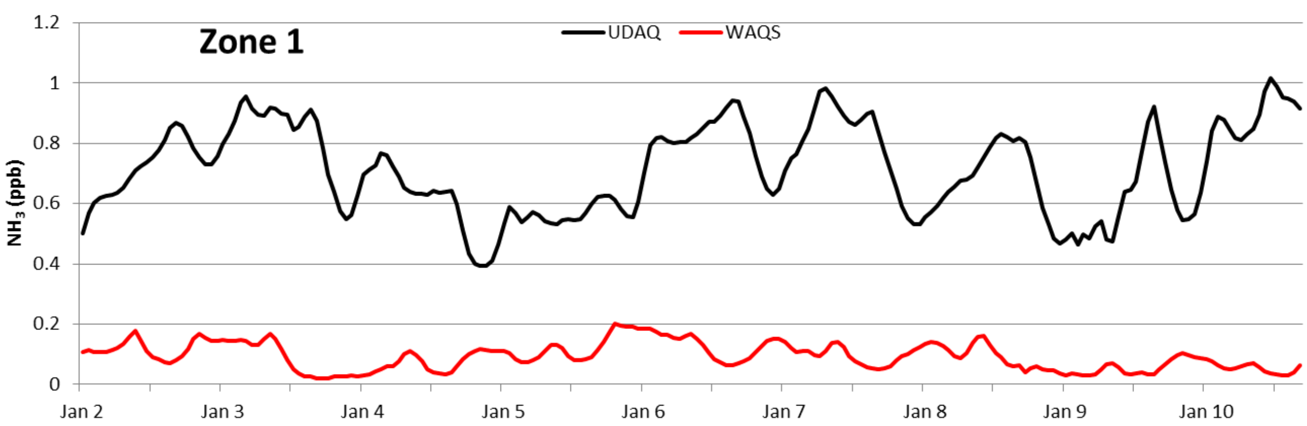
	Zone 1 (ppb)		Zone 2 (ppb)		Zone 3 (ppb)		Zone 4 (ppb)	
Day	UDAQ	WAQS	UDAQ	WAQS	UDAQ	WAQS	UDAQ	WAQS
January 1	0.456	0.084	0.077	0.018	0.011	0.011	0.0000	0.0000
January 2	0.716	0.120	0.111	0.037	0.022	0.011	0.0001	0.0001
January 3	0.813	0.083	0.086	0.035	0.018	0.021	0.0001	0.0002
January 4	0.601	0.073	0.134	0.044	0.051	0.032	0.0002	0.0004
January 5	0.569	0.122	0.186	0.061	0.051	0.057	0.0041	0.0018
January 6	0.808	0.129	0.144	0.065	0.036	0.028	0.0009	0.0001
January 7	0.796	0.097	0.127	0.061	0.014	0.019	0.0000	0.0001
January 8	0.680	0.094	0.158	0.047	0.030	0.024	0.0003	0.0002
January 9	0.609	0.055	0.201	0.016	0.022	0.004	0.0001	0.0000
January 10	0.889	0.054	0.343	0.009	0.090	0.001	0.0000	0.0000

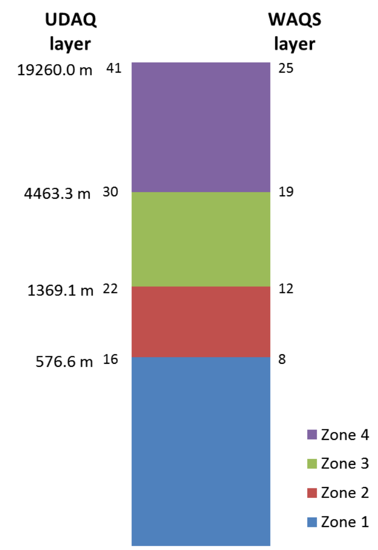
Figure A-5: Zonal Mean Hourly Average time series comparisons between UDAQ and WAQS

UDAQ and WAQS Zone Time Series	CAMx Layer Ranges
 	

UDAQ and WAQS Zone Time Series	CAMx Layer Ranges







Scaling WAQS Ammonia Concentrations

This section describes the approach to leverage the UDAQ's model ammonia concentrations to establish ammonia northern boundary concentrations for the visibility assessment of Utah's Power plants. **Table A-4** shows the sum of all the hourly values for the zonal mean for both UDAQ and WAQS. The table also shows the ratios between these values, which is a measure of how much larger on average are UDAQ concentrations compared to WAQS over the ten-day period examined. The values indicate that for all the zones UDAQ has higher concentrations than the WAQS. In Zone 1 and 2, the UDAQ's values are approximately a factor of seven and four times higher, respectively, than the WAQS.

Table A-4: Sum Total of Zonal Mean Concentrations

Category	Zone 1	Zone 2	Zone 3	Zone 4
UDAQ Total (ppb)	157.08	34.63	7.57	0.14
WAQS Total (ppb)	20.91	9.23	4.91	0.07
UDAQ/WAQS Ratio	**7.51**	**3.75**	**1.54**	**2.07**

The ratio values in the last row of **Table A-4** for zone 1 and the values for specific days in **Table A-3** could be used to derive a scaling factor that, when multiplied to the original WAQS concentrations, will result in comparable or equivalent ammonia concentrations to those estimated by UDAQ. **Figure A-6** shows the same results presented in **Figure A-4** with the difference that the WAQS concentrations have been increased across the entire 25 vertical layers by a factor of ten. The scaling factor of ten might be too large, but it was chosen as a 'conservative' correction. Furthermore, if this factor was not sufficient to make the WAQS' concentrations similar to UDAQ's ammonia concentrations, then this approach would not be sufficient to adjust the northern boundary concentrations. **Figure A-6** illustrates that the correction does indeed make the WAQS concentrations comparable in magnitude to UDAQ's; however, the spatial distributions are not similar. This should be expected given that both modeling platforms rely on different meteorology, emissions and ammonia deposition velocity configurations. However, the approach presented in this section to adjust the northern boundary concentrations has three important advantages:

1) It provides a correction to the original WAQS concentrations that by total mass would be comparable to UDAQ's. The spatial distribution will not be the same, but using WAQS concentrations is the most consistent approach in space and time (no discrepancies) for this project;
2) It provides increased ammonia through the boundaries for the entire winter season and not just a limited amount of time; and
3) It is a practical approach that is simple to implement and check for errors. Manipulation of UDAQ's data to collapse layers that approximate the WAQS CAMx layers is labor intensive and more susceptible to the introduction of errors.

Figure A-6: Comparison of Selected Hourly Average Ammonia Concentrations along the Northern Boundary between UDAQ and Increased NH_3 WAQS

<table>
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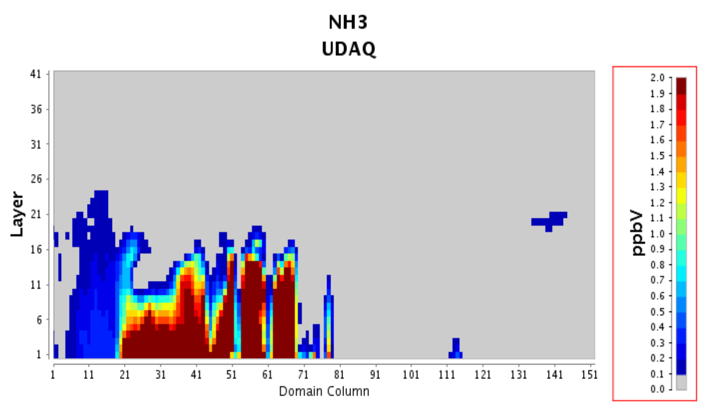
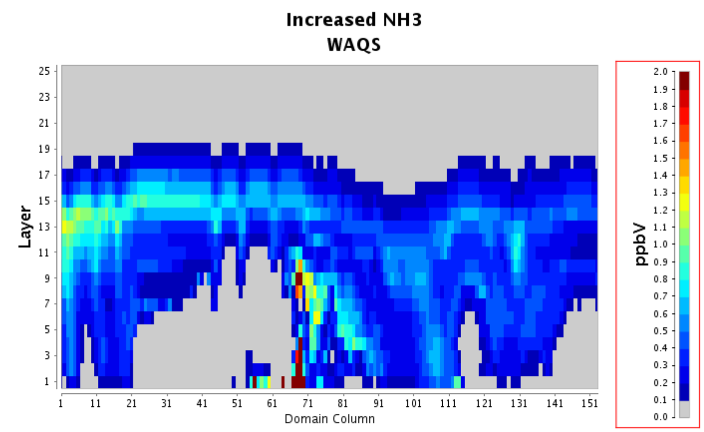
01:00 MST</td><td>

Min= 9.871 E-7, Max= 15.617</td><td>

Min= 1E-5, Max= 42.496</td></tr>
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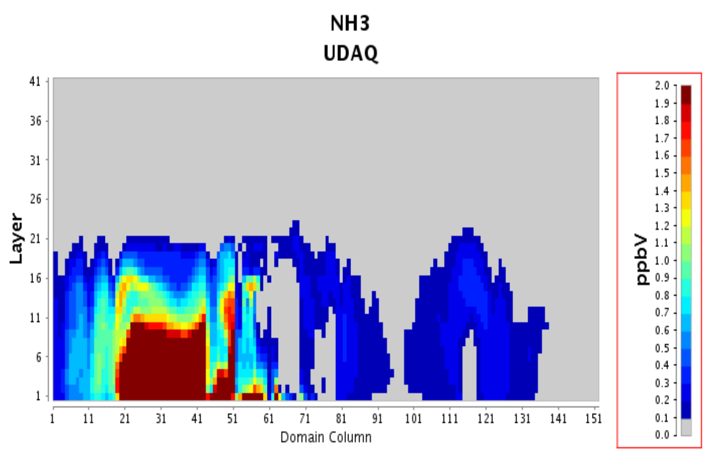
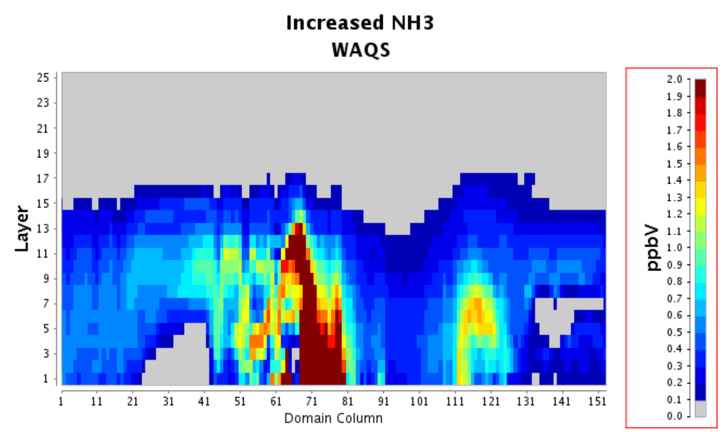
11:00 MST</td><td>

Min= 9.871 E-7, Max= 18.22</td><td>

Min= 1E-5, Max= 26.033</td></tr>
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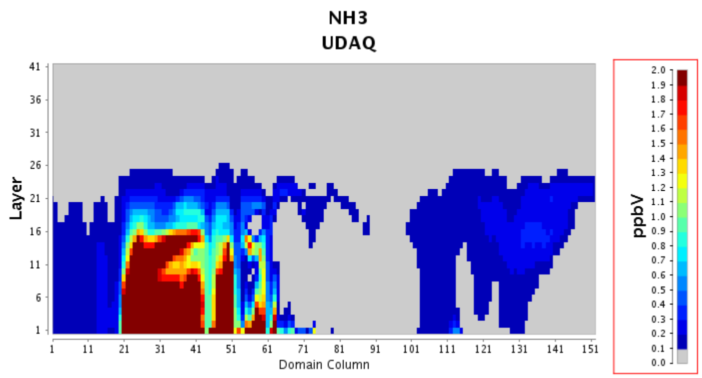
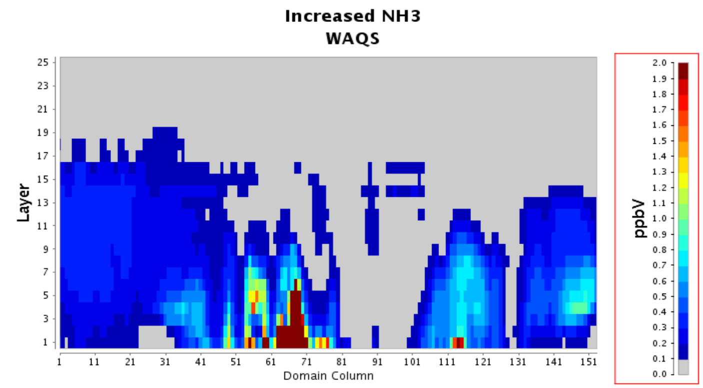
Day-Time	UDAQ	Increased NH_3 WAQS
1-8-2011 16:00 MST	 Min= 9.8087 E-7, Max= 15.531	 Min= 1E-5, Max= 42.496

<u>Conclusions</u>

In summary, this analysis shows that:

- Ammonia concentrations along the northern boundary of the 4-km computational domain differ between UDAQ's and WAQS modeling because:
  - The photochemical modeling is driven by different WRF simulations;
  - The UDAQ's surface ammonia emissions are larger than WAQS because UDAQ's provides additional ammonia along the Wasatch Range and Cache Valley,
  - They both have different vertical layer definitions,
  - The UDAQ's horizontal domain definition does cover the entire northern boundary of the 4km domain,
  - UDAQ provides data only for the first ten days in January, and
  - Both models were setup to estimate different ammonia deposition velocities.
- Graphical comparison of ammonia concentrations along the northern boundary between UDAQ's and WAQS simulations indicate that UDAQ's ammonia estimates are systematically higher.
- On average during the first ten days in January, a comparison of the total zonal means indicates that close to the surface (zone 1) UDAQ's ammonia could be seven times larger than WAQS estimates.

<u>Recommendations related to Boundary Conditions</u>

This analysis shows that using UDAQ's concentrations to define the boundary conditions along the northern boundary of the domain will result in higher ammonia concentrations relative to the original WAQS values. However, there are complications that make this approach unpractical.

1. It would be difficult to post-process the UDAQ's modeling concentrations to match the vertical layer definition for the WAQS. A significant amount of averaging will be required to achieve this objective and currently, there are no readily available tools to perform this step.
2. UDAQ's domain does not encompass the entire northern boundary, which implies that the resulting boundary conditions would have discrepancies. Additional guidance would be needed to fill the missing values along the boundaries.
3. UDAQ's data is limited to only ten days. The corrections to improve the model performance for the current modeling would need to be expanded to include at minimum, all the winter season (three months). Again, additional guidance would be needed to determine the boundary concentrations for the remaining days not included in UDAQ's modeling data.

An alternative to using UDAQ's concentrations was used in the main body of this study. The approach uses a scaling value that adjusts the current WAQS boundary concentrations to the same order of magnitude to UDAQ's modeling results. This eliminates the need to account for the spatial discrepancies due to differences of vertical and horizontal domain definitions between UDAQ and WAQS. The scaling factor value used for the WAQS is consistent along all vertical layers, resulting in similar magnitudes of ammonia concentrations to those in UDAQ. Additionally, the scaling factor can be applied for more than just ten days to encompass the entire winter season. **Figure A-6** presents a 'proof of concept' on how this alternative approach corrects the WAQS's original concentrations. Since the most defensible information available at this point to determine the scaling factor is presented in **Table A-4**, a single scaling factor of 7.51 was used to correct all the WAQS' modeling concentrations along the northern boundary of the computational domain for this project.

Appendix B Model Performance Evaluation for Revised CAMx Modeling with Ammonia Adjustments

B.1 Introduction

This appendix provides a characterization of the performance of the modeling platform used in this assessment when changes to the boundary concentrations and the ammonia deposition velocity described in **Appendix A** are made relative to the original 2011b Western Air Quality Study (WAQS) platform. The following sections provide the air quality Model Performance Evaluation (MPE) for the simulation performed using the 4-km domain once the ammonia modifications were performed. Additionally, MPE results are compared to the 2011b WAQS modeling to understand if the changes improve the performance of model-predicted particulates.

The MPE presented in this report is based on the comparison of the modeling results to the monitored concentrations of multiple pollutants for the year 2011. Model performance was assessed for selected ambient air particle-phase pollutants to provide a broader understanding of the model's performance. Altogether this information is used to provide an assessment of the model performance, magnitude of the errors and biases, and associated limitations for the assessment of future-year air impacts. This 'targeted' MPE is performed with the 2011b Base Case input data to model only the winter season (defined here as the months of January, February, and December) with the 4-km computational domain. The MPE focuses only on the changes in particulate nitrate and sulfate at Interagency Monitoring of Protected Visual Environments (IMPROVE) sites that fall within the state of UT. Focusing only on the performance of particulate nitrate and sulfate is the most relevant aspect since these species have a direct effect on the visibility predictions derived from the model. Additionally, the MPE of particulate ammonium at IMPROVE sites and ammonia at the Ammonia Monitoring Network (AMoN) sites are included in the analysis.

B.2 Model Configuration

In addition to emissions and meteorological fields, CAMx requires additional input files to perform the MPE simulation. Some of these inputs define the chemical mechanism, set the photolysis rates, describe surface characteristics, and set initial conditions (IC) and boundary conditions (BC) for the entire modeling domain. **Table B-1** summarizes relevant CAMx configurations that are used for this modeling using the computational domain defined in the modeling protocol (AECOM 2018). As part of the MPE, the modeling results (referred herein as PacifiCorp modeling results) are compared with MPE values estimated for the original 2011b WAQS Base case.

The shaded gray cells in **Table B-1** indicate the settings that are different in the current modeling relative to the original WAQS. Consistent with the modeling protocol, the ammonia deposition velocity rates have been reduced for this study. This is achieved by setting the RSCALE parameter to the value of 1 in the CAMx chemistry parameter file. Also, for the northern edge of the computational domain (northern boundary), ammonia concentrations have been adjusted to increase the original concentrations (derived from the WAQS) with a multiplicative factor of 7.5. This factor is applied for all hours and for all vertical levels of the ammonia long the northern boundary.

UDAQ's concentrations along the northern and western boundary strongly suggest that adjusting the ammonia deposition velocity is probably of far more importance than changing the boundary concentrations because this change will have an effect over the entire domain and not only along its edges. Reducing the ammonia deposition will likely increase available ammonia in the model and will influence the formation of nitrate and sulfate over the entire domain. The modification of the ammonia deposition velocity is performed in CAMx using the input parameter RSCALE.

The Intermountain Data Warehouse (IWDW) states that to reproduce the original 2011b WAQS modeling, the months of January to March 2011 should be modeled with 'winter-specific' meteorology and a winter version of CAMx 6.10. This approach was followed but was unable to produce reasonable results for January and February. December is outside this definition of WAQS defined winter and it was possible to produce adequate results for this month with the non-winter version of CAMx v6.10. It was determined that using the most recent version of CAMX (v 6.40) for both January and February and version 6.10 for December was sufficient to reproduce the original 2011b WAQS.

Table B-9: CAMx Air Quality Model Configurations

Science Options	Configuration	Details
Model Version	CAMx V6.10 CAMx V6.40	V6.10 used for December V6.40 used for January and February
Vertical Grid Mesh	25 vertical layers collapsed from WRF's 37 vertical layers structure	Layer 1 thickness ~24- m. Model top at ~19-km (AGL)
Grid Interaction	Two-way nesting for 36- and 12-km domains. One-way nesting for the 4-km domain.	
Plume-in-Grid (PiG)	Invoke PiG for all three PacifiCorp power plants	Subgrid-scale plume chemistry and dynamics module will be used for PacifiCorp power plants
Initial Conditions	10 day spin-up for 36-km and 12-km. 3 day spin-up for 4-km domains	December 21-31, 2010 for 36-km and12-km domains. 4-km IC derived from 12-km modeling results
Boundary Conditions[1]	36-km from MOZART global chemistry model	4-km boundary conditions derived from WAQS 12-km modeling results. The ammonia along the northern modeling boundary has been increased by a factor of 7.51
Chemistry		
Gas Phase Chemistry	CB6r2	Carbon Bond 6 version 2
Aerosol Chemistry	inorganic aerosol thermodynamics/partitioning model (ISORROPIA) equilibrium	
Cloud Chemistry	Regional Acid Deposition Model (RADM)-type aqueous chemistry	
Meteorological Processor	WRFCAMx	Compatible with CAMx v6.10
Horizontal Transport	K-theory with grid size dependent coefficient of horizontal eddy diffusion	

Science Options	Configuration	Details
Vertical Transport	K-theory (CMAQ-like in WRFCAMx)	Lower limit of vertical eddy diffusivity = 0.1 m^2/s or 2.0 m^2/s ; Land use dependent
Deposition Scheme[2]	Zhang dry deposition and CAMx-specific formulation for wet deposition	Ammonia deposition velocity rates are decreased by setting the parameter RSCALE = 1
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iternative (EBI) Fast Solver	
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Integration Time Step	Wind speed dependent	~0.1-1 min (4-km), 1-5 min (12-km), 5-15 min (36-km)

1 For PacifiCorp modeling, the ammonia along the northern modeling boundary is scaled along all vertical levels. The WAQS modeling remains unchanged.

2 For the PacifiCorp modeling, an RSCALE value of 1 is used. The WAQS modeling used a RSCALE value of 0.

B.3 Air Quality Model Performance Evaluation Methodology

The air quality MPE provides an assessment of the strengths and limitations of the air quality modeling system. The MPE results presented in Chapter B4.0 compare the 4-km domain 2011 base year model-predicted concentrations to available monitored concentrations for specific gas-phase and particle-phase species. The MPE has been conducted using a suite of statistical metrics and graphical analyses as described in this chapter.

B.3.1 Ambient Monitoring Data Used to Evaluate CAMx Model Performance

Data from ambient monitoring networks for select particulate species were used to evaluate CAMx's model performance of the WAQS and PacifiCorp modeling platforms. Ambient data for year 2011 were collected from each of the selected monitor networks. Statistical differences were calculated between the modeled concentrations and the monitored values. The statistics, time periods, and spatial extents assessed varied by the pollutant and metric of interest. Per the objective of this MPE, the PM evaluation includes sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4).

B.3.2 Interagency Monitoring of Protected Visual Environments (IMPROVE) Network

The Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network was established in 1985 and is a multiple federal agency effort designed to monitor visibility and related air quality, focused on 156 Class I visibility-sensitive regions in the U.S. (e.g., national parks) (Malm et al. 1994; Malm et al. 2002). The primary focus is on using aerosol chemical composition from a suite of filter-based measurements to reconstruct atmospheric light scattering and light absorbing properties.

The IMPROVE data are reported for actual temperature and pressure conditions at the sampling sites. The network monitors particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$) mass, particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) mass, and $PM_{2.5}$ speciated chemical composition using four independent modules with the following design:

- Filter Module A collects $PM_{2.5}$ on a Teflon substrate. These filters are analyzed for $PM_{2.5}$ mass concentration, optical absorption, hydrogen, and trace minerals and metals via particle-induced x-ray (PIXE) and x-ray fluorescence (XRF) methods.
- Filter Module B collects $PM_{2.5}$ on a nylon substrate preceded by a sodium carbonate coated tubular aluminum denuder that removes nitric acid vapors. These filters are analyzed by ion chromatography for NO_3, chloride, sulfate, and nitrite. A subset of IMPROVE sites do not use this filter.
- Filter Module C collects $PM_{2.5}$ on a quartz substrate. These filters are analyzed for carbonaceous material using Thermal Optical Reflectance (TOR). A backup secondary filter is used to quantify volatility loss artifacts.
- Filter Module D collects PM_{10} on a Teflon substrate that is analyzed for PM_{10} mass concentration.

B.3.3 Ambient Ammonia Monitoring Network (AMoN)

The Ammonia Monitoring Network (AMoN) provides measurements of ambient ammonia (NH3) concentrations at 66 locations across the United States through the National Atmospheric Deposition Program (NADP). The network provides valuable information for land managers, air quality modelers, ecologists, and policymakers that allow the assessment of long-term trends in ambient NH3 concentrations and deposition of reduced nitrogen species. It also helps to validate atmospheric models and assess changes in atmospheric chemistry due to SO_2 and NO_x reductions. The AMoN uses passive samplers, which do not require electricity or a data logger. The samples are deployed for 2-week periods. The NADP's Central Analytical Laboratory assembles and ships passive samplers to sites and, when returned, analyzes, quality assures, and provides the analytical data to the NADP.

B.3.4 Statistical Metrics and Benchmarks

As part of the MPE, the metrics defined in **Table B3-1** were calculated and presented in Section B3.0 for the select particle-phase species. The statistical metrics were calculated for each monitoring site, and the results were processed and reported for various spatial and temporal scales. Temporally, the statistical measures were calculated for 24-hour for the select particle-phase species. These results were averaged by month for display, further analysis, and reporting. The results are presented by monitoring network. The equations for the statistical metrics calculated and analyzed as part of the MPE are shown in **Table B-2**. The number of valid monitors used for calculating the statistical performance metrics is shown in **Table B-3**.

Table B-10: Definitions of Statistical Performance Metrics

Statistical Measure	Mathematical Expression	Notes
Mean Fractional Bias (MFB)	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as percent P_i = prediction at time and location i O_i =observation at time and location i N= Number of matched predictions and observations
Mean Fractional Gross Error (MFGE)	$\frac{2}{N}\sum_{i=1}^{N}\left\lvert\frac{P_i - O_i}{P_i + O_i}\right\rvert$	Reported as percent

Statistical Measure	Mathematical Expression	Notes
Normalized Mean Bias (NMB)	$\frac{\sum_{i=1}^{N}(P_i - O_i)}{\sum_{i=1}^{N} O_i}$	Reported as percent
Normalized Mean Error (NME)	$\frac{\sum_{i=1}^{N}\lvert P_i - O_i \rvert}{\sum_{i=1}^{N} O_i}$	Reported as percent
Coefficient of Determination (r^2)	$\frac{\left[\sum_{i=1}^{N}(P_i - \overline{P})(O_i - \overline{O})\right]^2}{\sum_{i=1}^{N}(P_i - \overline{P})^2 \sum_{i=1}^{N}(O_i - \overline{O})^2}$	$\overline{P}$ = arithmetic average of P_i, i=1,2,…, N; $\overline{O}$ = arithmetic average of O_i, i=1,2,…,N
Mean Observation	$\frac{1}{N}\sum_{i=1}^{N} O_i$	Reported as concentration (e.g., micrograms per cubic meter [$\mu g/m^3$] or parts per million by volume [ppmv] depending on the pollutant)
Mean Prediction	$\frac{1}{N}\sum_{i=1}^{N} P_i$	Reported as concentration (e.g., $\mu g/m^3$ or ppmv depending on the pollutant)

Table B-11: Number of Ambient Air Quality Monitors by Network and Season

Monitoring Network	Species	4-km Domain		
		January	February	December
IMPROVE (Daily)	Speciated PM Concentrations	15	15	15
AMoN (Bi-weekly)	Ammonia (NH3)	2	2	2

B.3.5 Particulate Statistical Measures

USEPA's (2007) PM suggested a suite of metrics for use in evaluating model performance. The standard set of statistical performance measures suggested for evaluating fine particulate models include: 1) normalized bias; 2) normalized gross (unsigned) error; 3) MFB; 4) MFGE; and 5) MFB in standard deviations. In past regional PM model evaluations (Tesche et al. 2005; Tonnesen et al. 2006), fractional bias and fractional error were found to be the most useful summary measures. Therefore, for this study, all error and bias metrics are calculated for PM species; however, the results only are analyzed for MFB and MFGE. While all statistics in **Table B-2** are presented for all chemical species discussed in this analysis, when assessing model performance for particle-phase species, the analysis focuses on MFB and MFGE.

As defined by Boylan and Russell (2006), the performance goals for PM species are MFB within ±30 percent and MFGE ≤50 percent. The performance criteria are MFB within ±60 percent and MFGE ≤75 percent. The performance goals are the more stringent of the two sets of metrics, and a good-performing model will achieve these goals. The performance criteria are less strict. If the criteria are equaled or exceeded, it suggests potential shortcomings with the model simulation. The goals and criteria increase at lower concentrations according to the following equations, in which C_o is the observation concentration and C_m is the model-predicted concentration:

Performance Goal:

$$FB \le \pm 170\, e^{\frac{-0.5(\overline{C_o}+\overline{C_m})}{0.5\mu g/m^3}} + 30$$

$$FE \le 150\, e^{\frac{-0.5(\overline{C_o}+\overline{C_m})}{0.75\mu g/m^3}} + 50$$

Performance Criteria:

$$FE \le 125 e^{\frac{-0.5(\overline{C_o}+\overline{C_m})}{0.75\mu g/m^3}} + 75$$

$$FB \le \pm 140 e^{\frac{-0.5(\overline{C_o}+\overline{C_m})}{0.5\mu g/m^3}} + 60$$

While the Boylan and Russell (2006) performance goals and criteria may not be achieved for this study, particularly for species that typically are difficult to model such as NO_3, performance goals and criteria will be used to put the PM model performance into context and to facilitate model performance inter-comparison across episodes, species, models, and sensitivity tests.

Recent modeling guidance does not recommend specific criteria that distinguish between adequate and inadequate model performance (USEPA 2007). Instead, it is recommended that a suite of performance measures and displays be analyzed and that a “weight of evidence” approach be used to assess whether the model performs sufficiently well to be used for the intended purpose.

B.3.6 Model Performance Evaluation Software Tool

The University of California Riverside Model Performance Evaluation Software (MPES) (Chien et al. 2005) was developed to efficiently compute performance metrics and to present results in both tabular and graphical formats. The MPES generates the statistical measures shown in **Table B-2** for appropriate temporal and spatial extents for each pollutant. The MPES was used to calculate the average of the model performance metrics for each month and to summarize these results using bar plots to compare the monthly average statistics for each species.

For particle-phase species, the comparison of modeled concentrations to ambient concentrations can be complicated. The PM is composed of many chemically different particle-phase species, and there are many different methods to measure these species, which makes it difficult to compare ambient concentrations to modeled concentrations. The comparison of modeled PM species to the monitored data must be performed in a consistent fashion. **Table B-4** identifies the approach that was used to map measured data from each of the PM monitoring sites to the CAMx modeled PM species.

Table B-12: Mapping of Monitored Particulate Species to Modeled Particulate Species

Compound	Monitored Species Definitions by Network[1]		CAMx Modeled Species Definitions[3]
	IMPROVE[2]	AMoN	
SO_4	SO_4	---	PSO_4
NO_3	NO_3	---	PNO_3
NH_4	NH_4	---	PNH_4
NH_3	---	NH_3 ($\mu g/m^3$)	NH_3

[1] Monitored species names are defined differently for each individual monitoring network and are available on-line. Compounds not measured by a network are indicated by "---."

[2] The IMPROVE monitoring program revised the methods used to report and analyze the data

[3] The model species in ppm is converted to $\mu g/m^3$ using STP condition

In addition to statistical summary tables, results are presented in graphical format to facilitate quantitative and qualitative comparisons between CAMx predictions and measurements. Together with the statistical metrics identified in **Table B-2**, the graphical procedures are intended to help: 1) identify unreasonable model-predicted concentrations; and 2) guide the implementation of performance improvements in the 2011 model input files in a logical, defensible manner. These graphical tools were used to depict the ability of the model to predict the observed particle-phase concentrations for comparison to PM standards.

Graphical displays include the following:

- Time-series plots for the entire period at select monitoring locations.
- Spatial plots of particulate concentration isopleths overlaid with monitoring values during selected days. These days are based on 20 percent worst days for IMPROVE monitors.

These graphical displays were generated with the MPES, where appropriate. Due to the large number of plots that are generated to cover all sites and all species, only selected graphical plots are presented in the MPE.

B.4 Model Performance Evaluation Results

The model-predicted concentrations of particle-phase chemical species were compared to monitored values. Model performance was evaluated for particulate SO_4, NO_3, NH_4 and gas-phase ammonia. The MPE provides the following analyses:

- Tables of annual and seasonal statistical metrics summarized by monitoring network;
- Bar charts of monthly mean fractional bias (MFB) by monitoring network;
- Time series plots for selected monitoring stations; and
- Spatial plots for the selected days.

B.4.1 Sulfate

Table B-5 below shows the MPE statistics that compare model results with available observations for all IMPROVE sites within the 4-km domain. The performance with the 2011b WAQS are compared to the PacifiCorp simulation. **Figure B-1** shows a bar chart that compares the monthly Mean Fractional Bias (MFB) for the original WAQS modeling and the PacifiCorp MPE simulation. In general, there are very small differences between the WAQS and PacifiCorp modeling simulations for the selected months. Both modeling simulations consistently over-predict concentrations during this time.

Figure B-2 shows time series that compares observed daily average sulfate concentration at selected IMPROVE monitoring sites with model-predicted concentrations. The sites fall within Utah, predominantly downwind from the location of PacifiCorp's power plants. The time series are presented for January, February, and December 2011. Most monitor sites record peak SO_4 concentrations in December, with isolated events throughout January and February. The lowest SO_4 concentrations tend to occur in early January. The models results generally follow the episodic peaks in the monitored SO_4 concentrations. The model results systematically show higher concentrations than is observed during all months, similar to the statistical analysis discussed above. The time series also illustrates that both modeling simulations are very similar throughout the simulation period.

Figure B-3 shows spatial plots of model-predicted sulfate daily average concentrations for selected days. These days belong to the 20% Worst visibility days from the monitoring record at IMPROVE sites in 2011 for at least 2 Class I areas in the 4-km domain. **Figure B-3** also presents the monitored 24-hour average SO_4 concentrations shown as circles. For the selected days both modeling simulations seem to produce a sulfate spatial pattern consistent with the observations. Sulfate concentrations are generally less than 1 $\mu g/m^3$ over the entire domain with isolated regions where concentrations exceed 2 $\mu g/m^3$. The figure also shows that in general over the entire domain, the differences between the WAQS and PacifiCorp simulations are small with only some isolated areas with both positive and negative values, indicative that in some instances the PacifiCorp results will produce slightly higher concentrations, but in other regions it will result in lower concentrations than the WAQS.

Table B-13: Model Performance Statistical Summary for Sulfate

Monitoring Network	Statistic (%)/ Concentration (µg/m³)	January		February		December	
		WAQS	PacifiCorp	WAQS	PacifiCorp	WAQS	PacifiCorp
IMPROVE (Daily)	MFB	78	78	58	57	53	53
	MFGE	80	81	64	64	56	57
	NMB	109	110	77	77	57	59
	NME	116	116	88	90	63	64
	R^2	0.177	0.177	0.017	0.008	0.540	0.537
	Observed Mean Concentration (µg/m³)	0.181	0.181	0.257	0.257	0.296	0.296
	Predicted Mean Concentration (µg/m³)	0.378	0.379	0.456	0.454	0.466	0.470

Figure B-11: Monthly Mean Fractional Bias for Sulfate

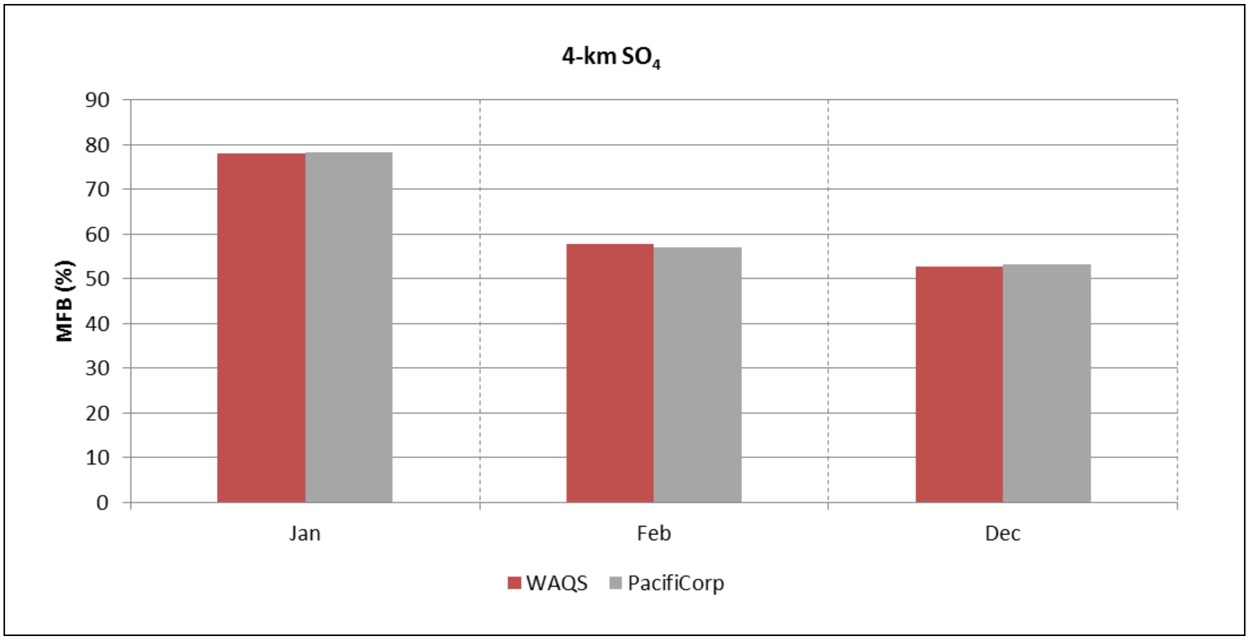


Figure B-12: Time Series for Sulfate at the Selected IMPROVE Sites for the Entire Period

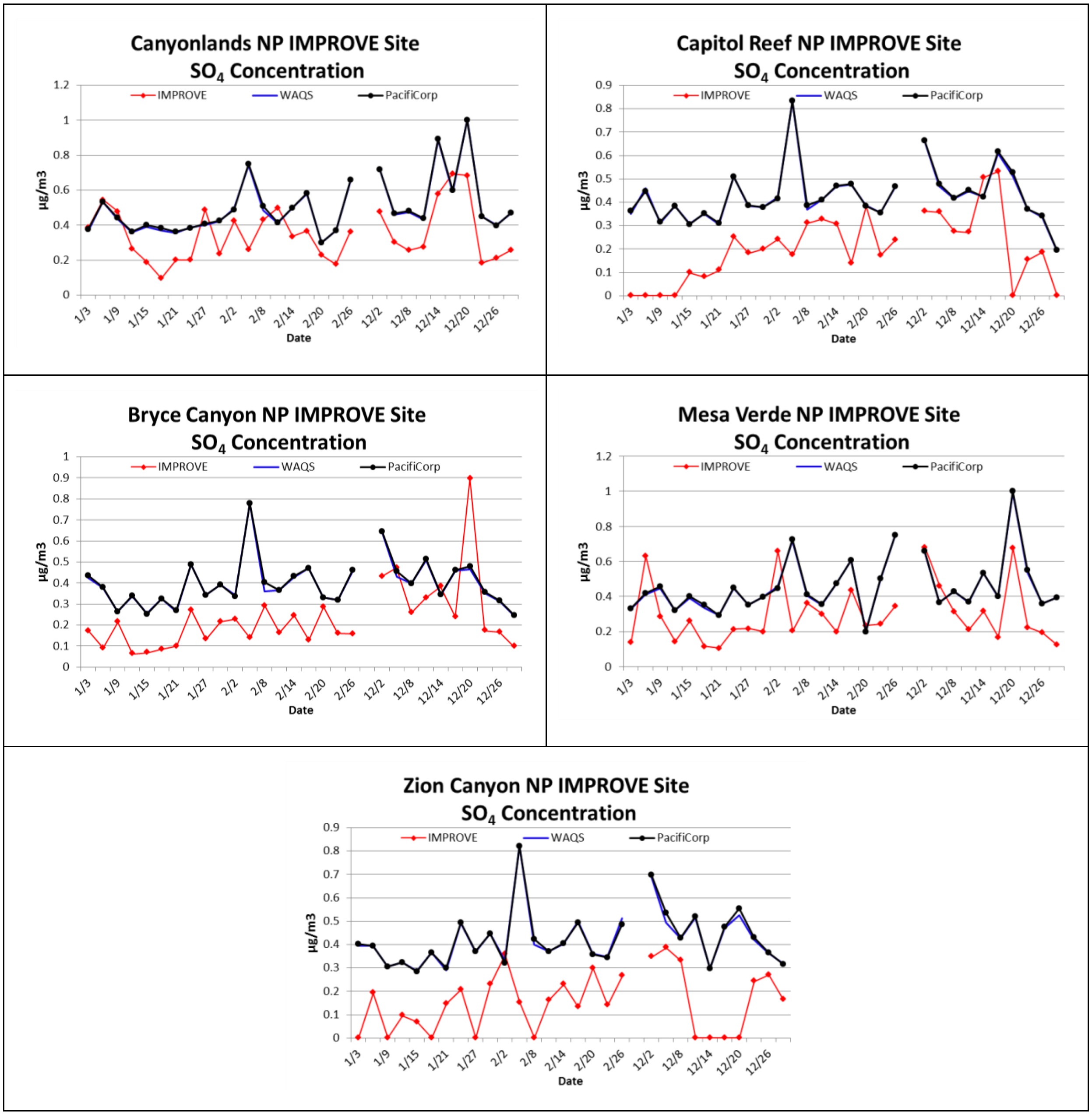
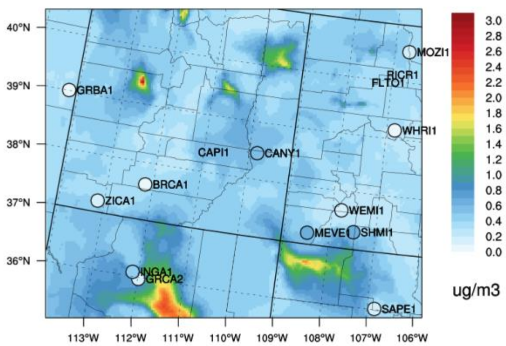
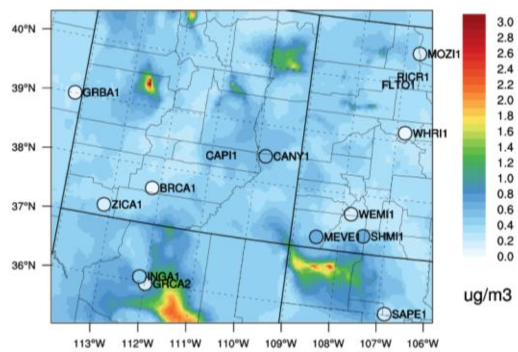
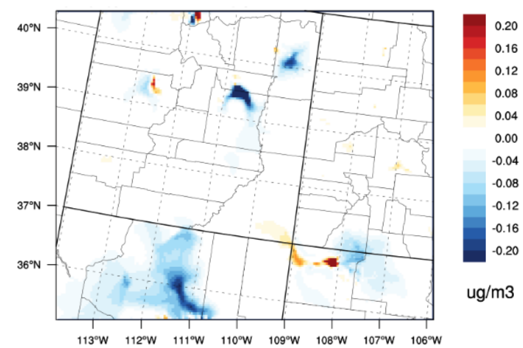
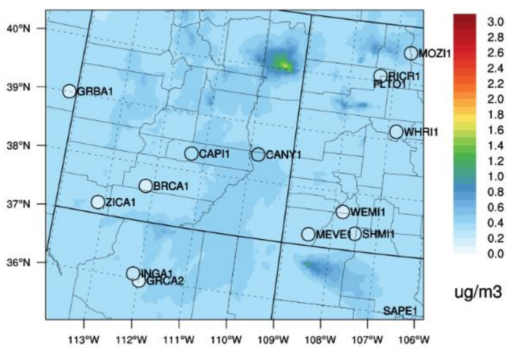
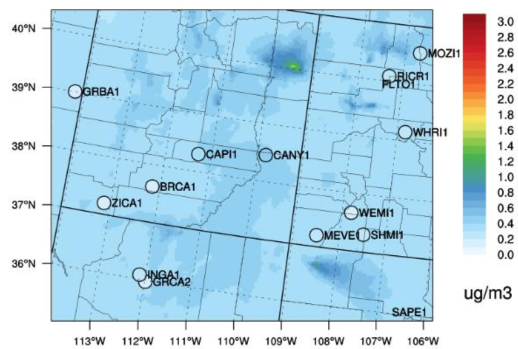
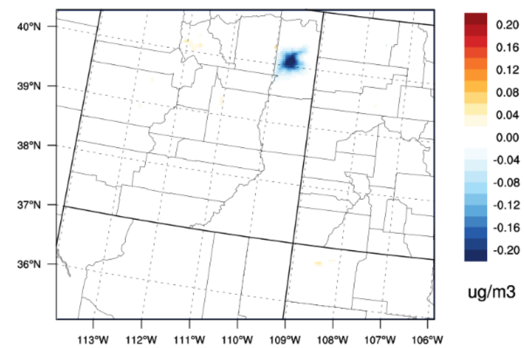
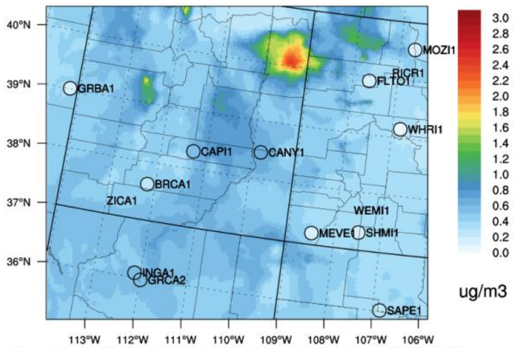
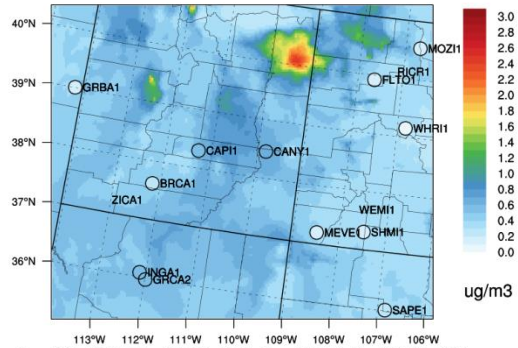
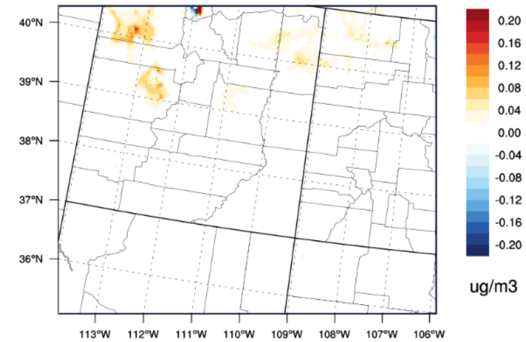


Figure B-3: Spatial Plots Comparing WAQS and PacifiCorp Modeling Concentrations for Sulfate for Selected Days

		WAQS	PacifiCorp	PacifiCorp –WAQS
January 6		 Max: 2.85 at (48, 114) or (-112.58, 39.35), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 3.04 at (48, 114) or (-112.58, 39.35), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 0.842 at (-108.14, 36.72), Min: -2.167 at (-111.08, 35.41)
February 11		 Max: 1.66 at (116, 122) or (-109.48, 40.01), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 1.53 at (116, 122) or (-109.48, 40.01), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 0.066 at (-110.01, 40.29), Min: -0.700 at (-111.93, 40.72)

		WAQS	PacifiCorp	PacifiCorp –WAQS
December 17		 Max: 2.41 at (118, 122) or (-109.39, 40.02), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 2.47 at (118, 122) or (-109.39, 40.02), Min: 0.00 at (1, 1) or (-113.78, 35.03)	 Max: 0.415 at (-111.92, 40.68), Min: -1.320 at (-111.93, 40.72)

B4.2 Nitrate

Table B-6 below shows the MPE statistics that compare model-predicted nitrate concentrations with available observations for all IMPROVE sites within the 4-km domain. The performance with the 2011b WAQS are compared to the PacifiCorp simulation. **Figure B-4** shows a bar chart that compares the monthly Mean Fractional Bias (MFB) for the original WAQS modeling and the PacifiCorp MPE simulation. The original WAQS simulations showed a systematic under prediction of model-predicted nitrate concentrations. The results for the PacifiCorp simulations show a general improvement in the formation of nitrate with slight over predictions in January and slight under predictions in December. Although both the WAQS and PacifiCorp simulations under predict nitrate concentration in February, the PacifiCorp biases are lower. Analysis of the other statistics provided in **Table B-7** show that the ammonia adjustments made to the PacifiCorp model configuration lead to improved nitrate performance.

Figure B-5 shows time series that compares observed daily average nitrate concentration at selected IMPROVE monitoring sites with model-predicted concentrations. The sites fall within Utah, predominantly downwind from the location of PacifiCorp's power plants. The time series are presented for January, February, and December 2011. Most monitor sites record peak nitrate concentrations in January and December, with isolated events in February. The time series show that at the selected Class I areas the PacifiCorp nitrate model-predicted concentrations are systematically higher than those predicted with the original WAQS. Neither model is able to consistently predict the peaks of nitrate in the monitored record, but the PacifiCorp simulations are better to reproduce these concentrations than the WAQS.

Figure B-6 shows spatial plots of model-predicted nitrate daily average concentrations for selected days. These days belong to the 20% Worst visibility days from the monitoring record at IMPROVE sites in 2011 for at least 2 Class I areas in the 4-km domain. **Figure B-6** also presents the monitored 24-hour average nitrate concentrations shown as circles. For the selected days both modeling simulations produce similar spatial patterns for nitrate concentrations, however the PacifiCorp results consistently lead to higher nitrate concentrations over the entire computational domain.

Table B-14: Model Performance Statistical Summary for Nitrate

Monitoring Network	Statistic (%)/ Concentration (µg/m^3)	January		February		December	
		WAQS	PacifiCorp	WAQS	PacifiCorp	WAQS	PacifiCorp
IMPROVE (Daily)	MFB	-74	15	-113	-52	-76	-7
	MFGE	134	101	129	88	121	109
	NMB	-61	8	-67	-27	-58	18
	NME	97	106	79	73	79	98
	R^2	0.015	0.083	0.034	0.139	0.294	0.259
	Observed Mean Concentration (µg/m^3)	0.192	0.192	0.171	0.171	0.188	0.188
	Predicted Mean Concentration (µg/m^3)	0.074	0.208	0.056	0.125	0.079	0.223

Figure B-13: Monthly Mean Fractional Bias for Nitrate

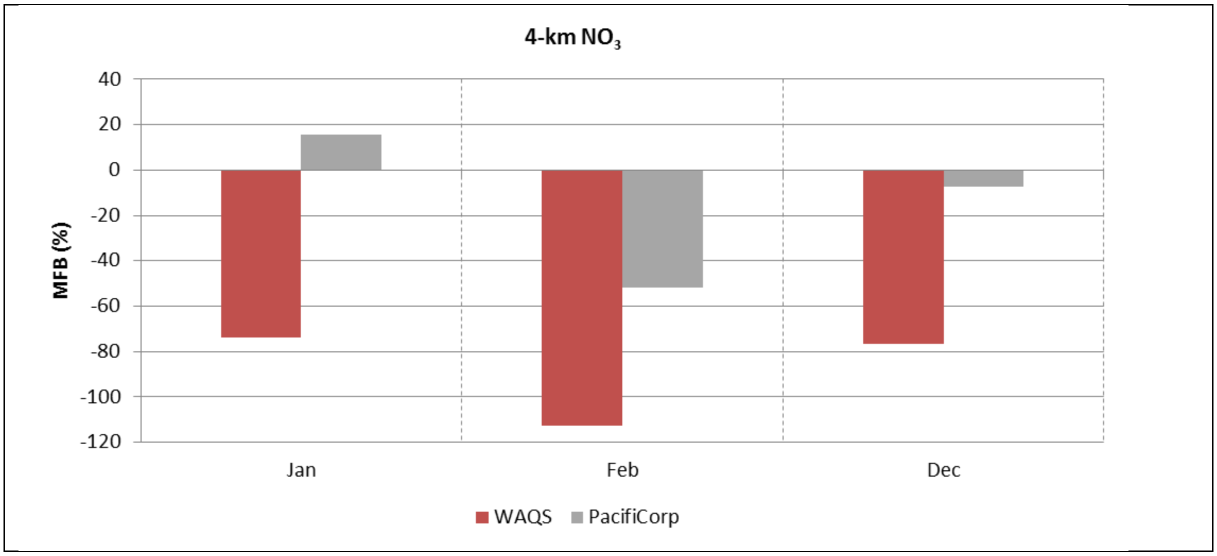


Figure B-14: Time Series for Nitrate at the Selected IMPROVE Sites for the Entire Period

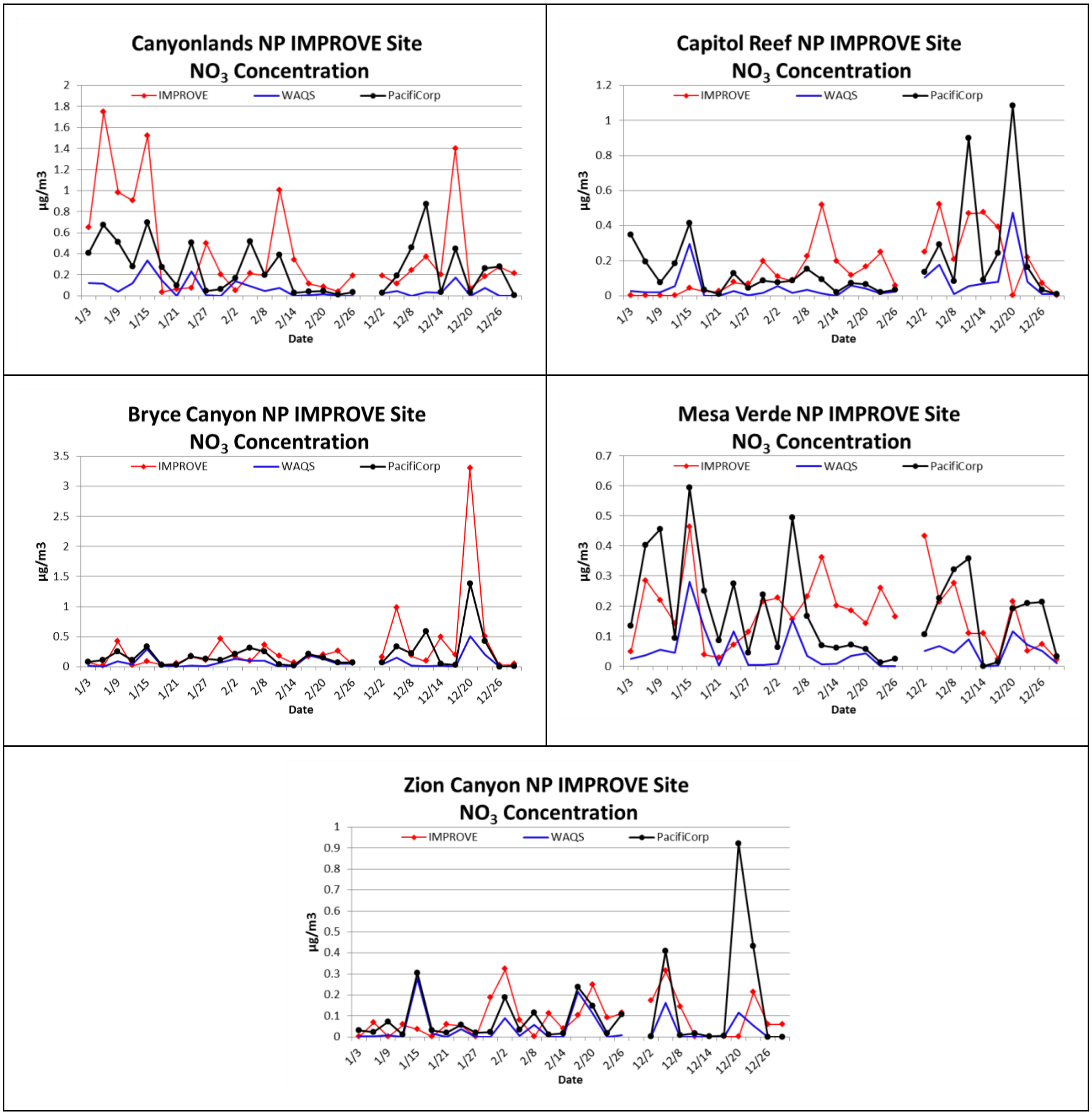
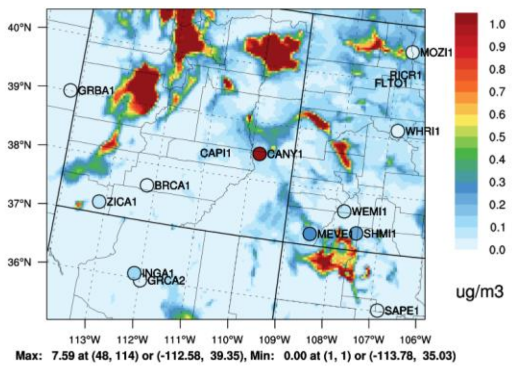
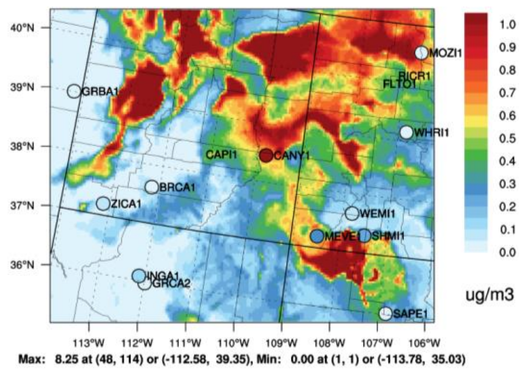
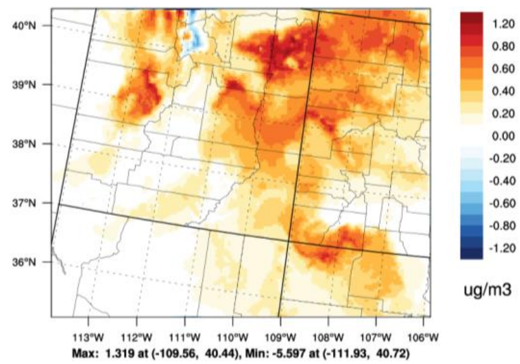
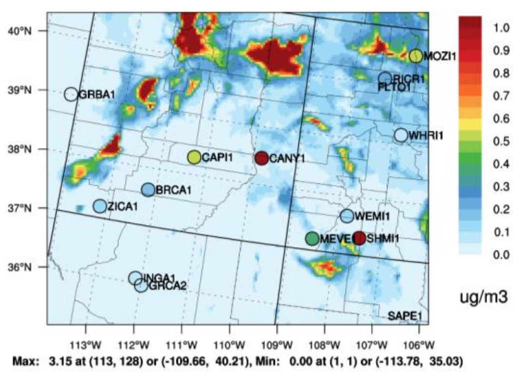
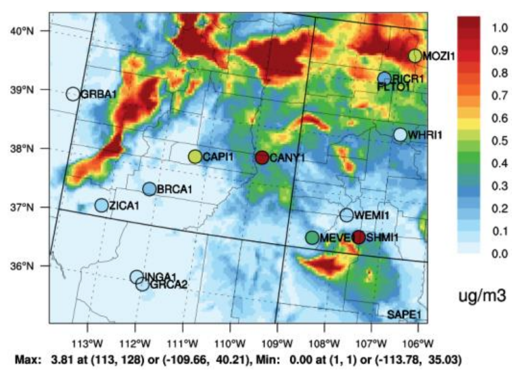
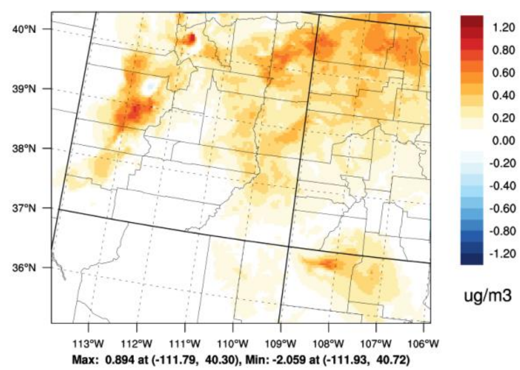
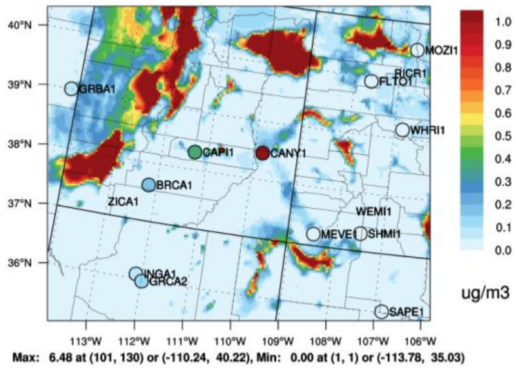
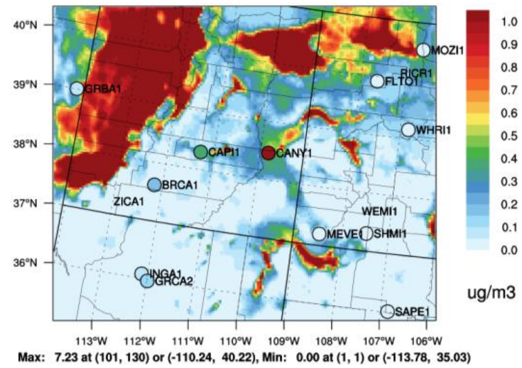
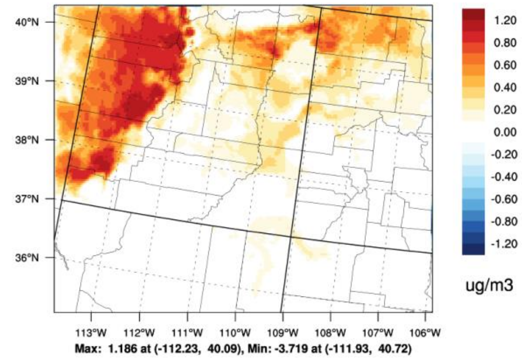


Figure B-15: 4-km Spatial Plots Comparing WAQS and PacifiCorp Modeling Concentrations for Nitrate for Select Days

Date	WAQS	PacifiCorp	PacifiCorp –WAQS
January 6			
February 11			

Date	WAQS	PacifiCorp	PacifiCorp –WAQS
December 17			

B4.3 Ammonium

Table B-7 below shows the MPE statistics that compare model results with available observations for all IMPROVE sites within the 4-km domain. **Figure B-7** shows a bar chart that compares the monthly Mean Fractional Bias (MFB) for the original WAQS modeling and the PacifiCorp MPE simulation. The statistics show that the original WAQS modeling results exhibit systematic under-predictions of ammonium concentrations for all the months. The changes in the configuration for the PacifiCorp simulations ultimately result in higher ammonium concentrations that lead to slight over-predictions of ammonium concentrations in January and December with slight under-predictions in February.

Figure B-8 shows time series that compares observed daily average ammonium concentration at selected IMPROVE monitoring sites with model-predicted concentrations. The sites fall within Utah, predominantly downwind from the location of PacifiCorp's power plants. The time series are presented for January, February, and December 2011. Most monitor sites record peak NH_4 concentrations in December, with isolated events throughout January and February. Except for Canyonlands, the lowest NH_4 concentrations the monitoring sites tend occur in early January. The model results generally follow the episodic peaks in the monitored NH_4 concentrations. The model results are systematically similar to the observed concentrations during all months, with both models being unable to reproduce the magnitude of the peaks. However, the PacifiCorp modeling scenario captures the overall distribution of the observed values better.

Figure B-9 shows spatial plots of model-predicted ammonium daily average concentrations for selected days each month. The days selected belong to the 20% Worst visibility days from the monitoring record at IMPROVE sites in 2011 for at least 2 Class I areas in the 4-km domain. **Figure B-10** also presents the monitored 24-hour average NH_4 concentrations shown as circles. For the selected days both modeling simulations seem to produce a spatial pattern consistent with the observations, except for Canyonlands, the both models under-predict relative to the observations. Ammonium concentrations are generally less than 1 $\mu g/m^3$ over the entire domain with some regions where concentrations exceed 4 $\mu g/m^3$. The figure also shows that in general over the entire domain the differences between the WAQS and PacifiCorp simulations are small in the southern portion of the computational domain but the PacifiCorp simulation consistently increases ammonium concentrations relative to the WAQS.

Table B-15: Model Performance Statistical Summary for Ammonium

Monitoring Network	Statistic (%)/ Concentration (µg/m³)	January		February		December	
		WAQS	PacifiCorp	WAQS	PacifiCorp	WAQS	PacifiCorp
IMPROVE (Daily)	MFB	-37	3	-21	-7	-5	20
	MFGE	61	54	48	46	38	44
	NMB	-43	-5	-22	-7	-17	11
	NME	57	59	44	46	37	46
	R^2	0.210	0.148	0.062	0.078	0.383	0.349
	Observed Mean Concentration (µg/m³)	0.122	0.122	0.146	0.146	0.166	0.166
	Predicted Mean Concentration (µg/m³)	0.069	0.116	0.113	0.136	0.137	0.184

Figure B-16: Monthly Mean Fractional Bias for Ammonium

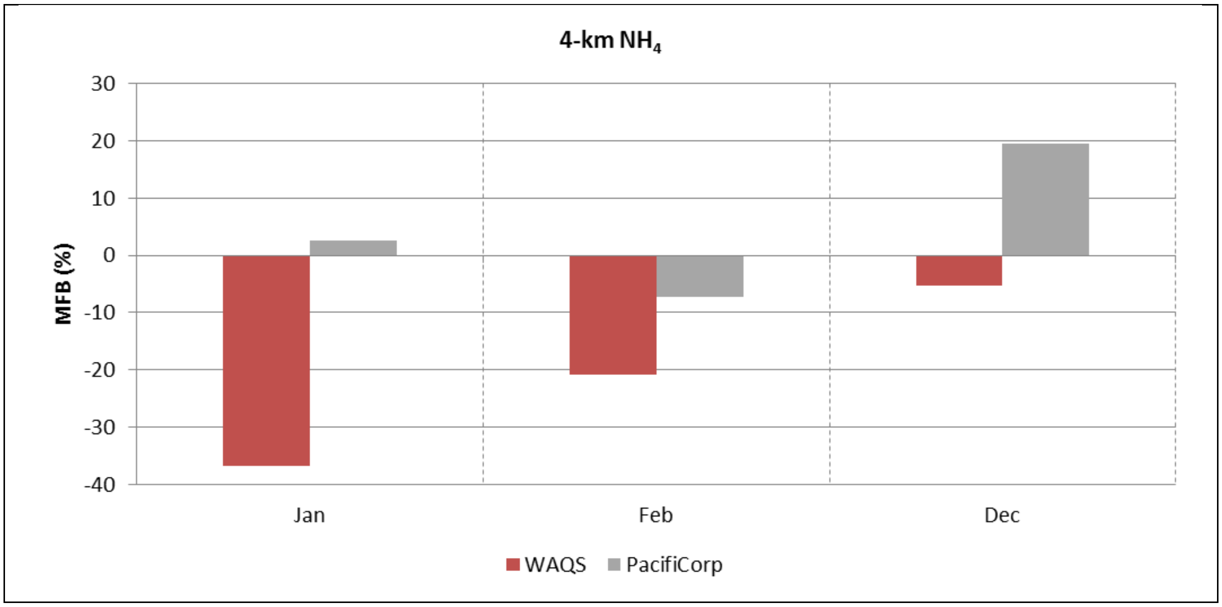


Figure B-17: Time Series for Ammonium at the Selected IMPROVE Sites for the Entire Period

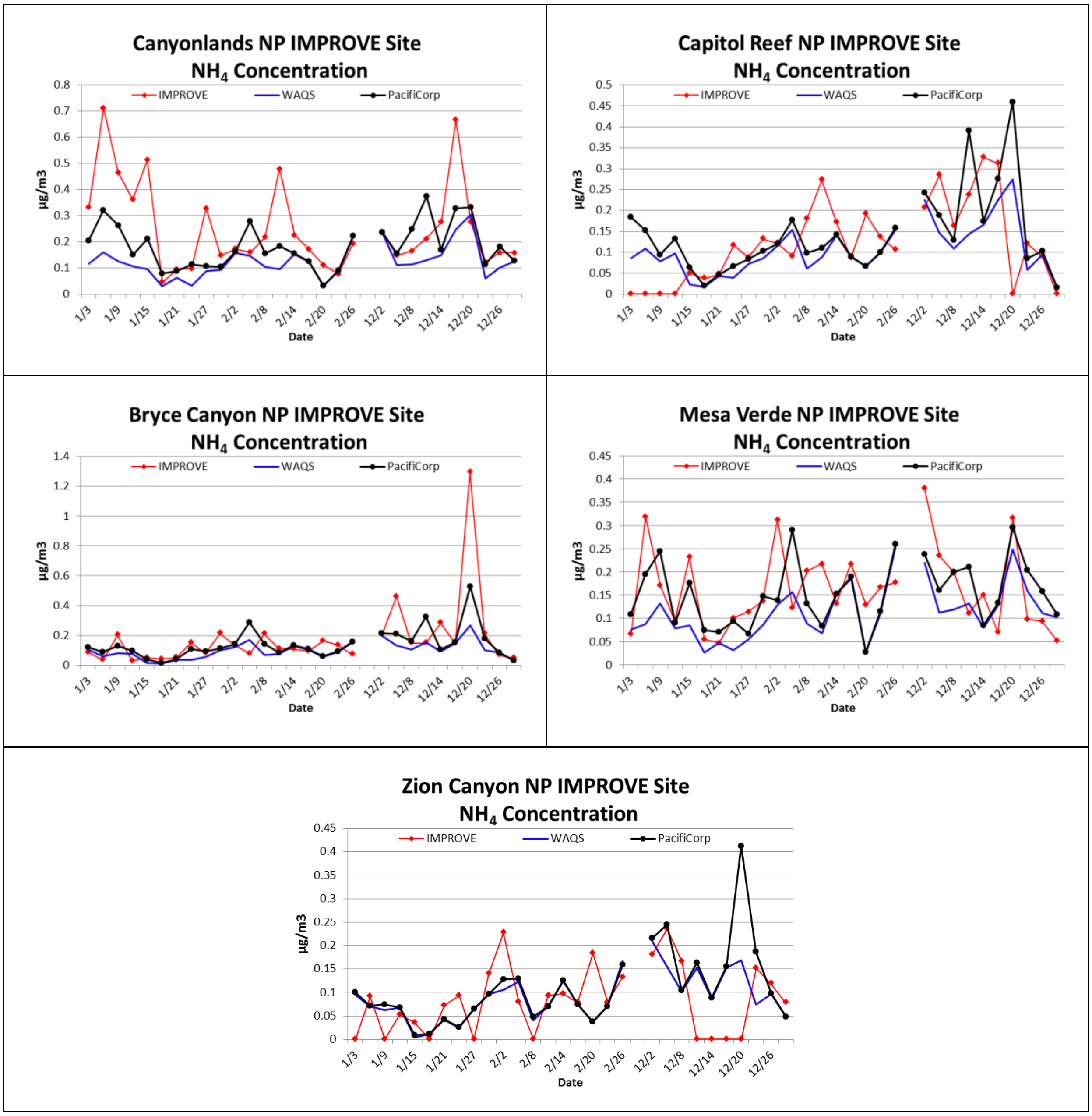
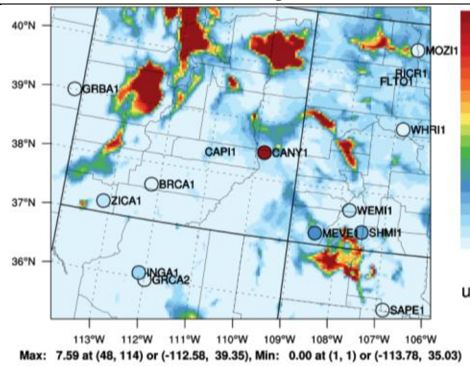
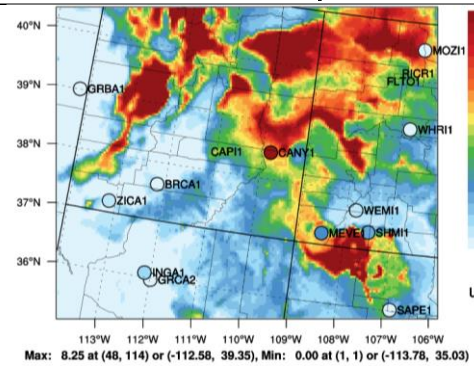
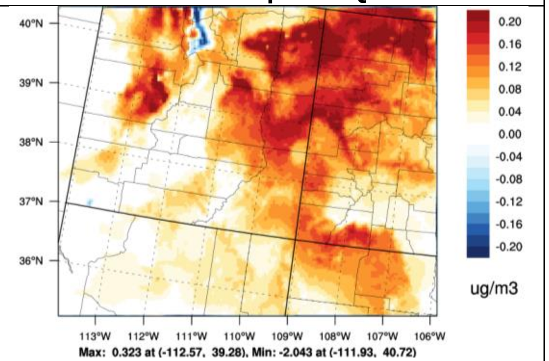
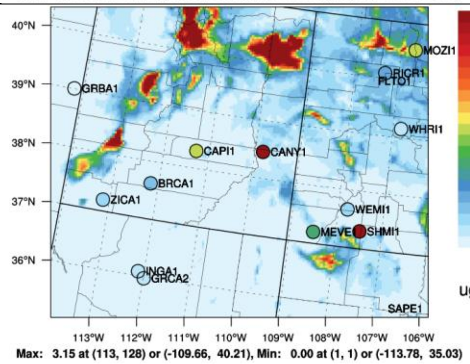
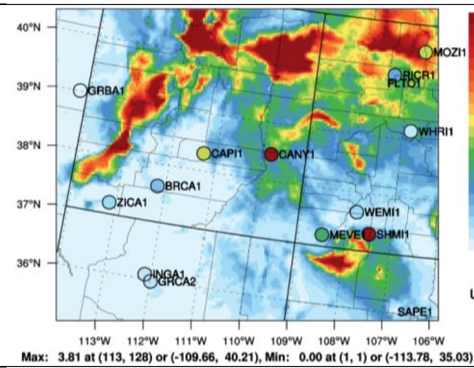
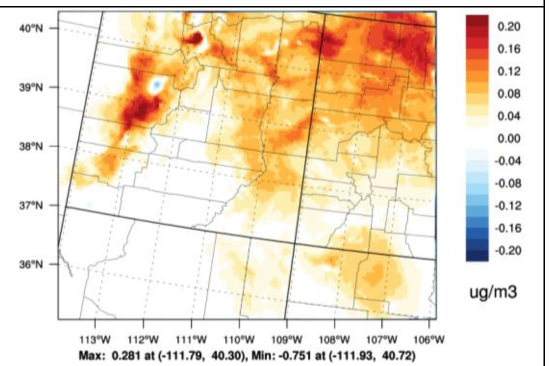
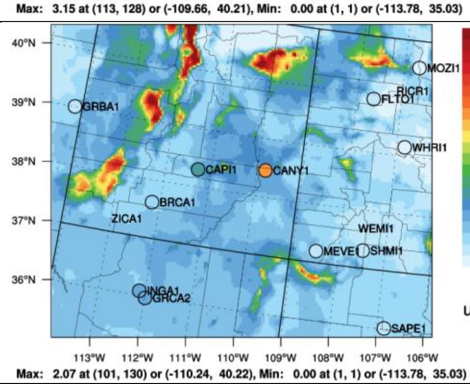
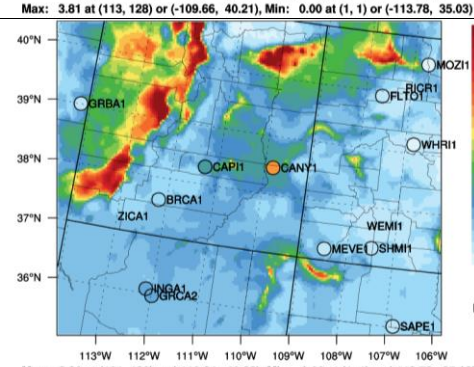
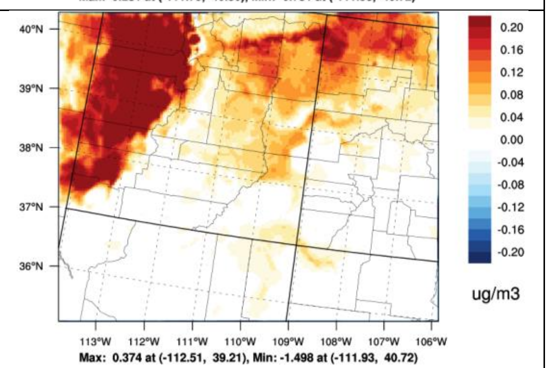


Figure B-18: 4-km Spatial Plots Comparing WAQS and PacifiCorp Modeling Concentrations for Ammonium for Select Days

<table>
<tr><th>Date</th><th>WAQS</th><th>PacifiCorp</th><th>PacifiCorp –WAQS</th></tr>
<tr><td>January 6</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>February 11</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>December 17</td><td>
</td><td>
</td><td>
</td></tr>
</table>

B4.4 Ammonia

Table B-8 below shows the MPE statistics that compare model-predicted ammonia concentrations with available observations at AMoN sites within the 4-km domain. The performance with the 2011b WAQS are compared to the PacifiCorp simulation. **Figure B-10** shows a bar chart that compares the monthly Mean Fractional Bias (MFB) for the original WAQS modeling and the PacifiCorp MPE simulation. The original WAQS simulations showed a systematic under-prediction of model-predicted ammonia concentrations. Although the model-predicted ammonia for the PacifiCorp simulations also show systematic under-predictions, the biases are noticeable lower which indicates better performance relative to the WAQS.

Figure B-11 shows time series that compares observed biweekly average ammonia concentrations at selected AMoN monitoring sites with model-predicted concentrations. The selected sites (located in New Mexico) are the only ones that fall within the computational domain and have data for the year 2011. The time series are presented for January, February, and December 2011. Most monitor sites record the largest ammonia concentrations in January and February. The time series show that the PacifiCorp ammonia model-predicted concentrations are systematically higher than those predicted with the original WAQS. Neither model is able to consistently predict the peaks of ammonia in the monitored record, but the PacifiCorp simulations are better to reproduce these concentrations than the WAQS.

Figure B-12 shows spatial plots of model-predicted ammonia daily average concentrations for selected days. These days belong to the 20% Worst visibility days from the monitoring record at IMPROVE sites in 2011 for at least 2 Class I areas in the 4-km domain. **Figure B-12** shows that for the selected days both modeling simulations produce very similar spatial patterns for the distribution of ammonia concentrations in the computational domain. Ammonia concentrations appear to be higher near the sources and rapidly decrease in magnitude farther away from these locations. Compared to the original WAQS, the PacifiCorp modeling results lead to consistently higher ammonia concentrations over the entire computational domain, particularly near the sources of this species.

Table B-16: Model Performance Statistical Summary for Ammonia

Monitoring Network	Statistic (%)/ Concentration (µg/m^3)	January		February		December	
		WAQS	PacifiCorp	WAQS	PacifiCorp	WAQS	PacifiCorp
AMoN (Bi-Weekly)	MFB	-120	-46	-126	-74	-125	-104
	MFGE	120	49	126	74	125	104
	NMB	-69	-25	-73	-52	-61	-46
	NME	69	30	73	52	61	46
	R^2	0.93	0.85	0.940	0.990	1.000	1.000
	Observed Mean Concentration (µg/m^3)	0.39	0.39	0.580	0.580	0.440	0.440
	Predicted Mean Concentration (µg/m^3)	0.12	0.29	0.154	0.281	0.174	0.236

Figure B-19: Monthly Mean Fractional Bias for Ammonia

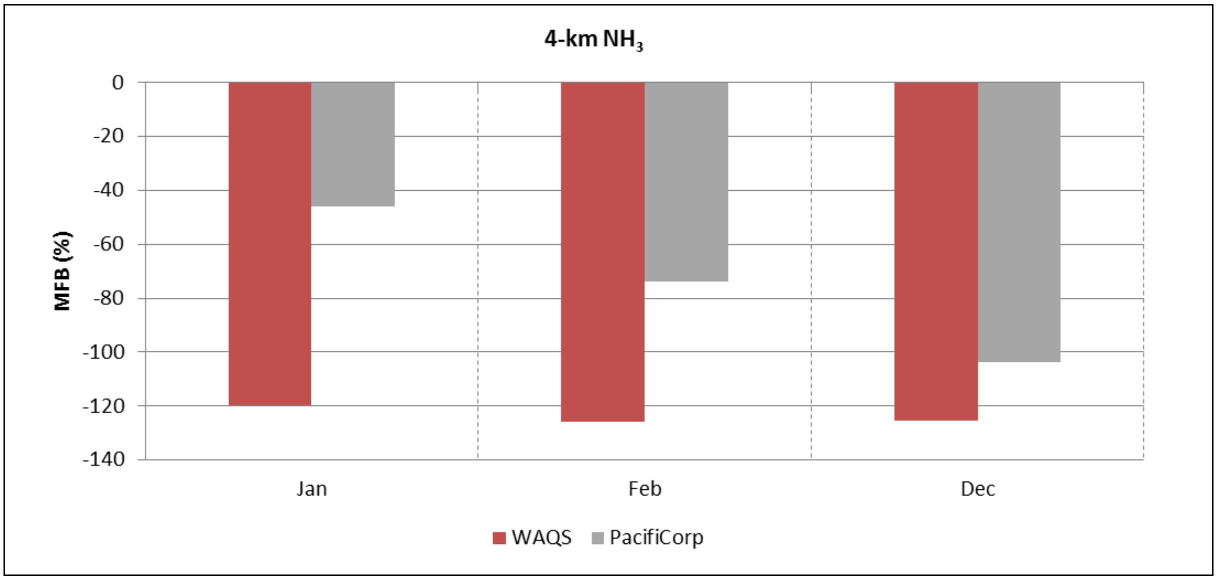


Figure B-20: Time Series for Ammonia at the Select AMoN Sites for the Entire Period

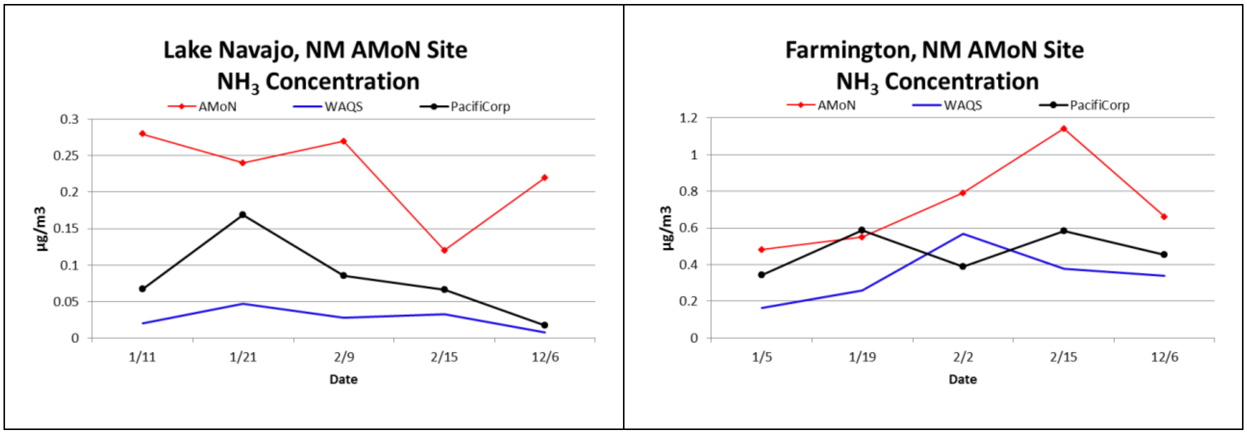
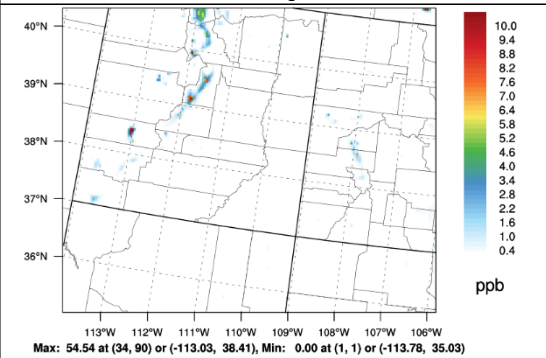
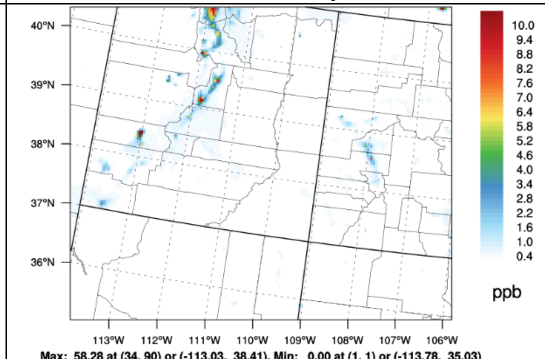
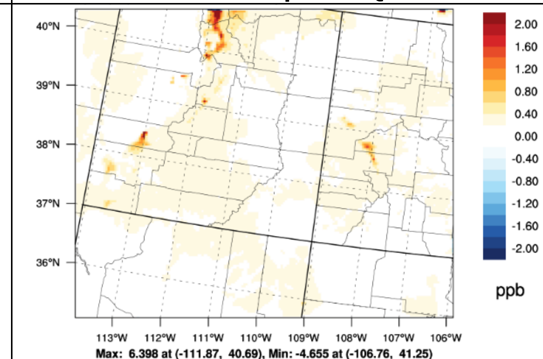
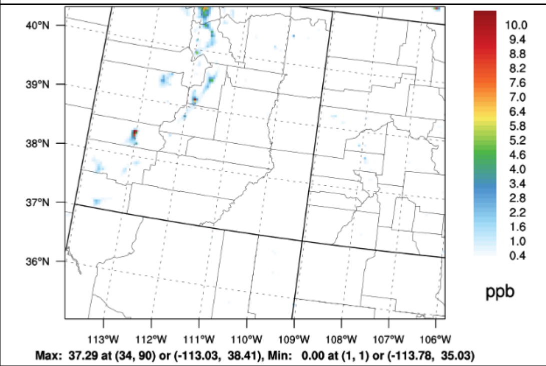
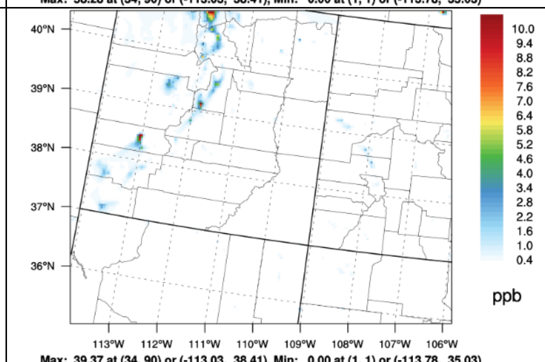
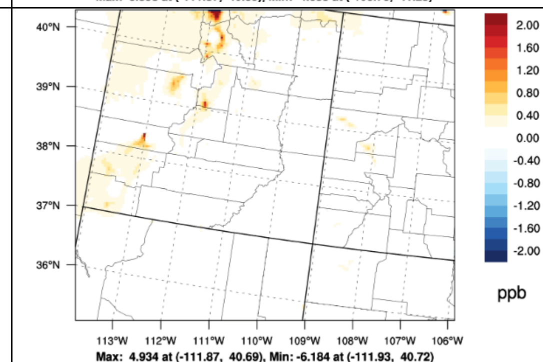
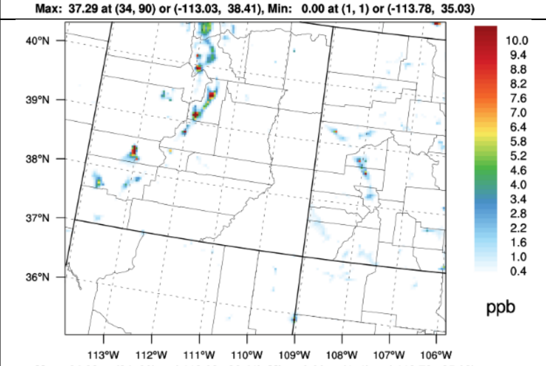
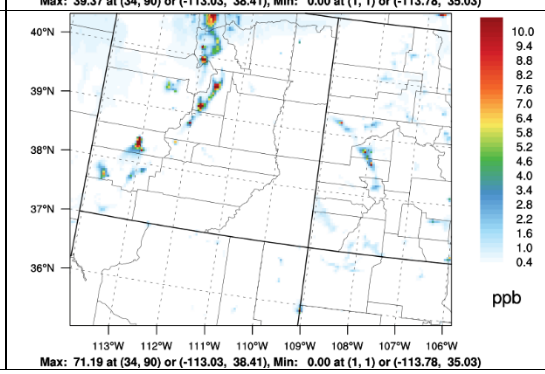
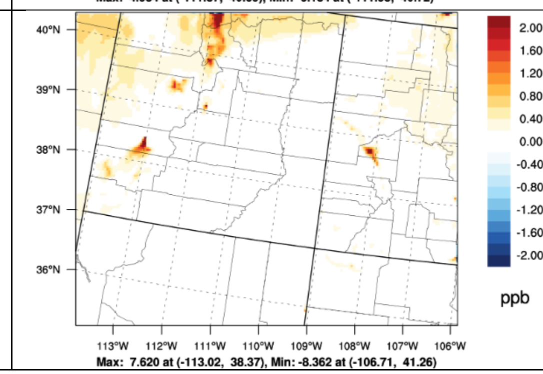


Figure B-21: 4-km Spatial Plots Comparing WAQS and PacifiCorp Modeling Concentrations for Ammonia for Select Days

Date	WAQS	PacifiCorp	PacifiCorp –WAQS
January 6			
February 11			
December 17			

B.5 Summary and Conclusions of Model Performance Evaluation

The modeling platform was evaluated with available observations for those species relevant to the visibility assessment of PacifiCorp's power plants in Utah. This modeling platform was configured with changes to the boundary concentrations and the ammonia deposition velocity with the intention to improve particulate formation over the original 2011b Western Air Quality Study (WAQS) platform. This MPE provides the analysis performed with the 4-km computational domain defined for this assessment in Chapter 2 and the ammonia modifications described in the modeling protocol (AECOM 2018). The MPE presented in this report is based on the comparison of the modeling results to the monitored concentrations of multiple pollutants for the year 2011. Model performance was assessed for a select subset of ambient air particle-phase pollutants. The MPE results show that:

1) Sulfate performance for the WAQS is extremely similar to the performance reported for all the months using PacifiCorp simulations with the ammonia adjustments. The original WAQS results showed a consistent over-prediction of model-predicted sulfate concentrations. The PacifiCorp performance for sulfate shows that the changes done to the ammonia boundary conditions and the ammonia depositions velocity have almost no noticeable effect in the formation of sulfate in the Class I areas within the computational domain.
2) The WAQS performance shows systematic under-prediction of nitrate, ammonia and ammonium concentrations for all the months analyzed. The PacifiCorp simulations show that the ammonia configuration adjustments lead to significantly higher concentrations for all these species. For some like nitrate and ammonium some months now show slight over-predictions.
3) For ammonia, the new simulations still under-predict concentrations relative to the observations. However, for all months in the new simulations the magnitude of negative biases gets reduced, which indicates better model performance due to the model configuration changes to ammonia.

In summary, the ammonia adjustments performed over the original 2011b WAQS modeling platform and explicitly simulated for the 4-km computational domain showed significant improvements in the model-predicted concentrations of sulfate, nitrate, ammonium and ammonia during the months of January, February, and December when higher contributions of nitrate are expected to affect visibility in Class I areas. These adjustments were performed for the modeling simulations to improve the visibility estimates due to different emissions scenarios as proposed in the approved modeling protocol.

Appendix C Time Series Analysis of Modeled Sulfate and Nitrate for Selected Class I Areas

This appendix provides a time series analysis in the form of bar charts for modeled sulfate and nitrate for select sites to understand the changes in these concentrations throughout the year for both the Utah SIP and USEPA FIP modeling scenarios. The sites selected represent concentrations at the following class I areas: Bryce Canyon NP, Capitol Reef NP and Mesa Verde NP. The analysis presented here explains why the modeled visibility impacts for the USEPA FIP at these sites (presented in **Table 4-3** in the main report) for the 20 percent worse days leads to larger modeled visibility improvements relative to the Utah SIP, and puts these model results into perspective.

Table 4-3 shows that the Class I area with the largest positive difference between the Utah SIP and the USEPA FIP visibility impacts is Capitol Reef NP. **Figure C-1** presents the modeled sulfate and nitrate daily average concentrations comparison between the USEPA FIP and Utah FIP during the 20 Percent Worst Days at Capitol Reef NP. This figure shows that sulfate concentrations are generally lower for most of the days for the Utah SIP scenario since the benefits of reductions in sulfur dioxide emissions are generally realized throughout the entire 20 percent worst days period. The nitrate concentrations are only significant over the fall and winter periods. Even then, the nitrate concentrations are higher for the Utah SIP scenario relative to the USEPA FIP for only eight days during this period and the maximum impacts occur on December 20th. The nitrate concentrations for the Utah SIP on that day are more than double the USEPA FIP contributions. This figure illustrates that only a few days of high nitrate concentration dominate the final visibility impairment estimates. Looking at the number of days, the Utah SIP is actually better than the USEPA FIP on many more of the 20 Percent Worst Days.

Figure C-2 presents modeled sulfate and nitrate daily average concentrations in the form of stacked bar charts during the 20 percent worst days for Capitol Reef NP, Bryce Canyon NP, and Mesa Verde NP. These stack bar charts allow for a direct comparison of particulate concentrations between the Utah SIP and USEPA FIP and is a good proxy for visibility since both nitrate and sulfate have similar contributions to haze in the new IMPROVE equation. **Figure C-2** shows the Utah SIP has lower concentrations compared to the USEPA FIP for most of the 20 percent worst days, with a few exceptions when nitrate concentrations are so large that the benefits of reducing sulfur dioxide in PacifiCorp power plants are not sufficient to offset the nitrate contributions. Notice the lower sulfate concentrations occur over the entire 20 percent worst days while the high nitrate occurs only for a few days during the fall and winter. Using the data derived from this figure, **Table C-1** presents a quantification with the number of days: the Utah SIP is better than, equivalent to, and worse than the USAEPA FIP at the three national parks. The table indicates that the number of days in which the Utah SIP is worse than the USEPA FIP for all three parks is only 5 days (out of 24-25 worst days), which implies that for the vast majority of the time the Utah SIP is better or equivalent to the USEPA FIP, but a few days of high nitrate during the winter skew the average visibility improvements resulting in positive values for the differences presented in **Table 4-3**.

Table C-2: Number of Days for 20 Percent Worst Days at Select Sites

Class I area	Number of Days			
	Utah SIP better than FIP (UT SIP – FIP) <0	Utah SIP equal to FIP (UT SIP – FIP) = 0	FIP better than Utah SIP (UT SIP – FIP) > 0	Total days in 20% worst period
Capitol Reef NP	14	7	3	24
Bryce Canyon NP	8	14	2	24
Mesa Verde NP	11	14	0	25

Figure C-3: Sulfate (top) and Nitrate (Bottom) daily average concentrations comparison between the USEPA FIP and Utah FIP during the 20 percent worst days at Capitol Reef NP.

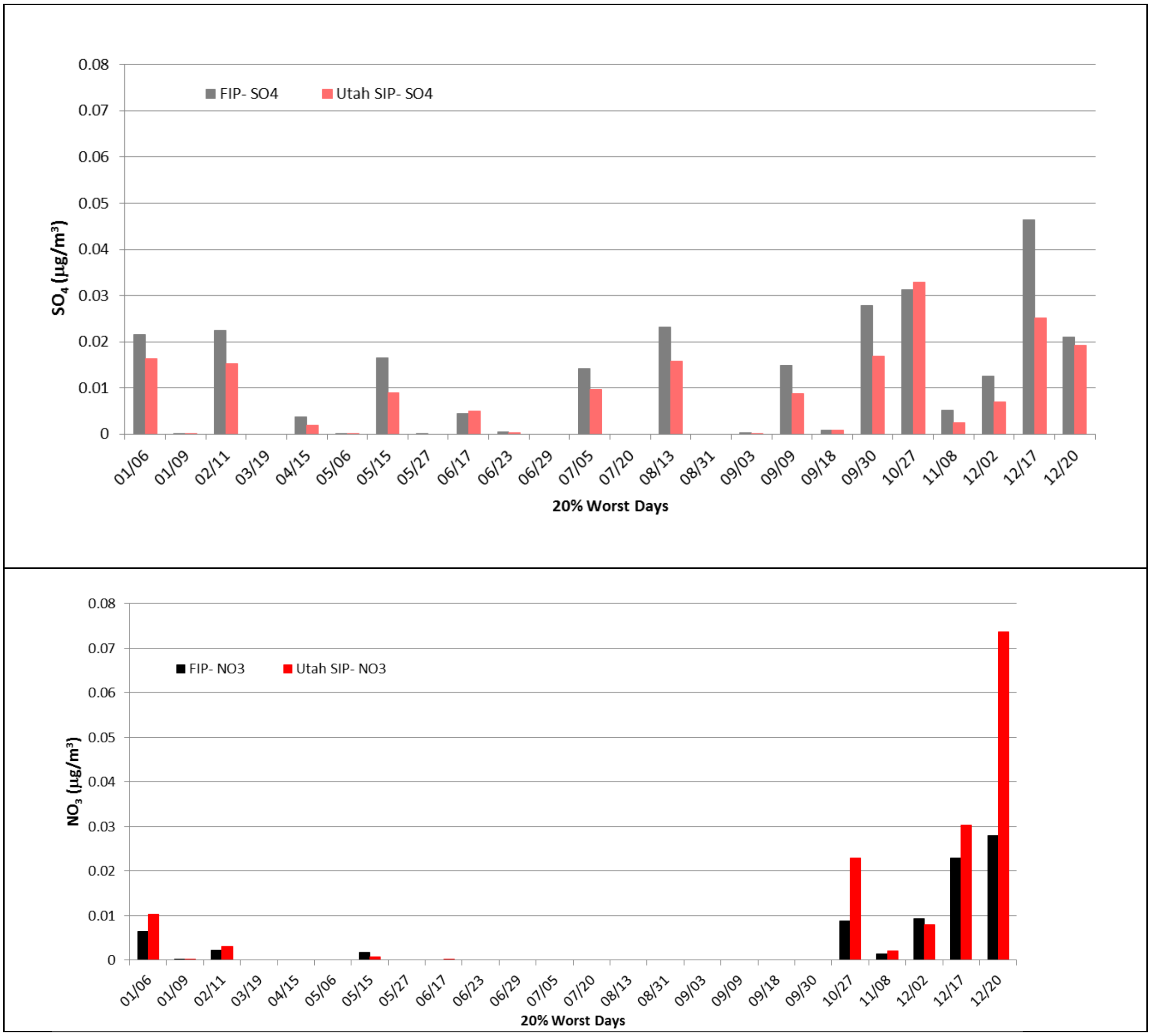
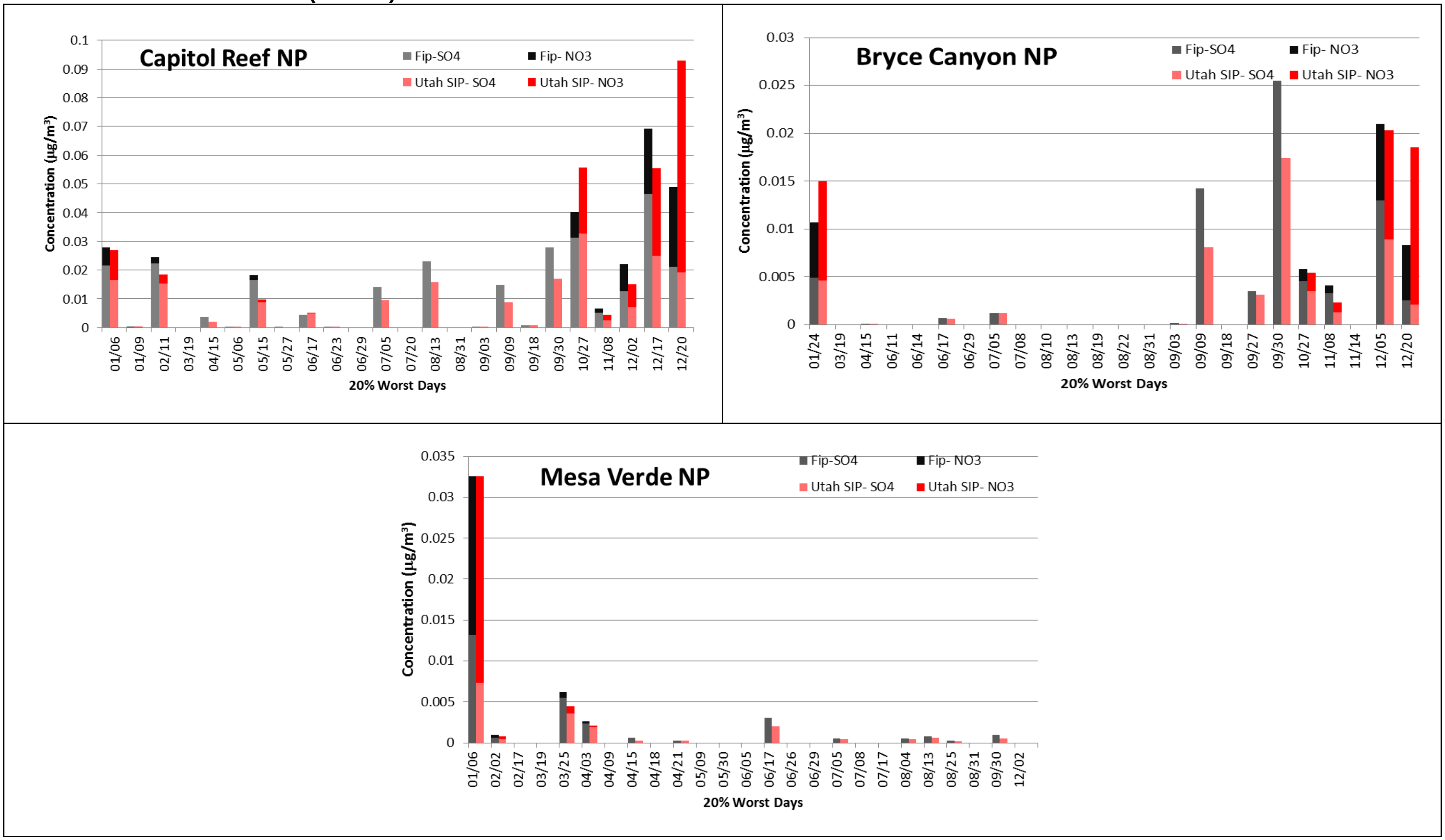


Figure C-4: Bar Charts of 20 Percent Worst Days for Sulfate and Nitrate at Capitol Reef NP (Top Right), Bryce Canyon NP (Top Left), and Mesa Verde NP (Bottom)



Appendix D Additional Visibility Assessments performed with SMAT-CE

SMAT-CE modeling results presented in Section 4.3 were obtained using the five-year averaging period of 2009 to 2013 with a base year of 2011. This appendix provides additional visibility estimates using SMAT-CE configured to consider two different averaging periods: 2007 to 2011 and 2011 to 2015, with base model years of 2009 and 2013, respectively. These additional analyses provide values for Zion NP when the monitoring data satisfies the 75% data completeness. Since the set of days that correspond to the 20 percent best and worst visibility depends on monitoring data, using different base years allows us to probe the future-year modeling and observe if these additional results lead to the same conclusion detailed in Chapter 4. The period 2007 to 2011 was selected since that is the first period prior to 2011 in which the monitoring data at Zion NP is complete. The period 2011 to 2015 was selected as it encompasses the most recent IMPROVE monitoring data available in SMAT-CE.

As part of the analysis we confirmed that the IMPROVE monitoring data at Zion NP during 2011 is missing data. **Figure D-1** presents the reconstructed daily extinctions for 2011 at Zion NP, which are used in the SMAT-CE calculations. This figure confirms that Zion NP 2011 observations did not satisfy SMAT-CE 75 percent data completeness requirement, since there are missing values for 30 days. While January is complete, there are numerous days of missing data from October to December.

Table D-1 presents the SMAT-CE settings used for both the 2009 and 2013 analyses. These settings are identical to the ones used for base year 2011 with the only differences in the start, end, and base model year. **Tables D-2** and **D-3** show the contribution to visibility on the 20 percent best and worst days due to PacifiCorp's power plants in Utah for the base year 2009. The results indicate that the Utah SIP scenario will not cause degradation of visibility relative to the Baseline at any of the analyzed Class I areas during either the 20 percent best or 20 percent worst visibility days. Furthermore, modeling results show that, on average, visibility improvement at the analyzed Class I areas is greater for the Utah SIP than for the USEPA FIP scenario during both the 20 percent best and worst visibility days for both the 20 percent best and worst days.

Tables D-4 and **D-5** show the contribution to visibility on the 20 percent best and worst days due to PacifiCorp's power plants in Utah for the base year 2013. Notice that for this analysis that one area, San Pedro Parks WA, now does not meet the 75 percent completion criteria. The results in these tables indicate that the Utah SIP scenario will not cause degradation of visibility relative to the Baseline at any of the analyzed Class I areas during either the 20 percent best or 20 percent worst visibility days. Furthermore, modeling results show that, on average, visibility improvement at the analyzed Class I areas is greater for the Utah SIP than for the USEPA FIP scenario during both the 20 percent best and worst visibility days for both the 20 percent best and worst days. This analysis also illustrates that the areas that individually do not show better improvement relative to the USEPA FIP can change depending on the base year, for instance for the 2013 base year Capitol Reef NP now shows a negative difference in column E for both best and worst days, which contrasts with the base results in 2011 (**Appendix C**). That is, for 2013 at Capitol Reef NP, the 2013 results indicated that the Utah SIP will lead to better visibility improvements.

Figure D-2: 2011 Daily Extinctions at Zion NP. Source: http://views.cira.colostate.edu/fed/

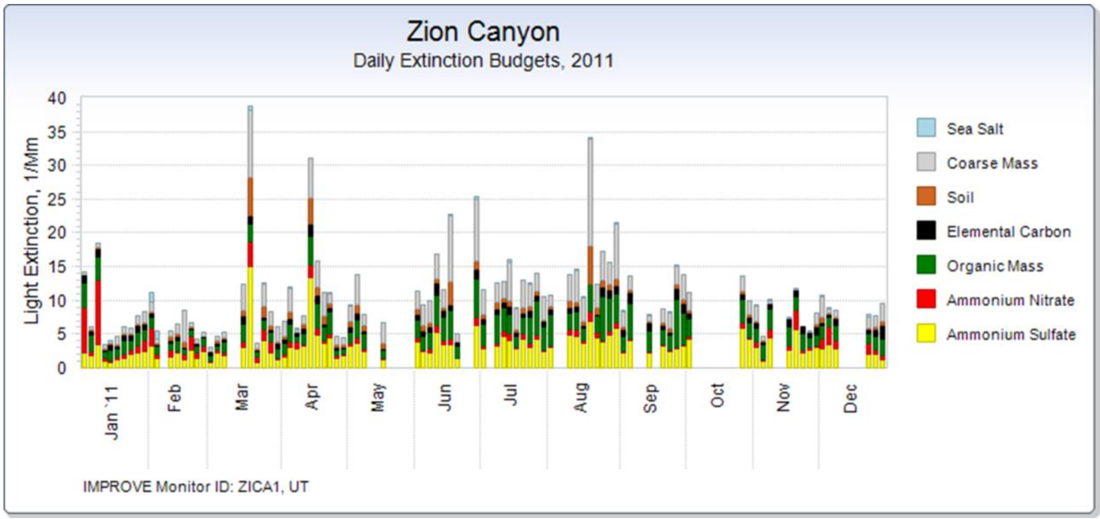


Table D-6: SMAT-CE Configuration Settings

Option	Main category	Setting	Default	2009	2013
Desired Output	Scenario Name	Name			
	Forecast	Temporally-adjust visibility levels at class 1 area	Yes	Yes	Yes
		Improve algorithm	use new version	use new version	use new version
		Use model grid cells at monitors	Yes	Yes	Yes
		Use model grid cells at class 1 area centroid	No	No	No
	Actions on run completion	Automatically extract all selected output files	Yes	Yes	Yes
Data Input	Monitor data	File name	ClassIareas_NEWIMPROVEALG_2000to2015_2017feb13_TOTAL.csv	ClassIareas_NEWIMPROVEALG_2000to2015_2017april27_TOTAL.csv	ClassIareas_NEWIMPROVEALG_2000to2015_2017april27_TOTAL.csv
	Model data	Baseline file	SMAT.PM.Large.12.SE_US2.2011eh.camx.grid.csv	Typical Year 2011 4-km model results	Typical Year 2011 4-km model results
		Forecast file	SMAT.PM.Large.12.SE_US2.2017eh.camx.grid.csv	Future-year 2025 4-km model results	Future-year 2025 4-km model results
	Using model data	Temporal adjustment at monitor	3x3	3x3	3x3
Filtering	Choose visibility data years	Start monitor year	2009	2007[1]	2011[2]
		End monitor year	2013	2011[1]	2015[2]
		Base model year	2011	2009[1]	2013[2]
	Valid visibility monitors	Minimum years required for valid monitor	3	3	3

[1] The values for the Start, End and Base model years are set to reflect a base year centered on the Typical Year (2009) and to perform the current design value calculation with the 5-year period surrounding this year (2007 to 2011).

[2] The values for the Start, End and Base model years are set to reflect a base year centered on the Typical Year (2013) and to perform the current design value calculation with the 5-year period surrounding this year (2011 to 2015).

Table D-7: Visibility Impacts for the Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Best Days using 2009 SMAT-CE Results

Class I Area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP*	0.07694	0.04525	0.03317	-0.0438	-0.01208
Black Canyon of the Gunnison NM*	0.02683	0.01322	0.01290	-0.0139	-0.00032
Bryce Canyon NP	0.02400	0.01152	0.01094	-0.0131	-0.00058
Canyonlands NP	0.07694	0.04525	0.03317	-0.0438	-0.01208
Capitol Reef NP	0.04612	0.02654	0.02384	-0.0223	-0.00270
Flat Tops WA*	0.04409	0.02275	0.01887	-0.0252	-0.00388
Grand Canyon NP	0.03234	0.01608	0.01346	-0.0189	-0.00262
La Garita WA*	0.02683	0.01322	0.01290	-0.0139	-0.00032
Maroon Bells-Snowmass WA*	0.04409	0.02275	0.01887	-0.0252	-0.00388
Mesa Verde NP	0.03437	0.01868	0.01433	-0.0200	-0.00435
Mount Zirkel WA	0.05659	0.03089	0.02096	-0.0356	-0.00993
San Pedro Parks WA	0.03156	0.01546	0.01358	-0.0180	-0.00188
Weminuche WA	0.02683	0.01322	0.01290	-0.0139	-0.00032
West Elk WA*	0.04409	0.02275	0.01887	-0.0252	-0.00388
Zion NP	0.01423	0.00650	0.00614	-0.0081	-0.00036
All Class I Area Average	**0.04039**	**0.02161**	**0.01766**	**N/A**	**-0.00395**

Table D-8: Visibility Impacts for the Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Worst Days using 2009 SMAT-CE Results

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.19360	0.10494	0.07654	-0.117	-0.02840
Black Canyon of the Gunnison NM	0.03798	0.02101	0.01760	-0.020	-0.00341
Bryce Canyon NP	0.00838	0.00416	0.00346	-0.005	-0.00070
Canyonlands NP	0.19360	0.10494	0.07654	-0.117	-0.02840
Capitol Reef NP	0.18456	0.10778	0.11326	-0.071	0.00548
Flat Tops WA	0.09688	0.05012	0.04572	-0.051	-0.00440
Grand Canyon NP	0.03661	0.01854	0.02033	-0.016	0.00179
La Garita WA	0.03798	0.02101	0.01760	-0.020	-0.00341
Maroon Bells-Snowmass WA	0.09688	0.05012	0.04572	-0.051	-0.00440
Mesa Verde NP	0.10428	0.04996	0.04639	-0.058	-0.00357
Mount Zirkel WA	0.10579	0.05116	0.04496	-0.061	-0.00620
San Pedro Parks WA	0.02453	0.01256	0.00936	-0.015	-0.00320
Weminuche WA	0.03798	0.02101	0.01760	-0.020	-0.00341
West Elk WA	0.09688	0.05012	0.04572	-0.051	-0.00440
Zion NP	0.01113	0.00546	0.00477	-0.006	-0.00069
All Class I Area Average	**0.08447**	**0.04486**	**0.03904**	**N/A**	**-0.00582**

Table D-9: Visibility Impacts for the Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Best Days using 2013 SMAT-CE Results

Class I area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.05339	0.03211	0.02089	-0.0325	-0.01122
Black Canyon of the Gunnison NM	0.03774	0.02039	0.01638	-0.0214	-0.00401
Bryce Canyon NP	0.01961	0.00921	0.00903	-0.0106	-0.00018
Canyonlands NP	0.05339	0.03211	0.02089	-0.0325	-0.01122
Capitol Reef NP	0.08181	0.04297	0.04469	-0.0371	0.00172
Flat Tops WA	0.04829	0.02489	0.02187	-0.0264	-0.00302
Grand Canyon NP	0.02088	0.01066	0.00907	-0.0118	-0.00159
La Garita WA	0.03774	0.02039	0.01638	-0.0214	-0.00401
Maroon Bells-Snowmass WA	0.04829	0.02489	0.02187	-0.0264	-0.00302
Mesa Verde NP	0.04406	0.02278	0.01884	-0.0252	-0.00394
Mount Zirkel WA	0.04886	0.02804	0.01645	-0.0324	-0.01159
San Pedro Parks WA*					
Weminuche WA	0.03774	0.02039	0.01638	-0.0214	-0.00401
West Elk WA	0.04829	0.02489	0.02187	-0.0264	-0.00302
Zion NP	0.01099	0.00502	0.00451	-0.0065	-0.00051
All Class I Area Average	**0.04222**	**0.02277**	**0.01851**	**N/A**	**-0.00426**

Table D-10: 2013 Visibility Impacts for the Baseline, USEPA FIP and Utah SIP Scenarios on the 20 Percent Worst Days using 2013 SMAT-CE Results

Class I Area	[A] Baseline (dv)	[B] USEPA FIP (dv)	[C] Utah SIP (dv)	[D] Utah SIP - Baseline	[E] Utah SIP - USEPA FIP
Arches NP	0.25117	0.14623	0.10929	-0.142	-0.03694
Black Canyon of the Gunnison NM	0.05094	0.03291	0.03605	-0.015	0.00314
Bryce Canyon NP	0.00870	0.00451	0.00414	-0.005	-0.00037
Canyonlands NP	0.25117	0.14623	0.10929	-0.142	-0.03694
Capitol Reef NP	0.11773	0.05939	0.05859	-0.059	-0.00080
Flat Tops WA	0.09512	0.04680	0.04168	-0.053	-0.00512
Grand Canyon NP	0.01472	0.00707	0.00589	-0.009	-0.00118
La Garita WA	0.05094	0.03291	0.03605	-0.015	0.00314
Maroon Bells-Snowmass WA	0.09512	0.04680	0.04168	-0.053	-0.00512
Mesa Verde NP	0.10341	0.03640	0.04178	-0.062	0.00538
Mount Zirkel WA	0.07734	0.03733	0.02850	-0.049	-0.00883
San Pedro Parks WA*					
Weminuche WA	0.05094	0.03291	0.03605	-0.015	0.00314
West Elk WA	0.09512	0.04680	0.04168	-0.053	-0.00512
Zion NP	0.00395	0.00191	0.00145	-0.002	-0.00046
All Class I Area Average	**0.09046**	**0.04844**	**0.04229**	**N/A**	**-0.00615**

ITEM 5

State of Utah
GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQ-031-19

M E M O R A N D U M

TO: Air Quality Board

THROUGH: Bryce C. Bird, Executive Secretary

FROM: Jay Baker, Environmental Scientist

DATE: February 21, 2019

SUBJECT: PROPOSE FOR PUBLIC COMMENT: Amend R307-110-28. Regional Haze.

The amendments to Section XX, Regional Haze, Parts A and D, will have to be incorporated into the Utah Air Quality Rules. R307-110-28 is the rule that incorporates the new amendments to Parts A and D into the rules. If the Board adopts the amendments Section XX, Regional Haze, these amendments will become part of Utah's State Implementation Plan when the rule is finalized.

Recommendation: Staff recommends that the Board propose R307-110-28 for public comment.

Appendix 1: Regulatory Impact Summary Table*

Fiscal Costs	FY 2019	FY 2020	FY 2021
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Person	$0	$0	$0
Total Fiscal Costs:	**$0**	**$0**	**$0**
Fiscal Benefits			
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Persons	$0	$0	$0
Total Fiscal Benefits:	**$0**	**$0**	**$0**
Net Fiscal Benefits:	$0	$0	$0

***This table only includes fiscal impacts that could be measured. If there are inestimable fiscal impacts, they will not be included in this table. Inestimable impacts for State Government, Local Government, Small Businesses and Other Persons are described in the narrative. Inestimable impacts for Non-Small Businesses are described in Appendix 2.**

Appendix 2: Regulatory Impact to Non-Small Businesses

No non-small businesses are expected to be impacted by this rulemaking. Large industrial businesses are already required to maintain and utilize the controls that this rule would require.

The Executive Director of the Department of Environmental Quality, Alan Matheson, has reviewed and approved this fiscal analysis.

R307. Environmental Quality, Air Quality.
R307-110. General Requirements: State Implementation Plan.

R307-110-28. Regional Haze.

The Utah State Implementation Plan, Section XX, Regional Haze, as most recently amended by the Utah Air Quality Board on [~~December 2~~]June 5, 201[~~5~~]9, pursuant to Section 19-2-104, is hereby incorporated by reference and made a part of these rules.

KEY: air pollution, PM10, PM2.5, ozone

Date of Enactment or Last Substantive Amendment: [~~June 7~~], 201[~~8~~]9
Notice of Continuation: January 27, 2017
Authorizing, and Implemented or Interpreted Law: 19-2-104

ITEM 6

State of Utah
GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQ-030-19

M E M O R A N D U M

TO: Air Quality Board

THROUGH: Bryce C. Bird, Executive Secretary

FROM: Jay Baker, Environmental Scientist

DATE: February 21, 2019

SUBJECT: PROPOSE FOR PUBLIC COMMENT: Amend R307-150-3. Applicability

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Sulfur Dioxide Milestone Inventory Requirements

Utah's Regional Haze State Implementation Plan (SIP) contains sulfur dioxide (SO_2) milestones that are based on 2006 SO_2 emissions from power plants. To ensure that SO_2 emissions reductions are occurring, R307-150 requires power plants to report their annual SO_2 emissions. In 2015, the Board approved a SIP revision with an alternative to best available retrofit technology (BART) for NO_x. Part of the alternative included the closure of the Carbon power plant. Emission reductions of SO_2 from the closure were included in the demonstration that the alternative was better than BART. Because the SO_2 reductions are part of the BART alternative for NO_x, they should not be counted towards reductions in the SO_2 milestone program. Staff is proposing this amendment to R307-150 to require the Carbon power plant SO_2 emissions to be reported as 8,005 tons/year in the annual SO_2 Milestone Report to EPA.

<u>Recommendation</u>: Staff recommends that the Board propose amended R307-150-3 for public comment.

Appendix 1: Regulatory Impact Summary Table*

Fiscal Costs	FY 2019	FY 2020	FY 2021
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Person	$0	$0	$0
Total Fiscal Costs:	**$0**	**$0**	**$0**
Fiscal Benefits			
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Persons	$0	$0	$0
Total Fiscal Benefits:	**$0**	**$0**	**$0**
Net Fiscal Benefits:	$0	$0	$0

***This table only includes fiscal impacts that could be measured. If there are inestimable fiscal impacts, they will not be included in this table. Inestimable impacts for State Government, Local Government, Small Businesses and Other Persons are described in the narrative. Inestimable impacts for Non-Small Businesses are described in Appendix 2.**

Appendix 2: Regulatory Impact to Non-Small Businesses

No non-small businesses are expected to be impacted by this rulemaking. This rule strictly applies to reporting requirements and are not anticipated to increase costs or benefits.

The Executive Director of the Department of Environmental Quality, Alan Matheson, has reviewed and approved this fiscal analysis.

R307. Environmental Quality, Air Quality.
R307-150. Emission Inventories.

R307-150-3. Applicability.

(1) R307-150-4 applies to all stationary sources with actual emissions of 100 tons or more per year of sulfur dioxide in calendar year 2000 or any subsequent year unless exempted in R307-150-3(1) (a)[~~below~~]. Sources subject to R307-150-4 may be subject to other sections of R307-150.

(a) A stationary source that meets the requirements of R307-150-3(1) that has permanently ceased operation is exempt from the requirements of R307-150-4 for all years during which the source did not operate at any time during the year.

(b) Notwithstanding R307-150-3(a), beginning with 2016 emissions, the Division of Air Quality will include emissions of 8,005 tons/yr of sulfur dioxide for the Carbon Power Plant in the annual regional sulfur dioxide milestone report required as part of the Regional Haze State Implementation Plan.

([~~b~~]c) Except as provided in R307-150-3(1)(a), any source that meets the criteria of R307-150-3(1) and that emits less than 100 tons per year of sulfur dioxide in any subsequent year shall remain subject to the requirements of R307-150-4 until 2018 or until the first control period under the Western Backstop Sulfur Dioxide Trading Program as established in R307-250-12(1)(a), whichever is earlier.

(2) R307-150-5 applies to large major sources.

(3) R307-150-6 applies to:

(a) each major source that is not a large major source;

(b) each source with the potential to emit 5 tons or more per year of lead; and

(c) each source not included in R307-150-3(2), R307-150-3(3)(a), or R307-150-3(3)(b) that is located in Davis, Salt Lake, Utah, or Weber Counties and that has the potential to emit 25 tons or more per year of any combination of oxides of nitrogen, oxides of sulfur and PM_{10}, or the potential to emit 10 tons or more per year of volatile organic compounds.

(4) R307-150-7 applies to Part 70 sources not included in R307-150-3(2) or R307-150-3(3).

(5) R307-150-9 applies to sources with Standard Industrial Classification codes in the major group 13 that have uncontrolled actual emissions greater than one ton per year for a single pollutant of PM_{10}, $PM_{2.5}$, oxides of nitrogen, oxides of sulfur, carbon monoxide or volatile organic compounds. These sources include, but are not limited to, industries involved in oil and natural gas exploration, production, and transmission operations; well production facilities; natural gas compressor stations; and natural gas processing plants and commercial oil and gas disposal wells, and ponds.

(a) Sources that require inventory submittals under R307-150-3(1) through R307-150-3(4) are excluded from the requirements of R307-150-9.

KEY: air pollution, reports, inventories

Date of Enactment or Last Substantive Amendment: [~~March 5~~], 201[~~8~~]9

Notice of Continuation: November 13, 2018
Authorizing, and Implemented or Interpreted Law: 19-2-104(1)(c)

ITEM 7

State of Utah
GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQ-029-19

M E M O R A N D U M

TO: Air Quality Board

THROUGH: Bryce C. Bird, Executive Secretary

FROM: Jaden Materi, Environmental Engineer

DATE: February 21, 2019

SUBJECT: PROPOSE FOR PUBLIC COMMENT: Amend R307-401-10. Source Category Exemptions.

UAC R307-401 currently requires a source with the potential to exceed the small source exemption thresholds described in R307-401-9 to submit a notice-of-intent (NOI) and receive an approval order. In April 2018, the DAQ received an NOI for a gasoline dispensing facility (GDF). Staff reviewed the NOI, evaluated potential permitting actions, and determined that an approval order would not include additional requirements for GDF sources beyond those already required in UAC R307-328 and 40 CFR 63 Subpart 6C.

UAC R307-401-10 therefore, has been amended to include GDFs as an exempt source category from the requirement to obtain an approval order in R307-401-5 through R307-401-8.

<u>Recommendation</u>: Staff recommends that the Board propose amended R307-401-10 for public comment.

Appendix 1: Regulatory Impact Summary Table*

Fiscal Costs	FY 2019	FY 2020	FY 2021
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Person	$0	$0	$0
Total Fiscal Costs:	**$0**	**$0**	**$0**
Fiscal Benefits			
State Government	$0	$0	$0
Local Government	$0	$0	$0
Small Businesses	$0	$0	$0
Non-Small Businesses	$0	$0	$0
Other Persons	$0	$0	$0
Total Fiscal Benefits:	**$0**	**$0**	**$0**
Net Fiscal Benefits:	$0	$0	$0

***This table only includes fiscal impacts that could be measured. If there are inestimable fiscal impacts, they will not be included in this table. Inestimable impacts for State Government, Local Government, Small Businesses and Other Persons are described in the narrative. Inestimable impacts for Non-Small Businesses are described in Appendix 2.**

Appendix 2: Regulatory Impact to Non-Small Businesses

No non-small businesses are expected to be impacted by this rulemaking. This rule exempts gasoline dispensing facilities from the permitting process, as they are already regulated under an existing rule. There are no anticipated costs or benefits due to this rule.

The Executive Director of the Department of Environmental Quality, Alan Matheson, has reviewed and approved this fiscal analysis.

R307. Environmental Quality, Air Quality.
R307-401. Permit: New and Modified Sources.

R307-401-10. Source Category Exemptions.

The source categories described in R307-401-10 are exempt from the requirement to obtain an approval order found in R307-401-5 through R307-401-8. The general provisions in R307-401-4 shall apply to these sources.

(1) Fuel-burning equipment in which combustion takes place at

no greater pressure than one inch of mercury above ambient pressure with a rated capacity of less than five million BTU per hour using no other fuel than natural gas or LPG or other mixed gas that meets the standards of gas distributed by a utility in accordance with the rules of the Public Service Commission of the State of Utah, unless there are emissions other than combustion products.

(2) Comfort heating equipment such as boilers, water heaters, air heaters and steam generators with a rated capacity of less than one million BTU per hour if fueled only by fuel oil numbers 1 - 6,

(3) Emergency heating equipment, using coal or wood for fuel, with a rated capacity less than 50,000 BTU per hour.

(4) Exhaust systems for controlling steam and heat that do not contain combustion products.

(5) A well site as defined in 40 CFR 60.5430a, including centralized tank batteries, that is not a major source as defined in R307-101-2, and is registered with the Division as required by R307-505.

(6) A gasoline dispensing facility as defined in 40 CFR 63.11132 that is not a major source as defined in R307-101-2. These sources shall comply with the applicable requirements of R307-328 and 40 CFR 63 Subpart CCCCCC: National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities.

KEY: air pollution, permits, approval orders, greenhouse gases

Date of Enactment or Last Substantive Amendment: [~~March 5~~], 201[~~8~~]

Notice of Continuation: May 15, 2017

Authorizing, and Implemented or Interpreted Law: 19-2-104(3)(q); 19-2-108

ITEM 8

State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQ-021-19

M E M O R A N D U M

TO: Air Quality Board

THROUGH: Bryce C. Bird, Executive Secretary

FROM: Jason Krebs, Environmental Scientist

DATE: February 20, 2019

SUBJECT: HJG Utah, LLC – Final Settlement Agreement

HJG Utah, LLC (HJG) owns and operates a produced water disposal facility in Duchesne County. On January 27, 2017, the Utah Division of Air Quality (DAQ) issued a notice of violation to HJG for violating Rule R307-401-5(1) by failing to obtain an approval order (AO) prior to construction of the Blue Bench 13-1 produced water disposal facility located at 5150 S HWY 87 in Duchesne, Utah. On July 31, 2017, DAQ filed a lawsuit in Eighth District Court in Duchesne County to collect penalties and secure the company's compliance with Utah environmental laws. As a result of the lawsuit, HJG applied for an AO with DAQ and obtained an AO on September 25, 2018.

To resolve the penalty portion of the lawsuit, the DAQ and HJG have negotiated a total settlement of $140,000. Of that amount, $70,000 will be paid in cash, and the remaining $70,000 will be deferred for a period of two years. Of the $70,000 cash payment, $56,000 will be paid to the Environmental Mitigation and Response Fund as authorized by Section 19-1-603(3) of the Utah Code. The remaining $14,000 will constitute a penalty amount with $4,000 in attorney's fees being reimbursed to the agency as authorized by Section 19-2-115(9)(b) of the Utah Code. If during the two year deferment period HJG does not violate its AO and Utah environmental laws, the deferred $70,000 will be waived.

In accordance with Section 19-2-104(3)(b)(i) of the Utah Code, this settlement is provided to the Board for review as the penalty exceeds $25,000. A copy of the settlement agreement is provided. The DAQ will withhold any further action on this case until the Board approves or disapproves the settlement.

<u>Recommendation</u>: Staff recommends that the Board approve the penalty amount and the settlement agreement.

CHRISTIAN C. STEPHENS (9068)
MARINA V. THOMAS (11251)
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Attorneys for Plaintiffs State of Utah et al.

IN THE EIGHTH DISTRICT COURT, DUCHESNE COUNTY
STATE OF UTAH

STATE OF UTAH on behalf of UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY, an agency of the State of Utah, and UTAH DIVISION OF AIR QUALITY, an agency of the State of Utah; BRYCE BIRD, DIRECTOR OF UTAH DIVISION OF AIR QUALITY, in his official capacity, Plaintiffs, vs. HJG UTAH LLC, Defendant.	**SETTLEMENT AGREEMENT** Civil Case No. 170800038 Judge: Honorable Samuel P. Chiara

RECITALS

This Settlement Agreement ("Agreement") is entered into between the Plaintiffs (referred to collectively as "UDAQ") and the Defendant HJG Utah LLC (referred to as "HJG Utah") under the Utah Air Conservation Act, Utah Code Ann. §§ 19-2-101 through 19-2-305 (the "Act"). For purposes of this Agreement, the Plaintiffs and the Defendant shall be referred to collectively as the "Parties."

1. UDAQ's Authority.

UDAQ has authority to administer the Act, to issue orders, and to exercise all incidental powers necessary to carry out the purposes of the Act, including settlement. Utah Code Ann. § 19-2-107(2)(b)(ix).

2. HJG Utah.

Defendant HJG Utah is a domestic limited liability company registered with the Utah Department of Commerce, Utah Division of Corporations and Commercial Code.

3. Notice of Violation.

On January 27, 2017, UDAQ issued a Notice of Violation and Order to Comply (NOV) to HJG Utah for violating Rule R307-401-5(1) of the Utah Administrative Code for failure to obtain an Approval Order (AO) prior to initiation of construction of the Blue Bench 13-1 salt water injection facility located at 5150 S HWY 87 Duchesne, Utah ("Blue Bench Facility"). The NOV required compliance with the Utah Air Quality Rules (Utah Administrative Code Rules R307-101 through R307-842). The NOV became final thirty days after issuance, triggering UDAQ's right to sue for penalties under Section 19-2-115(2)(a) of the Utah Code.

4. Complaint and State District Court Proceedings.

On July 31, 2017, UDAQ filed a Complaint against HJG Utah to collect penalties for the violations established in the NOV and secure compliance with the Utah Air Quality Rules. Counsel entered appearance on behalf of HJG Utah on September 28, 2017 and the parties agreed to several extensions of time to file an answer to resolve compliance issues and agree on the penalty amount. Current extended deadline for HJG Utah to file an answer is March 26, 2019.

5. Settlement Discussions.

The Parties have engaged in a series of settlement discussions that started shortly after the Complaint was filed. HJG Utah hired a consultant, submitted all the necessary documentation on March 16, 2018, and obtained an AO from UDAQ on September 25, 2018. The AO was administratively amended and reissued on November 26, 2018. The Parties agree that the best way to resolve the Complaint is to enter into a Settlement Agreement.

6. Purpose.

The purpose of this Agreement is to settle all the claims made in the Complaint.

7. Mutual Interest.

The Parties believe that it is in their mutual best interest to execute this Agreement and to settle all allegations made in the Complaint.

AGREEMENT

Without adjudication of any factual or legal issue and in order to settle all claims in the Complaint, the Parties agree to the following:

8. HJG Utah has fully complied with Rule R307-401-5(1) of the Utah Administrative Code when it comes to violations listed in the Complaint.

9. HJG Utah agrees to a total stipulated penalty of $140,000.00 (attorney's fees in the amount of $4,000.00 are included in this number) to settle the violations in the Complaint and reimburse UDAQ for attorney's fees expenditure. One half of this payment ($70,000.00) shall be paid to the State of Utah as provided below and the other half shall be deferred as provided below:

> **a) Civil Penalty and Attorney's Fees Paid to the State.** HJG Utah shall pay $14,000.00, which is 20% of the $70,000.00, as civil penalty within thirty (30) days of the effective date of this Agreement. The entire amount of attorney's fees ($4,000.00) shall be included in this number. The payment shall be made by wire transfer or ACH transfer in the amount of $14,000.00 payable to the State of Utah. The notation on the transfer shall clearly indicate that $10,000.00 is the amount of civil penalty and $4,000.00 is the amount of attorney's fees. If the payment is not timely made, additional penalties at the rate of $10,000.00 a day shall accrue and UDAQ may enforce payment through a civil action in the state district court.
>
> **b) Supplemental Environmental Project (SEP).** $56,000.00, which is 80% of the $70,000.00, shall be paid to the Environmental Mitigation and Response Fund as authorized by Section 19-1-603(3) of the Utah Code within thirty (30) days of the effective date of this Agreement. The payment shall be made by wire transfer or ACH transfer in the amount of $56,000.00 payable to the State of Utah. If the payment is not

timely made additional penalties at the rate of $10,000.00 a day shall accrue and UDAQ may enforce payment through a civil action in the state district court.

i) These funds shall be fully used and are not returnable.

ii) This payment is credited as a SEP at 1:1 ratio because HJG Utah is a small business and the project is of outstanding quality. Funds deposited into the Environmental Mitigation and Response Fund go towards environmental mitigation actions, environmental response action, site closures, and cleanups under Section 19-1-604(2) of the Utah Code. The funds may also be disbursed to other state agencies for similar activities under Section 19-1-604(4) of the Utah Code.

c) Deferred Penalty Amount. The remaining one half of the total penalty amount shall be deferred for two years from the effective date of this Agreement contingent on the Blue Bench Facility's compliance with the terms of the AO issued on November 26, 2018 (DAQE-AN159340002-18) as it may be modified or amended, the Utah Air Quality Rules, and the Utah Air Conservation Act. This remaining one half becomes due and payable to the State of Utah within thirty (30) days of the event of non-compliance through the same payment methods described in paragraph 9.a. UDAQ retains its discretion to reduce the amount of the deferred penalty depending on the nature and extent of a violation. If the payment under this paragraph 9.c is not timely made, additional penalties at the rate of $10,000 a day shall accrue. If Blue Bench Facility stays compliant during the two-year period specified in this paragraph 9.c, the deferred one half of the total penalty amount shall be forgiven and shall no longer be due and payable.

10. UDAQ shall dismiss the Complaint with prejudice within ten (10) calendar days of receiving the payments specified in paragraphs 9.a and 9.b. UDAQ retains the right to institute a new civil action to collect any penalty that may be triggered under paragraph 9.c.

11. None of the provisions of this Agreement shall be considered admissions by UDAQ or HJG Utah and shall not be used by any third party related or unrelated to this Agreement for purposes other than determining the basis of this Agreement. This Agreement resolves all liability and claims arising from or relating to the January 27, 2017 NOV and the Complaint.

12. If HJG Utah fulfills its payment obligation under paragraphs 9.a and 9.b of this Agreement, UDAQ forever releases and waives the claims dismissed under paragraph 10 of this Agreement.

13. All notices, requests, demands, and other communications under this Agreement shall be in writing and shall be given by (i) established express delivery service which maintains delivery records, (ii) hand delivery, (iii) certified or registered mail, postage prepaid, return receipt requested, or (iv) electronic mail, to the Parties at the following addresses, or at such other address as the Parties may designate by written notice in the following manner:

UDAQ

Bryce C. Bird
Utah Division of Air Quality
P.O. Box 144870
Salt Lake City, UT 84114-4870
bbird@utah.gov

With a copy to:

Marina V. Thomas
Christian C. Stephens
P.O. Box 140873
Salt Lake City, UT 84114-0873
marinathomas@agutah.gov
cstephens@agutah.gov

HJG Utah

Benjamin Machlis
Dorsey & Whitney LLP
111 S. Main Street, Suite 2100
Salt Lake City, UT 84111-2176
machlis.ben@dorsey.com

14. Successors and Assigns.

All the rights and obligations of the Parties under this Agreement shall be binding on and inure to the benefit of their permitted successors.

15. Entire Agreement.

This Agreement, which includes all recitals and terms, constitutes the entire agreement between the Parties related to the subject matter of this Agreement, and incorporates all prior correspondence, communications, or agreements between the Parties relating to the subject matter of this Agreement, and cannot be altered except in writing signed by all Parties.

16. Authority to Execute.

Each person executing this Agreement individually and personally represents and warrants that he or she is duly authorized to execute and deliver the same on behalf of the entity for which he or she is signing, and that all corporate and/or legislative authority and approvals have been obtained, and that this Agreement is a binding obligation on the Parties.

17. Effective Date.

This Agreement is effective on the date when the last party signs the Agreement.

This Agreement shall be executed as follows: counterparts.

Agreed:

________________________________ Date: ____________
Marina V. Thomas
Assistant Attorney General
For: UDAQ

Agreed:

________________________________ Date: ____________
Horst Geicke
President
For: HJG Utah

ITEM 9

Air Toxics

State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQA-028-19

M E M O R A N D U M

TO: Air Quality Board

FROM: Bryce C. Bird, Executive Secretary

DATE: February 13, 2019

SUBJECT: Air Toxics, Lead-Based Paint, and Asbestos (ATLAS) Section Compliance Activities – January 2019

Asbestos Demolition/Renovation NESHAP Inspections	22
Asbestos AHERA Inspections	24
Asbestos State Rules Only Inspections	1
Asbestos Notification Forms Accepted	159
Asbestos Telephone Calls	392
Asbestos Individuals Certifications Approved/Disapproved	63/0
Asbestos Company Certifications/Re-Certifications	3/18
Asbestos Alternate Work Practices Approved/Disapproved	12/0
Lead-Based Paint (LBP) Inspections	9
LBP Notification Forms Approved	1
LBP Telephone Calls	99
LBP Letters Prepared and Mailed	16
LBP Courses Reviewed/Approved	0
LBP Course Audits	1
LBP Individual Certifications Approved/Disapproved	30/0
LBP Firm Certifications	13

195 North 1950 West • Salt Lake City, Utah
Mailing Address: P.O. Box 144820 • Salt Lake City, Utah 84114-4820
Telephone (801) 536-4000 • Fax (801) 536-4099 • T.D.D (801) 903-3978
www.deq.utah.gov

Notices of Violation Sent	0
Compliance Advisories Sent	28
Warning Letters Sent	9
Settlement Agreements Finalized	5
Penalties Agreed to:	
Patch Boys	$ 2,639.50

Compliance

State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF AIR QUALITY
Bryce C. Bird
Director

DAQC-0212-19

M E M O R A N D U M

TO: Air Quality Board

FROM: Bryce C. Bird, Executive Secretary

DATE: February 12, 2019

SUBJECT: Compliance Activities – January 2019

Annual Inspections Conducted:

Major	9
Synthetic Minor	4
Minor	49

On-Site Stack Test Audits Conducted: 1

Stack Test Report Reviews: 27

On-Site CEM Audits Conducted: 0

Emission Reports Reviewed: 9

Temporary Relocation Requests Reviewed & Approved: 7

Fugitive Dust Control Plans Reviewed & Accepted: 149

Open Burn Permit Applications Completed .... Closed Season

Soil Remediation Report Reviews: 4

[1]Miscellaneous Inspections Conducted: 22

Complaints Received: 45

Breakdown Reports Received:.. 0

Compliance Actions Resulting From a Breakdown... 0

Warning Letters Issued:.. 1

Notices of Violation Issued:.. 2

Unresolved Notices of Violation

US Magnesium	08/27/2015
HJG Utah	01/27/2017
Western Water Solutions	05/02/2017
Geneva Rock Products	10/20/2017
Norbest	11/15/2017
Strang Excavating	01/17/2018
US Magnesium	03/02/2018
Gordon Creek Compressor Station	05/16/2018
JRJ Services	06/21/2018
JRJ Services	09/07/2018
Compass Minerals	12/10/2018
US Magnesium	01/08/2019
Mel Clark Construction	01/11/2019

Compliance Advisories Issued:.. 4

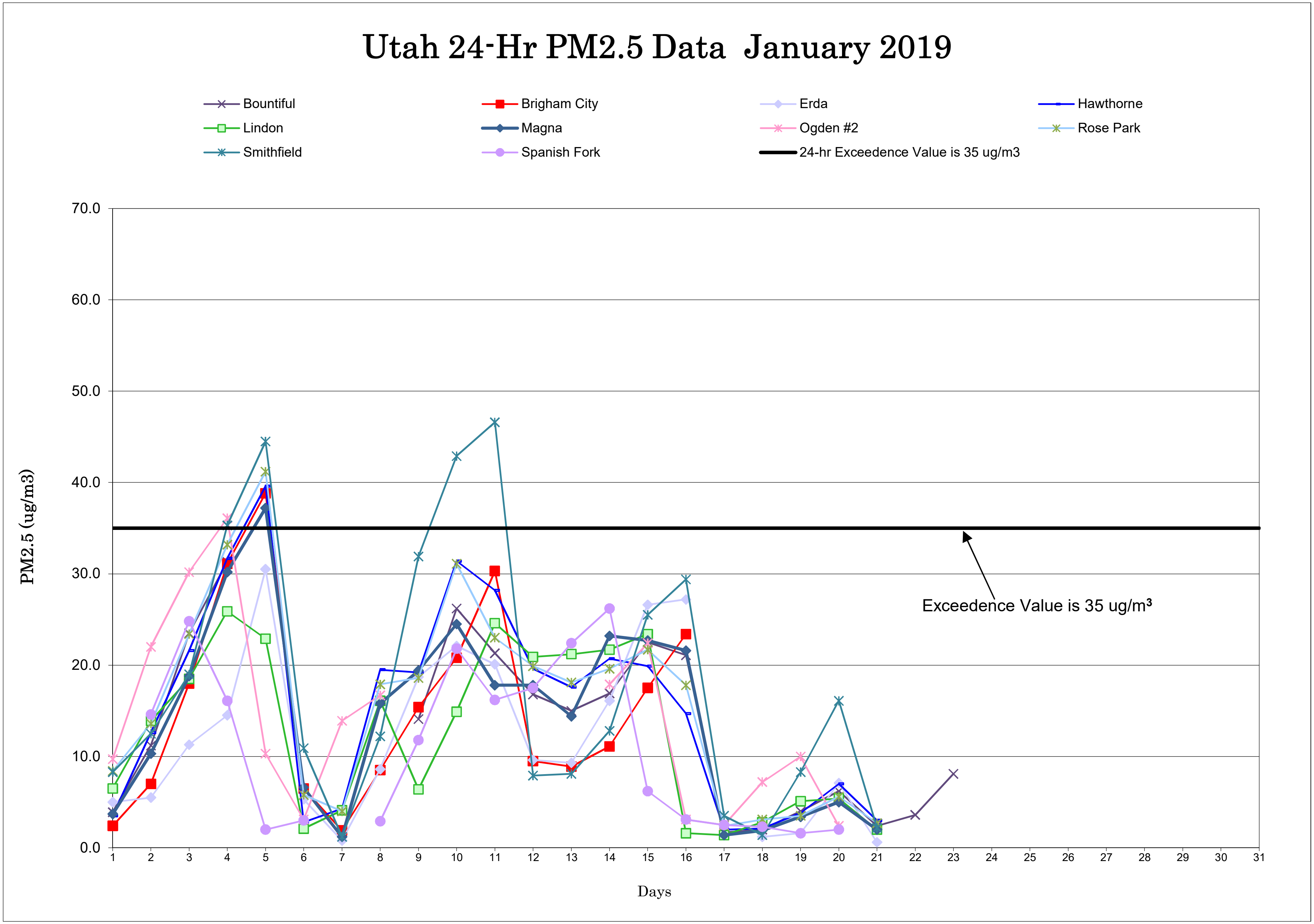
No Further Action Letters Issued.. 0

Settlement Agreements Reached:.. 3

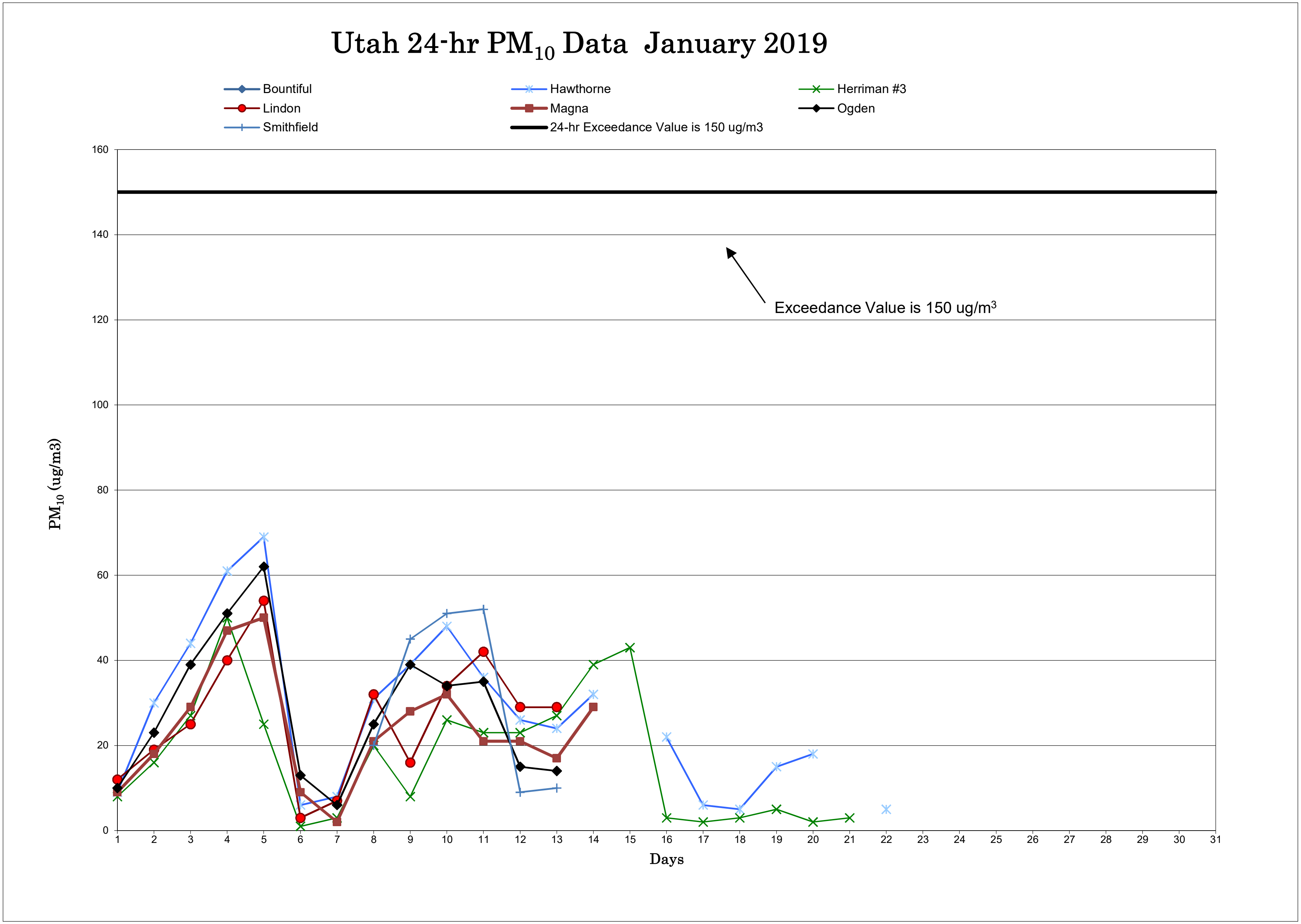
Compass Minerals (3).. $16,952.00

[1]Miscellaneous inspections include, e.g., surveillance, level I inspections, VOC inspections, complaints, on-site training, dust patrol, smoke patrol, open burning, etc.

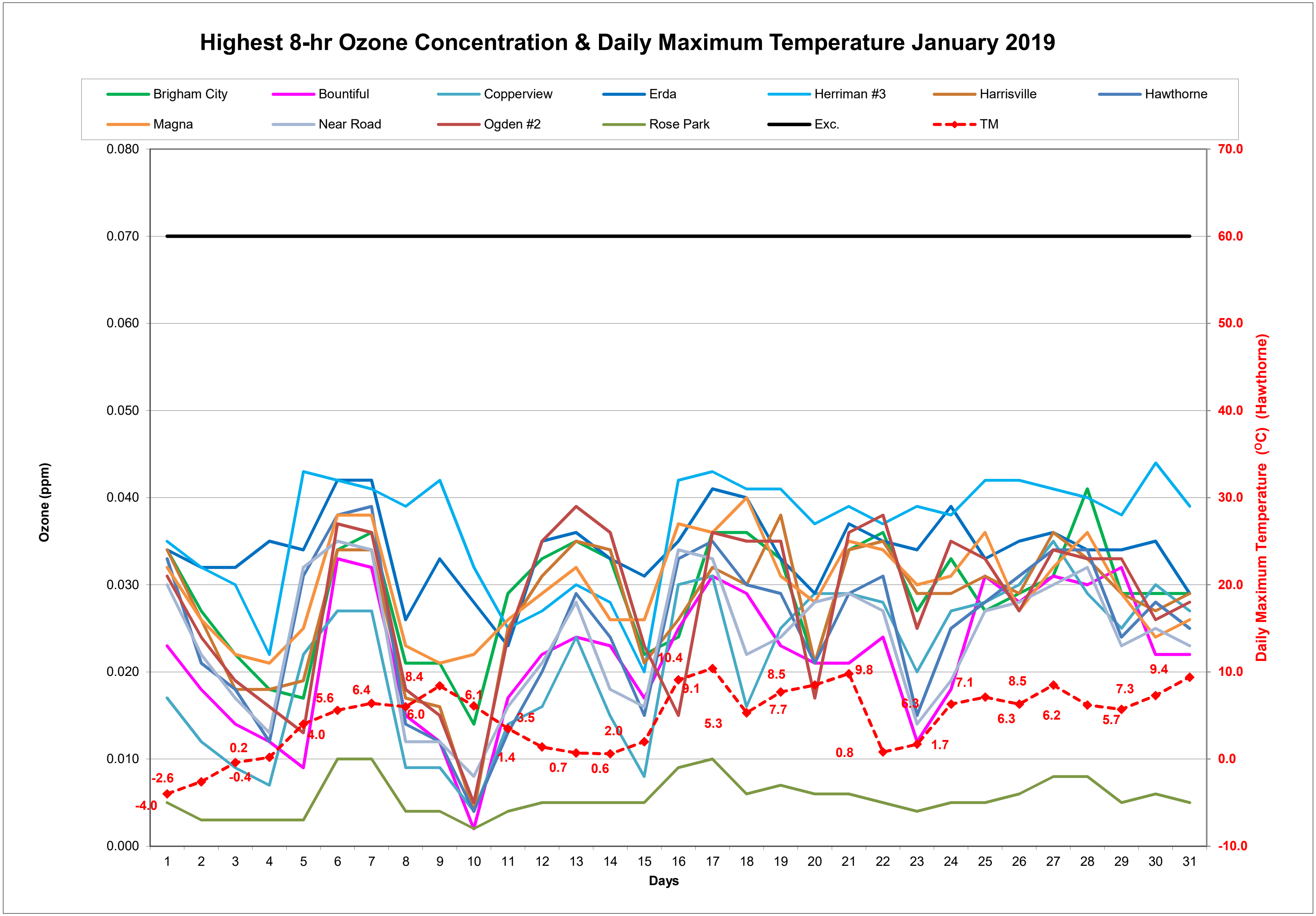
Air Monitoring

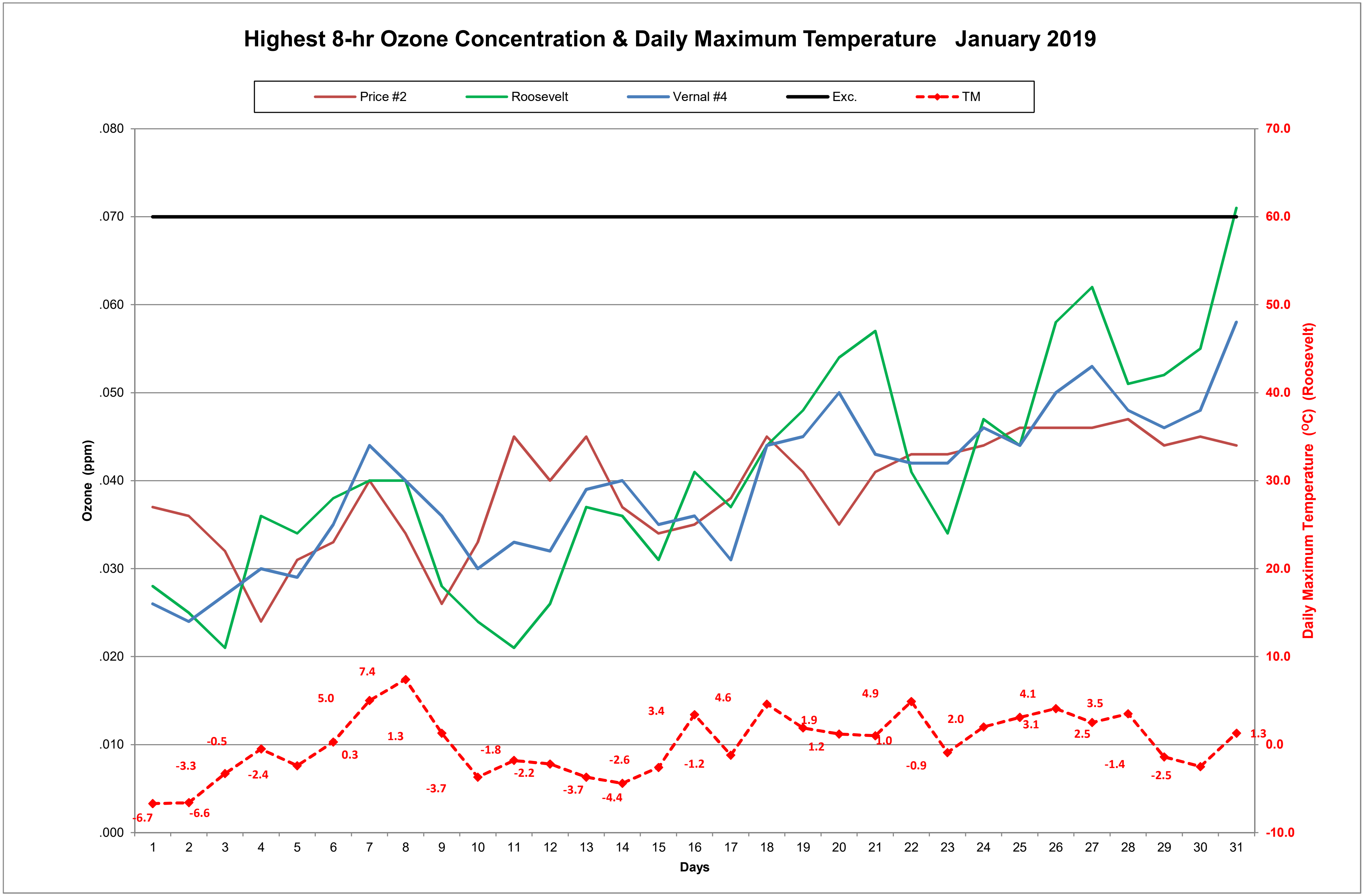


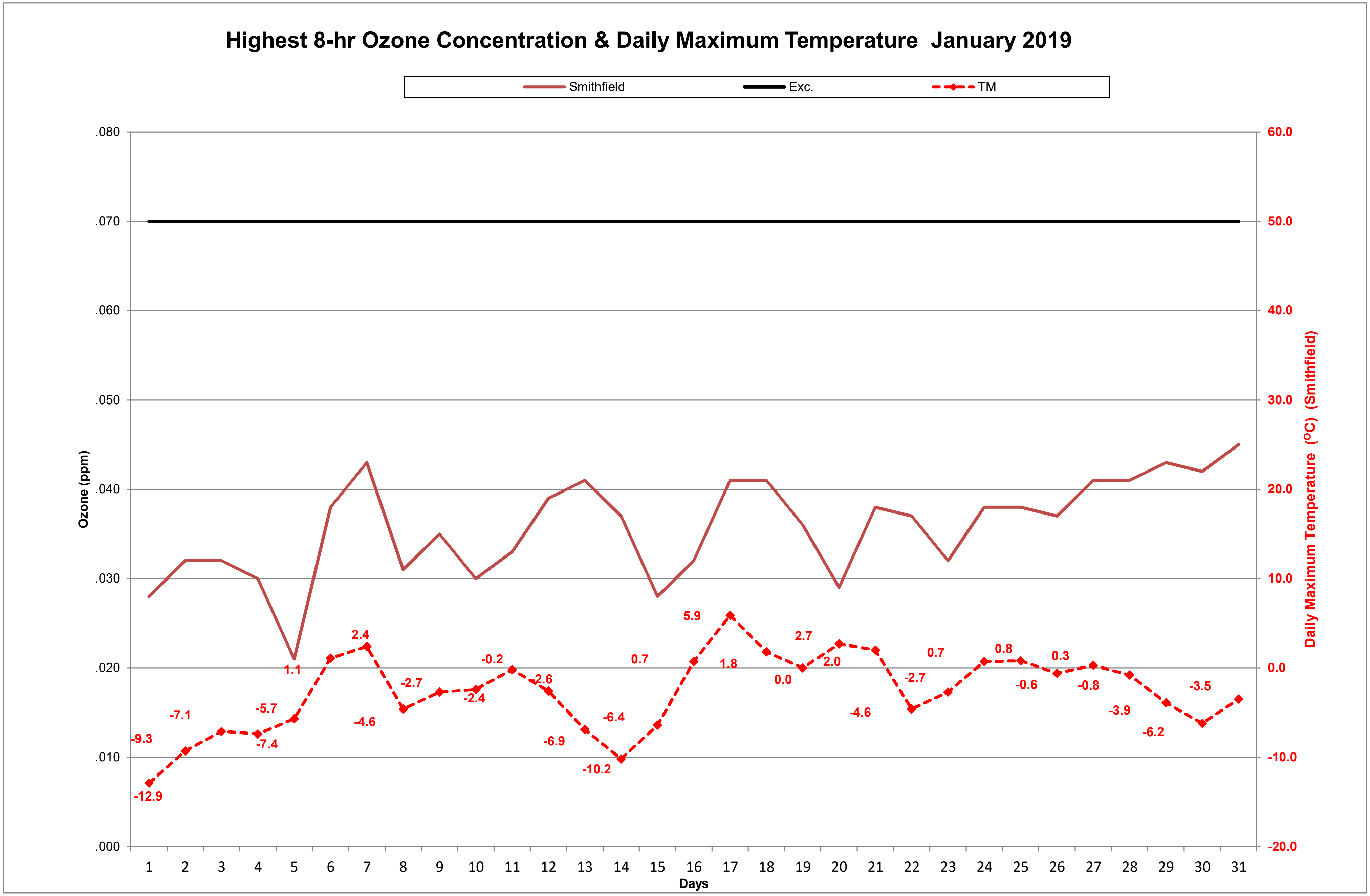
Utah Division of Air Quality



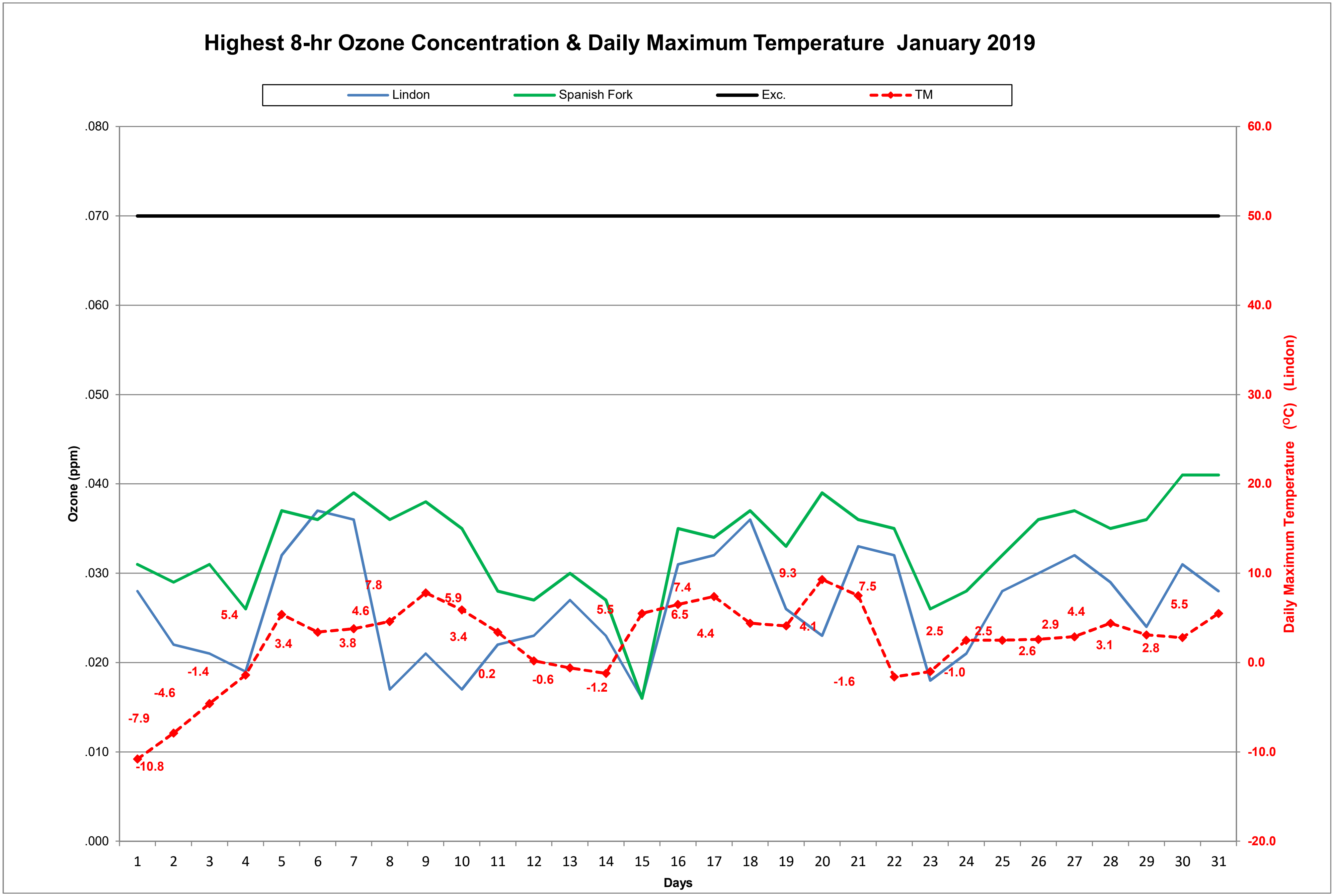
Utah Division of Air Quality

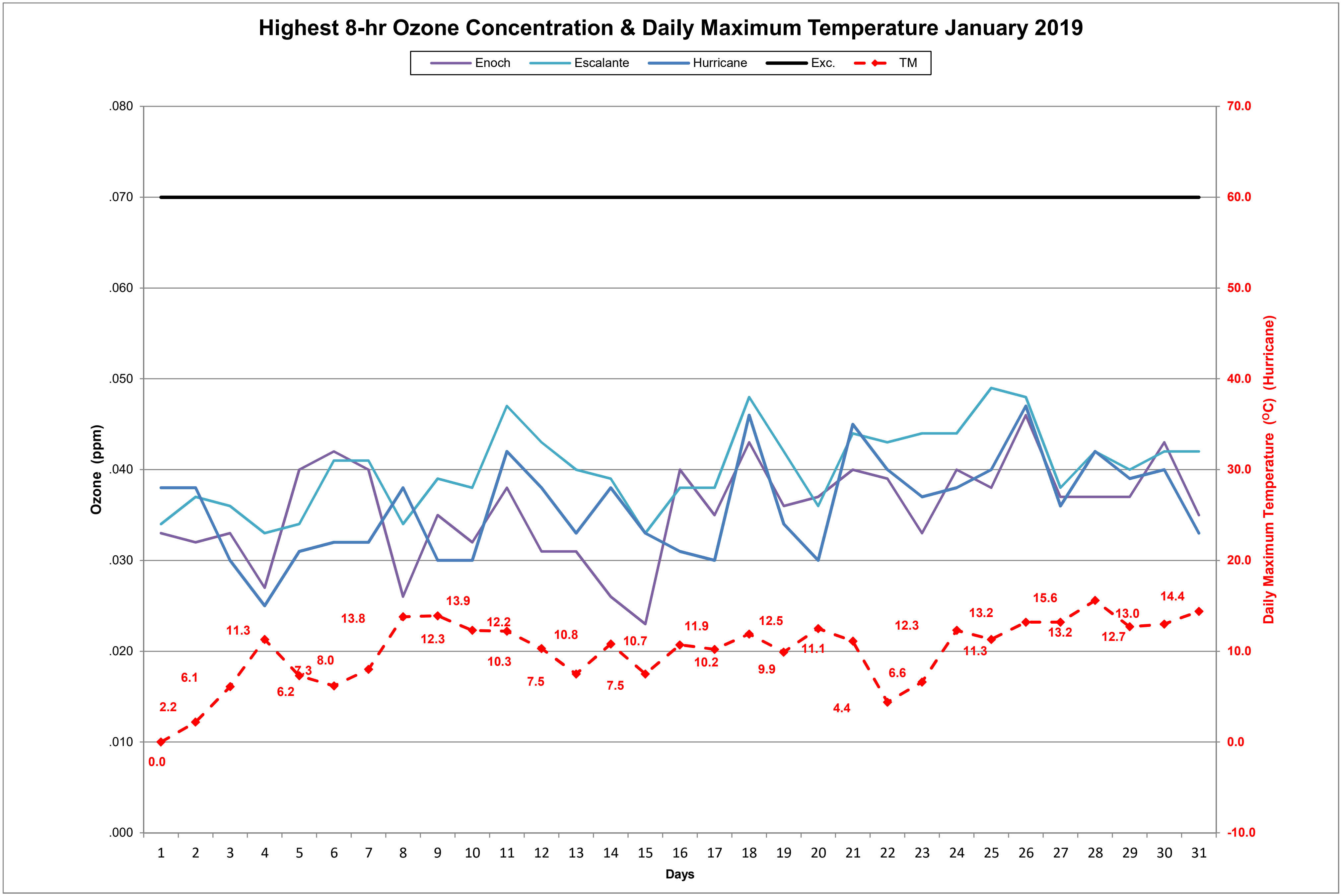

Highest 8-hr Ozone Concentration & Daily Maximum Temperature January 2019
Brigham City
Bountiful
Copperview
Erda
Herriman #3
Harrisville
Hawthorne
Magna
Near Road
Ogden #2
Rose Park
Exc.
TM
Ozone (ppm)
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Daily Maximum Temperature (°C) (Hawthorne)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
Days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
-4.0
-2.6
-0.4
0.2
4.0
5.6
6.4
6.0
8.4
6.1
3.5
1.4
0.7
0.6
2.0
9.1
10.4
5.3
7.7
8.5
9.8
0.8
1.7
6.3
7.1
6.3
8.5
6.2
5.7
7.3
9.4


Highest 8-hr Ozone Concentration & Daily Maximum Temperature January 2019
Price #2
Roosevelt
Vernal #4
Exc.
TM
Ozone (ppm)
Daily Maximum Temperature (°C) (Roosevelt)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-6.7
-6.6
-3.3
-0.5
-2.4
0.3
5.0
7.4
1.3
-3.7
-1.8
-2.2
-3.7
-4.4
-2.6
3.4
-1.2
4.6
1.9
1.2
4.9
1.0
-0.9
2.0
4.1
3.1
2.5
3.5
-1.4
-2.5
1.3

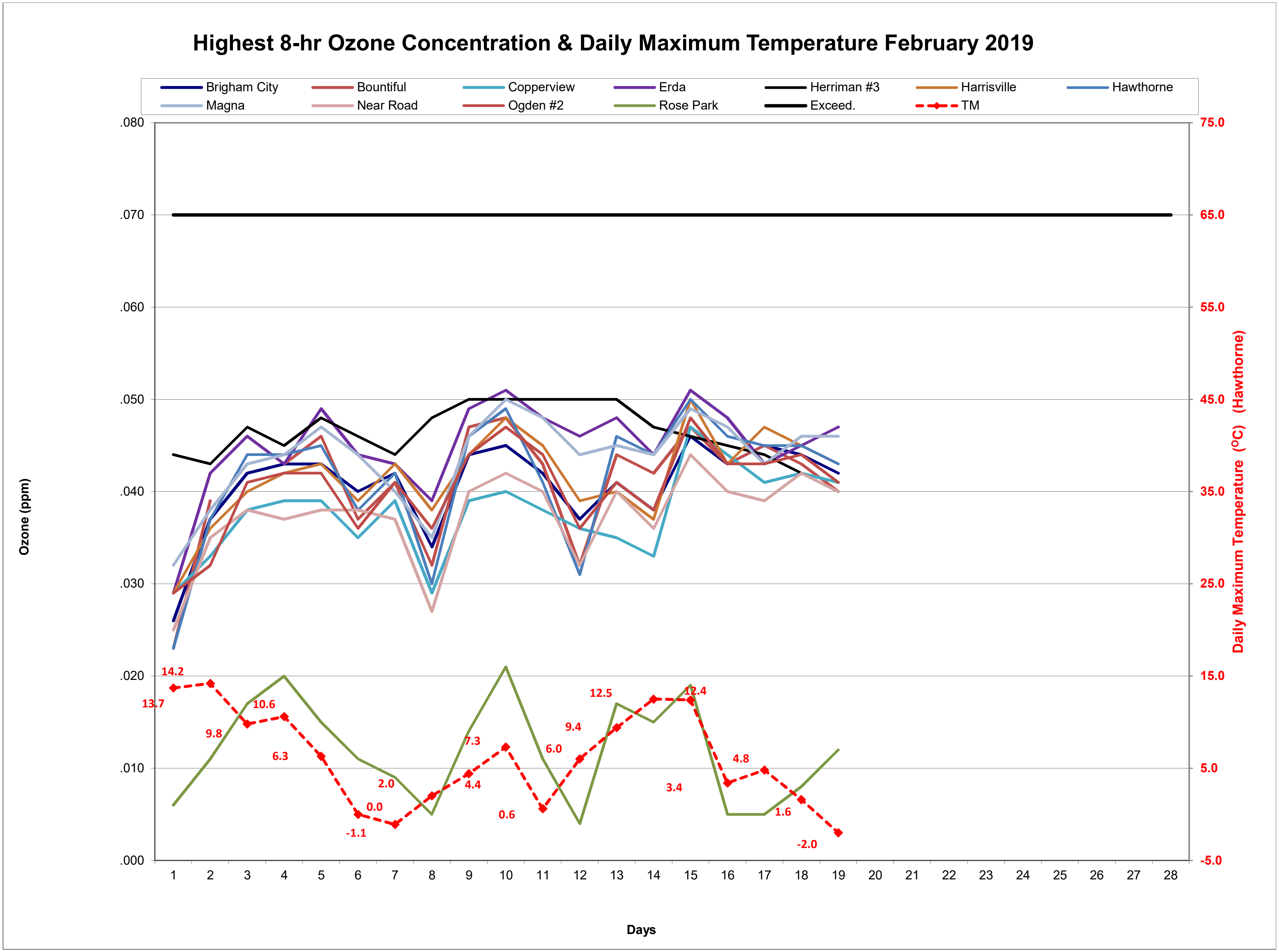


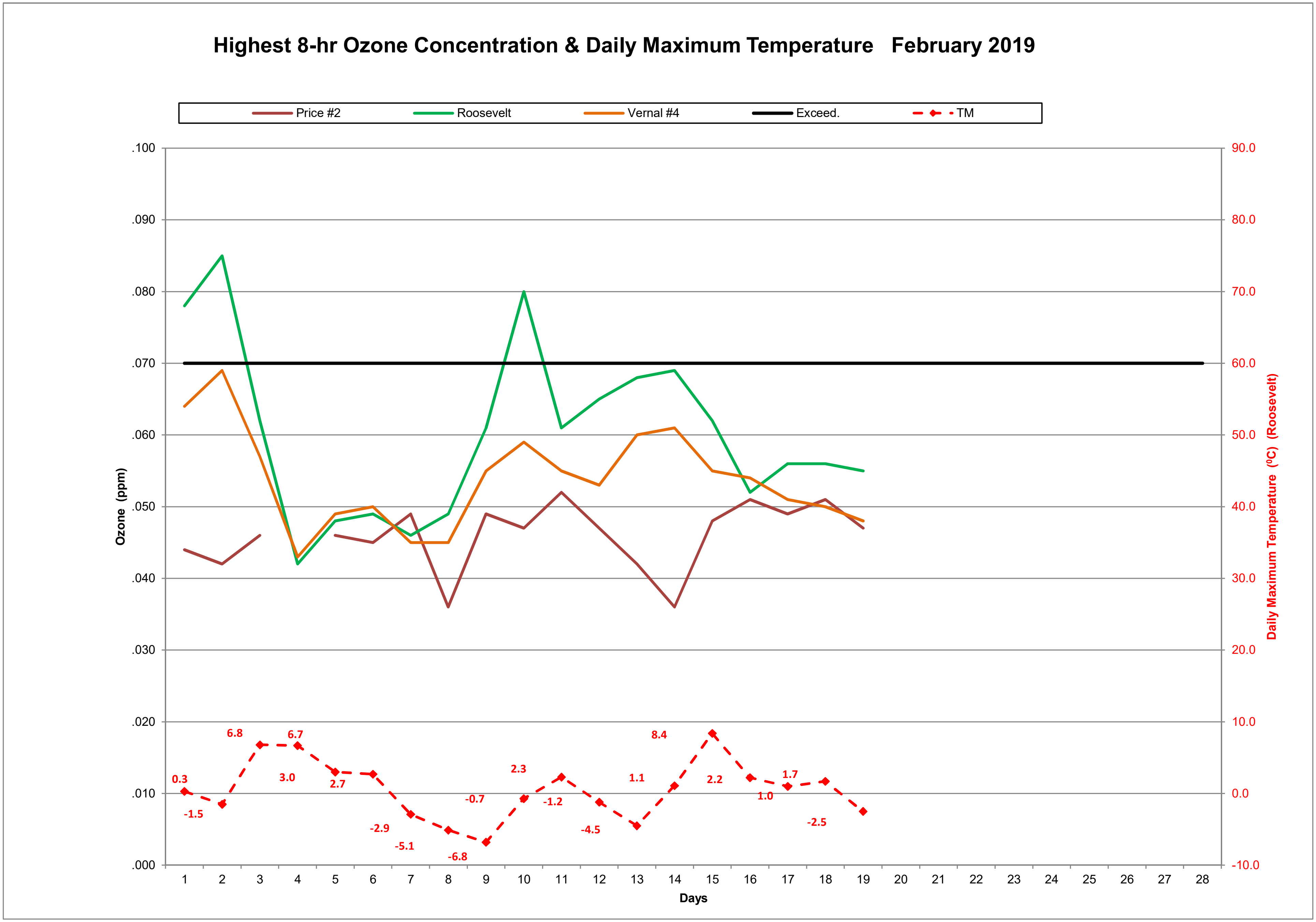
Highest 8-hr Ozone Concentration & Daily Maximum Temperature January 2019
Smithfield
Exc.
TM
Ozone (ppm)
Daily Maximum Temperature (°C) (Smithfield)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
-12.9
-9.3
-7.1
-7.4
-5.7
1.1
2.4
-4.6
-2.7
-2.4
-0.2
-2.6
-6.9
-10.2
-6.4
0.7
5.9
1.8
0.0
2.7
2.0
-4.6
-2.7
0.7
0.8
-0.6
0.3
-0.8
-3.9
-6.2
-3.5


Highest 8-hr Ozone Concentration & Daily Maximum Temperature January 2019
Lindon
Spanish Fork
Exc.
TM
Ozone (ppm)
Daily Maximum Temperature (°C) (Lindon)
Days
-10.8
-7.9
-4.6
-1.4
5.4
3.4
3.8
4.6
7.8
5.9
3.4
0.2
-0.6
-1.2
5.5
6.5
7.4
4.4
9.3
4.1
7.5
-1.6
2.5
-1.0
2.5
2.6
2.9
4.4
3.1
2.8
5.5

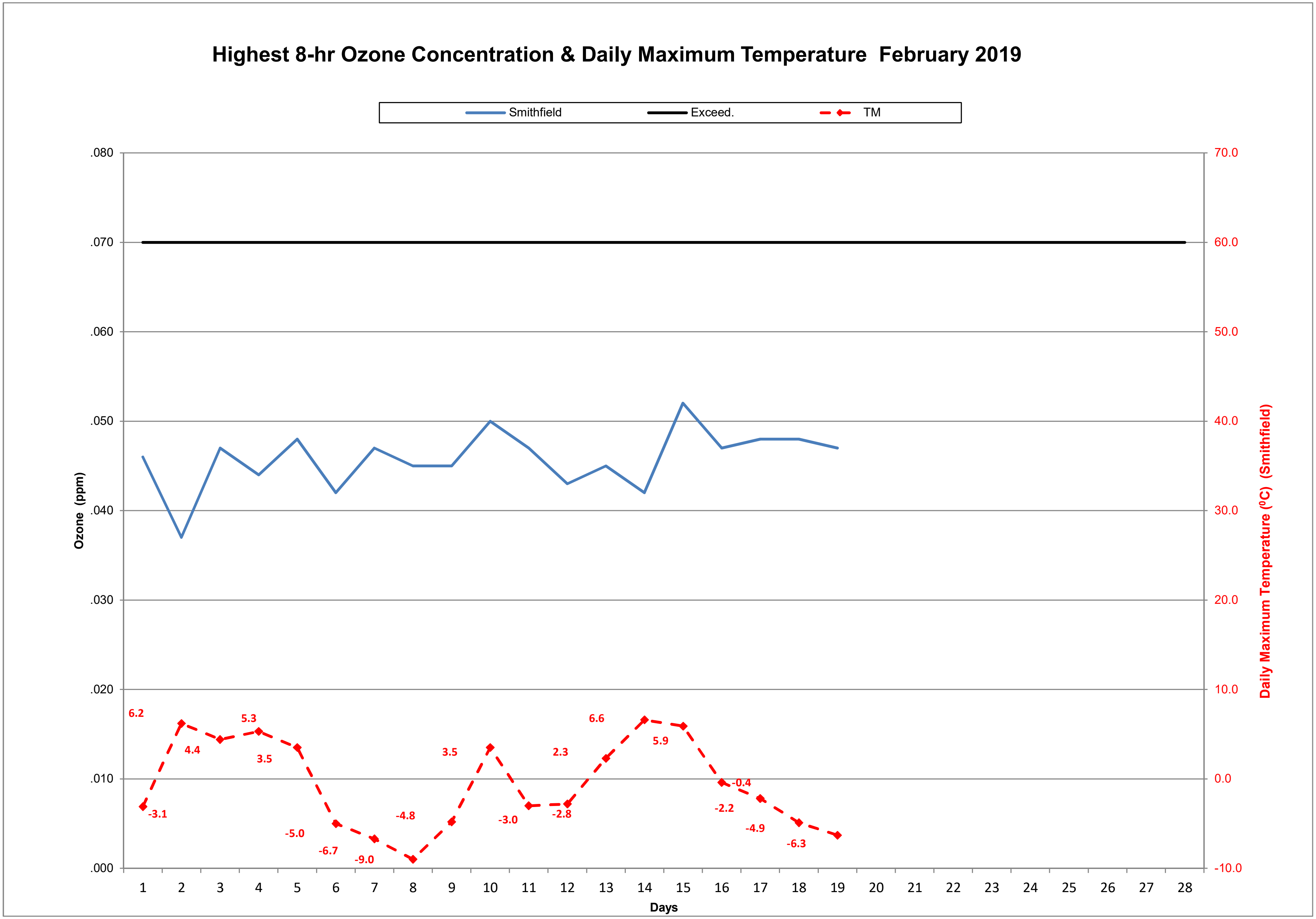


Highest 8-hr Ozone Concentration & Daily Maximum Temperature January 2019
Enoch
Escalante
Hurricane
Exc.
TM
Ozone (ppm)
Daily Maximum Temperature (°C) (Hurricane)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
0.0
2.2
6.1
11.3
7.3
6.2
8.0
13.8
13.9
12.3
12.2
10.3
7.5
10.8
7.5
10.7
11.9
10.2
12.5
9.9
11.1
4.4
6.6
12.3
13.2
11.3
15.6
13.2
13.0
12.7
14.4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

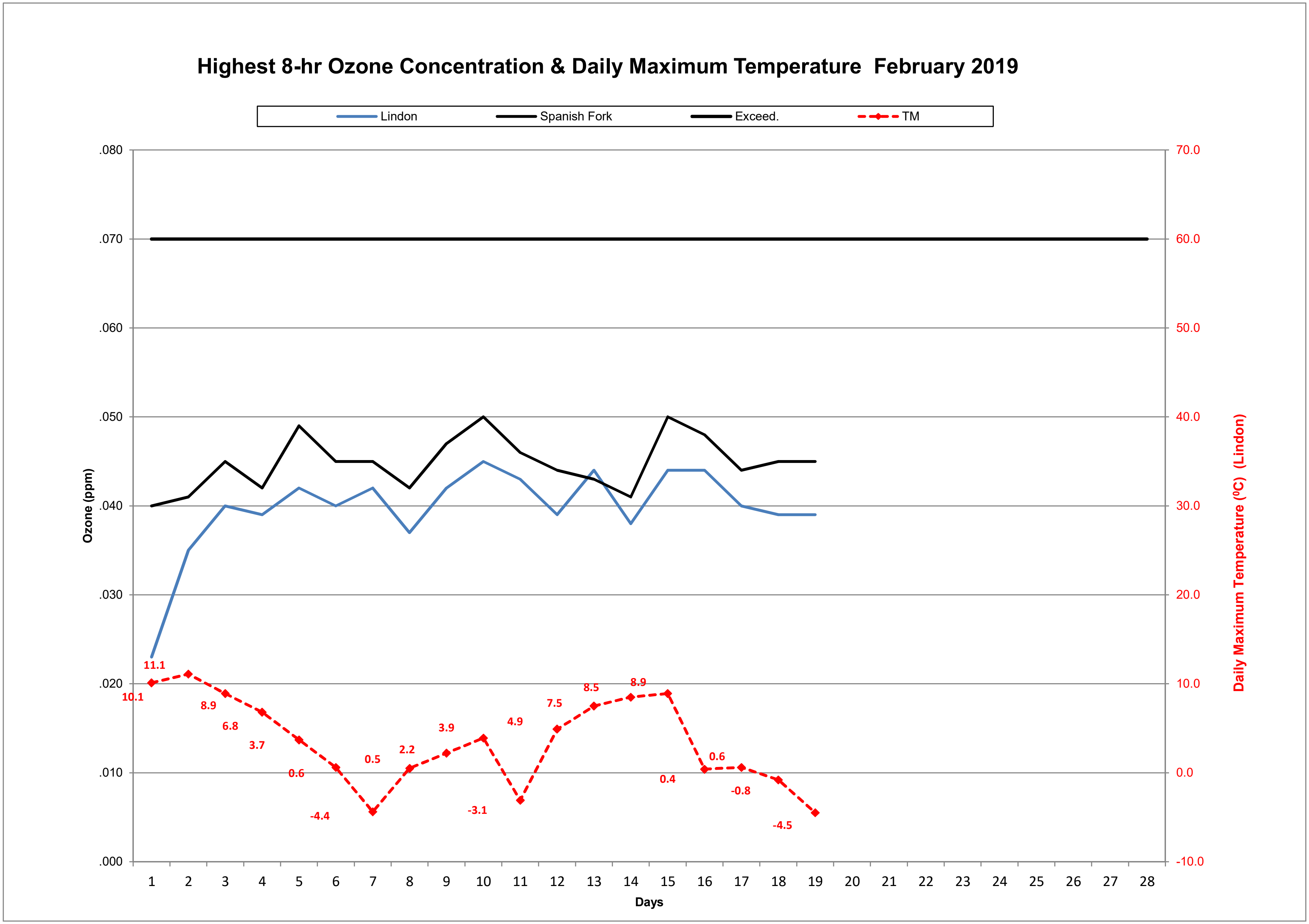

Highest 8-hr Ozone Concentration & Daily Maximum Temperature February 2019
Brigham City
Bountiful
Copperview
Erda
Herriman #3
Harrisville
Hawthorne
Magna
Near Road
Ogden #2
Rose Park
Exceed.
TM
Ozone (ppm)
Daily Maximum Temperature (°C) (Hawthorne)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
75.0
65.0
55.0
45.0
35.0
25.0
15.0
5.0
-5.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
14.2
13.7
10.6
9.8
6.3
2.0
0.0
-1.1
7.3
4.4
0.6
6.0
9.4
12.5
12.4
3.4
4.8
1.6
-2.0



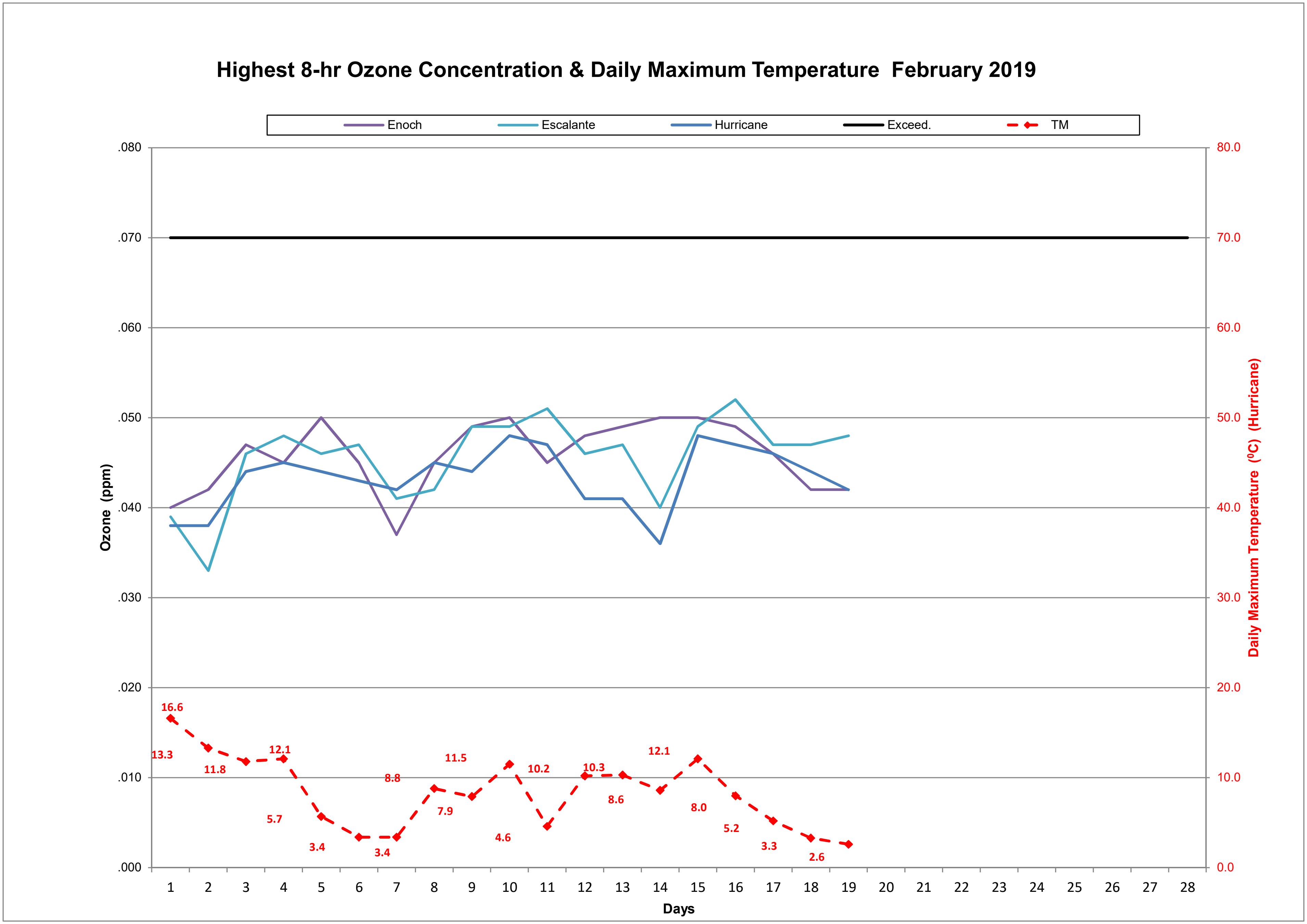
Highest 8-hr Ozone Concentration & Daily Maximum Temperature February 2019
Price #2
Roosevelt
Vernal #4
Exceed.
TM
Ozone (ppm)
Daily Maximum Temperature (ºC) (Roosevelt)
Days
0.3
-1.5
6.8
3.0
6.7
2.7
-2.9
-5.1
-6.8
-0.7
2.3
-1.2
-4.5
1.1
8.4
2.2
1.0
1.7
-2.5



Highest 8-hr Ozone Concentration & Daily Maximum Temperature February 2019
Smithfield
Exceed.
TM
Ozone (ppm)
Daily Maximum Temperature (⁰C) (Smithfield)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
6.2
-3.1
4.4
5.3
3.5
-5.0
-6.7
-9.0
-4.8
3.5
-3.0
2.3
-2.8
6.6
5.9
-0.4
-2.2
-4.9
-6.3



Highest 8-hr Ozone Concentration & Daily Maximum Temperature February 2019
Lindon
Spanish Fork
Exceed.
TM
Ozone (ppm)
.080
.070
.060
.050
.040
.030
.020
.010
.000
Daily Maximum Temperature (^{0}C) (Lindon)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
Days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
11.1
10.1
8.9
6.8
3.7
0.6
-4.4
0.5
2.2
3.9
-3.1
4.9
7.5
8.5
8.9
0.4
0.6
-0.8
-4.5



Highest 8-hr Ozone Concentration & Daily Maximum Temperature February 2019
Enoch
Escalante
Hurricane
Exceed.
TM
Ozone (ppm)
Daily Maximum Temperature (ºC) (Hurricane)
Days
.080
.070
.060
.050
.040
.030
.020
.010
.000
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
16.6
13.3
11.8
12.1
5.7
3.4
3.4
8.8
7.9
11.5
4.6
10.2
10.3
8.6
12.1
8.0
5.2
3.3
2.6

Ozone Summary Table

Site_ID	Site	State	2013	2014	2015	2016	2017	2018	2019	15-17	16-18	17-19	2019 Exceed Standard At
56-039-1011	Yellowstone NP	WY	63	60	62	60	63	64	49	61	62	58.8	84.5
32-033-0101	Great Basin NP	NV	74	64	66	63	65	71	50	64	66	62.1	75.5
16-023-0101	Craters of the Moon NP	ID	60	62	61	58	63	69	49	60	63	60.4	79.5
08-083-0101	Mesa Verde	CO	69	65	66	66	66	72	53	66	68	63.8	73.4
04-005-8001	Grand Canyon	AZ	69	67	70	64	65	68	51	66	65	61.2	78.5
49-053-0130	Zion NP	UT	70	65	66	64	67	69	49	65	66	61.8	75.5
49-047-7022	Whiterock	UT	74	64	68	81	66	69	67	71	72	67.3	76.5
49-047-2003	Ouray - Tribal	UT	92	79	67	96	103	67	98	88	88	89.3	41.5
49-047-2002	Redwash - Tribal	UT	85	61	66	83	76	68	74	75	75	72.7	67.5
49-047-1002	Dinosaur NM	UT		64	67	75	74	67	71	72	72	70.5	70.5
49-037-0101	Canyonlands NP	UT	66	64	65	64	64	68	51	64	65	61.0	79.1
49-017-0004	Escalante NM	UT	67	60	68			68	51		68	62.2	75.5
49-013-7011	Myton	UT	89	67	65	85	81	65	79	77	77	75.0	65.5
49-003-7001	Washakie - Tribal	UT	65	61	67	51	63	69		60	61	66.0	79.5
49-057-1003	Harrisville – HV	UT	73	70	74	73	73	77	48	73	74	66.0	61.5
49-057-0002	Ogden#2 - O2	UT	76	70	72	72	75	79	47	73	75	67.0	57.5
49-053-0007	Hurricane – HC	UT	69	66	69	62	67	69	48	66	66	61.3	75.5
49-049-5010	Spanish Fork - SF	UT	70	76	71	72	72	73	49	71	72	64.7	66.5
49-049-4001	Lindon – LN	UT						79	42			60.5	62.0
49-049-0002	North Provo - NP	UT	77	68	73	72	73			72			
49-047-1004	Vernal - V4	UT			64	73	68	69	64	68	70	67.0	74.5
49-045-0004	Erda-ED	UT			71	72	77	74	51	73	74	67.3	60.5
49-045-0003	Tooele - T3	UT	72	69									
49-035-4002	Near Road – NR	UT							48			48.0	70.5
49-035-3013	Herriman - H3	UT			74	76	78	78	50	76	77	68.7	55.5
49-035-3010	Rosepark-RP	UT						80	21			50.5	61.0
49-035-3006	Hawthorne – HW	UT	77	72	81	74	81	74	48	78	76	67.7	56.5
49-035-2005	Copperview - CV	UT						79	45			62.0	62.0
49-035-1002	Magna #2- MA	UT							45			45.0	70.5
49-021-0005	Enoch – EN	UT						67	49			58.0	74.0
49-013-0002	Roosevelt – RS	UT	104	62	60	81	78	71	87	73	76	78.7	62.5
49-011-0004	Bountiful – BV	UT	62	74	73	76	78	80	47	75	78	68.3	53.5
49-007-1003	Price - P2	UT	67	64	69	67	66	73	53	67	68	64.0	72.5
49-005-0007	Smithfield – SM	UT			48	62	63	69	50	57	64	60.7	79.5
49-003-0003	Brigham City - BR	UT	71	67	68	67	68	72	45	62	69	61.7	71.5

Data as of 03/05/2019. 2019 data not quality assured.

2019 Ozone Uintah Basin					
8-hr ozone	Myton	Whiterocks	Ouray	Redwash	Rangely, CO
1st Max	86	74	110	88	70
2nd Max	84	71	105	85	65
3rd Max	81	71	99	78	62
4th Max	79	67	98	74	59
5th Max	76	67	93	74	54
6th Max	76	64	85	72	53
7th Max	72	63	84	70	50
8th Max	71	63	83	68	49
9th Max	71	62	82	67	49
10th Max	70	60	78	67	47
Exceedances					
Jan	1		1		
Feb	7	3	13	6	
Mar	1		1		
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total	9	3	15	6	

Data as of 03/05/2019. 2019 data not quality assured.