BEFORE THE ENVIRONMENTAL APPEALS BOARD
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC

In re Desert Rock Energy Company, LLC PSD Permit Number AZP 04-01	)	PSD Appeal Nos. 83-03, 83-04, 83-05, & 83-06

PETITIONERS' JOINDER AND CONCURRENCE IN STATE OF NEW MEXICO'S MOTION TO SUPPLEMENT THE RECORD ON APPEAL, OR, IN THE ALTERNATIVE, FOR REMAND AND REOPENING OF THE PUBLIC COMMENT PERIOD

Petitioners Dine Care, Environmental Defense Fund, Grand Canyon Trust, Natural Resources Defense Council, San Juan Citizens Alliance, Sierra Club, and WildEarth Guardians hereby join and state their concurrence in the State of New Mexico's Motion to Supplement the Administrative Record, or, in the Alternative, for Remand and Reopening of the Public Comment Period, dated November 17, 2008. The State of New Mexico's Motion, and all attachments thereto, are attached hereto as Exhibit 1. Petitioners raised serious concerns regarding the sufficiency of the ozone analysis in their petition for review, and they agree with the State of New Mexico that the recent ozone monitoring data and the comments from the National Park Service are directly relevant to these issues. Petitioners therefore state their support for the State of New Mexico's motion, incorporate herein by reference New Mexico's November 17, 2008 Motion so that it is specifically included in the docket for this appeal, and respectfully request the same relief from the Board.

Respectfully submitted, this 13th day of December, 2008:

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Patrice Simms by Nicholas J. Persampieri with permission

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The undersigned hereby certifies that on December 12, 2008 he caused a copy of the foregoing to be served by mail on:

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EXHIBIT 1

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VIA OVERNIGHT MAIL

November 17, 2008

U.S. Environmental Protection Agency
Clerk of the Board, Environmental Appeals Board
Colorado Building
1341 G Street N.W., Suite 600
Washington, D.C. 20005

Re: ***In re Desert Rock Energy Company, LLC*, PSD Appeal No. 08-03; 8-04; Docket No. AZP 04-01**

Dear Clerk of the Board:

Enclosed please find an original and five copies of the State of New Mexico's *Motion to Supplement the Record on Appeal or, in the Alternative, for Remand and Reopening of the Public Comment Period* for filing with the Board in the above-referenced matter. Two exhibits are attached to each copy of the motion.

Please feel free to contact me at (505) 827-6087 if you have any questions or need any additional information.

Sincerely,

Seth T. Cohen
Assistant Attorney General

BEFORE THE ENVIRONMENTAL APPEALS BOARD
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

IN RE:	)	
	)	PSD Appeal Nos. 08-03 & 08-04
DESERT ROCK ENERGY COMPANY, LLC	)	
	)	
PSD Permit No. AZP 04-01	)	

STATE OF NEW MEXICO'S MOTION TO SUPPLEMENT THE RECORD ON APPEAL OR, IN THE ALTERNATIVE, FOR REMAND AND REOPENING OF THE PUBLIC COMMENT PERIOD

Petitioner State of New Mexico ("New Mexico") respectfully requests that the Environmental Appeals Board ("Board") consider new ozone evidence as part of the record on appeal in this matter. In the alternative, given the significance of this new evidence, New Mexico requests that the Board remand the Desert Rock PSD permit now and require EPA Region IX to reopen the public comment period so that it may consider the new ozone evidence. New Mexico conferred with EPA, Desert Rock Energy Company, LLC, and the Diné Power Authority regarding this motion; each of these parties opposes this motion. In support of this motion, New Mexico states the following:

INTRODUCTION

As is more particularly described below, two events with profound implications for the ozone issues raised in this case have occurred since New Mexico filed its Supplemental Brief on October 2, 2008. First, high October ozone levels have now pushed the region in which Desert Rock would be built into nonattainment. *See* Exhibit Z, attached hereto. Second, on October 3, 2008, the National Park Service ("NPS") submitted new information to EPA Region IX showing ozone impacts from the oil and gas industry that significantly exceed the impacts Region IX had assumed in its Desert Rock ozone analysis. *See* Exhibit AA, attached hereto. Both events provide direct support for positions asserted in the comment period and raised in New Mexico's Supplemental Brief. *See* AR 66, at 52-54; AR 57.9; AR 67; *and see* N.M. Supp. Br. at 41-56. Because this new information definitively shows that EPA's determination that Desert Rock would not "cause or contribute" to ozone nonattainment was clearly erroneous, the Board should consider the information in this appeal. The Board cannot fully and fairly evaluate the ozone issues raised in the Desert Rock petitions without taking this significant new ozone information into account.

As an alternative, the Board should remand the permit to EPA now to address the substantial new questions raised by the ozone information and to reopen the public comment period as to this issue.[1] A remand is an appropriate approach here because, given the significant difference between actual ozone conditions and the ozone conditions considered by EPA, the permitting record is inadequate and incomplete without additional analysis on this issue.

ARGUMENT

I. THE NEW OZONE INFORMATION WARRANTS CONSIDERATION.

As the EPA's "final decision maker," the Board has "on occasion considered requests to supplement the administrative record." *In re Dominion Energy Brayton Point, LLC*, 12 E.A.D. 490, 516 (EAB 2006); *and see In re Marine Shale Processors, Inc.*, 5 E.A.D. 751, 797 n. 65

[1] New Mexico acknowledges that the decision regarding reopening of the public comment period under 40 C.F.R. 124.14(b) "largely depends on the Region's discretion," however, where, as here, very substantial new questions have been raised, a failure to reopen the permitting record would constitute an abuse of that discretion. *In re NE Hub Partners, L.P.*, 7 E.A.D. 561, 584 (EAB 1998); *In re Keene Wastewater Treatment Plant*, NPDES Appeal No. 07-18, slip op. at 23 (EAB, March 19, 2008). Moreover, to the extent that the Board remands this permit on any other issue – including, as may now be inevitable, for reconsideration of the carbon dioxide analysis in the light of the recent decision in *In re Deseret Electric Power Cooperative*, PSD Appeal No. 07-03, slip op. (EAB Nov. 13, 2008), 13 E.A.D. at ___ such a remand should include an order that EPA redo its ozone analysis, including consideration the new information presented in this motion as well as opportunity for public comment.

(EAB 1995)(granting petitioner's requests to add exhibits to the record on appeal and considering those exhibits prior to ruling). By limiting the circumstances under which new information may reasonably be considered, the Board has ensured that it does not undermine the general preference for finality in the administrative process. *See, e.g., In re Keene Wastewater Treatment Plant*, NPDES Appeal No. 07-18, slip op. at 23 (EAB, March 19, 2008). Such an approach comports with the Board's recognition that an "[a]gency may relax procedural rules if the ends of justice so require." *In re Marine Shale Processors, Inc.* 5 E.A.D. 751, 763 n.11 (EAB 1995) *citing American Farm Lines v. Black Ball Freight Services*, 397 U.S. 532, 539 (1970). Board decisions provide an indication of the kinds of circumstances that justify consideration of new evidence. Such circumstances converge in the present case.

A. The Significance of The New Ozone Information Justifies Its Consideration by The Board in This Appeal or Compels a Remand.

The recent ozone data from the Four Corners region have enormous significance for the issues before the Board in this appeal: those data push the region into nonattainment.[2] Under the Clean Air Act's PSD permitting provisions, EPA's principal obligation is to ensure that a new source "will not cause or contribute to air pollution in excess of" the NAAQS. 42 U.S.C. § 7475(a) (3). The new data demonstrate that the EPA made a clear error on this fundamental point: Desert Rock's significant emission of ozone precursors (NO_x and volatile organic compounds) will necessarily "cause or contribute" to the ozone nonattainment in the region. The new information conclusively corroborates New Mexico's argument that even using EPA's

[2] The area is currently in nonattainment as a matter of fact. The formal legal process for redesignating the area begins with New Mexico's recommendation for redesignation, which must be submitted to EPA for approval by March 12, 2009. 73 Fed. Reg. 16436, 16503 (March 27, 2008). New Mexico is not suggesting here that the area now be treated as a legally designated nonattainment area for purposes of permitting Desert Rock. Rather, the fact that the area is now in nonattainment bears directly on EPA's obligations with respect to permitting under the PSD provisions of the Act.

estimation of Desert Rock's impacts on ozone levels. Desert Rock "would certainly 'cause or contribute' to a violation of the 8-hour ozone NAAQS." N.M. Supp. Br. at 51.

The Board has repeatedly made clear that it may properly exercise its discretion to consider new issues or information where such issues or information are of great significance. The Board has indicated, for example, that even when an issue was not preserved for review, the Board may still consider it if it is of sufficient significance. In *In re Campo Landfill Project*, 6 E.A.D. 505, 519 n.19 (EAB 1996). Likewise, where "significant new information" emerges after the close of the public comment period, it "appropriately should be considered" in finalizing a permit's terms. *In re Prairie State Generating Co.*, PSD Appeal No. 05-05, slip op. at 91 (EAB Aug. 24, 2006), 13 E.A.D. at ___. The Board has also indicated that where "new data, information, or arguments" arise after the issuance of a permit, such data, information or arguments may properly be considered if the new data "appear to raise substantial new questions." *In re Keene Wastewater Treatment Plant*, NPDES Appeal No. 07-18, slip op. at 23 (EAB, March 19, 2008). As the Board explained in *Keene*, "[i]t is the exceptional case in which data developed *after* the issuance of a final permit will be deemed *substantial* enough to warrant a reopening of the permitting record." *Id.* Desert Rock presents just such an exceptional case.

1. Elevated Ozone Levels Measured in October of 2008 Have Pushed The Region Above The NAAQS.

On October 15 and 18, 2008, the Navajo Lake Monitoring Station in San Juan County, New Mexico registered 8-hour ozone readings of 0.076 and 0.077 parts per million, respectively.[3] *See* Ex. Z. As a result of these two readings, the fourth highest 8-hour ozone level for 2008 is 0.075 ppm. *Id.* This brings the three-year average (2006-2008) of the fourth highest yearly 8-hour ozone levels to 0.077 ppm. *Id.* The new data therefore compel New Mexico to

[3] Upon receipt of these data, the New Mexico Environment Department undertook a quality assurance process for the data and also verified the proper functioning of the monitoring equipment.

redesignate the air quality control region encompassing the proposed Desert Rock site as nonattainment for ozone.

In addition to its serious practical consequences for New Mexico, nonattainment raises substantial issues regarding the Desert Rock permitting process. EPA based its issuance of the permit on its determination that, even with Desert Rock's substantial emission of ozone precursors, the area "would still be well below the 75 ppb level of the 8-hour ozone NAAQS." (EPA Response to Comments ("RTC") at 125.) New Mexico's Supplemental Brief contested this determination, asserting that EPA had relied on inherently deficient modeling, that EPA had not and could not reconcile the projected background ozone levels with actual data, and that the modeling provided an insufficient basis for proper assessment of Desert Rock's full impacts on ozone levels. *See* New Mexico's Supp. Br. at 41-52.

The new data provide conclusive support for New Mexico's arguments.[3] Contrary to EPA's conclusion that the area could absorb what it estimated to be Desert Rock's 4 ppb contribution to ozone levels and remain "well below" the NAAQS (RTC at 125), we now know as a matter of fact that the area is already in nonattainment. This means that Desert Rock's emissions will necessarily "cause, or contribute to, air pollution in excess of any...national ambient air quality standard" in violation of 42 U.S.C. § 7475(a)(3). New Mexico should not bear the burden of reducing ozone levels that are unduly exacerbated as a result of EPA's error. EPA's opposition to the consideration of such information now elevates discretionary matters of procedure over achievement of the fundamental purposes of the Clean Air Act.

[3] The recent ozone data showing nonattainment also provide conclusive support for New Mexico's argument that EPA's ozone analysis failed to consider ozone impacts over a sufficiently representative timeframe. EPA improperly relied on ozone modeling using only a 4-day span in June of 2002. New Mexico challenged the validity of such an approach because its narrow timeframe excluded consideration of changing variables over the course of an "ozone season [that] spans five months." Supp. Br. at 47. Indeed, the new data show that peak ozone levels occur as late as October, and therefore result from factors (climate, transport, etc.) very different from those typically exhibited in June.

2. Oil And Gas Activities Will Have A Much Greater Impact On Ozone Levels Than EPA Estimated.

In an October 3, 2008 letter to EPA Region IX, the NPS urged EPA to take a "harder look at [its ozone] analysis," and cautioned that areas surrounding Desert Rock were on the brink of nonattainment. Ex. AA. The NPS also provided a new analysis of the ozone impacts of oil and gas development in the region. Ex. AA. ("National Park Service Technical Comments on EPA's Response to Comments on the Desert Rock Prevention of Significant Deterioration (PSD) Permit Application," at 3). That analysis concludes that "the maximum 8-hr ozone enhancement from oil and gas, up to 10 ppb, could affect southwestern Colorado and northwestern New Mexico." *Id.* (Emphasis added).

This contrasts sharply with a key assumption underlying EPA's flawed ozone assessment. EPA relied on section 4.2 of a 2004 modeling report for the proposition that, as to ozone, oil and gas development would "be insignificant and in fact, lead to net lowering of ambient ozone levels." RTC at 125, n. 12; *and see* Ex. A (attached to New Mexico's Supplemental Brief) at 4.2.2. Thus, EPA concluded that even with "substantial oil and gas development in the area," the "area is projected to remain well below the 8-hour ozone standard." RTC at 124. As suggested in *Keene*, this new information ought to be considered because it raises "substantial new questions" about key determinations underlying the Region's ozone analysis. *Keene*, slip op. at 23, NPDES Appeal No. 07-18.

B. The Long Duration Of This Permitting Process Justifies Consideration Of The New Ozone Information.

The unusually long duration of the Desert Rock permitting process additionally makes this the kind of "exceptional case" in which "data developed *after* the issuance of a final permit" warrants consideration. *Keene*, slip op. at 23, NPDES Appeal No. 07-18. More than four years elapsed between the completion of the ozone modeling in 2004 and permit issuance in 2008. In addition, approximately 20 months passed between the close of the public comment period in late 2006 and the issuance of the permit.

The Board has recognized that such gaps can render determinations made in the permitting process outdated, particularly when significant new developments occur. In *Prairie State*, the Board recognized that "gaps" between the close of comments and agency action can give rise to new information that, if "significant enough," should be considered. Slip op. at 91-3, 13 E.A.D. at ___. In *In re St. Lawrence County Solid Waste Disposal Authority*, the Administrator noted that while an administrative record is normally closed at the end of the public comment period, "[i]n cases of unusual delay...the record may have to be reopened." PSD Appeal No. 90-9, at 3 n. 3 (Adm'r July 27, 1990). The Administrator found such delay in *St. Lawrence* because, in that case, the public comment period closed in March of 1989 but the final permit was not issued until June of 1990. *Id.* Due to the "unusual" 15-month interval between the close of comments and the issuance of the permit, the Administrator found it appropriate to consider the implications of the new NSPS proposed during that interval. *Id.*

Region IX has already determined that consideration of post-comment-period developments is appropriate in this case. The Region considered and responded to comments received well after the close of the comment period regarding significant new developments: the Supreme Court's decision regarding EPA's authority to regulate carbon dioxide under the Clean Air Act in *Massachusetts v. EPA*, ___ U.S.___, 127 S. Ct. 1438 (2007); and D.C. Circuit Court of Appeal's nullification of the Clean Air Mercury Rule in *New Jersey v. EPA*, D.C. Cir. Case No. 05-1097 (decided Feb. 8, 2008). *See* EPA Responses to Late-filed Public Comments, at 1.

By the same token, consistent with the Board's opinion in *Keene*, the significant ozone developments that have arisen during the course of this appeal warrant consideration.[5] The passage of time in this case has yielded new ozone data showing conditions about which the Region has, in this permitting process, only loosely speculated, and as to which we now know the Region was clearly in error. Such data should not be ignored.

C. The New Ozone Information Should Be Considered Because It Could Not Be Reasonably Ascertained Until Now.

The regulations governing the Board's review of this permitting decision require a petitioner to have raised "all *reasonably ascertainable* issues and submit all *reasonably available* arguments supporting their positions" during the public comment period. 40 C.F.R. § 124.13 (emphasis added). The Board has accordingly recognized that it may properly consider a new issue (or information) on appeal if that issue could not have been reasonably ascertained during the comment period. *See In re Campo Landfill Project*, 6 E.A.D. 505, 518-19 (EAB 1996)(allowing consideration of issues not reasonably ascertainable during comment period); *In re AES Puerto Rico L.P.*, 8 E.A.D. 324, 336 (EAB 1999)(refusing to consider new modeling information because of petitioner's failure to establish that such modeling was not reasonably ascertainable during the public comment period).

The Board may properly consider the new ozone information in this case because it was not reasonably ascertainable until now. Here, as is shown on Ex. Z, the final NAAQS exceedance that pushed the area into nonattainment did not occur until October 18, 2008. Clearly, such information could not have been reasonably ascertained at any prior point in this

[5] The Desert Rock permit is not final until the resolution of this appeal. 40 C.F.R. § 124.19(f)(1). Thus, as suggested by *Keene*, in the face of new developments of sufficient significance, there is no compelling jurisprudential distinction between the consideration, on appeal, of new developments arising after the close of comments but prior to permit issuance (as in *St. Lawrence*), and the consideration of new developments arising after permit issuance but while an appeal is pending.

permitting process. It bears noting that New Mexico did raise this issue to the extent it could by repeatedly warning the EPA at various times throughout the permitting process that the area was on the brink of nonattainment. N.M. Supp. Br. at 50. Likewise, the current assessment of ozone impacts from oil and gas development was provided to EPA Region IX by the NPS on October 3, 2008, and could not have been reasonably ascertained by New Mexico at an earlier stage in this permitting process.

CONCLUSION

For the foregoing reasons, New Mexico respectfully requests that the Board consider the new ozone information presented herewith in the course of its review of the Desert Rock PSD Permit. In the alternative, New Mexico requests that the Board remand the Desert Rock Permit now, with an order requiring Region IX to reopen the public comment period, so that this new ozone information may be properly considered.

Date: November 17, 2008

Respectfully Submitted,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on November 17, 2008 he caused a copy of the foregoing *State of New Mexico's Motion to Supplement The Record on Appeal Or, In The Alternative, for Remand and Reopening of The Public Comment Period*, with attachments, to be served by U.S. mail and electronic mail (except as otherwise indicated) on:

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Seth T. Cohen

October 3, 2008

N3615 (2350)

Ms. Deborah Jordan, Director
Air Division (AIR-1)
U.S. Environmental Protection Agency Region IX
75 Hawthorne Street
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Dear Ms. Jordan:

We have reviewed the document "EPA Responses to Public Comments on the Proposed Prevention of Significant Deterioration Permit for the Desert Rock Energy Facility (DREF)" as well as the U.S. Environmental Protection Agency's (EPA) permit and related information regarding the project. The proposed facility will include two, 750 MW pulverized-coal fired boilers on the Navajo Nation in northwestern New Mexico. There are 27 units of the National Park System within 300 km of the proposed plant site; nine of those units are mandatory Class I areas. As you know, we negotiated a mitigation agreement with the permit applicant to address impacts on our Class I areas; as a result, we did not object to permit issuance. We are pleased that EPA has incorporated the sulfur dioxide portion of the mitigation plan into the permit, by reference. We are also pleased that EPA has reduced the limit on emissions of nitrogen oxides from the main boilers, and tightened and/or clarified several other permit conditions. We sincerely appreciate EPA's support of our efforts to protect air quality related values in these spectacularly scenic national parks.

We are concerned, however, with some statements made by EPA in the "Responses to Public Comments" that could affect future permitting actions by EPA and other agencies. In the attached documents, we raise issues related to interpretation and application of EPA regulations and guidance, and highlight some analytical errors. We would welcome an opportunity to discuss our concerns with you and your staff, so that we can better understand EPA's perspective and position. Please contact Don Shepherd of my staff at (303) 969-2075 to schedule time for a conference call.

Sincerely,

Christine L. Shaver
Chief, Air Resources Division

Enclosures

EXHIBIT
AA

Supplemental Comments on the Air Quality Analysis for the Proposed Prevention of Significant Deterioration Permit for the Desert Rock Energy Facility

September 2008

Summary

The National Park Service (NPS) conducted diagnostic and chemical transport modeling to evaluate the potential impact of the proposed Desert Rock Energy Facility (DREF) on ammonium sulfate concentrations and haze in national parks on the Colorado Plateau. This modeling showed potentially significant impacts from DREF on haze in the parks. To evaluate the NPS modeling results, the Environmental Protection Agency (EPA) performed a simple bounding calculation, came to the erroneous conclusion that the simulated DREF impacts were outside reasonable bounds, and dismissed the NPS modeling. The NPS agrees that in theory the EPA bounding calculation was based on reasonable assumptions and produces a reasonable upper bound. However, the EPA inappropriately applied this calculation to the NPS modeling results. When applied properly, the NPS modeling results are well below this upper bound and should not have been dismissed. In addition, the proper application of the bounding method illustrates that the maximum 24-hour average values used in permit modeling significantly underestimate the peak hourly concentrations and thus the haze that visitors to the national parks would experience. Last, as the EPA assumed, the DREF plume would likely be embedded in emissions from the Four Corners basin when having its highest impact on national parks on the Colorado Plateau. Therefore, it is reasonable to assume that emission offsets from sources in the Four Corners basin would help mitigate the impact of DREF on air quality throughout the region.

Background

In response to the building of a greenfield 1500 MW coal-fired power plant in the Four Corners region called the Desert Rock Energy Facility (DREF), the National Park Service (NPS) conducted modeling to evaluate the potential impact of this facility in national parks on the Colorado Plateau. This consisted of diagnostic model using the CAPITA (Center for Air Pollution Impact and Trend Analysis) Monte Carlo Model (CMC) to explore the processes in the Four Corners region that could lead to high impacts from DREF and Eulerian grid modeling using the state-of-the-art CAMx chemical transport model. These models were used to analyze and simulate the potential impact of DREF on the ammonium sulfate concentrations and haze every hour during January 2001 at several national parks including the Grand Canyon, Arizona.

A range of results from the CMC model was presented based on varying assumptions. Results from both modeling analyses showed the potential for contributions of ammonium sulfate that could lead to visible haze over short periods of time at the modeled national parks. The CAMx simulation showed impacts near the lower end of the range predicted by the CMC modeling.

In the U.S. Environmental Protection Agency (EPA) Region 9's document "EPA's Responses to Public Comments on the Proposed Prevention of Significant Deterioration Permit for the Desert Rock Energy Facility," the EPA dismissed the modeling and analyses conducted by the NPS (see comment 21, pages 144-146). The reason for dismissing the NPS modeling was that the EPA conducted a simple analysis and determined the simulated ammonium sulfate impacts from DREF were outside reasonable bounds.

EPA Bounding Calculation

The EPA estimated the upper bound for the contribution of DREF to ammonium sulfate by assuming that the highest measured ammonium sulfate concentrations at the national parks were only due to sources in the Four Corners basin, and the fractional contribution from DREF to these concentrations would be equal to the ratio of the DREF SO_2 emissions to the SO_2 emissions from the Four Corners basin. The upper bound for the impact of DREF on these national parks is then the maximum measured concentrations multiplied by this fractional contribution.

The EPA approximated the SO_2 emissions from the Four Corners basin using emissions from the Four Corners and San Juan power plants. The maximum ammonium sulfate concentrations in the national parks during January 2001 were estimated from data collected by the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring program. IMPROVE collects 24-hour fine particulate samples that are analyzed for a number of constituents including sulfur and sulfate.

Errors in the Application of the Bounding Calculations

The assumptions the EPA used to estimate the upper bounds in the DREF impact were reasonable and justified. Unfortunately, the EPA misunderstood or ignored the differences between the measured data and the modeling results, thus misapplying the bounding calculation and comparison to modeled results. These errors resulted in severe errors in their analysis, leading the EPA to their erroneous conclusion.

The EPA had two significant errors and four less significant errors. The significant errors are due to differences between the spatial and temporal aggregation used in the reported NPS modeling results and the measured data. The NPS modeling results were reported every hour, averaged over a sight path for the national park, while the measured data was a 24-hour average at a single point. The impacts from sources such as DREF are often highly transient with high impacts that last a few hours or less. Therefore, the maximum 24-hour average will be significantly less than the maximum hourly average. Also, over a park there will be a gradient in the impact from sources, such as DREF. Therefore, a measurement at a point may or may not be greater than the average over a sight path. By chance, the impact from DREF at the IMPROVE monitors in the parks simulated by the CMC model were smaller than other areas of the park. Therefore, contrary to the EPA's assertion, the average concentrations over the sight paths and parks were actually higher than at the IMPROVE monitoring sites. As shown below, these two errors caused the EPA to use modeled impacts from DREF in their bounding calculations that were about an order of magnitude greater than the actual modeled, 24-hour, simulated concentrations at the IMPROVE monitoring sites. Such severe errors in the EPA's analysis led them to the flawed conclusion that the modeled results were unrealistically high.

The four less significant errors were, first, the EPA evaluated the CMC modeling results at Mesa Verde, but no modeling results were reported for this location. However, the report described and modeled how emissions from DREF would contribute to layered haze in the Four Corners basin, which could be seen from Mesa Verde. It is not known how the EPA obtained nor what they used for the CMC-simulated Mesa Verde concentrations in their analysis. Second, for the Grand Canyon measured concentrations, the EPA used IMPROVE concentrations measured at the Hance Camp location, above and away from the actual canyon. IMPROVE also has an in-canyon monitor at Indian Gardens; however, this monitor was not operating for half of

January 2001. The wintertime, above-canyon concentrations are typically 30% greater than in-canyon and up to a factor of 2 or more greater during the meteorological events when DREF would have its largest impact. Therefore, the EPA underestimated the measured in-canyon concentrations, which the NPS simulated, by more than 30%. The third error is that the EPA scaled the measured particulate sulfur concentration to ammonium sulfate. As documented on the IMPROVE website, in the early 2000s the X-ray fluorescence (XRF) system IMPROVE used to measure S was undergoing a number of changes, leading to higher uncertainties. The sulfate ion concentrations likely have less error and should have been used in the analysis. And last, a range of results was presented for the CMC modeling. The EPA chose to use only the highest simulated impacts in their evaluation. This was inappropriate because the CMC modeling was evaluating the DREF concentrations from a range of possible meteorological scenarios, not just what actually occurred in January 2001. The EPA should have evaluated the range of CMC modeling results to test whether or not the simulation was plausible for January 2001.

Revised Bounding Calculation

The NPS conducted a similar bounding exercise as the EPA for the CMC modeling; however, the errors noted in the EPA's analysis were addressed. Specifically, 24-hour simulated concentrations from the DREF power plant at the IMPROVE monitoring sites were compared to the measured concentrations. This included the actual simulated concentrations at the Mesa Verde monitoring site. The measured ammonium sulfate concentrations were estimated from the sulfate measurement instead of from sulfur. Concentrations at Indian Gardens were estimated by scaling the measured concentrations at Hance Camp by 1.3. As previously noted this is a lower bound on ammonium sulfate concentrations at Indian Gardens. The evaluation was done using two CMC modeling scenarios, first assuming a transformation rate of 1% and second assuming a rate of 5%. Both scenarios used the variable stack height simulation. These results were presented in Table 3 from the NPS report "Simulation of the Impact of the SO2 Emissions from the Proposed Sithe Power Plant on the Grand Canyon and other Class I Areas" by Schichtel et al. and reasonably span the range of results simulated by the CMC model.

The maximum measured ammonium sulfate concentrations at the three national parks are presented in Table 1. Also included is the upper bound estimated for the DREF impact and the simulated impact of DREF at the IMPROVE monitors in the national parks. The upper bound for the DREF impact was estimated by following the EPA procedure, i.e., multiplying the maximum concentrations in the parks by the relative contribution of DREF. The relative contribution from DREF is presented in Table 2 and was the ratio of the DREF SO_2 emissions to those from the San Juan and Four Corners power plants.

As shown in Table 1, the simulation using the 1% conversion rate is 25–57% below the upper bound for all three national parks, while the simulation using the 5% conversion rate is 35–100% greater than the upper bound. Note that in the EPA's analysis they estimated the CMC-simulated impact of DREF on these parks using the 5% transformation rate to be about 2000% greater than their estimated upper bound or more than an order of magnitude greater than reported in this analysis. The CAMx modeling results were similar to the CMC modeling results using the 1% conversion rates and would also likely be below this bound.

The contributions from the San Juan and Four Corners power plants were also simulated by the CMC model. However, these results were not presented in the original NPS report. Comparing the ammonium sulfate concentrations impacting the national parks from these two power plants to DREF's provides the opportunity to evaluate the assumption used by the EPA to estimate the upper bound. That is, whether or not the relative impact of DREF is equal to the relative emission rates. Table 3 presents the relative DREF impact for the three national parks averaged over all simulated days in January 2001 and for the days with the highest 24-hour impact from DREF. As shown, on the average day in January 2001, the ratios of the simulated sulfate concentrations are about half the ratio of emission presented in Table 2, indicating a smaller average contribution from DREF than the ratio of emissions suggests. However, on the days with the large impacts from DREF, the ratio of the simulated sulfate concentrations is about 1.5 times greater than the ratio of emissions for the Grand Canyon and Mesa Verde and a factor of 5.6 higher for Canyonlands. Therefore, on these days, DREF will have a higher impact on the national parks than estimated by using the ratio of emissions. In fact, if the estimated upper bounds in Table 1 are adjusted to account for the increased impact of DREF relative to the San Juan and Four Corners power plants, then the CMC simulations using the 5% conversion rate are equal to or below the upper bound.

Conclusions

When the EPA bounding calculation is done correctly, the CMC modeling results, and most likely the CAMx modeling results, are below the EPA estimated upper bound. The CMC modeling results using the 5% conversion rate were greater than the upper bound estimated using the EPA approach but equal to or below the estimated upper bound using the ratio of simulated concentrations instead of emission rates from the DREF, San Juan, and Four Corners power plants. In either case, this illustrates that the high conversion rate was most likely not reasonable for January 2001. However, this high conversion rate may occur during other years and this analysis does not rule out the possibility of similar impacts from the proposed DREF power plant in other years.

This analysis also illustrated two important points. First, the impact from a source over a short period of time, such as an hour, can be significantly higher than for a 24-hour average impact. Consequently, visibility assessment using 24-hour-average values will underestimate the instantaneous impact of the source on haze. Second, as the EPA assumed in their analysis, the DREF plume will often be imbedded in emissions from other sources in the Four Corners basin. Emission offsets from these sources for the increased emissions from DREF would likely help to mitigate the impact of DREF on air quality in this region.

Table 1. Simulated and measured ammonium sulfate concentrations during January 2001 at the national parks. All concentrations are 24-hour averages at the IMPROVE monitoring sites, and all units are in $\mu g/m^3$. The upper bound was calculated as the ratio of DREF SO_2 emissions to San Juan + Four Corners times the maximum measured ammonium sulfate concentrations. For example, the upper bound at Canyonlands = 0.046*1.93.

	Max Measured Ammonium Sulfate	**Upper Bound on DREF Impact**	**Max Simulated DREF Impact**	
Oxidation Rate	--		1%/hr	5%/hr
Grand Canyon - Indian Gardens = (1.3 * Hance)	1.60	0.074	0.040	0.10
Canyonlands	1.93	0.089	0.066	0.18
Mesa Verde	1.63	0.075	0.032	0.11

Table 2. SO_2 Emission rates from DREF and major sources in the Four Corners basin

Coal-fired Power Plant	**SO_2 Emission Rate (Tons SO_2 / yr)**
DREF	3319
San Jaun	42521
Four Corners	29502
Ratio of DREF to San Juan + Four Corners	**0.046**

Table 3. The impact of the simulated DREF power plant relative to the impacts from San Juan and Four Corners power plants for the average day during January 2001 and on the day with the maximum impact from DREF used in Table 1. The values are ratios of simulated concentrations at the IMPROVE monitoring sites and have no units.

	Average	**Maximum 24-hr DREF Impact**
Grand Canyon - Indian Gardens	0.058	0.062
Canyonlands	0.027	0.29
Mesa Verde	0.022	0.072

National Park Service Technical Comments
on
EPA's Response to Comments
on the
Desert Rock Prevention of Significant Deterioration (PSD) Permit Application
October 2008

Background

On July 31, 2008, EPA made its final decision to issue a PSD permit to the Desert Rock Energy Facility (DREF). Accompanying that decision were responses to comments filed by over 1,000 commenters, including the National Park Service (NPS). Although NPS does not object to the permit issued to DREF, we are concerned that EPA's response to some of our comments may be misinterpreted or misused in future permitting proceedings. Therefore, we offer the following observations and clarifications:

Best Available Control Technology (BACT)

EPA's approach to the BACT analysis and resulting BACT determination appears to be inconsistent with EPA guidance. For example:

- EPA policy and the NSR Workshop Manual advises that, absent evidence to the contrary, it should be assumed that issuance of a permit can be relied upon for BACT determinations. In this permit action, EPA acknowledges that BACT is a forward-looking and technology-forcing process, but relies excessively upon emission limits "...that have been achieved over a similar facility's decades long lifetime..." (p43) This is especially important with respect to SO_2, which is limited to 0.06 lb/mmBtu (24-hour block average) in the DREF permit, even though the Florida DEQ proposed a 24-hour limit of 0.05 lb/mmBtu for the FPL Glades project that was using coal with a much higher sulfur content. EPA also dismisses comments regarding the Chiyoda FGD system currently being installed on other plants, because they "are not yet constructed or operating....thus not useful for establishing BACT for DREF." (p.50) EPA's decision regarding the NO_x emission reflects an approach more consistent with EPA's guidance, i.e., that the emission rate for DREF "is lower than other NOx emission rates that have been ***proposed*** [emphasis added] for or achieved by other pulverized coal-fired boilers recently." (p. 12-13)
- BACT should be determined on a case-by-case basis based on the capability of control equipment, not on an assumption that an emission limit represents BACT simply because "the technology provides the greatest level of control, and on a lb/MMbtu basis, the required emission limit is lower than any other limit recently established for similar sources."(p.50).

EPA's rationale for rejecting some suggestions regarding the BACT analysis lacks thoroughness. For example:

- EPA's position that including control efficiencies in the permit "would make no additional contribution to the effectiveness of the permit" is false. EPA's justification is that "operation of the control equipment at the assumed efficiencies is necessary in order for the Applicant to comply with emission limits." However, if the source is burning coal with a sulfur content lower than assumed, for example, the degree of control efficiency required to meet the SO_2 limit decreases.

- EPA's should have conducted a more-thorough analysis of technically feasible options for controlling condensable PM, such as a wet electrostatic precipitator (WESP). EPA's rationale for eliminating a (WESP)from consideration was based solely upon the assumption that it "may use several million gallons of water per day. Such use could have significant impacts on the environment in the New Mexico desert where water is a scarce resource. EPA believes it is therefore not appropriate to require the use of a wet electrostatic precipitator (WESP) to control particulate matter emissions from the DREF." (p. 78) While the concerns EPA raised about water use may have been valid, that does not justify exclusion of this technology from consideration in a BACT analysis. EPA should have included a WESP in its "top-down" BACT analysis and evaluated the technology on its technical, economic, and environmental merits, including actual water usage and availability. If that water is available, then EPA should have included the cost of supplying that water in an objective economic analysis. [1]
- EPA's argument that it did not need to consider other options because the commenter has requested that "all possible combinations of techniques be considered" (p. 97) appears questionable, since a plain reading of the comment is that EPA should have included a WESP as well as five other specific options in its evaluation. Given the size of the project and its sensitive location, that does not constitute the "unreasonably large number of possibilities" that EPA asserts. EPA should have evaluated the other options on their merits.
- Instead of focusing on outliers in its discussion of PM stack test data (pp79-81), EPA should have conducted both a statistical evaluation of the data as well as research into the data and what factors may have influenced the results. EPA should not have dismissed these data because boilers may be sized or configured differently. Instead, EPA should have shown why those differences really matter, and why a larger fabric filter and/or superior filter media would not be able to achieve the lower emissions demonstrated by these other sources.

Finally, EPA asserts that it is not required to consider Integrated Gasification Combined Cycle (IGCC) in its BACT analysis because it would redefine the source. This statement could be misconstrued to limit the discretion we believe permitting authorities have to examine IGCC in their BACT analysis, even though it may not be required.

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[1] We understand that SO_2 may be further oxidized to SO_3 in the SCR and passed through a conventional wet scrubber unabated. In fact, the addition of moisture in the wet scrubber may actually hasten the conversion of SO_3 to H_2SO_4. While this is primarily a problem with high-sulfur eastern coals, and why wet ESPs are proposed for projects like Thoroughbred and Glades, it must at least be considered for all coal-fired PCs, especially if the project is to be located in a sensitive area and uses a wet scrubber. (On the other hand, the SCR/dry scrubber/baghouse combinations we see in the West avoid most of this problem by starting with low sulfur coal, avoiding the wet scrubber, and using the tail-end baghouse to capture both PM and sulfates. The DREF project includes hydrated-lime injection upstream of the baghouse which may neutralize the SO_3 coming out of the SCR.

Air Quality/AQRV Modeling Analysis

Ambient Air Quality Analysis: The Prevention of Significant Deterioration of Air Quality Program is intended, in part, to make sure that attainment areas do not become nonattainment areas. Therefore, it is essential that air quality modeling analyses be closely scrutinized to ensure that air quality standards will not be violated. In the DREF permit decision, EPA relies on ozone modeling performed for the Four Corners area, as part of the development by the New Mexico Environment Department (NMED) of a Clean Air Action Plan to ensure that the ozone NAAQS would be met. The NMED modeling projected that the area would remain "well below the 8-hour ozone standard through at least 2012, even with the potential addition of two new power plants and with substantial oil and gas development in the area." (p. 124) EPA should take a harder look at this analysis. In fact, Mesa Verde NP had two exceedances of the new 75 ppb standard in 2005-2007 and is borderline on violating the standard. Durango and Farmington have higher ozone than Mesa Verde and are likely to violate the new standard. According to recent modeling by NPS and CIRA[2], "Results indicate that the maximum 8-hr ozone enhancement from oil and gas, up to 10 ppb, could affect southwestern Colorado and northwestern New Mexico. Class I areas in this region that are likely to be impacted by increased ozone include Mesa Verde National Park and Weminuche Wilderness Area in Colorado, and San Pedro Parks Wilderness Area, Bandelier Wilderness Area, Pecos Wilderness Area and Wheeler Peak Wilderness Area in New Mexico." Therefore, we disagree that the area will "remain well below the 8-hour ozone standard through at least 2012." We strongly recommend that EPA (Region 9, 8, and 6) initiate a dialogue with Colorado, New Mexico and Federal Land Managers to discuss ozone issues in the Four Corners area so that we can collectively avoid a nonattainment problem.

Increment Consumption Analysis: With respect to the increment consumption analysis, EPA states that:

> "Using maximum actual emission rates unrealistically assumes that all emitting units emit at their maximum simultaneously at all times...If all sources are assumed to simultaneously emit at their 90th percentile emission rates, rather than their maximum rates, then the total emissions are much closer to what is actually emitted into the air...Instead of the 90th percentile, Sithe used the 99th percentile emission rate to be conservative. Despite this rationale for use of the 99th percentile emission rates, the actual degree of conservativism of specific emission rate assumptions will depend on how often those emission rates occur at the same time, and on how much their ambient impact overlaps in time and in space." (p. 133-134)

Use of maximum emission rates is not necessarily unrealistic and is consistent with guidance from EPA (i.e., New Source Review Workshop Manual). The basic premise behind DREF is that additional power generation capacity is needed at the proposed location, which is in the same area as the Four Corners Power Plant and San Juan Generating Station. If that premise is correct, then it is entirely likely that those existing

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[2] Marco A. Rodriguez (Cooperative Institute for Research in the Atmosphere, Colorado State University Fort Collins, 7 CO 80523-1375), Michael G. Barna (Air Resources Division, National Park Service Fort Collins, CO 80523-1375) and Tom Moore (Western Regional Air Partnership, Western Governors' Association, Fort Collins, CO 80523-1375), "Regional Impacts of Oil and Gas Development on Ozone Formation in the Western United States", enclosed

power plants will increase utilization to their maximum extent during periods of peak demand. In addition, when one considers that only three years of meteorological data were modeled to represent the 60-year life of the DREF project, it is very probable that the worst-case meteorological conditions were not captured.

Using maximum emission rates is an attempt to balance meteorological under-prediction and capture the potential for an increment violation under the range of meteorological conditions that could occur. To do this, the analysis must use the representative emission rate for the averaging time period of concern. Results from an increment analysis we conducted in December 2006, which used maximum emission rates, indicate that it is likely that the three-hour sulfur dioxide increment at Mesa Verde NP is being violated and that DREF may significantly contribute to that violation. (We would be pleased to share our results with EPA.)

Visibility Impact Analysis: With respect to the visibility impact analysis submitted by the NPS, we are disturbed that EPA dismisses the NPS refined modeling as an "overestimation" of the DREF impacts. As detailed in the attached "Supplemental Comments on the Air Quality Analysis for the Proposed Prevention of Significant Deterioration Permit for the Desert Rock Energy Facility, October 2008," EPA's critique of the NPS analysis had significant errors. While EPA's misapplication of the bounding calculation does not affect the NPS's determination that the mitigation measures agreed to by DREF sufficiently offset the visibility impact from proposed facility, we are concerned that EPA's characterization of our analysis could affect how other permitting authorities view refined analyses conducted for other proposed facilities. As you may know, the revised Federal Land Manager Air Quality Related Values Guidance report (FLAG) indicates that a refined visibility impact analysis, such as we did for DREF, is the preferred approach for evaluating visibility impacts when screening thresholds are exceeded. We request that EPA acknowledge that its conclusion that this approach produces an overestimation was based on an error-ridden assessment.

In a similar vein, it appears that EPA relied on its erroneous assessment of our modeling when concluding that the NPS's concerns regarding visibility impacts from DREF were "unsubstantiated" and "unconvincing." As EPA notes in its Response to Comments, the NPS did not issue an adverse impact finding because an acceptable mitigation agreement had been negotiated. (pp. 140-146) Thus, EPA's mischaracterization of the NPS analysis could be considered harmless in this permitting action; however, again, we are concerned that other permitting authorities may adopt EPA's flawed assessment, reasoning and conclusions in future permitting proceedings.

Cumulative Visibility Analysis: EPA states that there is no regulatory requirement for a cumulative visibility analysis, and "[p]artly in consideration of the mitigation package agreed to by Sithe, the FLMs did not require a cumulative visibility analysis in their assessment of whether the impact was adverse." EPA is correct that NPS did not pursue the need for a cumulative visibility analysis in this case, in part due to the negotiated mitigation package. Nevertheless, in general, we believe that there is a need to examine cumulative impacts on visibility – otherwise there would be no effective mechanism for preventing visibility impairment. Indeed, NPS raised concerns about the inadequacy of DREF's cumulative visibility analysis in our October 26, 2006, comments. EPA's 1980 visibility regulations also require an assessment of cumulative impacts on visibility from existing and permitted but not yet constructed sources in addition to the new source:

> EPA has always regarded permitted sources as part of existing background. *For instance, in assessing impacts on the national ambient air quality standards, permit applicants must account for the air quality impacts of permitted, as well as constructed, sources. This treatment should be the same for visibility assessment. The EPA does not believe that a change in the proposed language for new source review is necessary to effect this implementation.* The EPA concludes that the proposed language on assessing whether a proposed source will cause an adverse impact on visibility requires the reviewing authority to review the new source's impact in the context of background visibility impacts caused by both existing and previously permitted sources.[3] (emphasis added).

The U.S. E.P.A. Environmental Appeals Board has explicitly recognized the requirement for a cumulative visibility analysis:

Petitioners are correct that under EPA rules, in determining whether a proposed source will cause an adverse impact on visibility, the cumulative visibility impacts of the pending PSD applicant *and all PSD-permitted sources, including those not yet constructed,* must be assessed against background visibility conditions.[4] (emphasis added).

Additional Impact Analysis: We are concerned that EPA determined that DREF's additional impact analysis was adequate, even though it relied on a document that is grossly outdated. More specifically:

> "EPA disagrees that the additional impacts analysis was inadequate. Sithe's additional impacts analysis relied on "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals", EPA 450/2-81-078, December 12, 1980 (included as Attachment 34). Table 3.1 of this guidance document lists for various pollutants screening concentrations, representing minimum concentrations at which adverse growth effects or tissue injury were reported in the scientific literature. While dated, this document is the only guidance currently available for conducting additional impacts assessments. EPA believes that Sithe's additional impact analysis was adequate and meets regulatory requirements." (p. 150)

The referenced "screening" document includes evaluation criteria for completing analyses under 40 CFR 52.21 parts (o) and (p); additional impact analyses and AQRV impact analyses, respectively. EPA's apparent acceptance and use of a document we consider to be grossly outdated could have negative implications for assessing AQRVs,

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[3] 50 Fed. Reg. 28548 (July 12, 1985).

[4] *In the Matter of: Old Dominion Electric Cooperative Permit Application*, PSD Appeal No. 91-39 (1992 EPA App. LEXIS 37; 3 E.A.D. 779). Note: This language does not negate the intent that a new source's impact on visibility is to be measured compared to natural background visibility. Visibility impairment is defined as "any humanly perceptible change in visibility . . . from that which would have existed under natural conditions" (40 C.F.R. §51.301). States "must ensure that (a) source's emissions will be consistent with making reasonable progress toward the national visibility goal . . . ."(40 C.F.R. §51.307(c)). The visibility goal—natural conditions by 2064—has been codified in the Regional Haze Rule (40 C.F.R. §51.308(d)(1)(i)(B), and that goal was upheld by the D.C. Circuit Court in 2002 (*American Corn Growers Assoc. v. EPA*, No. 99-1348 (D.C. Cir. May 24, 2002).

and ignore the advances we have made in understanding the effects of air pollution on AQRVs. This guidance document, which was published in 1980, does not adequately assess established AQRVs including lakes, streams, soils, vegetation, and animals. In fact, Table 3.1 of the document considers only vegetation sensitivity. Further, the document establishes procedures to assess soil effects, but only in terms of the potential for direct uptake of these pollutants by vegetation, rather than potential effects as a result of biogeochemical changes in the soil substrate. Given the lack of information at the time of the document, it completely ignores deposition effects of important pollutants such as SO_2 and NO_x, which can have significant impacts on nutrient cycling and biogeochemical processes in aquatic and terrestrial ecosystems.

The authors of the 1980 document recognized that better information would become available over time and noted that when better AQRV information became available it should be used in place of the screening concentrations in the document. Over two and a half decades of research since this time has shown that in some cases, harmful ecosystem effects can occur at relatively low levels of deposition. Despite these numerous studies identifying harmful effects of current and historical sulfur and nitrogen deposition, the majority of the country is in attainment of both the primary and secondary NAAQS for SO_2 and NO_x, indicating that the standards are not protective of sensitive ecosystems. EPA OAQPS is currently reviewing the secondary standards for these pollutants, and has collected a large body of research on the effects of deposition in their second draft of the Integrated Science Assessment. We suggest that EPA Region 9 consult this synthesis of research and information on the effects of air pollution to soils and vegetation rather than utilizing the 1980 screening document. In addition, the FLAG guidance can provide useful information on AQRV analyses.

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2006

Regional Impacts of Oil and Gas Development on Ozone Formation in the Western United States

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ABSTRACT

The Intermountain West is currently experiencing a boom in oil and gas production, which has the potential to affect both the visibility and air quality of various Class 1 areas in the region. The following work presents an analysis of these impacts using the Comprehensive Air quality Model with extensions (CAMx). CAMx is a state-of-the-science 'one-atmosphere' Eulerian photochemical dispersion model that has been widely used in the assessment of gaseous and particulate air pollution (ozone, $PM_{2.5}$, PM_{10}). Meteorology and emissions inventories developed by the Western Regional Air Partnership Regional Modeling Center are used to establish a base line simulation for the year 2002. The predicted range of values for ozone in the National Parks and other Class I areas in the Western US is then evaluated with available observations from the CASTNET network. This evaluation demonstrates the model's suitability for subsequent planning, sensitivity, and emissions control strategy modeling. Once the base line simulation has been established an analysis of the model results is performed to investigate the regional impacts of oil and gas development on the ozone concentrations that affect the air quality of Class 1 areas. Results indicate that the maxima 8-hr ozone enhancement from oil and gas, up to 10 ppb, could affect southwestern Colorado and northwestern New Mexico. Class I areas in this region that are likely to be impacted by increased ozone include Mesa Verde National Park and

Weminuche Wilderness Area in Colorado, and San Pedro Parks Wilderness Area, Bandelier Wilderness Area, Pecos Wilderness Area and Wheeler Peak Wilderness Area in New Mexico.

IMPLICATIONS

The population growth in the Western United States is driving a rapid increase in the generation of electricity and fossil fuel production, leading to higher NO_x emissions. This development has the potential to affect the visibility and air quality of Class 1 areas in the region. Although emissions from oil and gas development may appear small compared to others such as coal-fired power plants and automobiles, they occur in remote regions of the country and can have a disproportionate effect on air quality in rural regions. The following work presents an analysis of these impacts using a state-of-the-science photochemical dispersion model.

INTRODUCTION

High ozone levels at the earth's surface, such as the photochemical smog that frequently envelopes Los Angeles in the summer have typically been regarded as an urban air quality problem. A disturbing trend in recent years, however, has been the rise of tropospheric ozone in remote regions of the western U.S.[1] Possible explanations for this trend include increasing background concentrations, largely due to emissions from Asia[2,3,4], or changes in the magnitude or distribution of regional emissions[1].

Ozone (O_3) is a strong oxidant that can harm human health at relatively low concentrations. In March 2008, the U.S. Environmental Protection Agency (EPA) tightened existing National Ambient Air Quality Standards (NAAQS) for ozone to 75 ppb (assessed as the 4^{th} highest monitored ozone concentration value over a running average eight hour period, averaged over 3 continuous years) from the previous 0.08 ppm, effectively reducing the compliance level of the ozone NAAQS by 9 ppb. In April 2008, the EPA Clean Air Science Advisory Committee clarified earlier recommendations to the EPA Administrator that a primary ozone standard between 60 and 70 ppb is necessary to protect human health[5].

Ozone is formed through a complex series of chemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. To combat rising ozone levels, these precursors must be reduced. As oil and gas development in the western U.S. continues to accelerate, however, there is significant potential that emissions from these sources will exacerbate the existing ozone problem. Although emissions from oil and gas development may appear small as compared to other emission categories such as coal-fired power plants and automobiles, they typically occur in remote regions of the country, far removed from urban areas, and can have a disproportionate effect on air quality in rural regions. For example, NO_x emissions from an internal combustion engine at a gas well may react with terpenes (a reactive VOC) emitted from pine forests and form ozone in an area where, previously, the right mix of precursors was not available for this reaction to take place. This is especially worrisome since recent observations indicate that many remote wilderness areas and national parks, such as Mesa Verde National Park in southwestern Colorado, are confronted with ozone concentrations that are trending towards the EPA's acceptable limits. Very near Mesa Verde National Park are rapidly growing oil and gas extraction operations in northwestern New Mexico. As this type of development continues throughout the West, it is essential to understand its potential negative impact on air quality in some of our nation's most cherished protected areas.

This study uses sophisticated meteorological and air pollution models to simulate air quality in the western U.S., with a particular focus on ozone concentrations in our national parks and wilderness areas. Model inputs for meteorology, emissions, and boundary concentrations were provided by the Western Regional Air Partnership (WRAP) The modeling system employed in this work is similar to those used in demonstrating compliance with current NAAQS[6,7].

Understanding the impacts of emissions from particular source categories such as oil and gas development is crucial to develop effective strategies that reduce regional air pollution. Although this article focuses on the impact of ozone pollution, the concept of "one-atmosphere" computer modeling is being employed by other groups like the WRAP in their regional air quality analyses[8]. This approach is used to investigate several issues related to regional formation and transport of air pollutants such as the primary and secondary NAAQS for ozone and particulate matter, visibility protection, and mitigating health and ecosystem effects due to excessive nitrogen deposition and toxic air pollutants such as mercury.

METHODOLOGY

The modeling system is comprised by three major components: MM5 (Mesoscale Model 5[9]), a regional weather model, CAMx (Comprehensive Air Quality Model with Extensions[10]), a chemistry transport model, and an inventory of pollutant emissions. CAMx simulates the emissions, dispersion, chemical reactions, and removal of pollutants in the troposphere by solving the pollutant continuity equation for each chemical species on a three-dimensional grid. Although computationally expensive, this type of simulation accounts for the complex physical and chemical processes that govern the fate of pollutants. MM5 provides the wind fields that CAMx needs to determine the transport of chemical species, as well as other meteorological variables such as temperature and mixing height. A detailed emission inventory specifies the hourly flux of emissions from numerous area and point pollutant sources. The emission inventory focuses on pollutants that are important for regional haze and visibility in the selected model domain, which includes the contiguous U.S., southern Canada, and northern Mexico. The inventory consists of 22 emission categories (e.g., automobiles, power plants, forest fires, oil and gas development) and was developed for the WRAP. Figure 1 shows the annual NO_x emissions associated with oil and gas development in the western U.S. Note that significant emissions occur throughout the Intermountain West, particularly in the Four Corners region of northwestern New Mexico.

The oil and gas emission inventory used in this study was initially compiled for the WRAP's regional haze simulations, with a focus on NO_x and oxidized sulfur (SO_x) emissions, which are precursors to fine particulate nitrate and sulfate, respectively. However, subsequent versions of this inventory have been developed and improved, and emissions of some species, such as VOC, have been substantially revised. Although this study uses an earlier version of the WRAP oil and gas emission inventory, it is anticipated that the general trends presented here give a gross indication of the impact of this source category on regional ozone formation. Future simulations will incorporate an updated oil and gas emission inventory from WRAP.

In this study, a simulation for 2002 is performed with CAMx and corresponds to the "base modeling year" being investigated by the WRAP, and the latest year in which detailed emissions were readily available. The first step in this analysis is the comparison between predicted ozone concentrations with available observations. Once the model performance of this "base case" simulation is deemed adequate, a second CAMx simulation that includes all the base case emissions except those from oil and gas is used to evaluate the air quality impacts of oil and gas in the western U.S. The impacts are determined by looking at the difference between the base case and the "absent oil and gas emissions" simulations.

ANALYSIS

Model Performance Evaluation

Ozone concentrations predicted by the model are evaluated by comparing the surface layer values with available hourly measurements of ground-level ozone at 22 sites from the Clean Air Status and Trends Network[11] monitoring network. The sites chosen fall within the western region of the United States. An evaluation of CAMx's skill in predicting ozone is done in accordance with the EPA's suggested performance guidelines for ozone modeling[12]. Observation/prediction pairs are excluded from the analysis when the observed concentration is below a certain cut-off level. The EPA has suggested a cut-off value of 60 ppb, however, most of the sites considered here are located in remote, pristine areas, and thus the cut-off value is set at 20 ppb instead to represent background concentrations. Table 1 shows the annual model performance statistics for 1-h ozone in the western region of the United States (the focus of this study) during 2002. In general, CAMx is able to consistently predict the general annual trends for ozone concentrations, with a mean normalized bias of -1.6 % and a mean absolute normalized error of 22.7 %, falling well within the EPA's guidelines for acceptable model performance. Figure 2 shows estimated monthly normalized error and bias bar-plots. Throughout the year, the model also performs within EPA's goals, for instance the largest errors are less than 25% during the summer (August). The model seems to show some seasonality in the errors and biases; its performance is better for the winter and fall while slightly worse for the spring and summer. The model has a tendency to underpredict ozone concentrations during the summer and fall with the largest biases in August (-15%), while it overpredicts ozone during the winter and spring.

Oil and Gas Impacts

As indicated above, this study relies on two separate CAMx simulations to estimate the potential impacts of oil and gas emissions in the western U.S. A regional perspective of ozone formation is illustrated in Figure 3. Figure 3a shows the estimated peak 8-hr ozone concentration at each model grid cell that occurred during the 2002 base case simulation. As expected, there are high concentrations, exceeding 110 ppb, downwind of major urban areas such as Los Angeles, San Francisco, Salt Lake City, and Denver. The figure also demonstrates that for a large region of the southwestern U.S., that includes remote regions of Nevada, Wyoming, Utah, Arizona, New Mexico and Colorado, the new 8-hr primary NAAQS for ground-level ozone (75 ppb) is exceeded at least once through 2002 for many Class I areas. Generally, these maxima occur during hot, sunny days with light winds, when the meteorology is most favorable for ozone production. These periods also typically correspond to peak VOC emissions from biogenic and anthropogenic sources. The role of NO_x and VOC emissions from oil and gas development on ozone in the western U.S. is shown in Figure 3b. Note that the values for each grid cell in Figure 3b correspond to the dates and times for which ozone maxima occur (Figure 3a), but in this case, the ozone concentration is due solely to emissions from oil and gas development. Although the peak ozone maxima throughout the West are typically quite small, there is a strong signature of a 1-2 ppb of ozone throughout New Mexico, Colorado, and Wyoming, with a pattern that approximates the emissions shown in Figure 1. However, the maximum possible impacts of oil and gas emissions do not necessarily coincide in time with the maximum possible ozone concentrations as illustrated in Figure 4. The maxima 8-hr ozone enhancement from oil and gas alone shown in Figure 4a demonstrates that significant ozone concentrations, up to 10 ppb, could affect southwestern Colorado and northwestern New Mexico. Class I areas in this region that are likely to be impacted by increased ozone include Mesa Verde National Park and Weminuche Wilderness Area in Colorado, and San Pedro Parks Wilderness Area, Bandelier Wilderness Area, Pecos Wilderness Area and Wheeler Peak Wilderness Area in New Mexico. Ozone concentrations for the base case simulation during this period (Figure 4b) range from 40 to 70 ppb, thus in some places, like Mesa Verde NP and Weminuche, oil and gas has the potential to put these places out of compliance with the new EPA ozone standard. Figure 4a illustrates that there are three regions where oil and gas has the potential for maximum impacts on Class I areas: the south of Colorado and north of New Mexico, the southeastern corner of New Mexico, and finally western Wyoming. Table 2 shows when the maximum impacts due to oil and gas are achieved and what those impacts are for some of the sites that fall within the three regions identified above. The table also shows for those same sites what the maximum base case concentrations are and the date when are achieved. In general, these results show that most of the impacts occur during the summer and early fall, while the maximum concentrations occur mostly during the spring and early summer. Figure 5 shows 8 hr moving average time series for both the base case and the oil and gas impacts in selected sites from Table 2. Each of these sites represents one of the three main regions identified as having larger impacts from oil and gas emissions. The general trend of modeled ozone (Figure 5a) is low concentrations during the colder winter months, when limited photochemistry will occur, and higher concentrations during the warmer late spring and summer months, when meteorological conditions are more favorable to ozone production. Additionally, enhanced biogenic VOC emissions that occur during the spring and summer will further influence ozone formation in the region. The dashed lines in Figure 5a show the new EPA standards for ozone. It is evident from the figure that there are various instances in which ozone concentrations are higher than the new NAAQS in many of these Class I areas, particularly during the late spring and early summer. Figure 5b shows the resulting change in predicted ozone concentrations that are attributed solely to emissions from oil and gas development. This estimate was calculated by evaluating two CAMx simulations: the base case simulation, in which all emission categories are accounted, and a "no oil and gas" simulation, which is similar to the base case, except that oil and gas emissions are removed. The difference between these two simulations represents the contribution of oil and gas emissions on regional ozone. Notable in Figure 5b is the fact that oil and gas emissions can actually decrease ozone concentrations at various sites through the process of "NO_x scavenging", where available ozone is consumed by reacting with nitric oxide (NO). This effect is most prevalent in the winter, when ozone concentrations are lower. However, in the summer, the situation is reversed, and warm, stagnant conditions yield an increase in ozone from oil and gas emissions. Although these impacts appear relatively small (e.g., an increase of a few ppb in the summer), it should be remembered that this period corresponds with seasonally-high ozone concentrations.

This study, although not exhaustive, does indicate a clear potential for oil and gas development to impact negatively regional ozone concentrations in the western U.S., including several treasured national parks and wilderness areas in the Four Corners region. It is likely that accelerated energy development in this part of the country will worsen the existing problem. The formation of ozone pollution examined here represents a complex phenomenon involving non-linear physicochemical processes, uncertain emission inventories, and fine-scale transport in mountainous terrain. These simulations will be refined with the updated emission inventories available from the WRAP. Although a daunting technical problem, regional air quality modeling remains the only feasible option for developing emission control strategies that have the potential to reduce ozone concentrations and protect air quality.

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Table 1. Annual model performance statistics for 1-h ozone calculated with 22 CASTNET sites in the WRAP region. All values in ppb except where indicated.

	EPA goal	All sites (Western U.S)
Mean Observation		47
Mean Estimation		44
Standard deviation Obs.		13
Standard deviation Est.		12
Mean Bias Error		-3
Mean Normalized Bias Error (%)	$< \pm 15\%$	-1.6
Mean Absolute Gross Error		10
Mean Absolute Normalized Gross Error (%)	$< 35\%$	22.7
Mean Fractional Error (%)		23
Mean Fractional Bias (%)		-5.8

Table 2. Maximum impacts due to oil and gas in some of the sites of the Western U.S. Also shown are the maximum base case concentrations and the date when they are achieved.

Class I area	Lat.	Lon.	Max. impact (oil and gas)	Date max. impact occurs	Max. Concentration (Base case)	Date max. concentration occurs
Weminuche	37.65	-107.80	7	Aug. 5	87	May 22
San Pedro Parks	36.11	-106.81	5	Sep. 8	91	Apr. 24
Carlsbad Caverns	32.14	-104.48	4	Aug. 27	72	Apr. 27
Wheeler Peak	36.57	-105.42	3	Aug. 24	97	Apr. 23
Pecos	35.93	-105.64	3	Sep. 13	95	Apr. 24
Bandelier	35.78	-106.26	3	Jun. 30	91	Apr. 24
Mesa Verde	37.20	-108.48	3	Jul. 13	87	Apr. 23
Salt Creek	33.61	-104.37	3	Jul. 29	75	May 7
Great Sand Dunes	37.72	-105.51	2	Sep. 8	101	Apr. 23
La Garita	37.96	-106.81	2	Aug. 6	93	Apr. 23
Bridger	42.97	-109.75	2	Apr. 4	83	Jun. 19
Fitzpatrick	43.27	-109.57	2	Apr. 4	83	Jun. 19
Grand Teton	43.68	-110.73	1	Apr. 24	72	Jun. 3
Washakie	43.95	-109.59	0.6	Sep. 10	74	May 13

Figure 1. Annual NO_x emissions [Tons yr^{-1}] from oil and gas development in the western United States from the 2002 WRAP emission inventory.

Figure 2. Monthly model performance normalized error and bias bar-plots for 1-h ozone calculated with 22 CASTNET sites in the WRAP region.

Figure 3. Peak predicted annual ozone maxima [ppb, 8 hour average] in the western U.S from (a) the 2002 base case simulation and (b) the enhancement from VOC and NO_x emissions from oil and gas development that correspond to the dates and times of ozone maxima. The locations of all Class I areas in the region are indicated with red crosses.

Figure 4. Peak predicted annual ozone [ppb, 8 hour average] enhancement from VOC and NO_x emissions from oil and gas development in the western U.S. (a) and (b) corresponding ozone concentrations from the 2002 base case simulation. The locations of all Class I areas in the region are indicated with red crosses.

Figure 5. Time series of (a) simulated base case ozone [ppb, 8 hour average] for sites representative of one of the three main regions identified as having larger impacts from oil and gas emissions. (b) The change in ozone concentration [ppb, 8 hour average] at each site due solely to VOC and NO_x emissions from oil and gas development.

Figure 1. Annual NO_x emissions [Tons yr^{-1}] from oil and gas development in the western United States from the 2002 WRAP emission inventory.

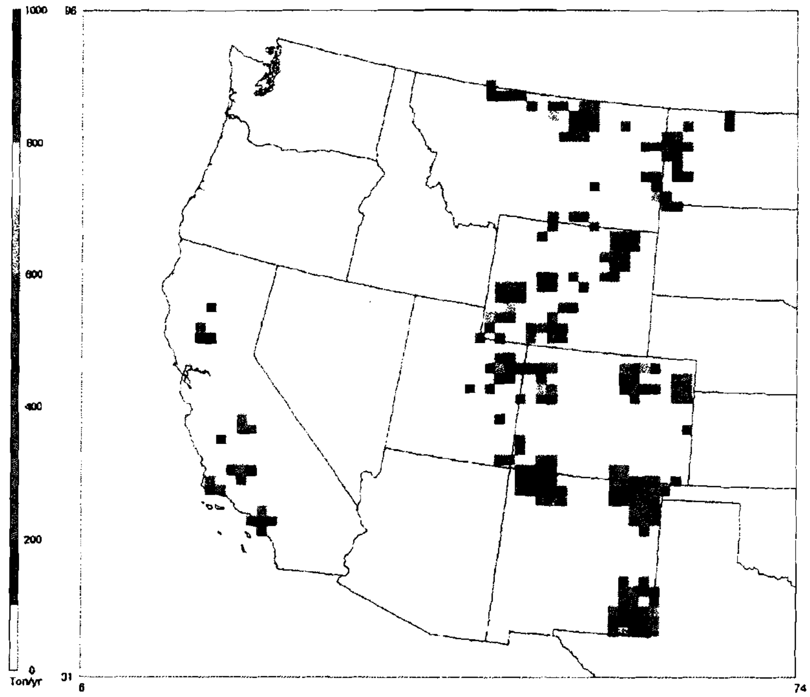
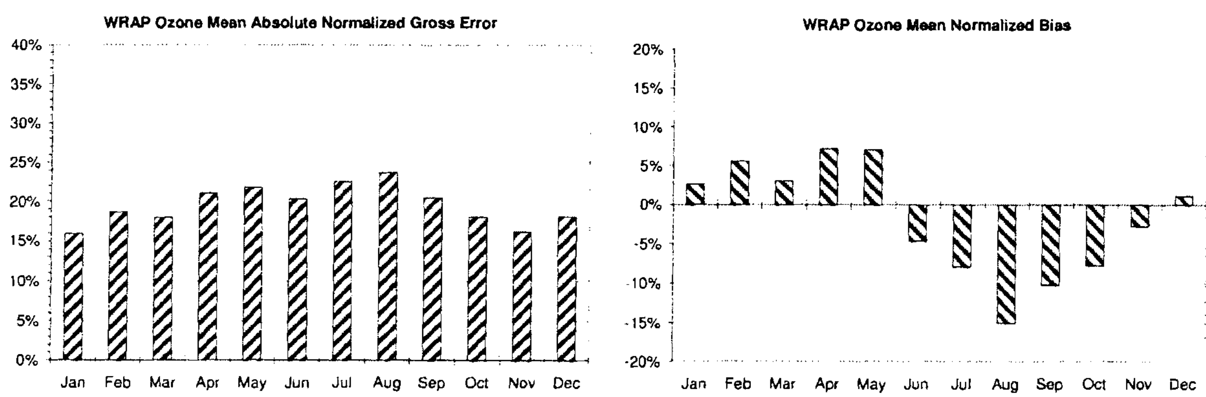


Figure 2. Monthly model performance normalized error and bias bar-plots for 1-h ozone calculated with 22 CASTNET sites in the WRAP region.



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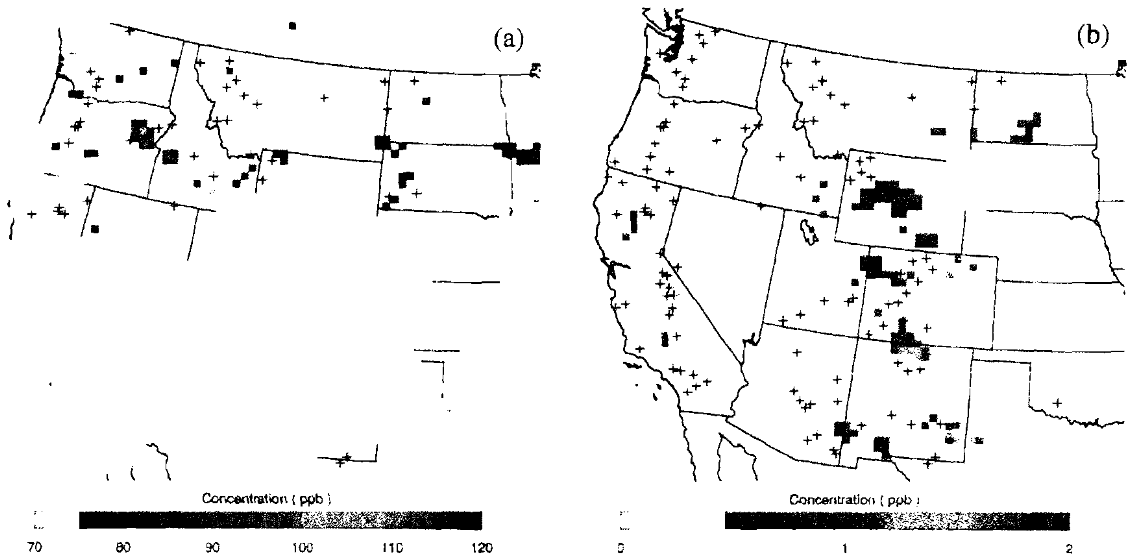

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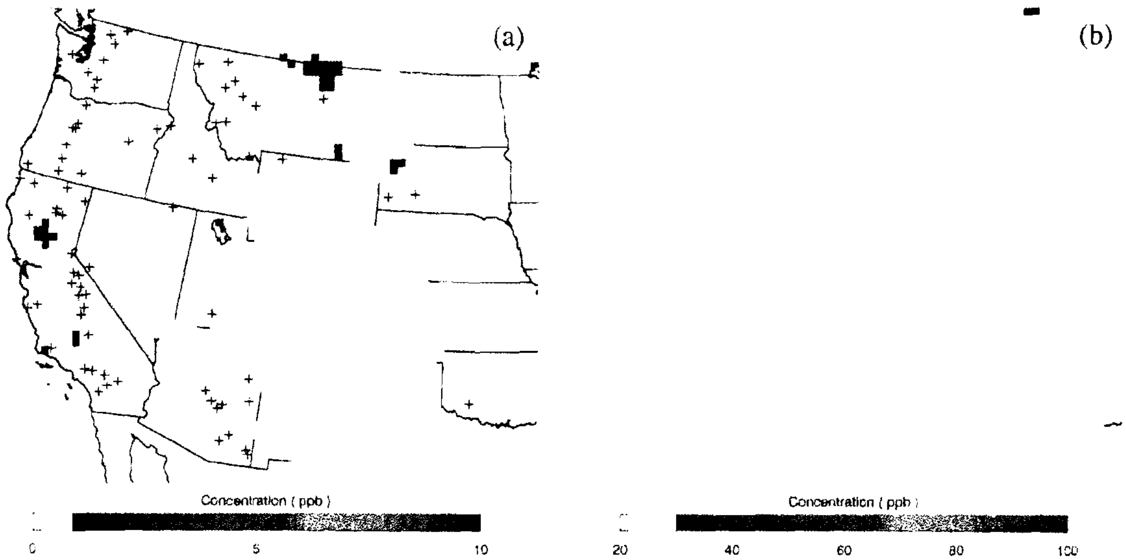

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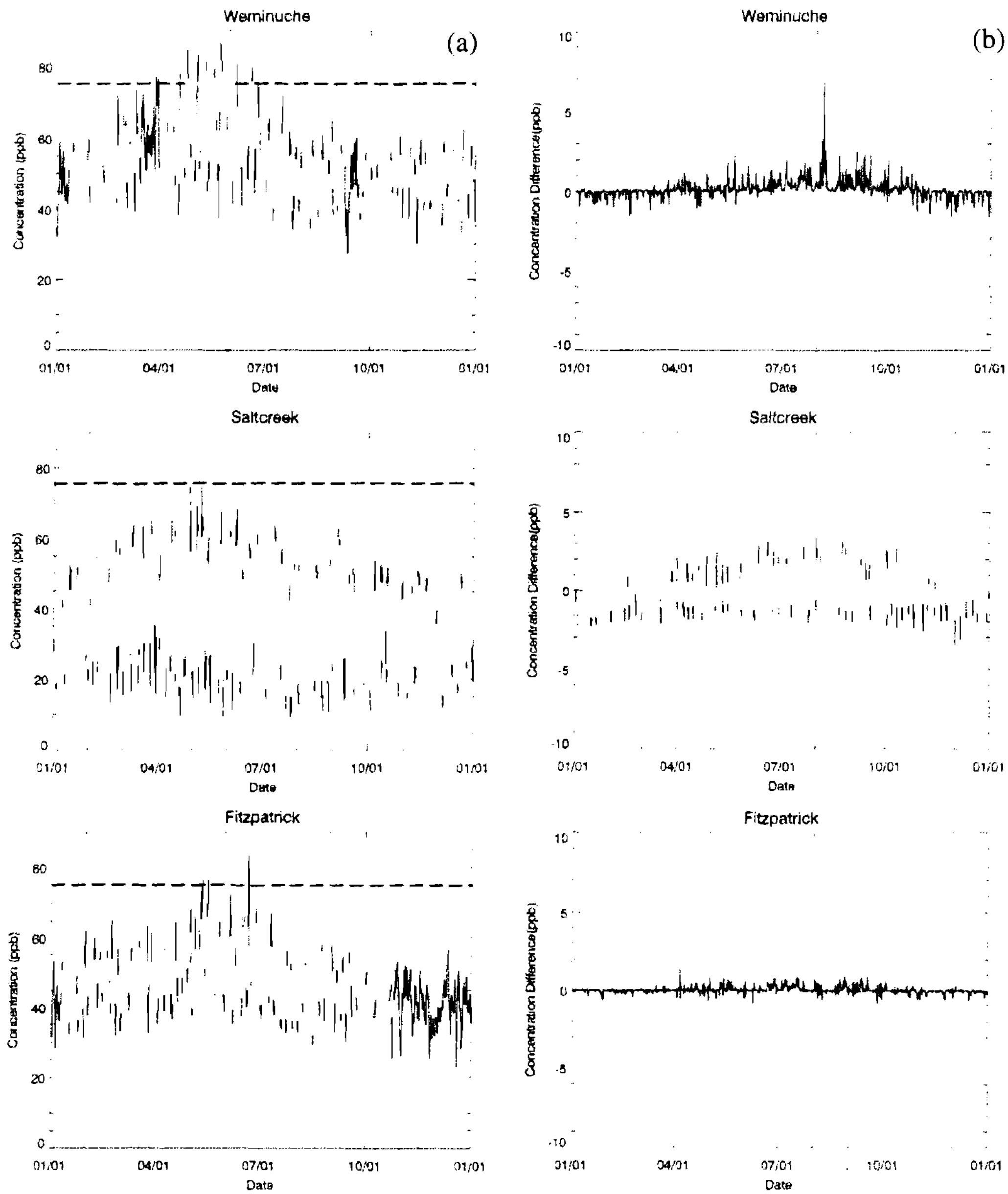

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OZONE DATA COLLECTED FROM THE NAVAJO LAKE MONITORING STATION SAN JUAN COUNTY, NEW MEXICO

2006

Date	8-hour average (ppm)
7/14/2006	0.087
4/20/2006	0.080
4/26/2006	0.080
6/18/2006	0.079
4th highest 8-hour average	**0.079**

-note: 2006 data collection began on March 23, 2006

2007

Date	8-hour average (ppm)
4/28/2007	0.08
8/15/2007	0.08
6/23/2007	0.079
8/25/2007	0.079
4th highest 8-hour average	**0.079**

2008

Date	8-hour average (ppm)
6/13/2008	0.077
10/18/2008	0.077
10/15/2008	0.076
6/4/2008	0.075
4th highest 8-hour average	**0.075**

3-year average of 4th highest 8-hour average: 0.077 ppm (truncated after third decimal place)

Data from EPA-AQS database and AQB database - 2008 data current as of 11/2/08
Retrieved by Josephine Ball, QA Manager, AQB

EXHIBIT
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