WILDEARTH GUARDIANS
A FORCE FOR NATURE

December 12, 2016

Via Hand Delivery

Ruth Welch
State Director
U.S. Bureau of Land Management
Colorado State Office
2850 Youngfield St.
Lakewood, CO 80215

Re: Protest of February 2017 Competitive Oil and Gas Lease Sale

Dear Ms. Welch:

Pursuant to 43 C.F.R. § 3120.1-3, WildEarth Guardians hereby protests the Bureau of Land Management's ("BLM's") proposal to offer 17 publicly owned oil and gas lease parcels covering 17,631.54 acres of land in the Tres Rios Field Office of Colorado for competitive sale on February 9, 2016. These parcels include public lands managed by BLM in Dolores, Montezuma, San Miguel, and Archuleta Counties, Colorado. The specific parcels being protested include the following, as identified by the BLM's in its Final February 2017 Oil and Gas Sale List:[1]

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Lease Serial Number	Acres	County
COC78157	360.00	Montezuma
COC78158	196.44	Dolores
COC78159	1727.44	Dolores
COC78160	1840.00	Dolores
COC78161	1240.00	Dolores
COC78162	920.00	San Miguel
COC78163	2360.54	San Miguel
COC78164	161.03	San Miguel
COC78165	240.00	San Miguel
COC78166	1080.00	Dolores
COC78167	530.00	San Miguel

[1] This list, which was made available on November 10, 2016, is on the BLM's website at https://www.blm.gov/style/medialib/blm/co/programs/oil_and_gas/Lease_Sale/2017/february.Par.10079.File.dat/Feb_2017_Final_SN_posting.pdf.

COC78168	880.00	San Miguel
COC78169	1200.00	San Miguel
COC78170	320.00	San Miguel
COC78171	2396.68	San Miguel
COC78172	1796.28	San Miguel
COC78173	383.13	Archuleta

In support of its proposed leasing decision, the agency prepared two separate Determination of Adequacy Under the National Environmental Policy Act ("DNA"). One DNA was prepared just for two parcels in Dolores County, DOI-BLM-CO-S010-2017-0001-DNA (hereafter "DNA 1"), and one for the remaining 15 parcels, DOI-BLM-CO-S010-2015-0039-DNA (hereafter "DNA 2"). A DNA does not satisfy NEPA's requirement that the impacts of major federal actions be analyzed and assessed. Rather, a DNA adopts prior NEPA analyses. In this case, the BLM's DNAs rely upon, "The BLM Tres Rios Field Office Record of Decision and Approved Resource Management Plan (TRFO ROD/RMP) (February 2015), San Juan National Forest Land and Resource Management Plan Final Environmental Impact Statement (RMP FEIS) (September 2013)." DNA 1 at 2; *see also* DNA 2 at unnumbered p. 3.

As will be explained, the BLM's proposal to lease falls short of ensuring compliance with the National Environmental Policy Act ("NEPA") , 42 U.S.C. § 4331, *et seq.* The BLM's reliance on underlying programmatic NEPA analysis to satisfy the agency's obligations to analyze and assess the reasonably foreseeable impacts of oil and gas leasing is wholly inappropriate as it fails to present any site-specific analysis and disclosure of impacts. The DNAs do not demonstrate that a stand-alone NEPA analysis is not required in this case or that the potentially significant impacts of leasing have been adequately analyzed and assessed.[2]

STATEMENT OF INTEREST

WildEarth Guardians is a nonprofit environmental advocacy organization dedicated to protecting the wildlife, wild places, wild rivers, and health of the American West. WildEarth Guardians is headquartered in Santa Fe, New Mexico, but has offices and staff throughout the western United States, including in Denver. On behalf of our members, Guardians has an interest in ensuring the BLM fully protects public lands and resources as it conveys the right for the oil and gas industry to develop publicly owned minerals. More specifically, Guardians has an interest in ensuring the BLM meaningfully and genuinely takes into account the climate implications of its oil and gas leasing decisions and objectively and robustly weighs the costs and benefits of authorizing the release of more greenhouse gas emissions that are known to contribute to global warming. WildEarth Guardians submitted comments on the BLM's proposed leasing June 13, 2016 and on September 8, 2016.[3]

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[2] For purposes of this protest, we hereby incorporate by reference comments on the BLM's DNAs and attachments thereto submitted by WildEarth Guardians on September 8, 2016. These documents should be a part of the BLM's records for its DNAs.

[3] WildEarth Guardians' September 8, 2016 comments were sent via electronic mail on September 8, 2016 to Tres Rios Field Office, including to the address, blm_co_trfo_2016_lease_sale@blm.gov, and to Tres Rios Field Office

The mailing address for WildEarth Guardians to which correspondence regarding this protest should be directed is as follows:

WildEarth Guardians
2590 Walnut St.
Denver, CO 80205

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STATEMENT OF REASONS

WildEarth Guardians protests the BLM's February 2017 oil and gas lease sale over the agency's failure to adequately analyze and assess the climate impacts of the reasonably foreseeable oil and gas development that will result in accordance with NEPA, 42 U.S.C. § 4331, *et seq*., and regulations promulgated thereunder by the White House Council on Environmental Quality ("CEQ"), 40 C.F.R. § 1500, *et seq*.

NEPA is our "basic national charter for protection of the environment." 40 C.F.R. § 1500.1(a). The law requires federal agencies to fully consider the environmental implications of their actions, taking into account "high quality" information, "accurate scientific analysis," "expert agency comments," and "public scrutiny," prior to making decisions. *Id*. at 1500.1(b). This consideration is meant to "foster excellent action," meaning decisions that are well informed and that "protect, restore, and enhance the environment." *Id*. at 1500.1(c).

To fulfill the goals of NEPA, federal agencies are required to analyze the "effects," or impacts, of their actions to the human environment prior to undertaking their actions. 40 C.F.R. § 1502.16(d). To this end, the agency must analyze the "direct," "indirect," and "cumulative" effects of its actions, and assess their significance. 40 C.F.R. §§ 1502.16(a), (b), and (d). Direct effects include all impacts that are "caused by the action and occur at the same time and place." 40 C.F.R. § 1508.8(a). Indirect effects are "caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." *Id*. at § 1508.8(b). Cumulative effects include the impacts of all past, present, and reasonably foreseeable actions, regardless of what entity or entities undertake the actions. 40 C.F.R. § 1508.7.

An agency may prepare an environmental assessment ("EA") to analyze the effects of its actions and assess the significance of impacts. *See* 40 C.F.R. § 1508.9; *see also* 43 C.F.R. § 46.300. Where effects are significant, an Environmental Impact Statement ("EIS") must be prepared. *See* 40 C.F.R. § 1502.3. Where significant impacts are not significant, an agency may issue a Finding of No Significant Impact ("FONSI") and implement its action. *See* 40 C.F.R. § 1508.13; *see also* 43 C.F.R. § 46.325(2).

Within an EA or EIS, the scope of the analysis must include "[c]umulative actions" and "[s]imilar actions." 40 C.F.R. §§ 1508.25(a)(2) and (3). Cumulative actions include action that, "when viewed with other proposed actions have cumulatively significant impacts and should

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Manager Connie Clementson, cclementson@blm.gov. *See* Exhibit 1, E-mails Transmitting WildEarth Guardians' Comment Letter to Tres Rios Field Office on September 8, 2016.

therefore be discussed in the same impact statement." 40 C.F.R. § 1508.25(a)(2). Similar actions include actions that, "when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together." 40 C.F.R. § 1508.25(a)(3). Key indicators of similarities between actions include "common timing or geography." *Id.*

Here, the BLM fell short of complying with NEPA with regards to analyzing and assessing the potentially significant climate impacts of oil and gas leasing. In support of its proposed leasing, the agency conducted no NEPA analysis whatsoever. The DNAs prepared by the BLM contain no actual, site-specific analysis of the impacts of the proposed leasing. What's more, the underlying NEPA relied upon to demonstrate compliance with NEPA fail to analyze the reasonably foreseeable greenhouse gas emissions both from the proposed leasing and from cumulative and similar actions. The agency further failed to assess the significance of any emissions, particularly in terms of carbon costs. Below, we detail how BLM's proposal fails to comply with NEPA.

1. **The BLM Failed to Analyze and Assess the Direct, Indirect, and Cumulative Impacts of Greenhouse Gas Emissions that Would Result from Issuing the Proposed Lease Parcels**

The BLM completely rejected analyzing and assessing the potential direct and indirect greenhouse gas emissions, including carbon dioxide and methane, that would result from the reasonably foreseeable development of the proposed leases and emissions that would result from consumption of oil and gas produced from the leases. Although acknowledging that development of the lease parcels would occur and that greenhouse gas emissions would be produced, no analysis of these emissions was actually prepared. In fact, the BLM claims such an analysis would be "impossible." DNA 2, Attachment E at BLM Response to Comment #7(b).

The BLM relies on the 2015 TRFO ROD/RMP and 2013 RMP FEIS to argue that an appropriate analysis has been completed. The ROD, RMP, and FEIS, however, contain no analysis of the reasonably foreseeable greenhouse gas emissions that would result from development and ultimate consumption of oil and gas from the leases. Furthermore, to the extent the ROD, RMP, and FEIS do present a cumulative analysis of reasonably foreseeable greenhouse gas emissions associated with construction and production of oil and gas wells, this analysis fails to address the reasonably foreseeable impacts of oil and gas processing, refining, and ultimate consumption. Put another way, it fails to disclose the full life-cycle impacts of oil and gas that will be produced in the Field Office.

The BLM's position is all the more egregious given that other BLM Field Offices, including, but not limited to, the Vernal Field Office of Utah, the Four Rivers Field Office in Idaho, the Miles City Field Office in Montana, the Royal Gorge Field Office in Colorado, and others have not only estimated reasonably foreseeable greenhouse gas emissions associated with the development of oil and gas leases, but clearly do not believe that such information is speculative or not useful to analyze under NEPA.

Most recently, in the Vernal Field Office of Utah, the BLM developed an estimate of both direct and indirect emissions related to proposed oil and gas leasing. In an EA prepared in October, the agency explained:

> Direct greenhouse gas emissions from speculative future oil and gas well production on the proposed lease parcels was calculated assuming one well per parcel. Total Greenhouse Gas Warming Potential (GWP), which includes direct emissions of carbon dioxide, methane, and nitrous oxide from an oil or gas producing well is estimated based on the emissions estimates from the Greater Monument Buttes Final Environmental Impact Statement ([BLM 2016] Table 4.2.1.1.1-1), which is the most recent NEPA calculation of GHG in the lease area. The per-well GWP emissions estimate was made by dividing the Project Total GWP emissions in Table 4.2.1.1.1-1 (3,096,936 tpy) by the total number of producing oil and gas wells used to generate the GWP emissions estimates (5,740 wells). This gives a GWP emissions estimate of approximately 540 tons per year GWP emissions on a per-well, per-parcel basis. Actual emissions may range from zero if a parcel is not leased or not developed after leasing, to an unknown upper range.

Exhibit 2, BLM, "Environmental Assessment, November 2016 Competitive Oil and Gas Lease Sale," EA No. DOI-BLM-UT-G010-2016-033-EA at 39-40, available online at https://eplanning.blm.gov/epl-front-office/projects/nepa/59590/86059/103236/Fianl_for_Posting.pdf. In this EA, the BLM not only analyzed and assessed direct greenhouse gas emissions, but also estimated reasonably foreseeable indirect emissions related to the consumption of oil and gas produced from proposed leases. In its EA, the BLM presented an estimate of "low," "average," and "high" emissions, reporting that consumption related emissions could be nearly 500,000 metric tons of carbon dioxide equivalent annually. *See* Exhibit 2 at 40.

In the Four Rivers Field Office of Idaho, the BLM utilized an emission calculator developed by air quality specialists at the BLM National Operations Center in Denver to estimate likely greenhouse gases that would result from leasing five parcels. *See* Exhibit 4C to Guardians' September 8, 2016 Comments at 41.[4] Relying on a report prepared in 2013 for the BLM by Kleinfelder, the agency estimated that 2,893.7 tons of carbon dioxide equivalent ("CO_2e") would be released per well. *Id.* at 35. Based on the analyzed alternatives, which projected between 5 and 25 new wells, the BLM estimated that total greenhouse gas emissions would be between 14,468.5 tons and 72,342.5 tons annually. *Id.*

In the Miles City Field Offices of Montana, the BLM estimated likely greenhouse gas emissions from development of oil and gas leases. To do so, the agency first calculated annual greenhouse gas emissions from oil and gas activity within the Field Offices. *See* Exhibit 15 to Guardians' September 8, 2016 Comments at 51. The BLM then calculated total greenhouse gases by assuming that the percentage of acres to be leased within the federal mineral estate of the Field Offices would equal the percentage of emissions. *Id.* Although we have concerns over the validity of this approach to estimate emissions (an "acre-based" estimate of emissions is akin

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[4] Throughout this Protest, we reference exhibits submitted as part of our September 8, 2016 comment letter. However, the same exhibits were also submitted as part of our June 13, 2016 comment letter.

to estimating automobile emissions by including junked cars, which has the misleading effect of reducing the overall "per car" emissions), nevertheless it demonstrates that the BLM has the ability to estimate reasonably foreseeable greenhouse gas emissions associated with oil and gas leasing and that such estimates are valuable for ensuring a well-informed decision.

In the Royal Gorge Field Office of Colorado, the BLM contracted with URS Group Inc. to prepare an analysis of air emissions from the development of seven oil and gas lease parcels. *See* Exhibit 3, URS Group Inc., "Draft Oil and Gas Air Emissions Inventory Report for Seven Lease Parcels in the BLM Royal Gorge Field Office," Prepared for BLM, Colorado State Office and Royal Gorge Field Office (July 2013). This report estimated emissions of carbon dioxide and methane on a per-well basis and estimated the total number of wells that could be developed in these seven parcels. *See* Exhibit 3 at 3 and 5. This report was later supplanted by the Colorado Air Resource Management Modeling Study, or CARMMS, which estimated reasonably foreseeable emissions of greenhouse gases, criteria pollutants, and hazardous air pollutants associated with oil and gas development throughout Colorado, as well as part of New Mexico, and modeled air quality impacts. *See* Exhibit 4, ENVIRON, "Colorado Air Resource Management Modeling Study (CARMMS) 2021 Modeling Results for the High, Low and Medium Oil and Gas Development Scenarios," Prepared for BLM Colorado State Office (January 2015), available online at http://www.blm.gov/style/medialib/blm/co/information/nepa/air_quality.Par.97516.File.dat/CARMMS_Final_Report_w-appendices_012015.pdf. As part of the CARMMS report, the BLM estimated per well emissions, including greenhouse gas emissions, in tons per year, as follows:

Phase	PM_{10}	$PM_{2.5}$	VOC	CO	NO_X	SO_2	CO_2	CH_4	N_2O	HAP
Conventional Construction	5.21	0.64	0.05	0.23	0.72	0.02	108.1	0.00	0.00	0.01
CBM Construction	3.37	0.44	0.03	0.12	0.36	0.01	56.58	4.06	0.00	0.00
Conventional Production	1.15	0.15	6.67	1.30	0.73	0.00	251.9	17.14	0.00	0.43
CBM Production	2.25	0.25	13.10	1.13	0.62	0.00	181.6	19.05	0.00	1.31

The BLM finally attempts to argue that an analysis of greenhouse gas emissions is more appropriate at the drilling stage. We have yet to see the BLM actually prepare such a site-specific analysis in conjunction with an oil and gas lease development proposal. Recent analyses prepared for drilling in the Tres Rios Field Office confirms that no such analysis is conducted by the BLM. *See* Exhibit 5, BLM, "Environmental Assessment, D.J. Simmons, Inc. Two Pinto Wells Project, Pinto 1-7 and Pinto 3-17 Oil Wells, Dolores County, Colorado," DOI-BLM-CO-S010-2012-0036-EA (July 2013). What's more, this argument has no merit as the agency has proposed no stipulations that would grant the BLM discretion to limit, or outright prevent, development of the proposed leases on the basis of greenhouse gas emissions and/or climate concerns. The BLM is effectively proposing to make an irreversible commitment of resources, which is the hallmark of significance under NEPA. *See* 42 U.S.C. § 4332(c)(v) and 40 C.F.R. § 1502.16. The failure to prepare an EIS—or any analysis for that matter—for the proposed leases is therefore contrary to NEPA.

2. The BLM Failed to Analyze the Costs of Reasonably Foreseeable Carbon Emissions Using Well-Accepted, Valid, Credible, GAO-Endorsed, Interagency Methods for Assessing Carbon Costs that are Supported by the White House

Compounding the failure of the BLM to make any effort to estimate the greenhouse gas emissions that would result from reasonably foreseeable oil and gas development is that the agency also rejected analyzing and assessing these emissions in the context of their costs to society. It is particularly disconcerting that the agency refused to analyze and assess costs using the social cost of carbon protocol, a valid, well-accepted, credible, and interagency endorsed method of calculating the costs of greenhouse gas emissions and understanding the potential significance of such emissions.

The social cost of carbon protocol for assessing climate impacts is a method for "estimat[ing] the economic damages associated with a small increase in carbon dioxide (CO2) emissions, conventionally one metric ton, in a given year [and] represents the value of damages avoided for a small emission reduction (i.e. the benefit of a CO2 reduction)." Exhibit 10 to Guardians' September 8, 2016 Comments. The protocol was developed by a working group consisting of several federal agencies, including the U.S. Department of Agriculture, EPA, CEQ, and others, with the primary aim of implementing Executive Order 12866, which requires that the costs of proposed regulations be taken into account.

In 2009, an Interagency Working Group was formed to develop the protocol and issued final estimates of carbon costs in 2010. These estimates were then revised in 2013 by the Interagency Working Group, which at the time consisted of 13 agencies, including the Department of Agriculture. This report and the social cost of carbon estimates were again revised in 2015. *See* Exhibit 13 to Guardians' September 8, 2016 Comments.

Depending on the discount rate and the year during which the carbon emissions are produced, the Interagency Working Group estimates the cost of carbon emissions, and therefore the benefits of reducing carbon emissions, to range from $10 to $212 per metric ton of carbon dioxide. *See* Chart Below. In July 2014, the U.S. Government Accountability Office ("GAO") confirmed that the Interagency Working Group's estimates were based on sound procedures and methodology. *See* Exhibit 16 to Guardians' September 8, 2016 Comments.

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Revised Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

Discount Rate	5.0%	3.0%	2.5%	3.0%
Year	Avg	Avg	Avg	95th
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

Most recent social cost of carbon estimates presented by Interagency Working Group on Social Cost of Carbon. The 95th percentile value is meant to represent "higher-than-expected" impacts from climate change.

Although often utilized in the context of agency rulemakings, the protocol has been recommended for use and has been used in project-level decisions. For instance, the EPA recommended that an EIS prepared by the U.S. Department of State for the proposed Keystone XL oil pipeline include "an estimate of the 'social cost of carbon' associated with potential increases of GHG emissions." Exhibit 14 to Guardians' September 8, 2016 Comments.

More importantly, the BLM has also utilized the social cost of carbon protocol in the context of oil and gas leasing. In recent Environmental Assessments for oil and gas leasing in Montana, the agency estimated "the annual SCC [social cost of carbon] associated with potential development on lease sale parcels." Exhibit 15 to Guardians' September 8, 2016 Comments at 71. In conducting its analysis, the BLM used a "3 percent average discount rate and year 2020 values," presuming social costs of carbon to be $46 per metric ton. *Id.* In Idaho, the BLM also utilized the social cost of carbon protocol to analyze and assess the costs of oil and gas leasing. Using a 3% average discount rate and year 2020 values, the agency estimated the cost of carbon to be $51 per ton of annual CO_2e increase. *See* Exhibit 4C to Guardians' September 8, 2016 Comments at 81. Based on this estimate, the agency estimated that the total carbon cost of developing 25 wells on five lease parcels to be $3,689,442 annually. *Id.* at 83.

To be certain, the social cost of carbon protocol presents a conservative estimate of economic damages associated with the environmental impacts climate change. As the EPA has noted, the protocol "does not currently include all important [climate change] damages." Exhibit 10 to Guardians' September 8, 2016 Comments. As explained:

> The models used to develop [social cost of carbon] estimates do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research.

Id. In fact, more recent studies have reported significantly higher carbon costs. For instance, a report published this month found that current estimates for the social cost of carbon should be increased six times for a mid-range value of $220 per ton. *See* Exhibit 12 to Guardians'

September 8, 2016 Comments at 2. In spite of uncertainty and likely underestimation of carbon costs, nevertheless, "the SCC is a useful measure to assess the benefits of CO2 reductions," and thus a useful measure to assess the costs of CO2 increases. Exhibit 10 to Guardians' September 8, 2016 Comments.

That the economic impacts of climate change, as reflected by an assessment of social cost of carbon, should be a significant consideration in agency decisionmaking, is emphasized by a recent White House report, which warned that delaying carbon reductions would yield significant economic costs. *See* Exhibit 6, Executive Office of the President of the United States, "The Cost of Delaying Action to Stem Climate Change" (July 2014), available online at https://www.whitehouse.gov/sites/default/files/docs/the_cost_of_delaying_action_to_stem_climate_change.pdf. As the report states:

> [D]elaying action to limit the effects of climate change is costly. Because CO_2 accumulates in the atmosphere, delaying action increases CO_2 concentrations. Thus, if a policy delay leads to higher ultimate CO_2 concentrations, that delay produces persistent economic damages that arise from higher temperatures and higher CO_2 concentrations. Alternatively, if a delayed policy still aims to hit a given climate target, such as limiting CO_2 concentration to given level, then that delay means that the policy, when implemented, must be more stringent and thus more costly in subsequent years. In either case, delay is costly.

Exhibit 6 at 1.

The requirement to analyze the social cost of carbon is supported by the general requirements of NEPA and federal case law. As explained, NEPA requires agencies to analyze the consequences of proposed agency actions and consider include direct, indirect, and cumulative consequences. In terms of oil and gas leasing, an analysis of site-specific impacts must take place at the lease stage and cannot be deferred until after receiving applications to drill. *See New Mexico ex rel. Richardson v. Bureau of Land Management*, 565 F.3d 683, 717-18 (10th Cir. 2009); *Conner v. Burford,* 848 F.2d 1441 (9th Cir.1988); *Bob Marshall Alliance v. Hodel,* 852 F.2d 1223, 1227
(9th Cir.1988).

To this end, courts have ordered agencies to assess the social cost of carbon pollution, even before a federal protocol for such analysis was adopted. In 2008, the U.S. Court of Appeals for the Ninth Circuit ordered the National Highway Traffic Safety Administration to include a monetized benefit for carbon emissions reductions in an Environmental Assessment prepared under NEPA. *Center for Biological Diversity v. National Highway Traffic Safety Administration*, 538 F.3d 1172, 1203 (9th Cir. 2008). The Highway Traffic Safety Administration had proposed a rule setting corporate average fuel economy standards for light trucks. A number of states and public interest groups challenged the rule for, among other things, failing to monetize the benefits that would accrue from a decision that led to lower carbon dioxide emissions. The Administration had monetized the employment and sales impacts of the proposed action. *Id.* at 1199. The agency argued, however, that valuing the costs of carbon emissions was too uncertain. *Id.* at 1200. The court found this argument to be arbitrary and capricious. *Id.* The court noted that

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while estimates of the value of carbon emissions reductions occupied a wide range of values, the correct value was certainly not zero. *Id.* It further noted that other benefits, while also uncertain, were monetized by the agency. *Id.* at 1202.

More recently, a federal court has done likewise for a federally approved coal lease. That court began its analysis by recognizing that a monetary cost-benefit analysis is not universally required by NEPA. *See High Country Conservation Advocates v. U.S. Forest Service*, 52 F.Supp.3d 1174 (D. Colo. 2014), citing 40 C.F.R. § 1502.23. However, when an agency prepares a cost-benefit analysis, "it cannot be misleading." *Id.* at 1182 (citations omitted). In that case, the NEPA analysis included a quantification of benefits of the project. However, the quantification of the social cost of carbon, although included in earlier analyses, was omitted in the final NEPA analysis. *Id.* at 1196. The agencies then relied on the stated benefits of the project to justify project approval. This, the court explained, was arbitrary and capricious. *Id.* Such approval was based on a NEPA analysis with misleading economic assumptions, an approach long disallowed by courts throughout the country. *Id.*

A recent op-ed in the New York Times from Michael Greenstone, the former chief economist for the President's Council of Economic Advisers, confirms that it is appropriate and acceptable to calculate the social cost of carbon when reviewing whether to approve fossil fuel extraction. *See* Exhibit 7, Greenstone, M., "There's a Formula for Deciding When to Extract Fossil Fuels," *New York Times* (Dec. 1, 2015), available online at http://www.nytimes.com/2015/12/02/upshot/theres-a-formula-for-deciding-when-to-extract-fossil-fuels.html?_r=0.

In light of all this, it appears more than reasonable to have expected the BLM to take into account carbon costs as part of its NEPA analyses. The agency did not. In fact, the BLM did not even address carbon costs in one of its DNAs, DOI-BLM-CO-S010-2015-0039-DNA. In the other DNA, DOI-BLM-CO-S010-2017-0001-DNA, the BLM rejected the notion that a social cost of carbon analysis was appropriate, implicitly concluding that there would be no cost associated with the proposed oil and gas leasing.

In response to comments, the BLM provides various excuses for rejecting addressing the social cost of carbon emissions associated with reasonably foreseeable oil and gas development. Each of these excuses fall flat.

It is first important to point out that the BLM does not deny that social cost of carbon is a valid and useful method to assess climate impacts. Instead, the agency asserts that such an analysis would be "challenging" and "uncertain." DNA 1, Attachment E at Response to Comments #6. However, the BLM does not get to avoid complying with NEPA because an analysis would be challenging or uncertain.

As to the "challenging" nature of the analysis, calculating the social cost of carbon amounts to a simple multiplication equation. Other BLM Field Offices have been able to complete such simple multiplication equations. We understand that multiplication can at times be challenging, but presume that the Tres Rios Field Office staff have acquired the ability to conduct such mathematical exercises

The BLM also confusingly asserts that analyzing social cost of carbon would lead to an "unbalanced" analysis. DNA 1, Attachment E at Response to Comments #6. It is unclear what exactly the agency means in making this statement, but it appears the BLM may be asserting that assessing carbon costs would not lead to what it perceives to be an "apples to apples" assessment of costs and benefits. Putting aside the merits of this argument, it is unclear how rejecting conducting any assessment of carbon costs leads to any more of a "balanced" assessment of costs and benefits. Here, in spite of the BLM's concern over balance, the agency only assesses purported economic "benefits" with no mention at all of any costs. By any measure, the current analysis is not balanced because it only represents one side of a cost-benefit analysis. For BLM to assert that assessing carbon costs would somehow skew the outcome of this already one-sided analysis is difficult, if not impossible, to comprehend.

Even if, as the BLM believes, it would not produce an "apples to apples" type of economic assessment, the costs of carbon are still a relevant consideration in the NEPA process. Particularly given that the social cost of carbon protocol is meant to illustrate economic damages, the relevancy of carbon costs appears unquestionable. Rejecting any and all consideration of carbon costs does not resolve any perceived "imbalance" in the NEPA process, but rather it signals that the BLM did not make a well-informed decision.

The fact that the BLM has, in the context of other oil and gas lease sale environmental analyses, clearly acknowledged that social cost of carbon analyses are appropriate, useful, and possible, the refusal of the agency to similarly undertake such analyses in the current context is unsupported under NEPA and cannot stand to support the decision to offer the aforementioned lease parcels for sale and issuance in February 2017.

Sincerely,

Jeremy Nichols
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Exhibit 1

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Jeremy Nichols <jnichols@wildearthguardians.org>

Comments on the Feb 2017 Tres Rios Oil and Gas Lease Sale

Tim Ream <tream@wildearthguardians.org> Thu, Sep 8, 2016 at 4:42 PM
To: blm_co_trfo_2016_lease_sale@blm.gov
Cc: Jeremy Nichols <jnichols@wildearthguardians.org>

Attached please find comments on the above-listed project. Additional emails are forthcoming with referenced attachments.

TIMOTHY REAM
CLIMATE & ENERGY CAMPAIGN DIRECTOR

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7 attachments

- **CO February 2017 lease EA comments.pdf** 282K
- **Ex. 1 - PublicLandsEmissions-brief.pdf** 289K
- **Ex 1A - Over-leased-Report-EcoShift(1).pdf** 1038K
- **Ex. 2 - nepa_revised_draft_ghg_guidance_searchable.pdf** 451K
- **Ex 2A - CEQ final NEPA climate guidance.pdf** 427K
- **Ex. 3 - UT May15 lease EA comments.pdf** 1439K
- **Ex. 4 - Pawnee Oil and Gas DEIS.pdf** 9845K

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Jeremy Nichols <jnichols@wildearthguardians.org>

Comments on the Feb 2017 Tres Rios Oil and Gas Lease Sale

Tim Ream <tream@wildearthguardians.org> Thu, Sep 8, 2016 at 4:55 PM
To: cclementson@blm.gov
Cc: Jeremy Nichols <jnichols@wildearthguardians.org>

Attached please find comments on the above-listed project. Additional emails are forthcoming with referenced attachments.

TIMOTHY REAM
CLIMATE & ENERGY CAMPAIGN DIRECTOR

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Follow @ourcarbon

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www.wildearthguardians.org

Before the revolution, everyone says it's impossible. After the revolution, everyone says it was inevitable.

Keep It in the Ground!

7 attachments

- **CO February 2017 lease EA comments.pdf** 283K
- **Ex. 1 - PublicLandsEmissions-brief.pdf** 289K
- **Ex 1A - Over-leased-Report-EcoShift(1).pdf** 1038K
- **Ex. 2 - nepa_revised_draft_ghg_guidance_searchable.pdf** 451K
- **Ex 2A - CEQ final NEPA climate guidance.pdf** 427K
- **Ex. 3 - UT May15 lease EA comments.pdf** 1439K
- **Ex. 4 - Pawnee Oil and Gas DEIS.pdf** 9845K

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Exhibit 2

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Exhibit 2

U.S. Department of the Interior
Bureau of Land Management

Environmental Assessment

November 2016 Competitive Oil and Gas Lease Sale
DOI-BLM-UT-G010-2016-033-EA

October 14, 2016

PREPARING OFFICE

U.S. Department of the Interior
Bureau of Land Management
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Environmental Assessment
November 2016 Competitive Oil and Gas Lease Sale
DOI-BLM-UT-G010-2016-033-EA

Prepared by
U.S. Department of the Interior
Bureau of Land Management

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October 14, 2016

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Chapter 1. Introduction

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1.1. Identifying Information:

1.1.1. Title, EA number, and type of project:

November 2016 Competitive Oil and Gas Lease Sale

DOI-BLM-UT-G010-2016-0033-EA

1.1.2. Location of Proposed Action:

See Appendix A for legal descriptions of Lease Parcels and Appendix B for a Map of the Lease Parcels

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1.2. Introduction:

The Bureau of Land Management (BLM) has prepared this environmental assessment (EA) to disclose and analyze the environmental consequences of the sale of 28 proposed parcels during the November 2016 oil and gas lease sale and subsequent potential development. The EA is an analysis of potential impacts that could result from the implementation of a proposed action or alternatives to the proposed action. The EA assists the BLM in project planning and ensuring compliance with the National Environmental Policy Act (NEPA), and in making a determination as to whether any significant impacts could result from the analyzed actions. *Significance* is defined by NEPA and is found in regulation 40 CFR 1508.27. An EA provides evidence for determining whether to prepare an Environmental Impact Statement (EIS) or a statement of Finding of No Significant Impact (FONSI). A FONSI statement documents the reasons why implementation of the selected alternative would not result in significant environmental impacts (effects) beyond those already addressed in the Vernal Field Office Resource Management Plan (VFO RMP) [BLM 2008b] EIS's listed in Section 1.7.1, "FEISs " If the decision maker determines that this project has significant impacts following the analysis in the EA, then an EIS would be prepared for the project. If not, a Decision Record may be signed for the EA approving the selected alternative, whether the proposed action or another alternative.

1.3. Background

In general, the BLM Utah State Office (USO) conducts a quarterly competitive lease sale to sell available oil and gas lease parcels in the state. In the process of preparing a lease sale the BLM USO compiles a list of lands nominated and legally available for leasing, and sends a parcel list to the appropriate Field Office where the parcels are located, in this case the Vernal Field Office (VFO). VFO staff then:

- reviews and verifies that the parcels are in conformance with the VFO RMP [BLM 2008b] as being available for leasing;
- reviews any new information that has become available;
- assesses any circumstances that have changed to determine what level of analysis is required;

- attaches appropriate stipulations and notices;
- conducts appropriate consultations;
- completes site visits;
- and identifies any special resource conditions for potential bidders.

The Field Office then either determines that existing analyses provides an adequate basis for making a decision or that additional analysis is needed before making a leasing recommendation.

Initially 102 Parcels were sent to the VFO for consideration for the 2016 lease sale. (Additional information is available on the oil and gas leasing webpage.)[1] The VFO reviewed those 102 preliminary parcels, and deferred 74 full parcels and 5 partial parcels from consideration for the November 2016 lease sale due to issues related to workforce limitations and competing workload priorities, white-tailed prairie dog habitat, Greater Sage-Grouse habitat, Yellow-billed Cuckoo habitat, pending analysis of new information related to lands with wilderness characteristics inventories, pending legislative actions and State Director discretion.

The surface rights for most of the 28 parcels considered in the EA are managed by the Bureau of Land Management and administered by the VFO with smaller portions owned by other Federal, State and private entities. (see Appendix A, November 2016 Preliminary Oil and Gas Lease Sale List; and Appendix B, Maps). Appendix A provides the surface ownership, legal descriptions and acreages by the parcel identification number. The 28 parcels encompass a total of 12,224.48 acres.

An EA is being used to determine whether leasing the remaining parcels would result in significant impacts beyond those disclosed in the EISs listed in Section 1.7.1.Section 1.7.1, "FEISs " The EA and unsigned FONSI are made available to the public for a 30-day public comment period on the BLM ePlanning Website.[2] After analyzing and incorporating all substantive comments received during the public comment period, changes to the document and/or lease parcels list are made if necessary. The EA and unsigned FONSI are released again with an updated parcel list including applicable lease stipulations and notices through a Notice of Competitive Lease Sale which initiates a 30-day protest period.

1.4. Purpose and Need

The need for the sale is to respond to the public's lease nomination requests. Offering parcels for competitive oil and gas leasing provides for the orderly development of fluid mineral resources under BLM's jurisdiction in a manner consistent with multiple use management and environmental consideration for the resources that may be present. The purpose of the lease sale review process is to ensure that adequate provisions are included in the lease terms, notices and stipulations to protect public health and safety, ensure the project conforms with the land use plan, and ensure full compliance with the objectives of NEPA and other federal environmental laws and regulations designed to protect the environment, and comply with the BLM's multiple use management for public lands. The sale and development of oil and gas leases is needed to meet the energy needs of the United States public. The BLM is required by law to review areas that have been nominated for oil and gas leasing. Oil and gas leasing is a principal use of the public lands as identified in Section 102(a)(12), 103(1) of the Federal Land Policy and Management

[1]http://www.blm.gov/ut/st/en/prog/energy/oil_and_gas/oil_and_gas_lease.html
[2]http://www.blm.gov/pgdata/content/wo/en/prog/planning/planning_overview/eplanning2.html

Act of 1976 (FLPMA), and it is conducted to meet requirements of the Mineral Leasing Act of 1920, as amended, the Mining and Minerals Policy Act of 1970, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987 (Reform Act). Leases would be issued pursuant to 43 CFR subpart 3100.

1.5. Conformance with BLM Land Use Plan

The Proposed Action described below is in conformance with VFO RMP, and the Record of Decision and Approved Resource Management Plan Amendments for the Great Basin Region, including the Greater Sage-Grouse Sub-Regions of Idaho and Southwestern Montana, Nevada and Northeastern California, Oregon and Utah [BLM 2015], as amended in 2015, because they are specifically provided for in the planning decision(s). More specifically, the proposed Action is in conformance with the following decisions from the VFO RMP:

- The Record of Decision for the VFO RMP decisions MIN 6 – MIN 14 (pages 98-99) identifies those specific lands within the Vernal Field Office that are available for leasing as illustrated on its corresponding Oil and Gas Leasing map (Figure 8a in VFO RMP).
- Appendices; K (Surface Stipulations to all Surface Disturbing Activities), L (Utah's T&E and Special Status Species Lease Notices for Oil and Gas and BLM Committed Measures) and R (Fluid Mineral Best Management Practices) of the Vernal RMP Record of Decision contain pertinent stipulations, lease notices and committed measures.

It is also consistent with VFO RMP decisions and their corresponding goals and objectives related to the management of (including but not limited to) air quality, cultural resources, recreation, riparian, soils, water, vegetation, fish & wildlife and Areas of Critical Environmental Concern (ACEC).

Standard lease terms provide for reasonable measures to minimize adverse impacts to specific resource values, land uses, or users (Standard Lease Terms are contained in Form 3100-11, Offer to Lease and Lease for Oil and Gas, U.S. Department of the Interior, BLM, October 2008 or later edition). Compliance with valid, nondiscretionary statutes (laws) is included in the standard lease terms. Nondiscretionary actions include the BLM's requirements under federal environmental protection laws, such as the Clean Water Act, Clean Air Act, Endangered Species Act, National Historic Preservation Act, and Federal Land Policy Management Act, which are applicable to all actions on federal lands.

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Once the lease has been issued, the lessee has the right to use as much of the leased land as necessary to explore for, drill for, extract, remove, and dispose of oil and gas deposits located under the leased lands, subject to the standard lease terms and additional restrictions attached to the lease in the form of lease stipulations. Even if no restrictions are attached to the lease, the operations must be conducted in a manner that prevents unnecessary or undue degradation of the public lands and minimizes adverse impacts to the land, air, water, cultural, biological, and visual elements of the environment, as well as other land uses or users. Also included in all leases are two mandatory stipulations for the statutory protection of cultural resources (BLM Washington Office Instruction Memorandum No. 2005-03, Cultural Resources and Tribal Consultation for Fluid Minerals Leasing) and threatened or endangered species mandatory stipulation (BLM Washington Office Instruction Memorandum No. 2002-174, Endangered Species Act Section 7 Consultation), which are described in Sections 4.1.1.5 and 4.1.1.11, respectively. BLM would also encourage industry to consider participating in EPA's Natural Gas STAR program under all alternatives. The

program is a flexible, voluntary partnership wherein EPA works with companies that produce, process, transmit and distribute natural gas to identify and promote the implementation of cost-effective technologies and practices to reduce emissions of methane, a greenhouse gas.

1.6. Relationship to Statues, Regulations, or Other Plans

The proposed action is consistent with federal environmental laws and regulations, Executive Orders, Department of Interior, and BLM policies and is in compliance, to the maximum extent possible, with state laws and local and county ordinances and plans, including the following:

- Title V of the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2776, 43 U.S.C. 1761) and the regulations issued there under at 43 Code of Federal Regulations, part 2800.
- Taylor Grazing Act (1934), as amended.
- Utah Standards and Guidelines for Rangeland Health. (1997)
- BLM Utah Riparian Management Policy. (2005)
- Section 106 of the National Historic Preservation Act of 1966, as amended and associated regulations at 36 CFR Part 800.
- Bald and Golden Eagle Protection Act of 1962.
- Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended.
- BLM Manual 6840- Special Status Species Management.
- Migratory Bird Treaty Act. (1918)
- Utah Partners in Flight Avian Conservation Strategy Version 2.0.
- Birds of Conservation Concern 2002.
- Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds.
- MOU between the USDI BLM and USFWS to Promote the Conservation and Management of Migratory Birds. (4/2010)
- Protection of Ground Water Associated with Oil and Gas Leasing, Exploration and Development. (BLM UT IM 2010–055)
- Oil and Gas Adjudication Handbook—Competitive Leases. (Handbook H-3120-1 - Competitive Leases (P))
- MOU Among the USDA, USDI and EPA Regarding Air Quality Analysis and Mitigation for Federal Oil and Gas Decisions Through the NEPA Process. (2011)
- BLM Manual 6310 - Conducting Wilderness Characteristics Inventory of BLM Lands.
- BLM Manual 6320 - Considering Lands with Wilderness Characteristics in the BLM Land Use Planning Process.

- BLM Manual 8100 - The Foundations for Managing Cultural Resources.
- Vernal Field Office Surface Disturbance Weed Policy IM-UT-G010-10-001.
- Utah Greater Sage-Grouse Proposed Land Use Management Plan Amendment and Final Environmental Impact Statement (FEIS)[BLM 2015]
- The Utah Greater Sage-Grouse Approved Resource Management Plan Amendment (GRSG ARMPA)
- Record of Decision and Approved Resource Management Plan Amendments for the Great Basin Region, Including the Greater Sage-Grouse Sub-Regions of Idaho and Southwestern Montana, Nevada and Northeastern California, Oregon and Utah (GRSG ROD)

The attached Interdisciplinary Team Checklist, Appendix C, was developed after consideration of these laws, ordinances, policies and plans.

1.7. Documents Incorporated by Reference:

In order to reduce redundant paperwork and analysis in the NEPA process (*See* 40 CFR §§ 1502.20 and 1502.21) the following documents and their associated information or analysis are hereby incorporated by reference.

1.7.1. FEISs

- Vernal Field Office Final Environmental Impact Statement (FEIS) and Resource Management Plan (RMP) [BLM 2008a] and Record of Decision
- Utah Greater Sage-Grouse Proposed Land Use Management Plan Amendment and Final Environmental Impact Statement (FEIS)[BLM 2015]
- Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement [BLM 2007] and Record of Decision.
- Final EIS West Tavaputs Plateau Natural Gas Full Field Development Plan, UT-070-05-055 July 2010

1.7.2. Other Documents

- Greater Uinta Basin Oil and Gas Cumulative Impacts Technical Support Document [BLM 2012b]

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1.8. Identification of Issues:

The proposed action was reviewed by an interdisciplinary team composed of resource specialists from the Vernal Field Office. The interdisciplinary team conducted Literature review, GIS review and site visits to validate existing data and gather new information in order to make an informed leasing recommendation from March to May 2016. The results of the interdisciplinary team review are contained in the Interdisciplinary Team Checklist, Appendix C. February 2016 letters or memorandum were sent, to the National Park Service, United States Fish and Wildlife Service,

United States Forest Service, and State of Utah's Public Lands Policy Coordination Office, Division of Wildlife Resources (DWR) and School and Institutional Trust Lands Administration to provide notice of the lease sale. The letters included parcel location descriptions and an invitation to attend the interdisciplinary team parcel site visits.

Public notification was initiated by entering the project information on the BLM ePlanning NEPA Register (https://www.blm.gov/epl-front-office/eplanning) on March 23, 2016. Additional information for the public is maintained on the Utah BLM Oil and Gas Leasing Webpage (http://www.blm.gov/ut/st/en/prog/energy/oil_and_gas/oil_and_gas

Letters were sent to the surface owners of the split estate parcels to solicit their comments and concerns about the pending lease sale.

As a result of this coordination and scoping to solicit issues and concerns, comments were received from agencies, groups, and individuals. The commenters raised the resource issues of concern, which are listed in Chapter 5 and in Appendix E.

The Utah Division of Wildlife Resources (UDWR) provided recommendations regarding wildlife species and habitat and resulted in the addition of lease notices to multiple parcels. Scoping comments were considered by resource specialists when making their impact determination for the ID team checklist. No comments identified an alternative other than the Proposed Action or no action.

All of the issues raised were considered during the internal Interdisciplinary Team review.

1.9. Summary

This chapter has presented the purpose and need of the proposed project. In order to meet the purpose and need of the proposed project in a way that resolves potential issues, the BLM has considered and/or developed two alternatives. These alternatives are presented in Chapter 2. The potential environmental impacts or consequences resulting from the implementation of each alternative considered in detail are analyzed in Chapter 4 for each of the identified issues.

Chapter 2. Proposed Action and Alternatives

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2.1. Description of Alternatives Analyzed in Detail

This environmental assessment focuses on the Proposed Action and No Action alternatives. Other alternatives were not considered in detail because the issues identified during scoping did not indicate a need for additional alternatives or mitigation beyond those contained in the Proposed Action. The No Action alternative is considered and analyzed to provide a baseline for comparison of the impacts of the Proposed Action.

2.2. Alternative A-Proposed Action

Under Alternative A, 28 of the 102 parcels (12,224.48 total acres) would be offered for lease at the November 2016 competitive Oil and Gas Lease Sale, to be held by the Utah BLM State Office at a location designated by the Utah State Office before the Lease Sale. These parcels would be offered for lease subject to the applicable laws and regulations, the standard lease terms contained in BLM Form 3100-11 (Offer to Lease and Lease for Oil and Gas, October 2008), and the additional resource protection measures attached consistent with the VFO RMP [BLM 2008b]. Legal descriptions of and stipulations and notices attached to each parcel can be found in Appendix A, and a map of the parcels can be found in Appendix B.

Leasing is an administrative action that affects economic conditions but does not directly cause environmental consequences. However, leasing is considered to be an irretrievable commitment of resources because the BLM generally cannot deny all surface use of a lease unless the lease is issued with a No Surface Occupancy stipulation. Potential oil and gas exploration and production activities, committed to in a lease sale, could impact resources and uses in the planning area. Direct, indirect or cumulative effects to resources and uses could result from as yet undetermined and uncertain future levels of lease exploration or development.

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Although at this time it is unknown when, where, or if future well sites or roads might be proposed on any leased parcel, should a lease be issued site specific analysis of individual wells or roads would occur when a lease holder submits an Application for Permit to Drill (APD). The Reasonably Foreseeable Development (RFD) scenario serves as an analytical baseline for identifying and quantifying direct, indirect, and cumulative effects of oil and gas activity and forms the foundation for the analysis of the effects of oil and gas management decisions in planning and environmental documents. It is assumed that each lease sold would have at least one well pad developed and that those well pads, including all associated infrastructure, would disturb an estimated 4 acres. With 28 proposed leases the estimated surface disturbance would be 116 acres.

Several parcels are located in areas identified by the Vernal Field Office RMP/ROD [BLM 2008b] as "No Surface Occupancy" (NSO) with no exceptions, waivers, or modifications. Access to the minerals within the lease would have to occur from the BLM-managed, private, and State lands adjacent to these parcels. As with on-lease development, an APD, would be submitted to the BLM. Any connected actions (see BLM NEPA Handbook H-1701-1 p. 45) associated with the APD would be subject to the requirements of certain laws and regulations including NEPA, the National Historic Preservation Act, and the Endangered Species Act, and would not be approved until those requirements had been met.

Parcels 032, 067, 151, and 152 are within existing Oil and Gas Units, and surrounded by existing Oil and Gas leases. If leased, lessees would be required to join a unit and leases would be

developed in accordance with lease stipulations. (See Appendix A for Unit stipulations and Appendix G for Oil and Gas Unit maps)

2.2.1. Well Pad and Road Construction

Equipment for well pad construction would consist of dozers, scrapers, and graders. Topsoil from each well pad would be stripped to a maximum depth of six inches and stockpiled for future reclamation. Disturbance for each well pad would be estimated at an area of approximately 350 feet by 250 feet (~2 acres of land), including topsoil piles. For this analysis, it was assumed that disturbance for well pads could be as high as 4 acres per well to account for any infrastructure (e.g., roads) that would be required if the wells were to go into production (see below).

It is anticipated that new or upgraded access roads would be required to access well pads and maintain production facilities. Construction of new roads or upgrades to existing roads would require a 30-foot construction width and would be constructed of native material. Any new roads constructed for the purposes of oil and gas development would be utilized year-round for maintenance of the proposed wells and other facilities, and for the transportation of fluids and/or equipment, and would remain open to other land users. The type of equipment required for these activities would be the same as that needed for well pad construction. It is not possible to determine the distance of road that would be required because the location of the wells would not be known until the APD stage. However, for purposes of analysis it is assumed that disturbance from access roads would be approximately 1.8 acres of disturbance for each well pad (0.5 mile of road/well pad).

2.2.2. Drilling and Completion Operations

Once construction or expansion of an individual well pad is completed, drilling equipment would be moved onto the new well pad. It is assumed that wells would be drilled utilizing a conventional, mechanically-powered mobile drilling rig. The exact type and size of drilling rig would be dependent upon rig availability at the time of project implementation. Drilling operations would consist of drilling the hole, running and cementing intermediate casing, drilling the production hole, and running and cementing production casing. Water required for the drilling and completion of the proposed gas wells would be hauled by truck from a combination of the permitted water sources. It is estimated that approximately 3 acre-feet of water would be needed for the drilling and completion of one well. For the purposes of this document it is assumed that the water would be obtained from a fresh water source that would be depleting to the Colorado River System.

The casing and cementing program would be designed to isolate and protect the shallower formations, especially usable ground water, encountered in the well bore as directed by BLM Utah Instruction Memorandum 2010-055 and to prohibit pressure communication or fluid migration between zones. The cement would protect the well by preventing formation pressure from damaging the casing, and by retarding corrosion by minimizing contact between the casing and formation fluids. The type of casing used and the depth to which it is set would depend upon the physical characteristics of the formations that are drilled. Site-specific descriptions of drilling procedures would be included in the APD and the COAs for each well.

If testing indicates economic potential, completion operations would set production casing to the total drilled depth, perforate the casing in target production zones, and hydraulically fracture (fracking) the productive formation under high pressure. The fracking material would likely

contain sand or other proppant material to keep the fractures open, thereby allowing hydrocarbons to flow more freely into the casing. The next phase would be to flow and test the well to determine rates of production.

2.2.3. Hydraulic Fracturing

Hydraulic fracturing (HF) is a well stimulation technique used to increase oil and gas production from underground rock formations. As a result, HF would be evaluated at the APD stage should the lease parcel be sold/issued, and a development proposal submitted. The following paragraphs provide a general discussion of the HF process that could potentially be implemented if development were to occur, including well construction information and general conditions encountered within the VFO.

HF involves the injection of fluids through a wellbore under pressures great enough to fracture the oil and gas producing formations. The fluid is generally comprised of a liquid such as oil, carbon-dioxide or nitrogen, and proppant (commonly sand or ceramic beads), and a minor percentage of chemicals to give the fluid desirable flow characteristics, corrosion inhibition, etc. Water based gel is commonly used in the VFO area. The proppant holds open the newly created fractures after the injection pressure is released. Oil and gas flow through the fractures and up the production well to the surface.

HF has been used by oil and natural gas producers since the late 1940s and, for the first 50 years, was mostly used in vertical wells in conventional formations. HF is still used in these settings, but the process has evolved. Technological developments (including horizontal drilling) have led to the use of HF in "unconventional" hydrocarbon formations that could not otherwise be profitably produced.

The use of horizontal drilling through unconventional reservoirs combined with high-volume water based multi-stage HF activities has led to an increase in oil and gas activity in several areas of the country which has, in turn, resulted in a dramatic increase in domestic oil and gas production nationally.

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2.2.4. Production Operations

If wells were to go into production, facilities could be located at the well pad or off location and typically include a well head, a dehydrator/separator unit, and storage tanks for produced fluids. The production facility would typically consist of two storage tanks, a truck load-out, separator, and dehydrator facilities. Oil wells will also have a pump jack on the well head. Construction of the production facility would be located on the well pad and not result in any additional surface disturbance.

All permanent surface structures would be painted a flat, non-reflective color (e.g., juniper green, Carlsbad Canyon, Shadow Gray) specified by the BLM in order to blend with the colors of the surrounding natural environment. Facilities that are required to comply with the Occupational Safety and Health Act (OSHA) would be excluded from painting color requirements. All surface facilities would be painted immediately after installation and under the direction and approval of the BLM.

If oil is produced, the oil would be stored on location in tanks and the majority transported by truck to a refinery with a smaller portion being transported by pipeline. The volume of tanker

truck traffic for oil production would be dependent upon production of the wells, however, it is estimated oil would be transported to a Salt Lake City refinery at least once a week, using 280-barrel tanker trucks.

If natural gas is produced, construction of a gas pipeline would be necessary to transport the gas. An additional Sundry Notice, right of way (ROW) and NEPA analysis would be completed, as needed, for any pipelines and/or other production facilities across public lands if not included in the original APD. BLM Best Management Practices (BMPs), such as burying the pipeline or installing the pipeline within the road, would be considered at the time of the proposal. For the purpose of this EA, it is assumed that 0.5 mile of pipeline would be installed within the 30-foot road width per well pad.

All operations would be conducted following the "Gold Book" Surface Operating Standards for Oil and Gas Exploration and Development. The Gold Book was developed to assist operators by providing information on the requirements for conducting environmentally responsible oil and gas operations on federal lands. The Gold Book provides operators with a combination of guidance and standards for ensuring compliance with agency policies and operating requirements, such as those found at 43 CFR 3000 and 36 CFR 228 Subpart E; Onshore Oil and Gas Orders (Onshore Orders); and Notices to Lessees. Included in the Gold Book are environmental BMPs; these measures are designed to provide for safe and efficient operations while minimizing undesirable impacts to the environment.

Periodically, a workover or recompletion on a well may be required to ensure that efficient production is maintained. Workovers can include repairs to the well bore equipment (casing, tubing, rods, or pump), the wellhead, or the production facilities. These repairs would usually be completed in 7 days per well, during daylight hours. The frequency for this type of work cannot be accurately projected because workovers vary by well; however, an average work time may be one workover per well per year after about 5 years of production. In the case of a recompletion, where the wellbore casing is worked on or valves and fittings are replaced to stimulate production, all by-products would be stored in tanks and hauled from the location. For workover operations, it may be necessary to rework the surface location to accommodate equipment. At the completion of the work, the surface location would be re-graded and reclaimed to pre-existing conditions.

Exploration and development on split-estate lands is also addressed in the Gold Book, along with IM 2003-131, Permitting Oil and Gas on Split-Estate Lands and Guidance for Onshore Oil and Gas Order No. 1, and IM 2007-165, Split-Estate Report to Congress – Implementation of Fluid Mineral Leasing and Land Use Planning Recommendations. Proper planning and consultation, along with the proactive incorporation of these BMPs into the APD Surface Use Plan of Operations by the operator typically result in a more efficient APD and environmental review process, increased operating efficiency, reduced long-term operating costs, reduced final reclamation needs, and less impact to the environment.

2.2.5. Interim Reclamation

All fluids in the reserve pit would be allowed to dry prior to reclamation work. After fluids have evaporated from the reserve pit, sub-soil would be backfilled and compacted within 90 days. If the fluids within the reserve pit have not evaporated within 90 days (weather permitting or within one evaporation cycle i.e. one summer), the fluid would be pumped from the pit and disposed of in accordance with Utah Guidance for Management of Oil and Gas Exploration and Production Pits (IB No. UT 2013–038). Portions of the well pad not needed for production of the

proposed well, including the reserve pit, would be recontoured, and topsoil would be replaced, scarified, and seeded. The 30-foot road construction width would be reclaimed to an 18-foot wide crowned running surface plus drainage ditches. The topsoil would be spread over the interim reclamation area, seeded, left in place for the life of the well, and then used during the final reclamation process. Reclaimed land would be seeded with a mixture (certified weed free) and rate as recommended or required by the BLM.

2.2.6. Produced Water Handling

Water is often associated with either produced oil or natural gas. Water is separated out of the production stream and can be temporarily stored in the reserve pit for 90 days. Permanent disposal options include discharge to evaporation pits or underground injection. Handling of produced water is addressed in Onshore Oil and Gas Order No. 7.

2.2.7. Maintenance Operations

Traffic volumes during production would be dependent upon whether the wells produced natural gas and/or oil, and for the latter, the volume of oil and/or water produced.

Well maintenance operations may include periodic use of work-over rigs and heavy trucks for hauling equipment to the producing well, and would include inspections of the well by a pumper on a regular basis or by remote sensing. The road and the well pad would be maintained for reasonable access and working conditions.

2.2.8. Plugging and Abandonment

If the well does not produce economic quantities of oil or gas, or when it is no longer commercially productive, the well would be plugged and abandoned. Newly drilled wells would be plugged and abandoned following procedures contained in Onshore Order No. 2 as approved by a BLM Authorized Officer after review by a Petroleum Engineer and Geologist, which would include requiring cement plugs at strategic positions in the well bore. All well pads with BLM managed surface would be reclaimed according to the standards established in the Green River District Reclamation Guidelines.

2.3. Alternative B – No Action

Under the No Action alternative none of the nominated parcels would be offered for sale. No oil and gas exploration and development activity associated with this lease sale would occur.

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Chapter 3. Affected Environment:

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This chapter presents the potentially affected existing environment (i.e., the physical, biological, social, and economic values and resources) of the impact area as identified in the Interdisciplinary Team Checklist found in Appendix C. This chapter provides the baseline for comparison of impacts/consequences described in Chapter 4. Only those aspects of the affected environment that are potentially impacted are described in detail (see Appendix C).

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3.1. Resources/Issues Brought Forward for Analysis

3.1.1. Air Quality

The Project Area is located in the Uinta Basin, a semiarid, mid-continental climate regime typified by dry, windy conditions, limited precipitation and wide seasonal temperature variations subject to abundant sunshine and rapid nighttime cooling. The Uinta Basin is designated as unclassified/attainment by the EPA under the Clean Air Act. This classification indicates that the concentration of criteria pollutants in the ambient air is below National Ambient Air Quality Standards (NAAQS), or that adequate air monitoring is not available to determine attainment.

NAAQS are standards that have been set for the purpose of protecting human health and welfare with an adequate margin of safety. Pollutants for which standards have been set include ground level ozone, (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM_{10}) or 2.5 microns in diameter ($PM_{2.5}$). Airborne particulate matter consists of tiny coarse-mode (PM_{10}) or fine-mode ($PM_{2.5}$) particles or aerosols combined with dust, dirt, smoke, and liquid droplets. $PM_{2.5}$is derived primarily from the incomplete combustion of fuel sources and secondarily formed aerosols, whereas PM_{10} is primarily from crushing, grinding, or abrasion of surfaces. Table 3.1, "Air Quality Regulatory Backgrounds for the Uinta Basin" lists ambient air quality background values for the Uinta Basin and NAAQS standards.

Table 3.1. Air Quality Regulatory Backgrounds for the Uinta Basin

Pollutant	Averaging Period(s)	Uinta Basin Background Concentration (µg/m³)	NAAQS (µg/m³)
SO_2	Annual 24-hour 3-hour 1–hour	0.8[2] 3.9[2] 10.1[2] 19.0[2]	--[1] --[1] 1,300 197
NO_2	Annual 1–hour	17 8.1[3] (2010), 60.2[3] (2011)	100 188
PM_{10}	Annual 24-hour	7.0[4] 16.0[4]	--[6] 150
$PM_{2.5}$	Annual 24-hour	9.4[3] 17.8[3]	15 35
CO CO	8-hour 1-hour	3,450[4] 6,325[4]	10,000 40,000

Pollutant	Averaging Period(s)	Uinta Basin Background Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
O_3	8-hour	100.0[3,5]	70
1 – The 24-hour and annual SO_2 NAAQS have been revoked by USEPA. 2 – Based on 2009 data from Wamsutter Monitoring Station Data (USEPA AQS Database). 3 – Based on 2010/2011 data from Redwash Monitoring Station (USEPA AQS Database). 4 – Based on 2006 data disclosed in the Greater Natural Buttes FEIS. [BLM 2012a]. 5 – Ozone is measured in parts per billion (ppb) 6 – The annual PM_{10} NAAQS has been revoked by USEPA.			

Existing point and area sources of air pollution within the Uinta Basin include the following:

- Exhaust emissions (primarily CO, NO_x, $PM_{2.5}$, and HAPs) from existing natural gas fired compressor engines used in transportation of natural gas in pipelines;
- Natural gas dehydrator still-vent emissions of CO, NO_x, $PM_{2.5}$, and HAPs;
- Gasoline and diesel-fueled vehicle tailpipe emissions of VOCs, NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$;
- Oxides of sulfur (SO_x), NO_x, fugitive dust emissions from coal-fired power plants, and coal mining/ processing;
- Fugitive dust (in the form of PM_{10} and $PM_{2.5}$) from vehicle traffic on unpaved roads, wind erosion in areas of soil disturbance, and road sanding during winter months; and,
- Long-range transport of pollutants from distant sources.

Two year-round air quality monitoring sites were established in summer 2009 near Red Wash (southeast of Vernal, Utah) and Ouray (southwest of Vernal). These monitors were certified as Federal Reference Monitors in fall of 2011, which means they can be used to make a NAAQS compliance determination. The complete EPA Ouray and Redwash monitoring data can be found at: http://www.epa.gov/airexplorer/index.htm

Both monitoring sites have recorded numerous exceedances of the 8-hour ozone standard during the winter months (January through March 2010, 2011, 2013, and 2014). It is thought that high concentrations of ozone are being formed under a "cold pool" process. This process occurs when stagnate air conditions form with very low mixing heights under clear skies, with snow-covered ground, and abundant sunlight. These conditions, combined with area precursor emissions (NO_x and VOCs), can create intense episodes of ozone. The high numbers did not occur in January through March 2012 due to a lack of snow cover. This phenomenon has also been observed in similar locations in Wyoming. Winter ozone formation is a newly recognized issue, and the methods of analyzing and managing this problem are still being developed. Existing photochemical models are currently unable to reliably replicate winter ozone formation. This is due to the very low mixing heights associated with unique meteorology of the ambient conditions. Further research is needed to definitively identify ozone precursor sources that contribute to observed ozone concentrations.

The UDAQ conducted limited monitoring of $PM_{2.5}$ in Vernal, Utah in December 2006. During the 2006-2007 winter seasons, $PM_{2.5}$ levels were higher than the $PM_{2.5}$ health standards that became effective in December 2006. The $PM_{2.5}$ levels recorded in Vernal were similar to other areas in northern Utah that experience wintertime inversions. The most likely causes of elevated $PM_{2.5}$ at the Vernal monitoring station are those common to other areas of the western U.S. (combustion

and dust) plus nitrates and organics from oil and gas activities in the Basin. $PM_{2.5}$ monitoring that has been conducted in the vicinity of oil and gas operations in the Uinta Basin by the Red Wash and Ouray monitors beginning in summer 2009 have not recorded any exceedances of either the 24 hour or annual NAAQS.

HAPs are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental impacts. The EPA has classified 187 air pollutants as HAPs. Examples of listed HAPs associated with the oil and gas industry include formaldehyde, benzene, toluene, ethyl benzene, isomers of xylene (BTEX) compounds, and normal-hexane (n-hexane). There are no applicable Federal or State of Utah ambient air quality standards for assessing potential HAP impacts to human health.

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3.1.1.1. Greenhouse Gases and Climate Change

"Climate change" refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. "Global warming" refers to the recent and ongoing rise in global average temperature near Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change. Climate is both a driving force and limiting factor for ecological, biological, and hydrological processes, and has great potential to influence resource management.

As explained in CEQ's recent guidance on the consideration of GHG emissions and climate change in NEPA review, climate change science continues to expand and refine our understanding of the impacts of anthropogenic GHG emissions [CEQ 2016]. CEQ's first Annual Report in 1970 referenced climate change, indicating that "[m]an may be changing his weather." It is now well established that rising global atmospheric GHG emission concentrations are significantly affecting the Earth's climate. These conclusions are built upon a scientific record that has been created with substantial contributions from the United States Global Change Research Program (USGCRP).[1] Studies have projected the effects of increasing GHGs on many resources normally discussed in the NEPA process, including water availability, ocean acidity, sea-level rise, ecosystem functions, energy production, agriculture and food security, air quality and human health.

Based primarily on the scientific assessments of the USGCRP, the National Research Council, and the Intergovernmental Panel on Climate Change (IPCC), in 2009 the Environmental Protection Agency (EPA) issued a finding that the changes in our climate caused by elevated concentrations of greenhouse gases in the atmosphere are reasonably anticipated to endanger the public health and public welfare of current and future generations. In 2015, EPA acknowledged more recent scientific assessments that "highlight the urgency of addressing the rising concentration of CO_2 in the atmosphere," finding that certain groups are especially vulnerable to climate-related effects. Broadly stated, the effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, ocean acidification, and harm to wildlife and ecosystems.

[1] *See* Global Change Research Act of 1990, Pub. L. 101–606, Sec. 103 (November 16, 1990). For additional information on the USCGCRP, visit http://www.globalchange.gov.

Consistent with CEQ's guidance, this EA includes a qualitative and quantitative analysis of possible greenhouse gas emissions that could occur as a result of reasonably foreseeable oil and gas development associated with the parcels being offered for lease. Additional information about potential emissions would also be available and calculated as part of subsequent site-specific reviews at the APD stage.

It is accepted within the scientific community that global temperatures have risen at an increased rate and the likely cause is gases that trap heat in the atmosphere, referred to as greenhouse gases (GHG). GHGs are composed mostly of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), water vapor, and ozone. The greenhouse gas effect is the process in which the radiation from the sun that heats the surface of Earth gets blocked by GHG molecules in Earth's atmosphere. Since GHGs are composed of molecules that absorb and emit infrared electromagnetic radiation (heat), they form an intrinsic part of the greenhouse effect.

Greenhouse gases are often presented using the unit of Metric Tons of CO_2 equivalent (MT CO_2e) or Million Metric Tons (MMT CO_2e), a metric to express the impact of each different greenhouse gas in terms of the amount of CO_2 making it possible to express greenhouse gases as a single number. For example, 1 ton of methane would be equal to 25 tons of CO_2 equivalent, because it has a global warming potential (GWP) 25 times that of CO_2 [The Guardian 2011].

As defined by EPA, the GWP provides "ratio of the time-integrated radiative forcing from the instantaneous release of one kilogram of a trace substance relative to that of one kilogram of CO_2." The GWP of greenhouse gas is used to compare global impacts of different gases and used specifically to measure how much energy the emissions of one ton of gas will absorb over a given period of time (e.g. 100 years), relative to the emissions of one ton of CO_2. The GWP accounts for the intensity of each GHG's heat trapping effect and its longevity in the atmosphere. The GWP provides a method to quantify the cumulative effects of multiple GHGs released into the atmosphere by calculating carbon dioxide equivalent for the GHGs.

- Carbon dioxide (CO_2), by definition, has a GWP of 1 regardless of the time period used because it is the gas being used as the reference. CO_2 remains in the climate system for a very long time; CO_2 emissions cause increases in the atmospheric concentrations of CO_2 that will last thousands of years [EPA 2016a].

- Methane (CH_4) is estimated to have a GWP of 28-36 times that of CO_2 over 100 years. CH_4 emitted today lasts about a decade on average, which is much less time than CO_2. But CH_4 also absorbs much more energy than CO_2. The net effect of the shorter lifetime and higher energy absorption is reflected in the GWP. The methane GWP also accounts for some indirect effects, such as the fact that methane is a precursor to ozone, and ozone is in itself a greenhouse gas (USEPA, 2016h).

- Nitrous Oxide (N_2O) has a GWP of 265-298 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for more than 100 years, on average [EPA 2016a]. Table 3.3. contains GHGs regulated by USEPA and global warming potentials.

Table 3.2.

Air Pollutant	Chemical Symbol/ Acronym	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298

Hydrofluorocarbons	HFCs	Varies
Perfluorocarbons	PFCs	Varies
Sulfur hexafluoride	SF_6	22,800

Source: [EPA 2016a]

The IPCC concluded that "warming of the climate system is unequivocal" and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations" [IPCC 2007]. Extensive research and development efforts are underway in the field of carbon capture and sequestration (CCS) technology, which could help direct management strategies in the future. The IPCC has identified a target worldwide "carbon budget" to estimate the amount of CO_2 the world can emit while still having a likely chance of limiting global temperature rise to 2°C above pre-industrial levels. The international community estimates this budget to be 1 trillion tonnes of carbon [IPCC 2016].

Because GHGs circulate freely throughout Earth's atmosphere, climate change is a global issue. The largest component of global anthropogenic GHG emissions is CO_2. Global anthropogenic carbon emissions reached about 7,000,000,000 MT per year in 2000 and an estimated 9,170,000,000 MT per year in 2010 [Boden et. al. 2013]. Oil and gas production contributes to GHGs such as CO_2 and methane. Natural gas systems were the largest anthropogenic source category of CH_4 emissions in the United States in 2014 with 176.1 MMT CO_2 e of CH_4 emitted into the atmosphere. Those emissions have decreased by 30.6 MMT CO_2 e (14.8 percent) since 1990 [EPA 2016b].

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 [NASA 2007]. In 2001, the IPCC indicated that by the year 2100, global average surface temperatures would increase 1.4 to 5.8°C (2.5 to 10.4°F) above 1990 levels. The National Academy of Sciences [Hansen et. al., 2006] has confirmed these findings, but also indicated that there are uncertainties regarding how climate change may affect different regions. Observations and predictive models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Data indicate that northern latitudes (above 24° N) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. It also shows temperature and precipitation trends for the conterminous United States. For both parameters we see varying rates of change, but overall increases in both temperature and precipitation.

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3.1.2. Cultural

The National Historic Preservation Act (NHPA) (54 USC § 300101 et. seq.), requires government agencies to take into account the effects of their actions on properties listed or eligible for listing on the National Register of Historic Places (NRHP). These effects may include direct impacts to resources or indirect impacts that may effect NRHP criteria such as: location, design, setting, materials, workmanship, feeling, and association. Cultural resources are defined as any evidence of past human activities and can include structures such as historic or prehistoric buildings, canals and rock art.

Cultural resources are sensitive, irreplaceable resources with potential public and scientific uses and an important and integral part of our national heritage. Cultural resources constitute "a definite location of human activity, occupation, or use identifiable through field inventories (i.e., surveys), historical documentation, or oral evidence" (BLM-M-8100). The term cultural resource also includes "archaeological, historic, or architectural sites, structures, or places with important

public and scientific uses, and may include definite locations (i.e., sites or places) of traditional cultural or religious importance to specified social and/or cultural groups. Cultural resources are concrete, material places and things that are located, classified, ranked, and managed through the system of identifying, protecting, and utilizing for public benefit. They may be but are not necessarily eligible for the National Register" (BLM-8100).

General Cultural Overview

The cultural-chronological sequence represented in the area includes the Paleoindian, Archaic, Fremont, Protohistoric, and Historic. The earliest inhabitants of the region are representative of the Paleoindian stage (ca. 12,000 - 8000 B.P.), characterized by the adaptation to terminal Pleistocene environments and by the exploitation of big game fauna. The Archaic stage (ca. 8000 B.P.-1500 B.P.) is characterized by the dependence on a foraging subsistence, with people seasonally exploiting a wide spectrum of plant and animal species in different eco-zones. Early Archaic (ca. 6000-3000 B.C.) sites in the Basin include sand dune sites and rockshelters primarily clustered in the lower White River drainage. The Middle Archaic era (ca. 3000-500 B.C.) is characterized by improved climatic conditions and an increase in human population on the northern Colorado Plateau. The Late Archaic period (ca. 500 B.C. - A.D. 550) in the Uinta Basin is distinguished by the continuation of Elko Series projectile points with the addition of semi-subterranean residential structures at base camps. By about A.D. 100, maize horticulture and Rose Springs arrow points had been added to the Archaic life way. The Fremont stage (A.D. 500-1300) is characterized by reliance upon domesticated corn and squash, increasing sedentism, and, in later periods, substantial habitation structures, pottery, and "bow and arrow" technology. Proto historic groups including the Utes appeared at approximately A.D. 1100. Historic (~ A.D. 1800 to Present) life ways in the area are marked by livestock grazing, agriculture, timber, mining, bee keeping, and freighting.

All available cultural resource information was reviewed and analyzed for the Area of Potential Effect (APE), which is defined as the entire parcel being offered for the November 2016 Oil and Gas lease sale. All twenty-eight parcels were analyzed and evaluated for this undertaking. Development of resources in any of the proposed parcels may impact cultural resources, and several areas are more likely than others for potential impacts. Research on all parcels was conducted to identify results from previous cultural inventories. Parcels with no previous inventories were compared to similar geographic locations where inventories have been conducted. For example, areas such as Nine Mile Canyon and Steinaker Reservoir have greater potential for impacts due to: findings from previous surveys and research conducted in those areas, the number of known sites in or within one mile of the parcels, and their distance from permanent water. These parcels include four near or adjacent to Steinaker Reservoir: 069, 070, 071, and 142. Several of these parcels have been surveyed from 14%-100%. Those surveys have documented over 40 sites in the area including, villages, canal systems, and numerous human remains. Similarly, two proposed parcels are within the Nine Mile Canyon corridor. Nine Mile Canyon is significant for the numerous cultural resources and the archaeological information that has been acquired from that area. These parcels, 009 and 010, contain approximately forty sites and are surrounded by over 100 cultural resources within one mile of the parcel boundaries with hundreds of more sites throughout the canyon. Many of these resources have been or are being listed on the National Registry of Historic Places because of their significance as part of the archaeological record. All six parcels are listed under the NSO lease category.

Appendix H includes the cultural resource report describing resources for each parcel in more detail. There are a total of twenty-eight parcels analyzed for this inventory and each is identified using the BLM Sale ID number as the parcel number.

In addition to analysis of cultural resources the BLM is required to consult with Native American Tribes concerning the identification of cultural values, religious beliefs, and traditional practices of Native American people that may be affected by actions on BLM-administered lands. Consultation includes the identification of places of traditional cultural importance to Native American Tribes or that may be considered sacred to particular Native American Tribes or individuals. The NHPA was amended in 1992 to explicitly allow that "...properties of traditional religious and cultural importance to an Indian Tribe...may be determined to be eligible for inclusion on the NRHP." Per existing laws, as amended, and subsequent regulations and agency direction BLM initiated government-to-government consultation for the Proposed Action by sending letters to the following Tribal groups: the Ute Indian Tribe, the Ute Mountain Ute, the Navajo Nation, the Hopi, the Zia Pueblo, the Laguna Pueblo, the Pueblo of Jemez, the Santa Clara Pueblo, the Goshute, the White Mesa Ute, the Northwest Band of Shoshone, the Southern Ute, and the Eastern Shoshone. A letter describing the proposed undertaking was sent to each tribe on May 24, 2016. The BLM received a response from the Hopi Tribe on June 13, 2016. The Hopi Tribe requested more information about parcels with sensitive cultural resources. A cultural resource report describing resources in all parcels was sent to the Hopi Tribe on August 16, 2016. Consultation with the tribes will continue throughout the NEPA process.

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3.1.3. Areas of Critical Environmental Concern

Areas of Critical Environmental Concern (ACECs) are special management areas designated by BLM to protect significant historic, cultural, or scenic values; fish and wildlife resources; natural process or systems; and/or natural hazards that have more than locally significant qualities which give it special worth, consequence, meaning, distinctiveness, or cause for concern, especially compared to any similar resource. ACECs have qualities or circumstances that make them fragile, sensitive, rare, irreplaceable, exemplary, unique, endangered, threatened, or vulnerable to adverse change. They have been recognized as warranting protection in order to satisfy national priority concerns or to carry out the mandates of Federal Lands Policy and Management Act (FLMPA) and have qualities which warrant highlighting in order to satisfy public or management concerns about safety and public welfare.

Potential ACECs must meet the following criteria:

Relevance: presence of a significant historic, cultural, or scenic value; fish or wildlife resource or other natural process or system; or natural hazard; and

Importance: the above described value, resource, process, system, or hazard shall have substantial significance and values. This generally requires qualities of more than local significance and special worth, consequence, meaning, distinctiveness, or cause for concern.

The following lease parcels occur partially or fully within areas designated as ACECs.

Table 3.3. Parcels within ACECs

ACEC	Lease Parcels	Relevance and Importance Values
Nine Mile Canyon (44,168 acres)	009, 010	High value scenery, cultural resources, and special status species.

3.1.4. Lands with Wilderness Characteristics

Lands with wilderness characteristics are areas having at least 5,000 acres in a natural or undisturbed condition, and provide outstanding opportunities for solitude and/or primitive forms of recreation. A full description of inventory findings and maps are documented in the administrative record of the wilderness characteristics reviews completed by the VFO and are available upon request.

Six proposed lease parcels are located in lands found to possess wilderness characteristics. Parcel (ID#) 009, and 010 are located within the Currant Canyon wilderness characteristics unit in southeastern Duchesne County. The Currant Canyon lands with wilderness characteristics unit was inventoried after the completion of the 2008 VFO RMP [BLM 2008b]. Therefore, the unit has not been analyzed through a land use planning process. Approximately 20,700 acres in the Currant Canyon unit possess wilderness characteristics, including size, naturalness, outstanding opportunities for both solitude and primitive and unconfined recreation and supplemental values such as wildlife viewing opportunities, and unique geological formations.

Parcels (ID#) 032, 038, 039 and 049 occur within the Desolation Canyon wilderness characteristics unit located near the intersection of Uintah, Carbon and Duchesne Counties. These parcels occur within sections of the Desolation Canyon unit which have been analyzed through a land use planning process. Decisions regarding the management of wilderness characteristics in this unit are reflected in the VFO RMP. [BLM 2008b]The Desolation Canyon unit was inventoried during revision of the VFO RMP and found to have wilderness characteristics. Protection of lands with wilderness characteristics for the unit was analyzed in at least one alternative. However, the VFO record of decision selected an alternative that emphasizes other multiple uses as a priority over protecting wilderness characteristics because "the area is considered high potential for O&G development". [BLM 2008b]Approximately 95,000 acres in the Desolation Canyon inventory unit (Vernal and Price Field Offices) possess wilderness characteristics, including size, naturalness, outstanding opportunities for both solitude and primitive and unconfined recreation and supplemental values such as wildlife habitat, historic and prehistoric properties, and unique geological formations.

Table 3.4. Parcels and Acres Overlapping Lands with Wilderness Characteristics

Inventory Unit Name	Total Acres of Lands with Wilderness Characteristics in Unit	Acres Overlapping Lease Parcels	Parcel #s
Desolation Canyon (Vernal and Price Field Offices)	95,000	959	032, 038, 039, 049
Currant Canyon	20,700	1,561	009, 010
Total	115,700	2,520	

3.1.5. Livestock Grazing & Rangeland Health Standards

The following specific parcels were determined to have possible effects to Livestock Grazing and Rangeland Health Standards due to the current amount of existing Oil and Gas development.

Parcel Number	Livestock Grazing Allotment
103	Split Mountain Allotment

The allotment this parcel is within ranges from desert salt shrub to sage steppe. Numerous areas consist of small to large ephemeral drainages, and some border the Green River. Elevation ranges from around 4,000 to 5,000 feet in elevation. The area is located within the 5–8 inch annual precipitation zone. Soils are sandy to desert clay loam. The Sand Wash allotment Rangeland Health Assessments was last conducted in 2014.

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3.1.6. Plants: Special Status Species

3.1.6.1. Plants: BLM-Sensitive Plants

The BLM-Sensitive plant species presented in Table 3.5, "BLM-Sensitive Plants" occur within the Project Area or have the potential to be affected by the Proposed Action.

Table 3.5. BLM-Sensitive Plants

Species	Status	Potential Occurrence and Habitat Type	Parcels
Aquilegia scopulorum var. *goodrichii* (rock columbine)	BLM-Sensitive	Habitat includes semi-barren, white shale layers of the Green River Formation in pinyon-juniper plant communities on the West Tavaputs Plateau from 7,400 to 9,420 feet elevation.	004, 005, 007, 009, 010
Astragalus hamiltonii (Hamilton milkvetch)	BLM-Sensitive	Habitat includes eroding slopes of the Duchesne River Formation in desert shrub and pinyon-juniper plant communities from 5,500 to 6,740 feet elevation.	069, 070, 071, 142
Cryptantha grahamii (Graham catseye)	BLM-Sensitive	Habitat includes sparsely vegetated shale slopes, benches, and terraces of the Green River Formation in salt desert shrub and pinyon-juniper communities from 4,750 to 6,750 feet elevation.	049
Erigeron untermanii (Untermann fleabane)	BLM-Sensitive	Habitat includes open, wind-swept, marly ridges and slopes in Salina wildrye, pinyon-juniper, limber pine, and Douglas-fir plant communities on the West Tavaputs Plateau from 7,000 to 9,300 feet elevation.	004, 005, 009, 010
Mentzelia goodrichii (Goodrich blazingstar)	BLM-Sensitive	Habitat includes eroding slopes of the Green River and Uinta Formations in desert shrub, pinyon-juniper, mountain-mahogany, limber pine, and Douglas-fir plant communities on the West Tavaputs Plateau from 6,440 to 8,800 feet elevation	004, 005, 009, 010
Penstemon goodrichii (Goodrich beardtongue)	BLM-Sensitive	Habitat includes red and grey clays of the Duchesne River Formation in shadscale, sagebrush, and pinyon-juniper plant communities from 5,600 to 6,200 feet elevation.	093, 094, 103
Penstemon grahamii (Graham beardtongue)	BLM-Sensitive	Habitat includes semi-barren, white to tan shale and oil shale slopes, hills, and ridges of the Green River Formation in shadscale, Salina wildrye, and pinyon-juniper plant communities from 5,000 to 6,300 feet elevation.	032, *121, *122
Penstemon scariosus var. *albilfluvis* (White River beardtongue)	BLM-Sensitive	Habitat includes semi-barren, white to tan shale and oil shale slopes, hills, and ridges of the Green River Formation in shadscale, Salina wildrye, and pinyon-juniper plant communities from 5,000 to 6,800 feet elevation.	*121, *122

Phacelia argylensis (Arglye Canyon phacelia)	BLM-Sensitive	Known only from Argyle Canyon in Duchesne County, Utah. Habitat includes wash bottoms in shale of the Green River Formation in pinyon-juniper-serviceberry-Douglas-fir plant communities at 7,595 feet elevation.	004, 005, 009, 010
Thelesperma subnudum var. *caespitosum* (Green River greenthread)	BLM-Sensitive	Habitat includes semi-barren, eroding slopes and ridges of the Green River Formation in desert shrub and pinyon-juniper plant communities on the West Tavaputs Plateau from 6,000 to 8,800 feet elevation.	004, 005, 009, 010
Yucca sterilis (sterile yucca)	BLM-Sensitive	Known occurrences of the species are found growing in sandy soils. However, this species is new to the Utah BLM-Sensitive plant species list and, as such, has not been extensively surveyed for nor is the range and exact habitat requirements fully understood. Therefore, at this time, any sandy soils within the proposed lease parcels have to be assumed to be potential habitat for the species.	all parcels
*Parcel contains habitat designated as Conservation Agreement Areas for the species that will require additional mitigation measures if developed (see SWCA 2014).			

3.1.6.2. Plants: Threatened, Endangered, Proposed, and Candidate

During GIS review of the parcels, the federally listed plant species presented in Table 3.6, "Threatened, Endangered, Proposed, and Candidate Plants" occur within the Project Area or have the potential to be affected by the Proposed Action.

Table 3.6. Threatened, Endangered, Proposed, and Candidate Plants

Species	Status	Potential Occurrence and Habitat Type	Parcels
Hesperidanthus argillaceus (clay reed-mustard)	Threatened	Habitat includes steep slopes in soils between the Uinta and Green River Formations in shadscale, sagebrush, and mixed-desert shrub plant communities at 4,900 to 5,600 feet elevation.	032, 038, 049, 067
Hesperidanthus suffrutescens (shrubby reed-mustard)	Endan-gered	Habitat includes semi-barren slopes and hill tops of white shale from the Green River Formation. Soils and habitat may often include clast stones on the surface. Typical plant communities include: black sagebrush, shadscale, mixed-desert shrub, mountain-mahogany, and pinyon-juniper. From 5,100 to 7,000 feet elevation.	049, 067
Sclerocactus brevispinus (Pariette cactus)	Threatened	Habitat includes clay badlands of cobbles and gravel pavements from the Uinta Formation in mixed-desert shrub (saltbush) plant communities from 4,800 to 5,200 feet elevation.	*038, 049, 067, 105
Sclerocactus wetlandicus (Uinta Basin hookless cactus)	Threatened	Habitat includes river benches, slopes, and hills of fine textured xeric soils from the Duchesne River, Green River, Mancos, and Uinta Formations, generally overlain with large, round cobble. Associated plant communities include mixed-desert shrub and pinyon-juniper plant communities from 4,700 to 5,800 feet elevation.	*038, 049, 067, 105

Spiranthes diluvialis (Ute ladies'-tresses)	Threatened	Habitat includes gravelly sand and sandy loam soils within wet places including wet meadows, margins of rivers, lakes, and streams, riparian sandbars, sub-irrigated springs and seeps, and irrigated fields. Typical plant communities include sedges, grasses, and forbs with little to no woody plant canopy. From 4,400 to 7,100 feet elevation.	005, 012, 013, *038, 069, 071, 094, 103
*Parcels contain habitat designated as Core Conservation Areas for the species that will require additional mitigation measures if developed. [USFWS 2014]			

3.1.7. Recreation

The BLM's basic units of recreation management are the Special Recreation Management Area (SRMA) and the Extensive Recreation Management Area (ERMA). A SRMA is an area where recreation is emphasized. Within an ERMA, recreation is generally unstructured and dispersed, minimal recreation-related investments are required, and there are minimal regulatory constraints. ERMAs generally cover all areas that are not designated as SRMAs. Popular recreational destinations in the project area include the Nine Mile SRMA.

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Table 3.7. Recreation SRMA and Sites

Recreation Areas/Sites	Parcels	Recreation features
Nine Mile SRMA	009, 010	Recreation opportunities available to visitors within the Nine Mile SRMA include but are not limited to backpacking, camping, dirt biking, enjoying natural and cultural features, four wheel driving, hiking, horseback riding, hunting, falconry, mountain biking, operating off highway vehicles (OHV), rock climbing, and scenic driving. The Nine Mile SRMA is managed to protect high-value cultural values and scenic quality

3.1.8. Visual Resource Management

The BLM uses a Visual Resource Management (VRM) system to inventory and manage visual resources on public lands. The primary objective of VRM is to manage visual resources so that the quality of scenic (visual) values is protected. The VRM system uses four classes (and their associated visual resource objectives) to describe the different degrees of surface disturbance or modification allowed on the landscape (see VRM table belowTable 3.9, "BLM Visual Resource Management (VRM) Class Objectives").

Visual Resource Inventory

As part of the VRM program, the BLM is to prepare and maintain — on a continual basis — an inventory of visual values of all its public lands. The inventory stage identifies the visual resources of an area and assigns them to an inventory class using the BLM's VRI process, which is described in BLM Manual H-8410-1. The VRI process consists of the following:

1. A scenic quality evaluation to rate the visual appeal of an area

2. A sensitivity level analysis to assess public concern of an area's scenic quality and their sensitivity to potential changes in the visual setting.

3. A delineation of distance zones to indicate the relative visibility of the landscape from primary travel routes or observation points.

Based on these three factors, BLM-administered lands are placed into one of four VRI classes — Class I, Class II, Class III, and Class IV — that represent the relative value of the visual resources and provide the basis for considering visual values in the resource management planning process. VRI Classes II, III, and IV are determined based on a combination of scenic quality, sensitivity level, and distance-zone overlays to assign the proper class. In the relative scale of visual values, Class II has a higher level of value than Class III, which is moderately valued. Class IV is least valued. VRI class—Class I—is assigned to special management areas where a management decision has previously been made to maintain a natural landscape. These areas are the most valued landscapes. This includes areas such as Wilderness Areas or Wilderness Study Areas, the wild section of national Wild and Scenic rivers, and other congressionally and administratively designated areas where decisions have been made to preserve a natural landscape. Since these areas are assigned the highest value, the inventory process does not provide a scoring method to assign VRI Class I. However, in the inventory process Class I areas are evaluated for their existing scenic quality, sensitivity level and distance from observation areas.

The Vernal Field Office completed a Visual Resource inventory in 2011. VFO inventory classes reflect the findings in regards to scenic quality, sensitivity level, and view shed. These findings are referenced in table 3.7 and reflect each proposed lease's visual inventory class. Note: some parcels may occur in multiple VRI classes and may appear to be duplicated in the VRI Class table.

Table 3.8. Visual Resource Class Objectives of Lease Parcels

VRI Class	Parcels
Class I	None
Class II	004, 005, 009, 010, 090, 103, 151
Class III	032, 038, 039, 049, 067, 070, 071, 093, 094, 103, 121, 122, 152
Class IV	006, 012, 013, 014, 015, 016, 039, 049, 067, 121, 122, 152

Table 3.9. BLM Visual Resource Management (VRM) Class Objectives

VRM Class	VRM Objective
Class I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
Class II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV	The objective of this class is to provide for management activities, which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

The proposed lease parcels would encompass several different VRM management classes as listed inTable 3.10, "Lease Parcels ID and associated VRM Classes". Note: some parcels may occur in multiple VRM Classes and may appear to be duplicated in the VRM Class Table below. The remaining parcels are located entirely on private land and do not have an associated VRM Class.

Table 3.10. Lease Parcels ID and associated VRM Classes

VRM Class	Parcel ID
Class I	None
Class II	038
Class III	004, 005, 009, 010, 012, 013, 014, 015, 032, 038, 067, 070, 094, 103, 121, 122, 151, 152
Class IV	006, 009, 010, 012, 013, 014, 015, 016, 032, 039, 049, 070, 071

3.1.9. Wildlife: Migratory Birds including Raptors

All of the lease parcels contain nesting and foraging habitat for migratory birds. The Migratory Bird Treaty Act of 1918 protects migratory birds and their parts. Executive Order 13186, signed on January 10, 2001, directs federal agencies to evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. The MOU between the US Department of Interior BLM and United States Fish and Wildlife Service (USFWS) to promote the Conservation and Management of Migratory Birds (extended 5/2015) also strives to increase the conservation of migratory birds and avoid and minimize adverse impacts on these species through collaboration with USFWS. The BLM and USFWS have decided to focus on the Birds of Conservation Concern (BCC). [USFWS 2008]identified each of the Bird Conservation Regions (BCRs) in the United States for the review and analysis of projects. The parcels are within BCR 16 (Southern Rockies/Colorado Plateau). Species lists for BCR16 have been reviewed and the potential exists for several migratory bird species, currently designated as species of concern, to nest within the parcels, primarily between April and September. Additional discussion is contained in Table 3.11, "Wildlife: Special Status Species Potential Occurrence".

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3.1.9.1. Raptors

Raptors, including the red-tailed hawk, Cooper's hawk, sharp-shinned hawk, American kestrel, northern harrier, great horned owl, and other less common species utilize each of the habitat types within the lease parcels and may be present year round or seasonally. Nesting tends to be concentrated around cliffs, large trees, embankments, and other habitat features. Raptor management is guided by Appendix A in the 2008 RMP. [BLM 2008c]These are best management practices which are BLM-specific recommendations for implementation of the U.S. Fish and Wildlife Service, Utah Field Office's "Guidelines for Raptor Protection from Human and Land Use Disturbances". The Guidelines were originally developed by the Fish and Wildlife Service in 1999, and were updated in 2002 based on recent court rulings, policy decisions, and Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. The Guidelines were provided to BLM and other land-managing agencies to provide raptor management consistency while ensuring project compatibility with the ecological requirements of raptors. The best management practices include timing limitations and controlled surface measures to protect raptor species. Table 3.11, "Wildlife: Special Status Species Potential Occurrence" identifies sensitive raptor species potential occurrence and habitat within the parcels.

3.1.10. Wildlife: Non-USFWS Designated

3.1.10.1. Elk

Elk occur year-round in the project area in low numbers. Resident elk use the low-elevation water resources, such as the Green River. Parcels 005, 009, 070, and 152 are in crucial elk wintering habitat and parcels 006, 012, 013, 014, 015, and 016 are in calving habitat. Crucial habitat provides shelter and forage for elk during critical times of the year.

3.1.10.2. Mule Deer

Parcels 009, 070, 152, 121, and 122 are within crucial winter and parcels 004, 070, 094, and 103 are within fawning range for mule deer. Crucial range provides unique habitat for deer. The function of crucial winter range is to provide shelter and forage to big game, ensuring their survival during periods of significant winter and fawning stress. Mule deer populations in the western U.S. have historically fluctuated due to environmental factors (e.g., drought, severe winters). Deer populations in eastern Utah have declined in recent years. Unusually high deer mortalities in the 1980s and 1990s are primarily attributed to the severe, 1983-1984 and 1992-1993 winters, and to a prolonged, seven-year drought between 1986 and 1992. These conditions decimated the fawn population as well as a large percentage of the adult deer population. A very slow recovery of the deer population has occurred since that time. Fawn production and survival, which continued to be low through 1996, began to improve after 1996 with good forage and winter conditions. The current drought is causing severe stress to mule deer, once again reducing their populations and limiting the forage on which they depend. However, these are environmental factors that are beyond human control. Factors within human control that affect the population of mule deer in the area include hunting, grazing, energy development, increased recreation, and predation.

3.1.11. Wildlife: Special Status Species

BLM manages sensitive species in accordance with BLM Manual 6840 with the objective to initiate proactive conservation measures that reduce or eliminate threats to these species to minimize the likelihood of and need for listing of these species under the ESA. Special status species are, collectively, the federally listed or proposed and Bureau sensitive species, which include both Federal candidate species and delisted species within 5 years of delisting. There are 57 BLM Utah sensitive species, including 12 species under conservation agreement and 4 candidate species. Of these, 52 species occur or potentially occur within the VFO. The Utah sensitive species lists also includes federally listed species. VFO has used available data sources to determine if the parcels fall within known habitat for BLM or UDWR sensitive species. After site-specific review, it has been determined that the Special Status Species listed in Table 3.11, "Wildlife: Special Status Species Potential Occurrence" may occur within the project area or be affected by the proposed action.

Table 3.11. Wildlife: Special Status Species Potential Occurrence

Species	Status	Potential Occurrence and Habitat Type	Parcels
Fish			
Bonytail Chub, Colorado Pikeminnow, Humpback Chub, Razorback Sucker	Endangered	These species occur in the Green River. Habitat is not present within the proposed project area; however, water depletion is anticipated to occur.	All parcels
Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub	Conservation Agreement Species	These species occur in the Green River. Habitat is not present within the proposed project area; however, water depletion is anticipated to occur.	All parcels
Mammals			
Townsend's Big-Eared Bat, Big Free-Tailed Bat, Spotted Bat, Fringed Myotis, Allens Big Eared Bat, Western Red Bat	BLM Sensitive	These species potentially occur throughout Utah; however, no occurrence records exist for the extreme northern or western parts of the state. Known occurrences have been reported in northeastern Uintah County. Habitat is present within the proposed project area.	All parcels
Black-Footed Ferret	Endangered	Utilizes prairie dog burrows for shelter and feed on the prairie dogs. Populations of Black-footed ferrets have been introduced into the wild in Coyote Basin, in Uintah County area ferrets are characterized as "non-essential experimental" populations (UDWR 2007).	094, 103
Raptors			
Golden Eagle	BLM Sensitive, Bird of Conservation Concern	Throughout the summer, golden eagles are found in mountainous areas, canyons, shrub-land and grassland. During the winter they inhabit shrub-steppe vegetation, as well as wetlands, river systems and estuaries. Golden eagles are quite common to Uintah County. All parcels contain foraging habitat however no known nests exist within them.	All parcels
Bald Eagle	BLM Sensitive, Bird of Conservation Concern	Throughout the winter, bald eagles are typically found near rivers, lakes, and marshes where unfrozen, open waters offer the opportunity to prey on fish and waterfowl. The Colorado and Green River corridors are well used by Utah's wintering bald eagles. The eagles begin to arrive in November.	038, 069, 071, 094, 103, 142
Mexican Spotted Owl	Threatened	In Utah, found primarily in rocky canyons. Nests in caves or crevices. Roosts on ledges or in trees in canyons. The species prefers mesic (moister/cooler) canyons with mixed conifer or riparian components.	004, 005, 009, 010

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Species	Status	Potential Occurrence and Habitat Type	Parcels
Ferruginous Hawk	BLM Sensitive, Bird of Conservation Concern	This species is known to occur in the West Desert and the Uinta Basin as a summer resident and a common migrant. Within the Uinta Basin, the species is more associated with prairie dog colonies as the main prey base. These parcels contain foraging habitat; however no known or documented ferruginous hawk nests are within ½ mile of the proposed project.	All parcels
Short-eared Owl	Wildlife Species of Concern	Inhabits arid grasslands, agricultural areas, marshes, and occasionally open woodlands. In Utah, cold desert shrub and sagebrush-rabbit brush habitats also are utilized.	All parcels
Birds			
Gray Vireo	Bird of Conservation Concern	Dry shrubby areas, chaparral, and sparse woodlands. Habitat is present within the proposed project area.	All parcels
Grasshopper Sparrow	Bird of Conservation Concern	In Utah, the species is widespread and has been known to breed in Uintah, Duchesne, and Daggett Counties. Habitat is present within the proposed project area.	All parcels
Bobolink	Wildlife Species of Concern	Short grass prairies, alpine meadows, riparian woodlands, and reservoir habitats.	All parcels
Brewer's Sparrow	Bird of Conservation Concern	Desert and shrubland/chaparral. Habitat is present within the proposed project area.	All parcels
Yellow-billed Cuckoo	Threatened	Wooded habitat with dense cover and water nearby, including woodlands with low, scrubby, vegetation, overgrown orchards, abandoned farmland, and dense thickets along streams and marshes.	Potential Habitat 094, 103
Sage-grouse	BLM Sensitive Species	Sage-grouse are emblematic of the sagebrush steppe of the intermountain West.	General Habitat Management Areas 032, 067, 152

Priority Habitat Management Areas (PHMA), General Management Habitat Management Area (GHMA) and Population Areas (PA) for Greater Sage-grouse (GRSG) in Utah were identified in the 2015 *Record of Decision and Approved Resource Management Plan Amendments for the Great Basin Region, Including the Greater Sage-grouse Sub-Regions of Idaho and Southwestern Montana, Nevada and Northeastern California, Oregon and Utah* (GRSG ROD) and the *Utah Greater Sage-grouse Approved Resource Management Plan Amendment* [BLM 2015]. PHMA is GRSG habitat on BLM-administered lands identified as having the highest value in order to maintain populations in UT. GHMA is GRSG habitat on BLM administered lands where some management will apply and there are some areas of occupied seasonal or year-round habitat outside of PHMA. The 15 GRSG PAs were mapped in the GRSG land use plan amendment process to improve the organization and structure of GRSG planning documents. Using the PA concept in those documents the BLM was able to discuss differences in habitat, threats, and impacts in different sections of the GRSG planning area by simply referencing a PA. Lands in the PA that do not include PHMA or GHMA may provide for connectivity or facilitate movement of birds between habitats. Although the boundaries of population areas were drawn using some biological considerations it is important to note that they are not intended to reflect distinct populations. More information about PHMA, GHMA and the individual PA's is available in

Section 1.3.2 in the GRSG Proposed Land Use Plan Amendment and Final Environmental Impact Statement (GRSG FEIS).[BLM 2015]

For the November 2016 lease sale, 17 of the proposed lease parcels, comprising 7,937.55 acres, are outside of PHMA and GHMA, but within a PA. GRSG habitat has not been identified or mapped in these areas.

Three of the proposed lease parcels for the November 2016 lease sale are within GHMA. One parcel is in the Carbon PA and two are within the Uinta PA. Descriptions of conditions in these PAs are included in Section 3.3.5 of the GRSG FEIS. [BLM 2015].

Parcel 032 is in GHMA within Carbon PA. The Carbon PA is located in north central UT and contains several subpopulations (refer to Map 1-2 of the GRSG FEIS 2015). Parcel 32 is within the Anthro Mountain breeding complex and the birds use this area seasonally for brood-rearing and winter. Only the western portion of the parcel (approximately 80 acres of the 320 acres) is mapped as GHMA, however, the entire parcel is within the PA. There are no occupied leks within 5 miles of parcel 032. The nearest occupied lek is approximately 21 miles to the west of the parcel. This parcel is surrounded by existing leases that have developed well-pads and is within the Deseret Oil and Gas Unit.

Parcels 067 and 152 are in GHMA within the Uintah PA. The Uintah PA is located in northeastern UT and is comprised of three different GRSG areas (refer to Map 1-2 of the GRSG FEIS [BLM 2015]). This PA also includes several subpopulations. Parcels 067 and 152 are within the Book Cliffs GRSG breeding complex and birds use this area when transitioning from nesting to brood-rearing areas along Willow Creek. Even though these parcels are near Hill Creek, GRSG are not known to use the area within these parcels for brood-rearing. There is a steep drop-off to the creek from the uplands separating the habitat types. The parcels are surrounded by existing leases and producing oil and gas wells. The nearest occupied lek is 5 miles to the east of parcel 067, and 4.6 miles northeast of parcel 152. Parcel 067 is within the Little Canyon Oil and Gas Unit. The area surrounding parcel 067 is highly developed. There are 8 producing oil and gas wells in the section where 067 is proposed to be leased. Parcel 152 is within the Flat Stone Oil and Gas Unit which is also surrounded by existing leases that are highly developed with several existing oil and gas wells in the area. Only 20 of the 80 acres for parcel 152 are within the mapped GHMA. However, the entire parcel is within the Uintah PA.

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Chapter 4. Environmental Effects:

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This chapter discusses the environmental consequences of implementing the alternatives described in Chapter 2 on the Resources identified in the ID team checklist and carried forward in Chapter 3. Under NEPA, actions with the potential to affect the quality of the human environment must be disclosed and analyzed in terms of direct and indirect effects—whether beneficial or adverse and short or long term—as well as cumulative effects. Direct effects are caused by an action and occur at the same time and place as the action. Indirect effects are caused by an action but occur later or farther away from the resource. Beneficial effects are those that involve a positive change in the condition or appearance of a resource or a change that moves the resource toward a desired condition. Adverse effects involve a change that moves the resource away from a desired condition or detracts from its appearance or condition. Cumulative effects are the effects on the environment that result from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions.

The No Action alternative (offer none of the nominated parcels for sale), serves as a baseline against which to evaluate the environmental consequences of the Proposed Action alternative (offer of eleven parcels for sale with additional resource protective measures). For each alternative, the environmental effects are analyzed for the resources that were carried forward for analysis in Chapter 3.

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4.1. Direct and Indirect Impacts

4.1.1. Alternative A – Proposed Action

This section analyzes the impacts of the proposed action to those potentially impacted resources described in the Affected Environment (Chapter 3).

4.1.1.1. Air Quality

The act of leasing would not result in changes to air quality. However, should the leases be issued, development of those leases could impact air quality conditions. It is not possible to accurately estimate potential air quality impacts by computer modeling from the project due to the variation in emission control technologies as well as construction, drilling, and production technologies applicable to oil versus gas production and utilized by various operators, so this discussion will remain qualitative.

Should development on issued leases be proposed, and prior to authorizing specific proposed projects on the subject lease parcels, emission inventories would need to be developed. Air quality dispersion modeling, which may also be required, includes direct and cumulative impact analysis for demonstrating compliance with the NAAQS, plus analysis of impacts to Air Quality Related Values (i.e. deposition, visibility), particularly as they might affect nearby Class 1 areas (National parks and Wilderness areas). Such proposed development would be a minor air pollution source under the Clean Air Act. At present, control technology on some emissions sources (e.g. drill rigs) is not required by regulatory agencies. Possible future development would result in different emission sources associated with two project phases: well development and well production. Annual estimated emissions from development of a single well are summarized in Table 4.1, "Anticipated Emissions [1](tons per year)".

Table 4.1. Anticipated Emissions [1](tons per year)

Pollutant	Development	Production	Total
NO_x	14.2	2.2	16.4
CO	3.2	3.2	6.4
SO_x	0.9	0	0.9
PM_{10}	0.7	0.03	0.73
$PM_{2.5}$	0.3	0.01	0.31
VOC	2.5	6.5	9.0
Benzene	0.03	0.13	0.16
Toluene	0.02	0.09	0.11
Ethylbenzene	0.02	0.22	0.24
Xylene	0	0.07	0.07
n-Hexane	0.05	0.08	0.13
Formaldehyde	0	0	0
[1] Emissions include one producing well and associated operations traffic during the year in which the project is developed			

Well development includes NO_x, SO_2, and CO tailpipe emissions from earth-moving equipment, vehicle traffic, drilling, and completion activities. Fugitive dust concentrations would occur from vehicle traffic on unpaved roads and from wind erosion where soils are disturbed. Drill rig and fracturing engine operations would result mainly in $NO_x$and CO emissions, with lesser amounts of SO_2. These emissions would be short-term during the drilling and completion phases.

During well production, continuous NO_x, CO, VOC, and HAP emissions would originate from well pad separators, condensate storage tank vents, and daily tailpipe and fugitive dust emissions from operations traffic. Road dust ($PM_{10}$and $PM_{2.5}$) would also be produced by vehicles servicing the wells.

Emissions of NO_x and VOC, ozone precursors, for a single well are estimated to be 16.4 tons/yr for NO_x, and 9.0 tons/yr of VOC (Table 4.1, "Anticipated Emissions [1](tons per year)") per well. Emissions would be dispersed and/ or diluted to the extent where any local ozone impacts from the Proposed Action would be indistinguishable from background conditions.

The primary sources of HAPs are from oil storage tanks and smaller amounts from other production equipment. Small amounts of HAPs are emitted by construction equipment. These emissions are estimated to be minor and less than one ton per year.

Application of Stipulations UT-S-01 and Notice UT-LN-96 to each of the parcels on federal surface would be adequate for the leasing stage to disclose potential future restrictions and to facilitate the reduction of potential impacts upon receipt of a site specific APD.

4.1.1.1.1. Greenhouse Gases Emissions

As explained in Section 3.1.1.1 and the recent CEQ guidance, the effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, ocean acidification, and harm to wildlife and ecosystems

There would be no GHG emissions as a direct result of the Proposed Action, which is administrative in nature – i.e., issuance of leases for Federal mineral resources. Nevertheless,

the BLM recognizes that GHG emissions are a potential effect of the subsequent fluid mineral exploration and/or development of any leases that are issued. Oil and gas activities may lead to the installation and production of new wells, which may consequently produce an increase in GHG emissions. The primary sources of GHG emissions include the following:

- Fossil fuel combustion for construction and operation of oil and gas facilities – vehicles driving to and from production sites, engines that drive drill rigs, etc. These produce CO_2 in quantities that vary depending on the age, types, and conditions of the equipment as well as the targeted formation, locations of wells with respect to processing facilities and pipelines, and other site-specific factors;

- Fugitive CH_4 – CH_4 that escapes from wells (both gas and oil), oil storage, and various types of processing equipment. This is a major source of global CH_4 emissions. These emissions have been estimated for various aspects of the energy sector, and starting in 2011, producers are required under 40 CFR 98, to estimate and report their CH_4 emissions to the USEPA; and

- Combustion of produced oil and gas – it is expected that future operations would produce marketable quantities of oil and/or gas. Combustion of the oil and/or gas would release CO_2 into the atmosphere. Fossil fuel combustion is the largest source of global CO_2.

In recent years, many states, tribes, and other organizations have initiated GHG inventories, tallying GHG emissions by economic sector. The U.S. EPA provides links to statewide GHG emissions inventories [EPA 2013]. Guidelines for estimating project-specific GHG emissions are available [URSC 2010], but some additional data, including the projected volume of oil or natural gas produced for an average well, number of wells (as well as other factors described in Section 4.2.1. Air Quality) were used to provide GHG estimates.

Rule of Reason

CEQ advises that agencies should be guided by a "rule of reason" in ensuring that the level of effort expended in analyzing GHG emissions or climate change effects is reasonably proportionate to the importance of climate change related considerations to the agency action being evaluated. This statement is grounded in the purpose of NEPA to concentrate on matters that that are truly significant to the proposed action (40 CFR §§ 1500.4(b), 1500.4(g), 1501.7.). CEQ guidance cautions against using a comparison of global GHG emissions to project-specific GHG emissions as a stand-alone reason for no detailed analysis [CEQ 2016]. In light of the difficulties in attributing specific climate impacts to individual projects, CEQ recommends agencies use the projected GHG emissions as a proxy for assessing a Proposed Action's potential climate change impacts [CEQ 2016].

Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions from speculative future oil and gas well production on the proposed lease parcels was calculated assuming one well per parcel. Total Greenhouse Gas Warming Potential (GWP), which includes direct emissions of carbon dioxide, methane, and nitrous oxide from an oil or gas producing well is estimated based on the emissions estimates from the Greater Monument Buttes Final Environmental Impact Statement ([BLM 2016] Table 4.2.1.1.1-1), which is the most recent NEPA calculation of GHG in the lease area. The per-well GWP emissions estimate was made by dividing the Project Total GWP emissions in Table 4.2.1.1.1-1 (3,096,936 tpy) by the total number of producing oil and gas wells used to generate the GWP emissions estimates (5,740 wells). This gives a GWP emissions estimate of approximately

540 tons per year GWP emissions on a per-well, per-parcel basis. Actual emissions may range from zero if a parcel is not leased or not developed after leasing, to an unknown upper range.

Indirect Greenhouse Gas Emissions

Indirect GHG emissions are estimated on a one-well per-parcel basis and presented as low, average, and high production scenarios estimated from current oil and gas production on other parcels in the same field. The low emissions estimate was based on an assumption of no production on the lease parcel. It is impossible to know which of these scenarios (if any) will actually occur, so emissions numbers are presented to estimate the range of possible indirect emissions that could occur as a result of the lease sale. Indirect GHG emissions are calculated only for carbon dioxide based on combustion of the product.

Table 4.2.

Indirect GHG Emissions (tpy)	Oil[4]	Gas[5]
Low[1]	0	0
Average[2]	21,197	14,987
High[3]	464,253	32,557

1. Assumes no development on a lease parcel
2. Average of production from selected parcels currently in operation. Data from Utah Division of Oil and Gas and Mining production sheet Appendix I[UDOGM 2016]
3. Highest producing parcel from above referenced source.
4. 4. Oil well GHG indirect emission factor: 0.43 MT CO_2 per Barrel[EIA 2006]
5. 5. Gas well indirect emission factor: 0.054717 MT of CO_2 per Mcf [EPA 2016c]

As it is not possible to assign a "significance" value or impact to these numbers, the emissions estimates themselves are presented as a proxy for impact. This is consistent with final CEQ guidance. [CEQ 2016]

Uncertainties of GHG Calculations

Although this EA presents a quantified estimate of potential GHG emissions associated with reasonably foreseeable oil and gas development, there is significant uncertainty in GHG emission estimates due to uncertainties with regard to eventual production volumes and variability in flaring, construction, and transportation.

End Uses

The estimates above provide a complete GHG lifecycle of a well from site inspection to possible indirect emissions through combustion. A rough estimate was possible using publicly available information and using estimates from future production for reasonably foreseeable development. With respect to the rough estimates of indirect CO_2 emissions, it should be noted that it is a difficult to discern with certainty what end uses for the fuels extracted from a particular leasehold might be reasonably foreseeable. For instance, some end uses of fossil fuels extracted from Federal leases include: combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make

chemicals, plastics, and synthetic materials. At this time, there is some uncertainty with regard to the actual development that may occur.

It is important to note that the BLM does not exercise control over the specific end use of the oil and gas produced from any individual federal lease. The BLM has no authority to direct or regulate the end use of the produced oil and/or gas. As a result, the BLM can only provide an estimate of potential GHG emissions using national approximations of where or how the end use may occur because oil, condensate, and natural gas could be used for combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make chemicals, plastics, and synthetic materials.

Availability of Input Data

In light of the difficulties in attributing specific climate impacts to individual projects, CEQ recommends agencies use the projected GHG emissions as a proxy for assessing a Proposed Action's potential climate change impacts. Estimates were made based on readily available data and reasonable assumptions about potential future development. There are many factors that affect the potential for GHG emissions estimates at the leasing stage: a lease may not be purchased, so no GHG emissions would be expected; a lease may be purchased but never explored, so again there would be no GHG emissions; a lease may be purchased and an exploratory well drilled that showed no development potential, so minimal GHG emissions would occur; or a lease may be purchased, explored, and developed. If developed there are notable differences in the potential for emissions related to a wide variety of variables, including the production potential of the well, economic considerations, regulatory considerations, and operator dynamics, to name a few. Further NEPA analysis would be conducted at the APD stage, when specific development details with which to analyze potential GHG emissions are likely to be known.

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Monetizing Costs and Benefits: Social Cost of Carbon

The 2016 CEQ guidance states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of GHGs in NEPA documents [CEQ 2016]. The BLM finds that including monetary estimates of the social cost of GHGs (SC GHG) in its NEPA analysis for this Proposed Action would not be useful. Since the BLM is not doing a cost-benefit analysis in this NEPA document, we do not believe monetizing only SCC would be instructive.

Given the global nature of climate change, estimating SCC of an individual decision requires assessing the impact of the project on the global market for the commodity in question. While the BLM is able to estimate the GHG emissions associated with reasonably foreseeable oil and gas development, this EA does not estimate the net effect of this action on global GHG emissions or climate change. Depending on the global demand for oil and gas, the net effect of this project may be partially offset by changes in production in other locations. Accounting for this potential substitution effect is technically challenging.

Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

The BLM holds regulatory jurisdiction over portions of natural gas and petroleum systems, identified in the USEPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks* [EPA 2016d]. Exercise of this regulatory jurisdiction has led to development of Best Management Practices (BMPs), which are state-of-the-art mitigation measures applied to oil and natural gas drilling and

production to help ensure that energy development is conducted in an environmentally responsible manner. The BLM encourages industry to incorporate and implement BMPs to reduce impacts to air quality through reduction of emissions, surface disturbances, and dust from field production and operations. Typical measures are mentioned below.

- Open burning of garbage or refuse would not occur at well sites or other facilities;
- Drill rigs would be equipped with Tier II or better diesel engines;
- Vent emissions from stock tanks and natural gas TEG dehydrators would be controlled by routing the emissions to a flare or similar control device which would reduce emissions by 95% or greater;
- All internal combustion equipment would be kept in good working order;
- Flared hydrocarbon gases at high temperatures in order to reduce emissions of incomplete combustion through the use of multi-chamber combustors;
- Watering dirt roads during periods of high use to reduce fugitive dust emissions;
- Co-location wells and production facilities to reduce new surface disturbances;
- Use of natural gas fired or electric drill rig engines;
- The use of selective catalytic reducers and low-sulfur fuel for diesel-fired drill rig engines;
- Adherence to BLM's Notice to Lessees' (NTL) 4a concerning the venting and flaring of gas on Federal leases for natural gas emissions that cannot be economically recovered;
- Protecting frac sand from wind erosion;
- Implementation of directional drilling and horizontal completion technologies whereby one well provides access to petroleum resources that would normally require the drilling of several vertical wellbores;
- Requiring that vapor recovery systems be maintained and functional in areas where petroleum liquids are stored; and
- Performing interim reclamation to reclaim areas of the pad not required for production facilities and to reduce the amount of dust from the pads.

Additionally, the BLM encourages oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce natural gas emissions. In October 2012, the EPA promulgated air quality regulations for completion of hydraulically fractured gas wells [EPA 2015]. These rules required air pollution mitigation measures that reduced the emissions of volatile organic compounds during gas well completions. Mitigation included utilizing a process known as a "green" completion in which natural gas brought up during flowback is captured in tanks rather than in open fluid pits. Among other measures to reduce emissions include the USEPA's Natural Gas STAR program. The EPA U.S. inventory data shows that industry's implementation of BMPs proposed by the program has reduced emissions from oil and gas exploration and development [EPA 2016b].

4.1.1.2. Cultural

There are no direct impacts to cultural resources from leasing, but there may be indirect impacts due to possible subsequent development. As stated in the Vernal RMP EIS, page 4-52 [BLM 2008c]: "While sites within the area of potential direct effects will have been identified and either avoided or mitigated as part of the specific mineral development projects, sites not located within the footprints of undertakings are also vulnerable to negative impacts as human traffic in the general area increases. Potential indirect effects on cultural resources include vandalism and looting of cultural resource sites related to increased human activity within areas of mineral development. Other indirect negative impacts related to increased human activity in given areas include trampling of sites simply through the shear volume of individuals visiting sites. Additional potential indirect effects include increased erosion on cultural resource sites located near well pads, pipelines, and other minerals related facilities where vegetation cover has been reduced or eliminated."

Cultural resources in parcels under an NSO stipulation would be protected; however, they could still be impacted by off lease development and resources on the adjacent Federal, private and State lands, such as surface disturbing activities and truck traffic that may cause increased dust/particulate matter that may affect rock art panels, and long-term changes in overall site settings. If development were to occur on adjacent land to access Federal minerals, an APD would not be approved until the requirements of laws and regulations, including NEPA, and the National Historic Preservation Act have been met. (Onshore Oil and Gas Order No. 1, Part III.F.a.2.) Also, each issued parcel would contain a mandatory stipulation for the statutory protection of cultural resources within proposed parcels (BLM Handbook H-3120-1 – Competitive Leases (P) p. 35), which would be enforced through any future authorization to conduct exploration or operational activities under the lease.

Potential impacts relating to future authorizations would be mitigated through avoidance whenever possible. Reasonable development could occur within the proposed parcels without effect to historic properties. In addition to the Cultural Resource Protection lease stipulation, the BLM would add lease notices UT-LN-67, UT-LN-68, UT-LN-69 and UT-LN-70, to all BLM surface–administered parcels offered for lease.

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Appendix H includes the cultural resource report describing resources for each parcel in more detail. There are a total of twenty-eight parcels analyzed for this inventory and each is identified using the BLM Sale ID number as the parcel number.

4.1.1.3. Areas of Critical Environmental Concern

The issuance of leases would not directly impact the ACEC's relevance and importance values. However, as the BLM generally cannot deny all surface use of a lease unless the lease is issued as a No Surface Occupancy stipulation, the issuance of leases does convey an expectation that drilling and development would occur. No surface occupancy, controlled surface use, and timing limitation stipulation UT-S-23 would be applied within the ACEC and mitigate impacts of oil and gas development on ACEC values.

The Nine Mile Canyon ACEC (44,168 acres) was designated in the Vernal RMP [BLM 2008c] to "be managed to enhance cultural and special status plant species while enhancing scenic vistas, recreation, and wildlife resource values." [BLM 2008b]The relevance and importance values are cultural resources, special status species, and high quality scenery. For a detailed explanation

of impacts to the specific related resources, please refer to the Cultural, Visual Resources and Plants: Special Status sections in Chapter 4 of this document.

The relevant and important value of scenery only applies within the Nine Mile Canyon itself and is protected by VRM Class II objectives from canyon rim to canyon rim within the river corridor. Because scenic relevant and important values are not attributed to areas above the rim, the Approved VFO RMP [BLM 2008b]states on page 41 that, "there is no need to restrict oil and gas leasing for visual purpose" above the canyon rim. Parcels 009 and 010 are located below the canyon rim. BLM would add the lease stipulation UT-S-23 - No Surface Occupancy to parcels 009 and 010. Leasing the parcels under a No Surface Occupancy stipulation would prevent any future associated development from occurring within these parcels. Thus, no direct impacts to relevant and important values within the Nine Mile Canyon ACEC are anticipated as a result of the proposed action.

Table 4.3. Nine Mile Canyon ACEC

ACEC	Lease Notice or Stipulation	Parcel
Nine Mile Canyon	UT-S-23 – No Surface Occupancy/Controlled Surface Use/Timing Limitations	009, 010

4.1.1.4. Lands with Wilderness Characteristics

Although the issuance of the lease would not directly impact the wilderness characteristics (naturalness, solitude, and primitive unconfined recreation) of the area, the issuance of leases does convey an expectation that drilling and development would occur. The potential development of the lease would likely cause indirect impacts to wilderness characteristics (see Table 3.3 above). A number of variables would influence the degree of impact to lands with wilderness characteristics, including where surface-disturbing activities occur, land form or topography, vegetation type, sequence of development, and reclamation time. If drilling and development were to occur in lands with wilderness characteristics, the wilderness characteristics in that area would likely be reduced. Impacts could include loss of naturalness and loss of opportunities for solitude or primitive unconfined recreation. Additional impacts from development could include a reduction in the size of the unit. Development associated with oil and gas leasing (e.g., well pads, access roads) could bisect or fragment a portion of the wilderness characteristics unit so that all or part of the unit no longer meets the size criteria.

Potential impacts to wilderness characteristics as a result of oil and gas development were anticipated in the Vernal FEIS and Proposed RMP [BLM 2008c], which states, "Construction of roads, well pads, compressors, pipelines, and power lines would disturb vegetation and soil and the natural characteristics of the non-WSA lands with wilderness characteristics. The presence of people, vehicles, and equipment, and the physical disturbance to the landscape would diminish opportunities for solitude and conflict with primitive forms of recreation".

For Desolation Canyon, the VFO FEIS and Proposed RMP [BLM 2008c] states that, "Given the resource potential, level of past production, existing leases, and ongoing exploration and development, it is anticipated [that the Desolation Canyon Unit and others] would lose all or most of their wilderness characteristics". The ROD qualifies on pages 33 and 34 that some areas were not selected to be managed for the purpose of preserving wilderness characteristics because they possess "high potential for oil and gas resources and currently have a large portions of the lands leased."[BLM 2008b] A portion of parcel 038 would be leased under Lease Stipulation UT-S-157 – No Surface Occupancy/Controlled Surface Use/Timing Limitations. Parcels 032,

and 039 are fully within the Desolation Canyon lands with wilderness characteristics unit, except for a cherry-stemmed road that is excluded from Parcel 039. Small portions of parcels 038 and 049 overlap the periphery of the Desolation Canyon Unit. All four of these parcels would be leased under standard oil and gas leasing stipulations. Where development occurs, wilderness characteristics would potentially be negatively affected; however, mitigation and project design features identified during future site-specific analysis could reduce the potential impacts to wilderness characteristics.

Impacts to wilderness characteristics for the Currant Canyon Unit have not been analyzed within a land use plan. Generally, impacts from the development of a lease would be similar to those described above. Parcels 009 and 010 are located along the southern boundary of the Currant Canyon lands with wilderness characteristics unit. These parcels are within an area subject to No Surface Occupancy stipulations to protect fragile soils, slopes and visual resources. BLM would add the lease stipulation UT-S-23 - No Surface Occupancy to parcels 009 and 010. Leasing the parcels under a No Surface Occupancy stipulation will prevent any future associated development from occurring within these parcels. Thus, no direct impacts to wilderness characteristics within lease parcels 009 and 010 that are within the Currant Canyon unit are anticipated as a result of the proposed action.

4.1.1.5. Livestock Grazing and Rangeland Health

Livestock grazing would continue; however, should development occur on the lease, loss of forage and possible reductions of AUMs would occur in the allotment due to disturbance and activity. Livestock movement patterns would be hindered by new roads and oil well pads. Increased traffic may lead to an increase in vehicle livestock collisions, and increasing mortality rates. Invasive weeds would be expected to increase along new roads and throughout well pads; past reclamation efforts have not been successful in eradication of invasive species or in obtaining the seral state of ecological site descriptions for those areas before disturbance occurred. Topsoil erosion would occur which would increase sediment loading within riparian areas and decrease viable soils for plant communities. Channelization would occur along roads.

Rangeland Health Assessments have been taken on these allotments in key areas for years. Some of these key areas could be lost due to disturbance from oil and gas development activity. Data would be and has been lost due to surface disturbance. New areas would have to be targeted as key areas for these allotments. Mitigation may need to take place on a site specific basis where Range Improvement Projects (RIPs) exist. This should include a 200 meter buffer from all RIPs. Depending on amount of disturbance, compensatory adjustments may be needed if AUMs are reduced on livestock operations. Compensatory adjustments would be looked at on a case by case basis at the Environmental Assessment level for the allotments' permit renewal process.

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4.1.1.6. Plants: Special Status

4.1.1.6.1. Plants: BLM-Sensitive Species

The issuance of leases would not directly impact BLM-Sensitive plant species on the nominated parcels. However, as the BLM generally cannot deny all surface use of a lease unless the lease is issued as a No Surface Occupancy stipulation, the issuance of leases does convey an expectation that drilling and development would occur. Chapter 3 identifies species that could be impacted through future actions on leased parcels. Beyond the potential loss or damage to individuals these

impacts include direct dispersed and indirect impacts including: the loss of suitable habitat for the species and its pollinators; increased competition for space, light, and nutrients with invasive and noxious weed species introduced and spread due to the Proposed Action; accidental spray or drift of herbicides used during invasive plant control; altered physiology (*i.e.*, photosynthesis, respiration, and transpiration) and reproductive success due to increased fugitive dust resulting from the surface disturbance and project related traffic. For the parcels on federally managed surface, application of the appropriate species-specific lease notices and application of lease notices UT-LN-49 (Utah Sensitive Species) , UT-LN-51 (Special Status Plants: Not Federally Listed), UT-LN-89 (Horseshoe milkvetch [*Astragalus equisolensis*]), and UT-LN-90 (Graham beardtongue [*Penstemon grahamii*]) would be adequate for the leasing stage to disclose potential restrictions against future authorizations. Lease notices UT-LN-49 and UT-LN-51 may require modifications to the Surface Use Plan of Operations. Lease notices UT-LN-89 and UT-LN-90 outline specific mitigation measures and survey requirements for each specific BLM-Sensitive plant species they include. Additionally, parcels identified as containing designated Conservation Agreement Areas (Table 3.4) will require additional mitigation and conservation measures if developed (see Conservation Agreement and Strategy for Graham's Beardtongue [*Penstemon grahamii*] and White River Beardtongue [*P. scariosus* var. *albifluvis*] SWCA 2014).

For a detailed descriptions of the Stipulation and Notices and how they are implemented see Appendix A.

Endangered Species Act (ESA) related stipulation (in accordance with BLM Handbook 3120–1 Competitive Leases (P) (H3120)) would be applied to all parcels: See Appendix A.

4.1.1.6.2. Plants: Threatened, Endangered, Proposed, and Candidate

The issuance of leases would not directly impact threatened, endangered, proposed, and candidate plant species on the nominated parcels. However, as the BLM generally cannot deny all surface use of a lease unless the lease is issued as a No Surface Occupancy stipulation, the issuance of leases does convey an expectation that drilling and development would occur. Chapter 3 identifies species that could be impacted through future actions on leased parcels. Beyond the potential loss or damage to individuals these impacts include direct dispersed and indirect impacts including: the loss of suitable habitat for the species and it's pollinators; increased competition for space, light, and nutrients with invasive and noxious weed species introduced and spread due to the Proposed Action; accidental spray or drift of herbicides used during invasive plant control; altered physiology (*i.e.*, photosynthesis, respiration, and transpiration) and reproductive success due to increased fugitive dust resulting from the surface disturbance and project related traffic. For the parcels on federally managed surface, application of the appropriate species-specific lease notices and application of lease notices UT-LN-49 (Utah Sensitive Species), T&E-05 (Listed Plant Species), T&E-12 (Pariette cactus [*Sclerocactus brevispinus*] and Uinta Basin hookless cactus [*Sclerocactus wetlandicus*]), T&E-20 (Clay reed-mustard [*Hesperidanthus suffrutescens*]), T&E-21 (Shrubby reed-mustard [*Hesperidanthus suffrutescens*]), and T&E-22 (Ute ladies'-tresses [*Spiranthes diluvialis*]) would be adequate for the leasing stage to disclose potential restrictions against future authorizations. Additionally, the parcels identified as containing Core Conservation Areas (Table 3.5) will require additional mitigation and conservation measures if developed (see Ecological Restoration Mitigation Calculation Guidelines for impacts to *Sclerocactus wetlandicus* and *Sclerocactus brevispinus* Habitat, USFWS 2014.

4.1.1.7. Recreation

The issuance of lease parcels 009 and 010 would not directly impact the Nine Mile SRMA. However, as the BLM generally cannot deny all surface use of a lease unless the lease is issued with a No Surface Occupancy stipulation, the issuance of leases does convey an expectation that drilling and development would occur.

Should construction and drilling occur, the sights and sounds associated with the development of the oil and gas related activities would be apparent to visitors participating in recreation related activities. The noise of construction and operation of producing wells, including the presence of work crews, vehicles, and equipment, would reduce primitive recreational opportunities in proximity to development. Impacts from light and sound would be minimized by implementing the VFO RMP [BLM 2008c] management decisions (MIN-5) that state, "The BLM would seek to minimize light and sound pollution within the Vernal Planning Area by using the best available technology such as installation of multi-cylinder pumps, hospital sound-reducing mufflers, and placement of exhaust systems to direct noise away from noise sensitive areas." The noise sensitive area would be the Nine Mile Canyon itself. The following lease stipulations and notices would be adequate for the leasing stage to disclose potential restrictions against future development of parcels 009, and 010: UT-S-23 - No Surface Occupancy/Controlled Surface Use and UT-LN-106 (Special Recreation Management Area).

Table 4.4. ACEC

ACEC	Lease Notice or Stipulation	Parcels
Nine Mile Canyon ACEC	UT-S-23 – No Surface Occupancy/Controlled Surface Use	009, 010

4.1.1.8. Visual Resources

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The issuance of leases would not directly impact Visual Resources. However, as the BLM generally cannot deny all surface use of a lease unless the lease is issued as a No Surface Occupancy stipulation, the issuance of leases does convey an expectation that drilling and development would occur.

For the purposes of this analysis, there could be potential effects to visual resources found in the existing inventory classification identified in VRI Section 3.1.8. These impacts would include future development in the form oil wells/pads, pipelines, compressors, power lines, constructed roads and other linear features. These impacts (form, line, color and texture) to the existing landscape found in the current VRI Classes would be allowable under the visual resource management decision which was established in the VFO RMP [BLM 2008b]. Further detailed analysis of these potential impacts to the VRI would be analyzed in the future as oil and gas development plans and permits to drill are submitted. Mitigations and design features in order to reduce the potential impacts to the VRI would be addressed at that time. Management decisions made in order to manage visual resources are reflected in the visual resource management classification (VRM), These classes would be utilized to address potential effects to the visual resource for the remainder of the document. Impact to visual resources would be considered relevant if the impacts of the proposed project do not conform to an area's designated visual resource management (VRM) class objectives which for this proposed action include VRM Class II, III, and IV. Short-term impacts are those that would affect visual resources for fewer than five years; long-term impacts would affect visual resources for more than five years. The potential direct adverse impacts to visual resources would include the visual contrasts created by

construction equipment, pipelines, well pads, temporary and permanent access roads, and other forms of infrastructure associated with oil and gas exploration and development. In general, drilling rigs and equipment, construction and maintenance vehicles, development infrastructure, and surface disturbance, including roads, would impact an area's scenic quality and appearance of naturalness with human-made form, color, and linear contrasts. A visual contrast rating process would be used for the VRM analysis, which involves comparing the project features with the major features in the existing landscape to determine whether the scenic values of the BLM managed lands within each parcel have been maintained. The following lease stipulations would be adequate for the leasing stage to disclose potential restrictions against future development of parcel 038: UT-S-157 (NSO/CSU/TL Visual Resources) and UT-S-159 (VRM I/II).

Table 4.5. VRM

VRM Class	Lease Notice or Stipulation	Parcels
All	UT-S-157 – No Surface Occupancy/Controlled Surface Use/timing Limitations — Visual Resources	All Parcels
Class /II	Controlled Surface Use – Visual Resources – VRM II	038

4.1.1.9. Wildlife: Migratory Birds including Raptors

The issuance of leases would not directly impact migratory birds and raptors on the nominated parcels. However, the issuance of leases does convey an expectation that construction and drilling could occur. Chapter 3 identifies that migratory birds and raptors occur on all parcels and could be potentially impacted through future actions on leased parcels. In addition to the direct loss and fragmentation of habitat, noise disturbances from increased traffic levels could displace migratory birds and raptors. However, the Lease Stipulation UT-S-261 (Buffers and timing limitations for raptor nests) and Lease Notice UT-LN-45 (notice for Migratory bird nesting surveys) would be applied to all parcels to mitigate/minimize these impacts. Modifications to a surface plan of operation would be addressed at the APD stage. Bird and raptor surveys would be conducted and utilized prior to any surface disturbing activity.

Application of the migratory bird and raptor lease notices would be adequate for the leasing stage to disclose potential restrictions to reduce potential impacts. Appropriate lease stipulations and notices have been included within the Proposed Action to protect habitat values (see Appendix A). Project-specific impacts relating to future authorizations cannot be analyzed until an exploration or development application is received.

4.1.1.10. Wildlife: Non-USFWS Designated

The issuance of leases would not directly impact fish and wildlife resources on the nominated parcels. Chapter 3 identifies species and habitats which could be potentially impacted through future actions on leased parcels. Project-specific impacts relating to future authorizations cannot be analyzed until an exploration or development application is received, however for both general fish and wildlife, impacts are assumed to include the direct loss and fragmentation of habitat upon construction of a well pad with its associated road and pipeline. In addition, noise disturbances from increased traffic levels could displace wildlife species.

Appropriate lease stipulations and notices have been included to protect big game habitat values (see Table 4.6, "General Wildlife Stipulations").

Table 4.6. General Wildlife Stipulations

Species	Stipulations	Parcels
Crucial elk calving	UT-S-247 TL-Crucial Deer Fawning & Elk Calving Habitat	006, 012, 013,014, 015, 016
Crucial elk winter	UT-S-230 TL-Crucial Deer and Elk Winter Range	005, 009, 070, 152
Crucial deer fawning	UT-S-247 TL-Crucial Deer Fawning & Elk Calving Habitat	004, 038, 070, 094, 103
Crucial deer wintering	UT-S-230 TL-Crucial Deer and Elk Winter Range	009, 070, 121, 122, 152

4.1.1.11. Wildlife: Special Status Species

The issuance of leases would not directly impact special status species or habitat. However, the issuance of a lease does convey an expectation that oil and gas development could occur. Chapter 3 identifies species and habitats which could be potentially impacted through future actions on leased parcels. Project-specific impacts relating to future authorizations cannot be analyzed until an application for development is received, however it is assumed to include the direct loss and fragmentation of habitat upon construction of a well pad with its associated road and pipeline. In addition to the direct loss and fragmentation of habitat associated with the Proposed Action, noise disturbances from increased traffic levels, or water depletion (for fish) could temporarily displace wildlife species. Refer to Table 4.7, "Special Status Species" for a brief summary of anticipated impacts should development occur and refer to Table 4.8, "Special Status Species Stipulations/Notices". for a description of the lease stipulations and notices.

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Table 4.7. Special Status Species

Species	Potential Impacts
Bonytail Chub, Colorado Pikeminnow, Humpback Chub, Razorback Sucker, Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub	All parcels have potential for drilling activities to use water from the Green River system. Water depletions reduce the ability of the river to create and maintain the primary constituent elements that define critical habitats. Food supply, predation, and competition are important elements of the biological environment. Food supply is a function of nutrient supply and productivity, which could be limited by reduction of high spring flows brought about by water depletions. Predation and competition from nonnative fish species have been identified as factors in the decline of the endangered fishes.
Townsend's Big-Eared Bat, Big Free-Tailed Bat, Spotted Bat, Fringed Myotis, Allens Big Eared Bat, Western Red Bat	Construction of roads and well pads could result in the loss of foraging habitat, making it less suitable for bats. As traffic volumes and/or project-related activities increase, adjacent habitats may be avoided due to human presence, noise, and the potential influx of invasive weeds.
Golden Eagle, Bald Eagle, Burrowing Owl, Ferruginous Hawk, Short-eared Owl	Potential effects of the Proposed Action on raptor species include: 1) increased indirect impacts (including poaching and collisions with vehicles), 2) direct loss or degradation of potential nesting and foraging habitats from construction and drilling, and 3) indirect disturbance from human activity (including harassment, displacement, and noise).
Gray Vireo, Grasshopper Sparrow, Brewer's Sparrow, Bobolink	The proposed action would result in a loss of habitat for migratory birds. Direct impacts to nesting and breeding migratory birds may occur, depending upon the time of construction and drilling. If development occurs in the spring, during the nesting season for most migratory birds, impacts would be greater than if development occurred between late summer and late winter. Impacts to birds during the spring could include nest abandonment, reproductive failure, displacement, and destruction of nests.

Species	Potential Impacts
Mexican Spotted Owl	Potential impacts include increased human presence; equipment and vehicle use; and surface disturbance in owl habitat. Associated visual and noise disturbance may adversely affect the behavior of owl during breeding, nesting, roosting, or foraging efforts.
Sage-grouse	Some potential impacts of oil and gas development to Sage-grouse include: (1) direct loss and fragmentation of habitat from well, road, and pipeline construction, (2) increased human activity causing avoidance and displacement, and (3) increased predation from installation of infrastructure (i.e., storage tanks, power lines, etc.).
Yellow-billed Cuckoo	The impacts could include loss of suitable habitat from construction and drilling. Disturbance due to noise from construction and human activities could cause birds to abandon nests or deter them from nesting in those areas.

The following Endangered Species Act (ESA) related stipulation (in accordance with BLM Handbook 3120–1–competitive Leases (P) (H-3120) p. 35) would be applied to all parcels:

> The lease may now and hereafter contain plants, animals, and their habitats determined to be special status species. BLM may recommend modifications to exploration and development proposals to further its conservation and management objectives to avoid BLM approved activity that will contribute to a need to list such a species or their habitat. BLM may require modification to or disapprove proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligation under requirements of the Endangered Species Act as amended, 16 U. S. C. § 1531 *et seq.* including completion of any required procedure for conference or consultation.

Parcels 032, 067 and 152 are within GHMA for GRSG, within oil and gas developed areas and within an oil and gas unit, therefore they are being considered for leasing for the November 2016 Lease Sale. It is assumed, at the leasing stage, that at least one well would be drilled on each of these leases. Therefore, each parcel could have approximately 4 acres of disturbance if development were to occur (refer to Proposed Action in Ch. 2). The GRSG habitat on these parcels is marginal, and the areas adjacent to these parcels have already had substantial impacts from existing development. In complying with RMP management, the BLM would be able to work with the operator at the time of the development to avoid that habitat

All of these three leases also include lease notices that alert the lessee that there is GRSG habitat on the parcel. Lease notices for Required Design Features (RDF), buffers and net conservation gain have been placed on these parcels. These inform the lessee that there are additional resources that are going to have to be considered at the time of development and some of the possible restrictions that may be associated with those resources. The lease notices listed here are to ensure management activities for GRSG at the development stage will be completed according to management action MA-SSS-5 in the GRSG ARMPA. This decision includes required mitigation for any action in GRSG habitat (GHMA or PHMA) in order to provide a net conservation gain to the species. This can be achieved through avoiding, minimizing or providing compensatory mitigation for those habitats impacted by the development. The buffer notice will be applied by ensuring that leks within GHMA are still protected to the extent needed in each situation to sustain that population. That would be decided on a case-by-case basis at the time of proposed development. See the table below for GHMA lease notices.

Impacts on GRSG in these populations would be minimal based on the incidental or low use of this habitat. However, the impacts could include but are not limited to degradation of overall habitat displacement and fragmentation of habitat (see GRSG FEIS section 4.3.7 for a detailed description of potential impacts on GRGS in GHMA from oil and gas activity).

Table 4.8, "Special Status Species Stipulations/Notices" lists all additional lease notices and stipulations that would also be applied to the indicated parcels.

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Table 4.8. Special Status Species Stipulations/Notices

Species	Lease Notice or Stipulations	Parcels
Bonytail Chub, Colorado Pikeminnow, Humpback Chub, Razorback Sucker	T&E-03 Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-49 Utah Sensitive Species	All
Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub	UT-LN-49 Utah Sensitive Species	All
Townsend's Big-Eared Bat, Big Free-Tailed Bat, Spotted Bat, Fringed Myotis, Allens Big Eared Bat, Western Red Bat	UT-LN-49 Utah Sensitive Species	All
Mexican Spotted Owl	T&E-06 NSO/CSU/TL Mexican Spotted Owl	004, 005, 009, 010
Bald Eagle	UT-S-278 CSU-Bald Eagle Winter Roost UT-LN-107 Bald Eagle Nesting and Winter Roost Habitat	038, 069, 071, 094, 103, 142,
Golden Eagle and Bald Eagle	UT-S-261 NSO/CSU/TL-Raptor Buffer UT-LN-49 Utah Sensitive Species UT-LN-40 Golden Eagle Habitat UT-LN-49 Bald Eagle Habitat	All
Ferruginous Hawk	UT-S-261 NSO/CSU/TL-Raptor Buffer UT-LN-49 Utah Sensitive Species	All
Short-eared owl	UT-S-261 NSO/CSU/TL-Raptor Buffer UT-LN-49 Utah Sensitive Species	All
Gray Vireo, Grasshopper Sparrow, Brewer's Sparrow, Bobolink	UT-LN-45 Migratory Birds UT-LN-49 Utah Sensitive Species	All
Sage-grouse GHMA	UT-LN-49 Ut. Sens. Species UT-LN-131 SG/Net Gain UT-LN-132 SG/RDF's UT-LN-133 SG/Buffer UT-S-195 NSO - SG/Leks UT-S-205 TL - SG/Brood Rearing UT-S-206 CSU - SG/Noise Reduction UT-S-207 CSU - SG/Structures	032, 067, 152
Yellow-billed Cuckoo	UT-LN-49 Utah Sens. Species UT-LN-113 Western YBC UT-LN-115 Light and Sound	038, 094, 103

Application of these stipulations and notices to each of the parcels on federal surface would be adequate for the leasing stage to disclose potential future restrictions and to facilitate the reduction of potential impacts upon receipt of a site specific APD.

4.1.2. Alternative B – No Action

4.1.2.1. Air Quality

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.1.1. Greenhouse Gases and Climate Change

Under the no action alternative no direct or indirect GHG emissions would occur from any potential future production from these lease parcels. Whether this would result in an actual reduction in future GHG emissions is unknowable, as this production could be made up from production from other oil and gas production fields.

4.1.2.2. Cultural

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.3. Areas of Critical Environmental Concern

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed

4.1.2.4. Lands with Wilderness Characteristics

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.5. Livestock Grazing & Rangeland Health

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.6. Plants: Special Status

4.1.2.6.1. Plants: BLM-sensitive Species

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.6.2. Plants: Threatened, Endangered, Proposed, and Candidate.

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.7. Recreation

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.8. Visual Recourses

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.9. Wildlife: Migratory Birds including Raptors

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.10. Wildlife: Non-USFWS Designated

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

4.1.2.11. Wildlife :Special Status Species

The No Action alternative would not result in potential impacts because the parcels would not be leased or developed.

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4.2. Cumulative Impacts Analysis

A cumulative impact is defined in CEQ regulations (40 CFR §1508.7) as "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively major actions taking place over a period of time. The cumulative impact area varies by resource.

Past, present, and reasonably foreseeable impacts may occur from a variety of activities. Dispersed recreation activities, such as sightseeing, biking, camping, and hunting, have occurred and are likely to continue to occur within the nominated parcels; these activities likely result in negligible impacts to resources because of their dispersed nature. Other land use activities, such as livestock grazing, vegetation projects, oil and gas development, and wildland fire, have also occurred within the nominated parcels and are likely to occur in the future. These types of activities are likely to have a greater impact on resources in the project area because of their more concentrated nature.

4.2.1. Air Quality

The cumulative impact area for air quality is the Uinta Basin, plus all regional Class I areas and other environmentally sensitive areas (e.g., national parks and monuments, wilderness areas, etc.) near the Uinta Basin. The Air Resource Management Strategy (ARMS) Modeling Project [BLM 2011] is a cumulative assessment of potential future air quality impacts associated with predicted oil and gas activity in the Uinta Basin . Consequently, past, present and reasonably foreseeable wells in the Uinta Basin are a part of the cumulative actions considered in this analysis. The ARMS is incorporated by reference and summarized below.

The ARMS Modeling Project predicted the following impacts to air quality and air quality related values for the 2010 typical year and four 2021 future year scenarios: 2021 on-the-books (OTB); 2021 Scenario 1 (NO_xcontrols); 2021 Scenario 2 (VOC controls); and 2021 Scenario 3 (NO_x and VOC controls).

- Ozone
    - The highest modeled ozone occurs in the Uinta Basin study area regardless of model scenario, and all scenarios predict exceedances of the ozone NAAQS and state AAQS in the Uinta Basin.
    - In the Uinta Basin, the ozone concentrations are highest during the winter period. In Class I and Class II areas outside the Uinta Basin study area, ozone concentrations are highest during the summer period.
    - During non-winter months in the Uinta Basin the model predicts that ozone may exceed the NAAQS and state AAQS (Ambient Air Quality Standards); however, model-adjusted results from the MATS tool (which accounts for model performance biases) indicate that non-winter ozone concentrations are below the NAAQS and state AAQS for all monitors and areas analyzed. Also, the 2021 scenarios have minimal effect on model-predicted ozone concentrations during non-winter months.
    - 2021 Scenario 2 tends to have the lowest 8-hour ozone concentration relative to all other 2021 scenarios (4th highest daily maximum is 3 ppb lower compared to the 2021 OTB Scenario). When comparing Scenario 2 to the OTB Scenario, a potential reduction in ozone concentrations occurs in the vicinity of the Ouray site (where the concentrations are already largest). There is no predicted ozone disbenefit associated with Scenario 2 mitigation measures (i.e., there is no area with predicted ozone increases relative to the OTB Scenario). This supports the assessment that peak ozone impacts are in VOC-limited areas.
    - 2021 Scenarios 1 and 3 are predicted to have higher ozone impacts than either the 2010 Typical year and the 2021 OTB Scenario. Both scenarios predict a relatively large increase in ozone concentrations within the vicinity of Ouray indicating potential ozone disbenefits associated with NO_x control mitigation measures.
- NO_2, CO, SO_2, $PM_{2.5}$, and PM_{10}
    - There are seven monitoring stations within the 4- km domain with daily $PM_{2.5}$ concentrations that exceed the NAAQS and state AAQS in the baseline emissions inventory.

- All modeled NO_2, CO, SO_2, $PM_{2.5}$, and PM_{10} values are well below the NAAQS and state AAQS in the Uinta Basin.
- The model-predicted $PM_{2.5}$ and PM_{10} concentrations may underestimate future impacts due to a negative model bias throughout the year in the 4-km domain with the largest bias occurring in summer [AECOM and STL].
- Results from the MATS tool (which accounts for model performance biases) indicate that $PM_{2.5}$ concentrations may exceed the NAAQS and state AAQS for select monitors and assessment areas in the 2010 Typical year. All 2021 scenarios predict that only one of these monitoring station would continue to exceed the NAAQS and state AAQS.
- No monitoring stations within the 4-km domain exceed the annual $PM_{2.5}$ NAAQS and state AAQS during the 2010 typical or 2021 Scenarios.
- Two unmonitored areas within the Uinta Basin exceed the annual $PM_{2.5}$ NAAQS and state AAQS during the 2010 typical year, and impacts in these areas tend to increase under 2021 Scenarios 1 and 2. Under 2021 Scenario 3, the annual PM_2 impacts decrease in the Uinta Basin due to combustion control measures.
- The 2021 scenarios generally have lower NO_2, CO, SO_2, $PM_{2.5}$, and PM_{10} concentrations than the 2010 Typical Year scenario, except for within the Uinta Basin.
- Under the 2021 scenarios, all assessment areas are within the PSD (Prevention of Significant Deterioration) increments for annual NO_2, 3-hour SO_2, annual SO_2, and annual PM_{10}.
- Under the 2021 scenarios, most assessment areas exceed the 24-hour $PM_{2.5}$ PSD increment.

- Visibility
  - Visibility conditions in Class I and sensitive Class II areas generally show improvement in the 2021 Scenarios relative to the 2010 Typical Year.
  - There also are no substantial differences in the 20th percentile best and worst visibility days between the 2021 Scenarios.
- Deposition and Acid Neutralizing Capacity
  - Results generally show a decrease in deposition for the 2021 Scenarios relative to the 2010 Typical Year.
  - The differences in estimated deposition between the 2021 Scenarios are generally very small.
  - Acid Neutralizing Capacity change at all seven sensitive lakes exceeds the 10 percent limit of acceptable change for all model scenarios.

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It is anticipated that the impact to ambient air quality and air quality related values associated with the Proposed Action would be indistinguishable from and dwarfed by the model and emission inventory scope and margin of error. The No Action alternative would not contribute any cumulative impacts.

Greenhouse Gases

Even though the Proposed Action of leasing would not contribute to cumulative effects on air resources, future foreseeable development could contribute to cumulative GHG emissions. The primary sources of emissions include the following:

- Fossil fuel combustion for construction and operation of oil and gas facilities – vehicles driving to and from production sites, engines that drive drill rigs, etc. These produce CO_2 in quantities that vary depending on the age, types, and conditions of the equipment as well as the targeted formation, locations of wells with respect to processing facilities and pipelines, and other site-specific factors.
- Fugitive CH_4 – CH_4 that escapes from wells (both gas and oil), oil storage, and various types of processing equipment. This is a major source of global CH_4 emissions. These emissions have been estimated for various aspects of the energy sector, and starting in 2011, producers are required under 40 C.F.R. §98, to estimate and report their CH_4 emissions to the EPA.
- Combustion of produced oil and gas – it is expected that operations will produce marketable quantities of oil and/or gas. Combustion of the oil and/or gas would release CO_2 into the atmosphere. Fossil fuel combustion is the largest source of global CO_2.

4.2.2. Cultural

The cumulative impact area for this resource is the parcel boundaries, and includes the entirety of Nine Mile Canyon, and Steinaker Reservoir. Past, present, and reasonably foreseeable activities within the parcels that could have potential cumulative impacts on cultural resources include increased visitation and motorized access into previously inaccessible areas. Cumulative impacts include dust accumulation and its impact on rock art, changes in visitation, inadvertent or advertent (i.e., vandalism and looting) damage to cultural resources, impacts to unidentified Traditional Cultural Properties and increased recreational use.

Surface disturbance resulting from mineral exploration and development including road, pipeline and electric line construction could potentially cause the greatest amount of cumulative impacts to cultural resources in the parcels. These activities have the potential to increase visual, noise, atmospheric and other such intrusions that affect the cultural setting of historic properties, which may contribute to their National Register of Historic Places eligibility determinations. The proposed action adds the potential for development to occur in these areas. The No Action alternative would not contribute any cumulative impacts.

Since climate change and global warming are global phenomena, for purposes of this NEPA analysis, the analysis presented above about the direct and indirect effects of GHG emissions from the proposed actions is also an analysis of the cumulative effects of the proposed actions. Consistent with CEQ guidance, the BLM has determined that this analysis "adequately addresses the cumulative impacts for climate change from the proposed action and its alternatives, and therefore a separate cumulative effects analysis for GHG emissions is not needed.

4.2.3. Areas of Critical Environmental Concern

The cumulative impact boundary of analysis for the Nine Mile Canyon ACEC (44,168 Acres) is the boundary of the respective ACEC resource area. The rationale for this boundary is that special management considerations are placed on the ACECs to protect the relevant and important (R&I) values. The R&I values of these ACECs include, Nine Mile ACEC: cultural resources, high

quality scenery, and special status species. The past, present, and foreseeable future actions with the potential to contribute to surface disturbance include development of new and existing mineral rights or realty actions (for example, oil wells, pump jacks, pipeline, road rights of ways, etc.). The cumulative effects and the area of impact would be the same as outlined in section 4.16.1 and 4.23.15.1 of the VFO RMP [BLM 2008b]. The proposed action would contribute to these cumulative impacts by making parcels 009 and 010 available for lease and mineral development within the Nine Mile ACEC. For specific analysis of the cumulative impacts to the R&I values contained within the ACEC please refer to the applicable sections of this document. The No Action alternative would not contribute any cumulative impacts.

4.2.4. Lands with Wilderness Characteristics

The cumulative impact area for lands with wilderness characteristics for this EA includes all lands with wilderness characteristics within the Desolation Canyon and Currant Canyon Units. The past, present, and foreseeable future actions with the potential to contribute to surface disturbance include development of new and existing mineral rights (leases) and/or realty actions (for example, pipeline or road rights-of-way). Reasonably foreseeable actions related to the implementation of the proposed action could result in the loss wilderness characteristics within the units affected.

Desolation Canyon Wilderness Character Inventory Unit (95,000 acres)

Leasing the parcels described in the proposed action (approximately 959 acres which represent approximately 1.0% of the Desolation Canyon Unit), combined with all other active leases within this lands with wilderness characteristics unit (approximately 57,776 acres) would result in total leased area of approximately 58,725 acres within the contiguous Desolation Canyon lands with wilderness characteristics unit. Cumulatively, 62% of the unit would be leased for oil and gas development. If development were to occur, it can be expected that wilderness characteristics would be lost specifically in the areas where associated surface disturbance occurs. Even if the majority of the unit is leased, there would continue to be areas greater than 5,000 contiguous acres which would meet the minimum size criteria for wilderness characteristics. Reasonably foreseeable development scenarios indicate that the cumulative impacts of the proposed action could affect an additional 1.0% of the unit; however, this is subject to each individual lease's surface use stipulations and topography and whether or not the lease is developed. For the Desolation Canyon unit, this level of development was disclosed in the VFO FEIS and Proposed RMP and accepted by the decision in the RMP [BLM 2008c].

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The No Action alternative would not contribute any cumulative impacts within the Desolation Canyon Unit.

Currant Canyon Wilderness Character Inventory Unit (20,700 acres)

Leasing the parcels described in the proposed action (approximately 1,561 acres which represent approximately 7.5% of the Currant Canyon Unit), combined with all other active leases within this lands with wilderness characteristics unit (approximately 13,154 acres) would result in the total leased area of approximately 14,715 acres. Depending upon the location of the well pad outside of the area that is NSO, there is potential for impacts to wilderness characteristics in the portion of Currant Canyon that is not subject to leasing restrictions. Cumulatively, 73% of this inventory unit would be leased for oil and gas development.

Additionally, while no decision has been issued, the preferred alternative for the Energy Gateway South FEIS would remove approximately 103 acres from the unit for development of a right-of-way along the unit's northern edge.

If development were to occur, it can be expected that wilderness characteristics would be lost specifically in the areas where associated surface disturbance occurs. In addition, if development were to occur on every current lease as well as the Energy Gateway South right-of-way, the layout of the ROW application, current leased and proposed parcels within the Currant Canyon lands with wilderness characteristics unit would result in the fragmentation of the unit so as to eliminate any area that would meet the minimum size criteria of 5,000 contiguous acres within the unit. However, leases are subject to each individual lease's surface use stipulations, constrained by topography and development of leases and proposed projects may or may not occur.

The No Action alternative would not contribute any cumulative impacts within the Currant Canyon unit.

4.2.5. Livestock Grazing & Rangeland Health Standards

The cumulative impact area for the lease sale is the boundary of the affected allotments. Ground disturbing activities associated with oil and gas development would include well pad construction, road upgrades and construction, compressor station and pipeline construction. This development results in a loss of AUMs and provides conditions for invasive plant species establishment and increase.

Natural resources affected within these allotments would include direct surface disturbing impacts to soil and vegetation from ground disturbing activities. Permitted livestock use on some of these allotments has already been reduced due to oil and gas development. Future reductions would be expected as a direct result of fragmentation and loss of forage. Surface impacts also directly (*alter water flow*) and indirectly (*noise and traffic offset animals loafing and watering at ponds*) affect the water improvements specifically managed for livestock. The analysis for any changes in AUM allocation and general grazing operations throughout these allotments would occur in separate permit renewal NEPA documents. The proposed action would contribute to these cumulative effects by making eleven parcels available for leased mineral development within active grazing allotments.

The No Action alternative would not result in cumulative impacts.

4.2.6. Plants: Special Status

4.2.6.1. Plants: BLM-Sensitive Species

The cumulative impact area for BLM-Sensitive plant species will be the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.17.2 4.23.16, and 4.23.14 in the VFO RMP [BLM 2008c]. Cumulative impacts include reduction in loss of habitat, habitat fragmentation, increased road access for OHV use and illegal collection of individuals. The past, present, and foreseeable future actions include development of new and existing mineral rights, including road, pipeline, and well pad construction. The Proposed Action would contribute to these cumulative impacts by making the proposed parcels available for lease sale and mineral development. The No Action alternative would not contribute any cumulative impacts.

4.2.6.2. Plants: Threatened, Endangered, Proposed, and Candidate

The cumulative impact area for threatened, endangered, proposed, and candidate plant species will be the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.17.2 4.23.16, and 4.23.14 in the VFO RMP[BLM 2008c]. Cumulative impacts include reduction in loss of habitat, habitat fragmentation, increased road access for OHV use and illegal collection of individuals. The past, present, and foreseeable future actions include development of new and existing mineral rights, including road, pipeline, and well pad construction. The Proposed Action would contribute to these cumulative impacts by making the proposed parcels available for lease sale and mineral development. The No Action alternative would not contribute any cumulative impacts.

4.2.7. Recreation

The cumulative impact area for the Nine Mile Canyon SRMA and respective SRMA boundary. The rationale for this boundary is the interconnected access of recreational resources (trailheads, campgrounds, etc.) within the SRMA. Cumulative impacts are incorporated by reference to 4.12.2. and 4.23.10 in the []. The past, present, and foreseeable future actions include development of new and existing mineral rights (including pump jacks, roads, pipelines, well pad construction, etc.). Cumulative impacts include noise, light and traffic from oil and gas drilling and production in the area which would change the recreational experience of the area. The proposed action would contribute to these cumulative impacts by leasing parcels 009 and 010 for mineral development. Cumulatively, this would reduce the availability and/or quality of outdoor recreation opportunities (both dispersed and developed) on public lands within the VFO planning area:

Nine Mile Canyon SRMA (44,168 Acres)

Currently approximately 23,903 acres are leased for oil and gas development within the Nine Mile Canyon SRMA. The proposed action would lease an additional two parcels within the Nine Mile SRMA, approximately 1,839 acres for a total of approximately 25,702 acres or 58% of the SRMA. The No Action alternative would not contribute any cumulative impacts.

4.2.8. Visual Resources

The cumulative impact area considered for visual resources is the applicable inventory units of the Vernal Field Visual Resource Inventory (November 2011). The rationale for this boundary is that the visual resource inventory serves as the baseline information for assessing potential effects to visual resources within the proposed projects. Cumulative impacts are incorporated by reference to 4.12.2. and 4.23.10 of the VFO RMP [BLM 2008b]. The past, current and future activities in the inventory unit would cumulatively increase the cultural modification done to the landscape. This is viewed as negative impact when assessing the scenic quality of an area. The proposed action would contribute to these cumulative impacts by making 28 parcels available for lease and mineral development Parcel 038 in VRM Class II areas; Parcels: 004, 005, 009, 010, 012, 013, 014, 015, 032, 038, 067, 070, 094, 103, 121, 122, 151, 152 in VRM Class III areas; and parcels: 006, 009, 010, 012, 013, 014, 015, 016, 032, 039, 049, 070, 071 in VRM Class IV. Visual contrast analysis would be conducted to determine if development is in compliance with VRM standards when the project proponents begin the work of developing the minerals within the

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parcels. When a plan of development is created, site specific VRM analysis would be conducted. The No Action alternative would not contribute any cumulative impacts.

4.2.9. Wildlife: Migratory Birds Including Raptors

The cumulative impact area for Migratory Birds is the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.21.2 and 4.23.18 in the VFO RMP [BLM 2008b]. Cumulative impacts include loss of migratory bird habitat, habitat fragmentation, and disruption or alteration of seasonal migration routes. The past, present, and foreseeable future actions with the potential to contribute to surface disturbance include development of new and existing mineral rights or realty actions (for example, pipeline or road rights of way) and the continuation of agricultural activities. The proposed action would contribute to these cumulative impacts by making the 28 proposed parcels available for lease sale and mineral development, with the potential for future surface disturbance should the leases be developed. The No Action alternative would not contribute any cumulative impacts.

4.2.10. Wildlife: Non-USFWS Designated

The cumulative impact area for elk and mule deer will be the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.21.2 and 4.23.18 in the VFO RMP [BLM 2008c]. Cumulative impacts to general wildlife and raptors include loss of habitat for wildlife and fisheries, habitat fragmentation, and disruption or alteration of seasonal migration routes. The past, present, and foreseeable future actions with the potential to contribute to surface disturbance include development of new and existing mineral rights or realty actions (for example, pipeline or road rights of way) or the continuation of agricultural activities. The proposed action would contribute to these cumulative impacts by making parcels 004, 005, 006, 009,012,013,014, 015, 016, 038, 070, 094, 103, 121, 122, and 152, available for mineral development, with the potential for future surface disturbance should the leases be developed. The No Action alternative would not contribute any cumulative impacts.

4.2.11. Wildlife: Special Status Species

The cumulative impact area for Special Status Animal Species is the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.17.2, 4.21.2, and 4.23.14 in the VFO RMP [BLM 2008c]. Cumulative impacts to threatened, endangered, candidate, or sensitive animal species include loss of habitat for wildlife and fisheries (including water depletion), habitat fragmentation, and disruption or alteration of seasonal migration routes. The past, present, and foreseeable future actions with the potential to contribute to surface disturbance include development of new and existing mineral rights or realty actions (for example, pipeline or road rights of way) or the continuation of agricultural activities. The proposed action would contribute to these cumulative impacts by making the 28 proposed parcels, as found in Appendix A, available for lease sale and mineral development, with the potential for future surface disturbance should the leases be developed. The No Action alternative would not contribute any cumulative impacts.

Greater Sage-Grouse

The cumulative impact area for GRSG is the Vernal Planning Area. Cumulative impacts are incorporated by reference to 4.17.2, 4.21.2, and 4.23.14 in the Vernal RMP [BLM 2008c] and

from chapter 5 of the GRSG FEIS. The proposed action does have a potential to contribute to surface disturbance and habitat fragmentation from development of new and existing mineral rights or realty actions (for example, pipeline or road rights-of-way). The proposed action could contribute to these cumulative impacts by making the 032, 067, 152 proposed parcels, as found in Appendix A, available for lease sale and mineral development. However, when added to the past, present, and foreseeable future impacts associated with the GRSG habitats in these PAs, these new impacts are not anticipated to affect local populations given their small size relative to the landscape (Parcel 032 is 0.0003% of the total acres of the Carbon population and Parcels 067 and 152 combined is 0.00005% of the total acres of the Uintah population), existing habitat conditions, and the presence of impacts from existing developments surrounding these parcels. The No Action alternative would not contribute any cumulative impacts.

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Chapter 5. Consultation and Coordination:

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The ID Team Checklist (Appendix C) provides the rationale for issues that were considered but not analyzed further. The issues were identified through the public and agency involvement process described below.

Table 5.1. List of Persons, Agencies and Organizations Consulted

Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
Utah State Historic Preservation Office (SHPO)	Consultation for undertakings, as required by the National Historic Preservation Act (NHPA) (16 USC 470)	The BLM initiated consultation on the proposed lease sale with the Utah SHPO under Section 106, of the NHPA on 05/24/2016. An additional consultation letter and cultural report for the proposed parcels was sent to the SHPO on 08/16/2016 with a determination of "No Adverse Effect". SHPO concurred with that determination on 09/21/216.
Ute Mountain Ute Tribe, Ute Indian Tribe, Goshute Indian Tribe, Zia Pueblo Tribe, White Mesa Ute Tribe, Navajo Nation, Laguna Pueblo Tribe, Northwest Band of Shoshone Tribe, Southern Ute Tribe, Eastern Shoshone Tribe, Santa Clara Pueblo Tribe, Hopi Tribe, Jemez Pueblo	Consultation as required by the American Indian Religious Freedom Act of 1978 (42 USC 1531) and NHPA (16 USC 1531)	Letters containing notification of this lease sale, location maps, and legal descriptions of the proposed parcels were sent to the Tribes 5/24/2016 . The letters detail the leasing proposal and requested comments and concerns. Consultation with tribes is ongoing. A response dated August 29, 2016 and received in the Vernal Field Office September 12, 2016, from the Hopi Tribe requested parcels 004, 005, 009, 010, and 014 be withdrawn from the lease sale. (Commented that leasing parcels 009, 010 & 014 would lead to increased and cumulative industrial traffic, noise and pollution on and around the so called Nine Mile Canyon Scenic By-way. Commented that they understand a No Surface Occupancy stipulation is proposed, but do not concur that this will result in no adverse effects.) A response dated August 2, 2016 and received in the Vernal Field Office August 8, 2016 from the Ute Indian Tribe stating that the Tribe asserted ownership of such lands and the Tribe has submitted a proposal to restore the trust status of lands within our historic Uncompahgre Reservation - now a part of our current Reservation - to the Secretary for the Department of Interior. Lands within the Uncompahgre Reservation are eligible for restoration under the Indian Reorganization Act of 1914 and we have asked the Administration

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Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
		to correct the ongoing Federal mismanagement of our lands.
Private land owners	Coordinated with as a leasing program partner.	May 18, 2016, letters were sent to all known private landowners potentially impacted by the proposed leasing. Phone responses have been received asking for more information.
Utah Public Lands Policy and Coordination Office	Coordinated with as a leasing program partner.	In February 2016 a letter providing notice of the lease sale, parcel locations and an invitation to attend parcel site-visits was transmitted to PLPCO. A response dated May 6th 2016 was received providing scoping comments.
National Park Service	Coordinated with as a leasing program partner.	In February 2016 a letter providing notice of the lease sale, parcel locations, and invitation to attend parcel site-visits was transmitted to NPS.
U.S. Fish and Wildlife Service	Informal Consultation	Consultation is ongoing.

5.1. Field Visits

Field visits for all parcels were conducted throughout March, April , and May 2016. An interdisciplinary team visited each parcel. Pictures of the parcels are included in Appendix F.

5.2. Public comment period

A public comment period was held June 14, 2016 through July 15, 2016.

The comments and responses form the comment period can be found in Appendix E.

Chapter 6. List of Preparers

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Table 6.1. List of Preparers

Name	Title	Responsible for the Following Section(s) of this Document
Melissa Wardle	Natural Resource Specialist	Team Lead, Chapters 1 and 2
Denise Ohler	Planning and Environmental Coordinator	Document Preparation and Review
Leonard Herr	Air Resources Specialist	Air Quality
Rene Arce	Recreation Planner	ACECs, WSR, Wilderness Characteristics, Recreation, SRMA, Visual Resources
David Christensen	Archaeologist	Cultural Resources
Dan Emmett	Wildlife Biologist	Wildlife
Matthew Lewis	Botanist	Plants
Craig Newman, Dusty Carpenter	Range Conservationist	Livestock Grazing and Rangeland Health

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Appendix A. Preliminary Oil and Gas Lease Sale List

BLM Sale ID	Legal Description of Available Parcel	Lease Stipulations and Notices
UT-1116-004	T. 11 S., R. 13 E., Salt Lake Sec. 19: Lots 2, 3, W2NE, E2NW, S2SE. 320.72 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-06: Mexican Spotted Owl UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-005	T. 11 S., R. 13 E., Salt Lake Sec. 35: S2. 320.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO - Riparian, Floodplain, and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-230: TL- Crucial Deer and Elk Winter Range UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-06: Mexican Spotted Owl T&E-22: Ute Ladies'-Tresses (spiranthes diluvialis) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures

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UT-1116-006	T. 10 S., R. 14 E., Salt Lake Sec. 24: SE; Sec. 25: NE, E2NW. 400.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-009	T. 11 S., R. 14 E., Salt Lake Sec. 25: W2NW, SENW, SW; Sec. 26: E2SW, SWSE; Sec. 35: Lots 1-4, N2N2, NESW, N2SE. 839.95 Acres	**Stipulations** UT-S-01: Air Quality UT-S-23: NSO/CSU/TL-Nine Mile Canyon ACEC UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-06: Mexican Spotted Owl UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-106: Special Recreation Management Area

UT-1116-010	T. 11 S., R. 14 E., Salt Lake Sec. 27: E2NW, NESW, S2SW; Sec. 28: E2SE; Sec. 33: E2SE; Sec. 34: NE, E2NW, N2SW, NWSE. 720 Acres	**Stipulations** UT-S-01: Air Quality UT-S-23: NSO/CSU/TL-Nine Mile Canyon ACEC UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-06: Mexican Spotted Owl UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-106: Special Recreation Management Area
UT-1116-012	T. 10 S., R. 15 E., Salt Lake Sec. 11: N2. 320 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO– Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO – Riparian, Floodplains, and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-22: Ute Ladies' Tresses (*spiranthes diluvialis*) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-128: Federal Flood Risk Management Standard

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UT-1116-013	T. 10 S., R. 15 E., Salt Lake Sec. 3: Lots 1-4, S2NW, SW; Secs. 4 and 9: All; Sec. 10: W2; Sec. 15: W2; Sec. 22: W2NW. 1,255.14 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO– Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO – Riparian, Floodplains, and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-22: Ute Ladies' Tresses *spiranthes diluvialis)* UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-128: Federal Flood Risk Management Standard
UT-1116-014	T. 10 S., R. 15 E., Salt Lake Sec. 17: All; Sec. 19: Lots 2-6, S2NE, SENW, E2SW, SE; Secs. 20, 29 and 30: All. 2540.78 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures

UT-1116-015	T. 10 S., R. 15 E., Salt Lake Sec. 28: NW. 160 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-016	T. 10 S., R. 15 E., Salt Lake Sec. 31: Lot 7, NESE. 75.79 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-159: CSU - VISUAL RESOURCES - VRM II UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures

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UT-1116-032	T. 11 S., R. 17 E., Salt Lake Sec. 10: E2. 320.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-195: NSO-Greater Sage-Grouse Leks UT-S-205: TL-Greater Sage-Grouse Brood Rearing and Nesting UT-S-206:CSU-Greater Sage-Grouse (Noise Reduction) UT-S-207: CSU-Greater Sage-Grouse (Structures) UT-S-261: TL-Raptor Buffers UT-S-317: Unit Joinder - Deseret Unit UTU89823X WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Up-per Colorado River Drainage Basin T&E-05: Listed Plant Species T&E-20: Clay Reed Mustard (*schoencrambe argillacea* UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consul-tation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-90: Graham's Penstemon (penstemon grahamii) UT-LN-96: Air Quality Mitigation Measures UT-LN-131: Greater Sage-Grouse-net Conservation Gain UT-LN-132: Greater Sage-Grouse-Required Design Features UT-LN-133: Greater Sage-Grouse-Buffer
UT-1116–038	T. 10 S., R. 18 E., Salt Lake Sec. 13: Lot 4. 40.04	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO– Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO-Riparian, Floodplain, and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-159: CSU VRM II UT-S-247: TL-Cru-cial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Up-per Colorado River Drainage Basin T&E-05: Listed Plant Species T&E-12: Pariette Cactus (*sclerocactus brevispinus*) and Uinta Basin Hookless Cactus (*[(sclero-cactus glaucus) brevispinus and wetlandicus]* T&E-22: Ute Ladies' Tresses (*spiranthes diluvialis*) UT-LN-37: Bald Eagle Habitat UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas

		UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-113: Western Yellow-billed Cuckoo UT-LN-128: Federal Flood Risk Management Standard UT-LN-107: Bald Eagle
UT-1116–039	T. 11 S., R. 18 E., Salt Lake Sec. 6: Lots 2-4, SWNE, S2NW, SW, NWSE; Sec. 7: NW, NWSW. 639.29 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-049	T. 11 S., R. 19 E., Salt Lake Sec. 28: SWSW; Sec. 33: W2NW, NWSW. 160.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-05: Listed Plant Species T&E-12: Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [sclerocactus glaucus (brevispinus and wetlandicus)] T&E-20: Clay Reed-Mustard (*schoencrambe argillacea*) T&E-21: Shrubby Reed-Mustard (*schoenocrambe suffrutescens*) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures

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UT-1116-067	T. 11 S., R. 20 E., Salt Lake Sec. 11: NENE. 40.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers UT-S-317: Unit Joinder - Little Canyon Unit UTU81878X UT-S-195: NSO-Greater Sage-Grouse Leks UT-S-205: TL-Greater Sage-Grouse Brood Rearing and Nesting UT-S-206:CSU-Greater Sage-Grouse (Noise Reduction) UT-S-207: CSU-Greater Sage-Grouse (Structures) WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-05: Listed Plant Species T&E-12: Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [*sclerocactus glaucus (brevispinus and wetlandicus)]* T&E-20: Clay Reed-Mustard (*schoencrambe argillacea*) T&E-21: Shrubby Reed-Mustard (*schoenocrambe suffrutescens*) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-107: Bald Eagle UT-LN-131: Greater Sage-Grouse-net Conservation Gain UT-LN-132: Greater Sage-Grouse-Required Design Features UT-LN-133: Greater Sage-Grouse-Buffer
UT-1116-069	T. 3 S., R. 21 E., Salt Lake Sec. 35: Lot 1, E2NE, N2SE. 201.89 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-05: Listed Plant Species T&E-22: Ute Ladies'-Tresses (spiranthes diluvialis) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources

		UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-128: Federal Flood Risk Management Standard
UT-1116-070	T. 4 S., R. 21 E., Salt Lake Sec. 1: Lots 1, 2, S2NE, NESE; Sec. 3: SWNE, SENW, N2NWSW, SWNWSW, N2SENWSW. 315.10 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-230: TL-Crucial Deer and Elk Winter Habitat UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-071	T. 4 S., R. 21 E., Salt Lake Sec. 1: Lots 3 and 4; Sec. 3: Lot 1. 121.28 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-22: Ute Ladies'-Tresses (spiranthes diluvialis) UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-128: Federal Flood Risk Management Standard UT-LN-107: Bald Eagle

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UT-1116-093	T. 5 S., R. 22 E., Salt Lake Sec. 29: SENE, NWNW, SWSW, SWSE. 160.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-094	T. 6 S., R. 22 E., Salt Lake Sec. 12: Lots 2, 3, 11, SWNE, NWSE. 114.12 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-02: Black-Footed Ferret T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-22: Ute Ladies'-Tresses (spiranthes diluvialis) UT-LN-37: Bald Eagle Habitat UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-113: Western Yellow-billed Cuckoo UT-LN-128: Federal Flood Risk Management Standard UT-LN-107: Bald Eagle

UT-1116-103	T. 5 S., R. 23 E., Salt Lake Sec. 29: SESE; Sec. 32: SWSE. 80.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-02: Black-Footed Ferret T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-22: Ute Ladies'-Tresses (spiranthes diluvialis) UT-LN-37: Bald Eagle Habitat UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-113: Western Yellow-billed Cuckoo UT-LN-128: Federal Flood Risk Management Standard UT-LN-107: Bald Eagle
UT-1116-105	T. 8 S., R. 23 E., Salt Lake Sec. 26: NENE 40	**Stipulations** UT-S-01: Air Quality UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin T&E-12: Pariette Cactus (*sclerocactus brevispinus*) and Uinta Basin Hookless Cactus (*[(sclerocactus glaucus) brevispinus and wetlandicus]* UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-53: Riparian Areas UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-128: Federal Flood Risk Management Standard

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UT-1116-121	T. 9 S., R. 25 E., Salt Lake Sec. 35: S2. 320.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-230: TL-Crucial Deer and Elk Winter Habitat UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-90: Graham's Penstemon (penstemon grahamii) UT-LN-96: Air Quality Mitigation Measures
UT-1116-122	T. 10 S., R. 25 E., Salt Lake Sec. 1: All; Sec. 10: NWNWSE, S2N2SE, S2SE; Sec. 11: W2; Sec. 14: W2; Sec. 15: All; Sec. 21: E2SW, SE; Sec. 28: E2. 2257.65	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-123: NSO- Riparian, Floodplains and Public Water Reserves UT-S-157: NSO/CSU/TL – Visual Resources UT-S-230: TL-Crucial Deer and Elk Winter Habitat UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-90: Graham's Penstemon (penstemon grahamii) UT-LN-96: Air Quality Mitigation Measures

UT-1116-123	T. 2 S., R. 2 W., Uintah Special Sec. 30: SENE. 40.00 Acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-142	T. 3 S., R. 21 E., Salt Lake Sec. 35: Lot 3, W2NE, NW, E2NESW. 302.73 Acres Acquired Lands	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-247: TL-Crucial Elk Calving and Deer Fawning Habitat UT-S-261: TL-Raptor Buffers UT-S-278: CSU-Bald Eagle Winter Roost WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin TUT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-107: Bald Eagle

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UT-1116-151	T. 11S., R. 15E., Salt Lake Sec 9: SESE 40.00acres	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-261: TL-Raptor Buffers UT-S-317: Unit Joinder - Gate Canyon II Unit UTU90523X WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures
UT-1116-152	T. 12 S., R. 21 E., Salt Lake Sec. 8: NENE, SWNW. . 80	**Stipulations** UT-S-01: Air Quality UT-S-96: NSO – Fragile Soils/Slopes Greater Than 40% UT-S-100: CSU – Fragile Soils/Slopes (21%- 40%) UT-S-157: NSO/CSU/TL – Visual Resources UT-S-317: Unit Joinder - Flat Stone Unit UTU90379X UT-S-195: NSO-Greater Sage-Grouse Leks UT-S-205: TL-Greater Sage-Grouse Brood Rearing and Nesting UT-S-206:CSU-Greater Sage-Grouse (Noise Reduction) UT-S-207: CSU-Greater Sage-Grouse (Structures) WO IM 2002-174: Endangered Species Act Stipulation **Notices** T&E-03: Endangered Fish of the Upper Colorado River Drainage Basin UT-LN-40: Golden Eagle Habitat UT-LN-45: Migratory Birds UT-LN-49: Utah Sensitive Species UT-LN-51: Special Status Plants: Not Federally Listed UT-LN-67: Historical and Cultural Resource Values UT-LN-68: Notification and Consultation Regarding Cultural Resources UT-LN-69: High Potential for Cultural Resources UT-LN-70: High Potential for Cultural Resource Occurrence UT-LN-96: Air Quality Mitigation Measures UT-LN-131: Greater Sage-Grouse-net Conservation Gain UT-LN-132: Greater Sage-Grouse-Required Design Features UT-LN-133: Greater Sage-Grouse-Buffer

Table A.1. Utah Stipulations

Stipulation Number	Utah Stipulations
UT-S-01	**AIR QUALITY** All new and replacement internal combustion gas field engines of less than or equal to 300 design-rated horsepower shall not emit more than 2 grams of NOx per horsepower-hour. **Exception:** This requirement does not apply to gas field engines of less than or equal to 40 design-rated horsepower. **Modification**: None **Waiver**: None AND All new and replacement internal combustion gas field engines of greater than 300 design rated horsepower must not emit more than 1.0 gram of NOx per horsepower-hour. **Exception**: None **Modification**: None **Waiver**: None
UT-S-23	**NO SURFACE OCCUPANCY/CONTROLLED SURFACE USE/TIMING LIMITATIONS – NINE MILE CANYON ACEC** No surface occupancy for oil and gas leasing within approximately 17,162 acres, and approximately 209 acres will be open to leasing subject to moderate constraints such as timing limitations and controlled surface use. **Exception**: None **Modification**: None **Waiver**: None
UT-S-96	**NO SURFACE OCCUPANCY – FRAGILE SOILS/SLOPES GREATER THAN 40%** No surface occupancy for slopes greater than 40 percent. **Exception:** If after an environment analysis the authorized officer determines that it would cause undue or unnecessary degradation to pursue other placement alternatives; surface occupancy in the NSO area may be authorized. Additionally a plan shall be submitted by the operator and approved by BLM prior to construction and maintenance and include: • An erosion control strategy, • GIS modeling, and • Proper survey and design by a certified engineer. **Modification:** Modifications also may be granted if a more detailed analysis, i.e. Order I, soil survey conducted by a qualified soil scientist finds that surface disturbance activities could occur on slopes greater than 40% while adequately protecting the area from accelerated erosion.**Waiver**: None

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UT-S-100	**CONTROLLED SURFACE USE – FRAGILE SOILS/SLOPES (21%-40%)** If surface-disturbing activities cannot be avoided on slopes from 21-40% a plan will be required. The plan will approved by BLM prior to construction and maintenance and include: • An erosion control strategy, • GIS modeling, • Proper survey and design by a certified engineer. **Exception**: None **Modification**: None **Waiver**: None
UT-S-123	**NO SURFACE OCCUPANCY – RIPARIAN, FLOODPLAINS, AND PUBLIC WATER RESERVES** No new surface-disturbing activities are allowed within active flood plains, wetlands, public water reserves, or 100 meters of riparian areas. Keep construction of new stream crossings to a minimum. **Exception:** An exception could be authorized if: (a) there are no practical alternatives (b) impacts could be fully mitigated, or (c) the action is designed to enhance the riparian resources. **Modification**: None **Waiver**: None
UT-S-157	**NO SURFACE OCCUPANCY/CONTROLLED SURFACE USE TIMING LIMITATION – VISUAL RESOURCES** Visual resource management activities will comply with BLM Handbook 8410-1. Within VRM Class I areas, very limited management activity will be allowed, with the objective of preserving the existing character of the landscape, allowing for natural ecological changes. The level of change to the landscape should be very low and shall not attract attention. Within VRM Class II areas, surface-disturbing activities will retain the existing character of the landscape. The level of change to the landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any change to the landscape shall repeat the basic elements of form, line, color and texture found in the predominant natural features of the characteristic landscape. Within VRM Class III areas, surface disturbing activities will partially retain the existing character of the landscape. The allowable level of change will be moderate, may attract attention, but should not dominate the view of the casual observer. Landscape changes should repeat the basic elements of form, line, color and texture found in the predominant natural features of the characteristic landscape. Within VRM Class IV areas, surface disturbing activities are allowed to dominate the view and the major focus of viewer attention. Major modifications to the existing character of the landscape are allowed. But every attempt should be made to minimize and mitigate the impacts. **Exception:** Exempted are recognized utility corridors. **Modification:** None **Waiver:** None

UT-S-159	**CONTROLLED SURFACE USE – VISUAL RESOURCES - VRM II** Within VRM II areas, surface-disturbing activities will retain the existing character of the landscape. The level of change to the landscape should be low. Management activities may be seen, but should not attract attention of the casual observer. Any change to the landscape must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape. **Exception**: Exempted are recognized utility corridors. **Modification**: None **Waiver**: None
UT-S-230	**TIMING LIMITATION – CRUCIAL DEER AND ELK WINTER RANGE** No surface disturbing activities in deer and elk crucial winter range from **December 1 - April 30.** **Exception**: This restriction would not apply if and/or elk are not present, or if it is determined through analysis and coordination with UDWR that impacts could be mitigated. Factors to be considered would include snow depth, temperature, snow crusting, location of disturbance, forage quantity and quality, animal condition, and expected duration of disturbance. **Modification**: The stipulation could be modified based on findings of collaborative monitoring and analysis. For example, the winter range configuration and time frames could be changed if current animal use patterns are determined to be inconsistent with the dates and boundaries established. **Waiver**: This stipulation could be waived if it is determined through collaborative monitoring and analysis that the area is not crucial winter range or that timing restrictions are unnecessary.
UT-S-247	**TIMING LIMITATION – CRUCIAL ELK CALVING AND DEER FAWNING HABITAT** In order to protect crucial elk calving and deer fawning habitat exploration, drilling, and other development activity will not be allowed from **May 15 - June 30.** **Exception**: This restriction would not apply to maintenance and operation of existing facilities. This stipulation may be excepted if either the resource values change or the lessee/operator demonstrates to BLMs satisfaction that adverse impact can be mitigated. **Modification**: None **Waiver**: None
UT-S-261	**TIMING LIMITATION – RAPTOR BUFFERS** Raptor management will be guided by the use of "Best Management Practices for Raptors and Their Associated Habitats in Utah" (Utah BLM, 2006, Appendix A), utilizing seasonal and spatial buffers, as well as mitigation, to maintain and enhance raptor nesting and foraging habitat, while allowing other resource uses. **Exception**: None **Modification**: Criteria that would need to be met, prior to implementing modifications to the spatial and seasonal buffers in the "*Raptor BMPs",* would include the following: 1. Completion of a site-specific assessment by a wildlife biologist or other qualified individual. See example (Attachment 1 of the Raptor BMPs in Appendix A) 2. Written documentation by the BLM Field Office Wildlife Biologist, identifying the proposed modification and affirming that implementation of the proposed modification(s) would not affect nest success or the suitability of the site for future nesting. Modification of the "BMPs" would not be recommended if it is determined that adverse impacts to nesting raptors would occur or that the suitability of the site for future nesting would be compromised. 3. Development of a monitoring and mitigation strategy by a BLM biologist, or other raptor biologist. Impacts of authorized activities would be documented to determine if the modifications were implemented as described in the environmental

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	documentation or Conditions of Approval, and were adequate to protect the nest site. Should adverse impacts be identified during monitoring of an activity, BLM would follow an appropriate course of action, which may include cessation or modification of activities that would avoid, minimize or mitigate the impact, or, with the approval of UDWR and the USFWS, BLM could allow the activity to continue while requiring monitoring to determine the full impact of the activity on the affected raptor nest. A monitoring report would be completed and forwarded to UDWR for incorporation into the Natural Heritage Program (NHP) raptor database. **Waiver**: None
UT-S-278	**CONTROLLED SURFACE USE – BALD EAGLE WINTER ROOST** Protect and restore cottonwood bottoms for bald eagle winter habitat along the Green and White Rivers, at Pelican Lake, and at the Cliff Creek Bald Eagle roost site, as well as any new roost sites discovered in the future. **Exception**: None **Modification**: None **Waiver**: None
UT-S-317	**UNIT JOINDER** The successful bidder will be required to join the _____Unit Agreement or show reason why a joinder should not be required.
UT-S-195	**NO SURFACE OCCUPANCY – GREATER SAGE-GROUSE LEKS** No surface-disturbing activities within 1/4 mile of active Greater Sage-Grouse leks year-round found outside of Priority Habitat Management Areas (PHMA). **Exception**: None **Modification**: None **Waiver**: None
UT-S-205	**TIMING LIMITATION – GREATER SAGE-GROUSE BROOD REARING AND NESTING** No surface-disturbing activities within 2 miles of active Greater Sage-Grouse leks found outside of Priority Habitat Management Areas (PHMA) within brood rearing and nesting habitat from **March 1 - June 15**. **Exception:** None **Modification:** None **Waiver:** None
UT-S-206	**CONTROLLED SURFACE USE – GREATER SAGE-GROUSE (NOISE REDUCTION)** Within ½ mile of known active Greater Sage-Grouse leks found outside of Priority Habitat Management Areas (PHMA) use the best available technology such as installation of multi-cylinder pumps, hospital sound reducing mufflers, and placement of exhaust systems to reduce noise. **Exception**: None **Modification**: None **Waiver**: None
UT-S-207	**CONTROLLED SURFACE USE – GREATER SAGE-GROUSE (STRUCTURES)** No permanent facilities or structures would be allowed within 2 miles Greater Sage-Grouse leks found outside of Priority Habitat Management Areas (PHMA) when possible.

	Exception: None **Modification**: None **Waiver**: None

Table A.2. Utah's Lease Notices

Number	Utah's Lease Notices
UT-LN-37	**BALD EAGLE HABITAT** The lessee/operator is given notice that lands in this lease have been identified as containing Bald Eagle Habitat. Modifications to the Surface Use Plan of Operations may be required in order to protect the Bald Eagle and/or habitat from surface disturbing activities in accordance with Section 6 of the lease terms, Endangered Species Act, and 43 CFR 3101.1-2.
UT-LN-40	**GOLDEN EAGLE HABITAT** The lessee/operator is given notice that lands in this lease have been identified as containing Golden Eagle Habitat. Modifications to the Surface Use Plan of Operations may be required in order to protect the Golden Eagle and/or habitat from surface disturbing activities in accordance with Section 6 of the lease terms, Endangered Species Act, and 43 CFR 3101.1-2.
UT-LN-45	**MIGRATORY BIRD** The lessee/operator is given notice that surveys for nesting migratory birds may be required during migratory bird breeding season whenever surface disturbances and/or occupancy is proposed in association with fluid mineral exploration and development within priority habitats. Surveys should focus on identified priority bird species in Utah. Field surveys will be conducted as determined by the authorized officer of the Bureau of Land Management. Based on the result of the field survey, the authorized officer will determine appropriate buffers and timing limitations.
UT-LN-49	**UTAH SENSITIVE SPECIES** The lessee/operator is given notice that no surface use or otherwise disruptive activity would be allowed that would result in direct disturbance to populations or individual special status plant and animal species, including those listed on the BLM sensitive species list and the Utah sensitive species list. The lessee/operator is also given notice that lands in this parcel have been identified as containing potential habitat for species on the Utah Sensitive Species List. Modifications to the Surface Use Plan of Operations may be required in order to protect these resources from surface disturbing activities in accordance with Section 6 of the lease terms, Endangered Species Act, Migratory Bird Treaty Act and 43 CFR 3101.1-2.
UT-LN-51	**SPECIAL STATUS PLANTS: NOT FEDERALLY LISTED** The lessee/operator is given notice that lands in this lease have been identified as containing special status plants, not federally listed, and their habitats. Modifications to the Surface Use Plan of Operations may be required in order to protect the special status plants and/or habitat from surface disturbing activities in accordance with Section 6 of the lease terms, Endangered Species Act, and 43 CFR 3101.1-2.
UT-LN-53	**RIPARIAN AREAS** The lessee/operator is given notice that this lease has been identified as containing riparian areas. No surface use or otherwise disruptive activity allowed within 100 meters of riparian areas unless it can be shown that (1) there is no practicable alternative; (2) that all long-term impacts are fully mitigated; or (3) that the construction is an enhancement to the riparian areas. Modifications to the Surface Use Plan of Operations may be required in accordance with section 6 of the lease terms and 43CFR3101.1-2.

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UT-LN-67	**HISTORICAL AND CULTURAL RESOURCE VALUES** The lessee/operator is given notice that lands in this lease may contain significant Historical and Cultural Resources. Modifications to the Surface Use Plan of Operations may be required for the protection of these resources.
UT-LN-68	**NOTIFICATION & CONSULTATION REGARDING CULTURAL RESOURCES** The lease area may now or hereafter be found to contain historic properties and/or resources protected under the National Historic Preservation Act (NHPA), the Archaeological Resources Protections Act (ARPA), the Native American Graves Protection and Repatriation Act (NAGPRA), the American Indian Religious Freedom Act (AIRFA), other statues and Executive Order 13007, and which may be of concern to Native American tribes, interested parties, and the State Historic Preservation Officer (SHPO). BLM will not approve any ground disturbing activities as part of future lease operations until it completes applicable requirements of the National Historic Preservation Act (NHPA), including the completion of any required procedure for notification and consultation with appropriate tribe(s) and/or the SHPO. BLM may require modifications to exploration and development proposals to further its conservation and management objectives on BLM-approved activities that are determine to affect or impact historic or cultural properties and/or resources.
UT-LN-69	**HIGH POTENTIAL FOR CULTURAL RESOURCES** This parcel is located in an area of high concentrations of cultural resources. Known cultural sites are fragile and many are buried under sandy deposits which migrate due to their susceptibility to wind. These sites, or large portions, are not visible from the surface. Therefore, the following mitigation measures may be applied to any surface disturbance of this parcel: 1) pre-surface disturbance cultural resource inventories; 2) pre-surface disturbance subsurface testing; 3) monitoring of ground disturbance; and 4) post-disturbance monitoring identifying resources as the soils stabilize around a project.
UT-LN-70	**HIGH POTENTIAL FOR CULTURAL RESOURCE OCCURRENCE** The lessee/operator is given notice that lands in this lease contain significant Cultural Resources. Modifications to the Surface Use Plan of Operations may be required for the protection of these resources. Class III level block inventories may be required to determine resource location and possible impact to the resource.
UT-LN-90	**GRAHAM'S BEARDTONGUE** *(PENSTEMON GRAHAMII)* In order to minimize effects to the federally proposed Graham's beardtongue, the Bureau of Land Management (BLM) in coordination with the U.S. Fish and Wildlife Service (Service) developed the following avoidance and minimization measures. The following avoidance and minimization measures should be included in the Plan of Development: 1. Pre-project habitat assessments will be completed across 100% of the project disturbance area within potential habitat1 prior to any ground disturbing activities to determine if suitable Graham's beardtongue habitat is present. 2. Within suitable habitat3, site inventories will be conducted to determine occupancy. Inventories: a. Must be conducted by qualified individual(s) and according to BLM and Service accepted survey protocols, b. Will be conducted in suitable and occupied habitat4 for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected (usually April 15th to May 20th in the Uintah Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or FWS botanist or demonstrating that the nearest known population is in flower),

c. Will occur within 300' from the centerline of the proposed right-of-way for surface pipelines or roads; and within 300' from the perimeter of disturbance for the proposed well pad including the well pad,

d. Will include, but not be limited to, plant species lists and habitat characteristics, and

e. Will be valid until April 15th the following year.

3. Design project infrastructure to minimize impacts within suitable habitat2:

a. Reduce well pad size to the minimum needed, without compromising safety,

b. Limit new access routes created by the project,

c. Roads and utilities should share common right-of-ways where possible,

d. Reduce the width of right-of-ways and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat,

e. Place signing to limit off-road travel in sensitive areas, and

f. Stay on designated routes and other cleared/approved areas.

4. Within occupied habitat4, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants:

a. Follow the above (3.) recommendations for project design within suitable habitats,

b. Construction of roads will occur such that the edge of the right of way is at least 300' from any plant,

c. Roads will be graveled within occupied habitat; the operator is encouraged to apply water for dust abatement to such areas from April 15th to May 20th (flowering period); dust abatement applications will be comprised of water only,

d. The edge of the well pad should be located at least 300' away from plants,

e. Surface pipelines will be laid such that a 300 foot buffer exists between the edge of the right of way and the plants, use stabilizing and anchoring techniques when the pipeline crosses the habitat (exposed raw shale knolls and slopes derived from the Parachute Creek and Evacuation Creek members of the geologic Green River Formation) to ensure pipelines don't move towards the population,

f. Construction activities will not occur from April 15th through May 30th within occupied habitat,

g. Before and during construction, areas for avoidance should be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc.,

h. Where technically and economically feasible, use directional drilling or multiple wells from the same pad,

i. Designs will avoid concentrating water flows or sediments into occupied habitat,

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	j. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and k. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible. 5. Occupied Graham's beardtongue habitats within 300' of the edge of the surface pipelines' right-of-ways, 300' of the edge of the roads' right-of-ways, and 300' from the edge of well pads shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the Service. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the Service. Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the U.S. Fish and Wildlife Service to ensure continued conservation of the species.
UT-LN-96	**AIR QUALITY MITIGATION MEASURES** The lessee is given notice that the Bureau of Land Management (BLM) in coordination with the U.S. Environmental Protection Agency and the Utah Department of Air Quality, among others, has developed the following air quality mitigation measures that may be applied to any development proposed on this lease. Integration of and adherence to these measures may help minimize adverse local or regional air quality impacts from oil and gas development (including but not limited to construction, drilling, and production) on regional ozone formation. • All internal combustion equipment would be kept in good working order. • Water or other approved dust suppressants would be used at construction sites and along roads, as determined appropriate by the Authorized Officer. • Open burning of garbage or refuse would not occur at well sites or other facilities. • Drill rigs would be equipped with Tier II or better diesel engines. • Vent emissions from stock tanks and natural gas TEG dehydrators would be controlled by routing the emissions to a flare or similar control device which would reduce emissions by 95% or greater. • Low bleed or no bleed pneumatics would be installed on separator dump valves and other controllers. • During completion, flaring would be limited as much as possible. Production equipment and gathering lines would be installed as soon as possible. • Well site telemetry would be utilized as feasible for production operations. • Stationary internal combustion engine would comply with the following standards: 2g NO_x/bhp-hr for engines <300HP; and 1g NO_x/bhp-hr for engines >300HP. Additional site-specific measures may also be employed to avoid or minimize effects to local or regional air quality. These additional measures will be developed and implemented in coordination with the U.S. Environmental Protection Agency, the Utah Department of Air Quality, and other agencies with expertise or jurisdiction as appropriate based on the size of the project and magnitude of emissions.

UT-LN-106	**SPECIAL RECREATION MANAGEMENT AREA** The lessee/operator is given notice that lands in this lease have been identified as being within a Special Recreation Management Area. Modifications to the Surface Use Plan of Operations may be required in order once an activity plan is prepared for the area to protect sensitive resources from surface disturbing activities in accordance with the Vernal RMP.
UT-LN-107	**BALD EAGLE** The Lessee/Operator is given notice that the lands in this parcel contains nesting/winter roost habitat for the bald eagle. The bald eagle was de-listed in 2007; however, it is still afforded protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c, 1940). Therefore, avoidance or use restrictions may be placed on portions of the lease. Application of appropriate measures will depend on whether the action is temporary or permanent, and whether it occurs within or outside the bald eagle breeding or roosting season. A temporary action is completed prior to the following breeding or roosting season leaving no permanent structures and resulting in no permanent habitat loss. A permanent action continues for more than one breeding or roosting season and/or causes a loss of eagle habitat or displaces eagles through disturbances, i.e. creation of a permanent structure. The following avoidance and minimization measures have been designed to ensure activities carried out on the lease will not lead to the need to consider listing the eagle as threatened or endangered. Integration of, and adherence to the following measures will facilitate review and analysis of any submitted permits under the authority of this lease. Current avoidance and minimization measures include the following: 1. Surveys will be required prior to operations unless species occupancy and distribution information is complete and available. All Surveys must be conducted by qualified individual(s), and be conducted according to protocol. 2. Lease activities will require monitoring throughout the duration of the project. To ensure desired results are being achieved, minimization measures will be evaluated. 3. Water production will be managed to ensure maintenance or enhancement of riparian habitat. 4. Temporary activities within 1.0 mile of nest sites will not occur during the breeding season of January 1 to August 31, unless the area has been surveyed according to protocol and determined to be unoccupied. 5. Temporary activities within 0.5 miles of winter roost areas, e.g., cottonwood galleries, will not occur during the winter roost season of November 1 to March 31, unless the area has been surveyed according to protocol and determined to be unoccupied. 6. No permanent infrastructure will be placed within 1.0 mile of nest sites. 7. No permanent infrastructure will be placed within 0.5 miles of winter roost areas. 8. Remove big game carrion from within 100 feet of lease roadways occurring within bald eagle foraging range. 9. Avoid loss or disturbance to large cottonwood gallery riparian habitats. 10. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in suitable habitat Utilize directional drilling to avoid direct impacts to large

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	cottonwood gallery riparian habitats. Ensure that such directional drilling does not intercept or degrade alluvial aquifers. 11. All areas of surface disturbance within riparian areas and/or adjacent uplands should be re-vegetated with native species. Additional measures may also be employed to avoid or minimize effects to the species between the lease sale stage and lease development stage. These additional measures will be developed and implemented in coordination with the U.S. Fish and Wildlife Service.
UT-LN-113	**WESTERN YELLOW-BILLED CUCKOO** The Lessee/Operator is given notice that the lands in or adjacent to this parcel contain potentially suitable habitat that falls within the range for western yellow-billed cuckoo, a federally listed species. Avoidance or use restrictions may be placed on portions of the lease. Application of appropriate measures will depend upon whether the action is temporary or permanent, and whether it occurs within or outside the breeding and nesting season. A temporary action is completed prior to the following breeding season leaving no permanent structures and resulting in no permanent habitat loss. A permanent action could continue for more than one breeding season and/or cause a loss of habitat or displace western yellow-billed cuckoos through disturbances. The following avoidance and minimization measures have been designed to ensure activities carried out on the lease are in compliance with the Endangered Species Act. Integration of, and adherence to, these measures will facilitate review and analysis of any submitted permits under the authority of this lease. Following these measures could reduce the scope of Endangered Species Act, Section 7 consultation at the permit stage. Avoidance and minimization measures include the following: 1. Habitat suitability within the parcel and/or within a 0.25 mile buffer of the parcel will be identified prior to lease development to identify potential survey needs. 2. Protocol Breeding Season Surveys will be required in suitable habitats prior to operations unless species occupancy and distribution information is complete and available. All Surveys must be conducted by permitted individual(s), and be conducted according to protocol. 3. For all temporary actions that may impact cuckoo or suitable habitat: a. If action occurs entirely outside of the cuckoo breeding season (June 1 – August 31), and leaves no structure or habitat disturbance, action can proceed without a presence/absence survey. b. If action is proposed between June 1 and August 31, presence/absence surveys for cuckoo will be conducted prior to commencing activity. If cuckoo are detected, activity should be delayed until September 1. c. Eliminate access routes created by the project through such means as raking out scars, revegetation, gating access points, etc. 4. For all permanent actions that may impact cuckoo or suitable habitat: a. Protocol level surveys by permitted individuals will be conducted prior to commencing activities. b. If cuckoos are detected, no activity will occur within 0.25 mile of occupied habitat. c. Avoid drilling and permanent structures within 0.25 mile of suitable habitat unless absence is determined according to protocol level surveys conducted by permitted individual(s).

	d. Ensure noise levels at 0.25 mile from suitable habitat do not exceed baseline conditions. Placement of permanent noise-generating facilities should be determined by a noise analysis to ensure noise does not encroach upon a 0.25 mile buffer for suitable habitat. 5. Temporary or permanent actions will require monitoring throughout the duration of the project to ensure that western yellow-billed cuckoo or its habitat is not affected in a manner or to an extent not previous considered. Avoidance and minimization measures will be evaluated throughout the duration of the project. 6. Water produced as a by-product of drilling or pumping will be managed to ensure maintenance or enhancement of riparian habitat. 7. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in suitable habitat. Ensure that such directional drilling does not intercept or degrade alluvial aquifers. 8. Ensure that water extraction or disposal practices do not result in change of hydrologic regime that would result in loss or degradation of riparian habitat. 9. Re-vegetate with native species all areas of surface disturbance within riparian areas and/or adjacent uplands. Additional measures to avoid or minimize effects to the species may be developed and implemented in consultation with the U.S. Fish and Wildlife Service between the lease sale stage and lease development stage to ensure continued compliance with the ESA.
UT-LN–128	**FEDERAL FLOOD RISK MANAGEMENT STANDARD** To mitigate potential impacts to floodplains, activities would be limited or precluded within the 500 year base flood level (area subject to flooding by the 0.2 percent annual chance flood) or the 100 year base flood elevation plus 3 feet. (Executive Order 13690 amending Executive Order 11988).
UT-LN-131	**GREATER SAGE-GROUSE – NET CONSERVATION GAIN** In Priority and General Habitat Management Areas (PHMA and GHMA) all actions that result in habitat loss and degradation will require mitigation that provides a net conservation gain to the Greater Sage-Grouse (GRSG). Mitigation must account for any uncertainty associated with the effectiveness of the mitigation and will be achieved through avoiding, minimizing and compensating for impacts. Mitigation will be conducted according to the mitigation framework found in Appendix F in the Utah Approved Management Plan Amendment.
UT-LN-132	**GREATER SAGE-GROUSE – REQUIRED DESIGN FEATURES** Apply the Required Design Features (RDF)* in Appendix C of the Utah Approved Management Plan Amendment when leasing within Priority and General Habitat Management Areas (PHMA and GHMA). *RDFs may not be required if it is demonstrated through the NEPA analysis that the RDF associated project/activity is: • Documented to not be applicable to the site-specific conditions of the project/activity (e.g. due to site limitations or engineering considerations). Economic considerations, such as increased costs, do not necessarily require that an RDF be varied or rendered inapplicable; • An alternative RDF, state-implemented conservation measure, or plan-level protection is determined to provide equal or better protection for GRSG or its habitat;

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	Provide no additional protection to GRSG or its habitat.
UT-LN-133	**GREATER SAGE-GROUSE - BUFFER** In Priority and General Habitat Management Areas (PHMA and GHMA), the BLM will apply the lek buffer-distances identified in the USGS Report Conservation Buffer Distance Estimates for Greater Sage-Grouse – A Review (Open File Report 2014-1239) in accordance with Appendix B, Applying Lek-Buffer Distances, consistent with valid and existing rights and applicable law in authorizing management actions.
T&E-02	**BLACK-FOOTED FERRET** The Lessee/Operator is given notice that the lands in this lease may contain occupied black-footed ferret habitat, an endangered species under the Endangered Species Act classified as an experimental, nonessential population in the state of Utah. Avoidance and minimization measures that should be followed are included within the *Cooperative Plan for the Reintroduction and Management of Black-Footed Ferrets in Coyote Basin, Uintah County, Utah* published by the Utah Division of Wildlife Resources in September, 1996. These measures may be updated based on the best available scientific data as it becomes available.
T&E-03	**ENDANGERED FISH OF THE UPPER COLORADO RIVER DRAINAGE BASIN** The Lessee/Operator is given notice that the lands in this parcel contain Critical Habitat for the Colorado River fish (bonytail, humpback chub, Colorado pike minnow, and razorback sucker) listed as endangered under the Endangered Species Act, or these parcels have watersheds that are tributary to designated habitat. Critical habitat was designated for the four endangered Colorado River fishes on March 21, 1994(59 FR 13374-13400). Designated critical habitat for all the endangered fishes includes those portions of the 100-year floodplain that contain primary constituent elements necessary for survival of the species. Avoidance or use restrictions may be placed on portions of the lease. The following avoidance and minimization measures have been designed to ensure activities carried out on the lease are in compliance with the Endangered Species Act. Integration of and adherence to these measures will facilitate review and analysis of any submitted permits under the authority of this lease. Following these measures could reduce the scope of Endangered Species Act, Section 7 consultation at the permit stage. Current avoidance and minimization measures include the following: 1. Surveys will be required prior to operations unless species occupancy and distribution information is complete and available. All surveys must be conducted by qualified individual(s). 2. Lease activities will require monitoring throughout the duration of the project. To ensure desired results are being achieved, minimization measures will be evaluated and, if necessary, Section 7 consultation reinitiated. 3. Water production will be managed to ensure maintenance or enhancement of riparian habitat. 4. Avoid loss or disturbance of riparian habitats. 5. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in suitable riparian habitat. Ensure that such directional drilling does not intercept or degrade alluvial aquifers. 6. Conduct watershed analysis for leases in designated critical habitat and overlapping major tributaries in order to determine toxicity risk from permanent facilities. 7. Implement Appendix B (Hydrologic Considerations for Pipeline Crossing Stream Channels, Technical Note 423).

	8. Drilling will not occur within 100 year floodplains of rivers or tributaries to rivers that contain listed fish species or critical habitat. 9. In areas adjacent to 100-year flood plains, particularly in systems prone to flash floods, analyze the risk for flash floods to impact facilities, and use closed loop drilling, and pipeline burial or suspension according to Appendix B (Hydrologic Considerations for Pipeline Crossing Stream Channels, Technical Note 423, to minimize the potential for equipment damage and resulting leaks or spills. Water depletions from *any* portion of the Upper Colorado River drainage basin above Lake Powell are considered to adversely affect or adversely modify the critical habitat of the four resident endangered fish species, and must be evaluated with regard to the criteria described in the Upper Colorado River Endangered Fish Recovery Program. Formal consultation with USFWS is required for all depletions. All depletion amounts must be reported to BLM. Additional measures to avoid or minimize effects to the species may be developed and implemented in consultation with the U.S. Fish and Wildlife Service between the lease sale stage and lease development stage to ensure continued compliance with the ESA
T&E-05	**LISTED PLANT SPECIES** The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for federally listed plant species under the Endangered Species Act. The following avoidance and minimization measures have been developed to facilitate review and analysis of any submitted permits under the authority of this lease 1. Site inventories: a. Must be conducted to determine habitat suitability, b. Are required in known or potential habitat for all areas proposed for surface disturbance prior to initiation of project activities, at a time when the plant can be detected, and during appropriate flowering periods, c. Documentation should include, but not be limited to individual plant locations and suitable habitat distributions, and d. All surveys must be conducted by qualified individuals. 2. Lease activities will require monitoring throughout the duration of the project. To ensure desired results are being achieved, minimization measures will be evaluated and, if necessary, Section 7 consultation reinitiated. 3. Project activities must be designed to avoid direct disturbance to populations and to individual plants: a. Designs will avoid concentrating water flows or sediments into plant occupied habitat. b. Construction will occur down slope of plants and populations where feasible; if well pads and roads must be sited upslope, buffers of 300 feet minimum between surface disturbances and plants and populations will be incorporated. c. Where populations occur within 300 ft. of well pads, establish a buffer or fence the individuals or groups of individuals during and post-construction. d. Areas for avoidance will be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc.

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	e. For surface pipelines, use a 10 foot buffer from any plant locations: f. If on a slope, use stabilizing construction techniques to ensure the pipelines don't move towards the population. 4. For riparian/wetland-associated species, e.g. Ute ladies-tresses, avoid loss or disturbance of riparian habitats. 5. Ensure that water extraction or disposal practices do not result in change of hydrologic regime. 6. Limit disturbances to and within suitable habitat by staying on designated routes. 7. Limit new access routes created by the project. 8. Place signing to limit ATV travel in sensitive areas. 9. Implement dust abatement practices near occupied plant habitat. 10. All disturbed areas will be re-vegetated with native species comprised of species indigenous to the area. 11. Post construction monitoring for invasive species will be required. 12. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in plant habitat. Ensure that such directional drilling does not intercept or degrade alluvial aquifers. 13. Lease activities will require monitoring throughout the duration of the project. To ensure desired results are being achieved, minimization measures will be evaluated and, if necessary, Section 7 consultation reinitiated. Additional measures to avoid or minimize effects to the species may be developed and implemented in consultation with the U.S. Fish and Wildlife Service between the lease sale stage and lease development stage to ensure continued compliance with the Endangered Species Act.
T&E-06	**MEXICAN SPOTTED OWL** The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for Mexican spotted owl, a federally listed species. The Lessee/Operator is given notice that the lands in this lease contain Designated Critical Habitat for the Mexican spotted owl, a federally listed species. Critical habitat was designated for the Mexican spotted owl on August 31, 2004 (69 FR 53181-53298). Avoidance or use restrictions may be placed on portions of the lease. Application of appropriate measures will depend whether the action is temporary or permanent, and whether it occurs within or outside the owl nesting season. A temporary action is completed prior to the following breeding season leaving no permanent structures and resulting in no permanent habitat loss. A permanent action continues for more than one breeding season and/or causes a loss of owl habitat or displaces owls through disturbances, i.e. creation of a permanent structure. The following avoidance and minimization measures have been designed to ensure activities carried out on the lease are in compliance with the Endangered Species Act. Integration of, and adherence to these measures, will facilitate review and analysis of any submitted permits under the authority of this lease. Following these measures could reduce the scope of Endangered Species Act, Section 7 consultation at the permit stage. Current avoidance and minimization measures include the following:

1. Surveys will be required prior to operations unless species occupancy and distribution information is complete and available. All Surveys must be conducted by qualified individual(s).

2. Assess habitat suitability for both nesting and foraging using accepted habitat models in conjunction with field reviews. Apply the conservation measures below if project activities occur within 0.5 mile of suitable owl habitat. Determine potential effects of actions to owls and their habitat.

    a. Document type of activity, acreage and location of direct habitat impacts, type and extent of indirect impacts relative to location of suitable owl habitat.

    b. Document if action is temporary or permanent.

3. Lease activities will require monitoring throughout the duration of the project. To ensure desired results are being achieved, minimization measures will be evaluated and, if necessary, Section 7 consultation reinitiated.

4. Water production will be managed to ensure maintenance or enhancement of riparian habitat.

5. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in canyon habitat suitable for Mexican spotted owl nesting.

6. For all temporary actions that may impact owls or suitable habitat:

    a. If the action occurs entirely outside of the owl breeding season (March 1 – August 31), and leaves no permanent structure or permanent habitat disturbance, action can proceed without an occupancy survey.

    b. If action will occur during a breeding season, survey for owls prior to commencing activity. If owls are found, activity must be delayed until outside of the breeding season.

    c. Rehabilitate access routes created by the project through such means as raking out scars, re-vegetation, gating access points, etc.

7. For all permanent actions that may impact owls or suitable habitat:

    a. Survey two consecutive years for owls according to accepted protocol prior to commencing activities.

    b. If owls are found, no actions will occur within 0.5 mile of identified nest site. If nest site is unknown, no activity will occur within the designated Protected Activity Center (PAC).

    c. Avoid drilling and permanent structures within 0.5 mi of suitable habitat unless surveyed and not occupied.

    d. Reduce noise emissions (e.g., use hospital-grade mufflers) to 45 dBA at 0.5 mile from suitable habitat, including canyon rims. Placement of permanent noise-generating facilities should be determined by a noise analysis to ensure noise does not encroach upon a 0.5 mile buffer for suitable habitat, including canyon rims.

    e. Limit disturbances to and within suitable habitat by staying on approved routes.

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	f. Limit new access routes created by the project. Additional measures to avoid or minimize effects to the species may be developed and implemented in consultation with the U.S. Fish and Wildlife Service between the lease sale stage and lease development stage to ensure continued compliance with the Endangered Species Act.
T&E-12	**PARIETTE CACTUS** *(sclerocactus brevispinus)* **AND UINTA BASIN HOOKLESS CACTUS** *[sclerocactus glaucus (brevispinus and wetlandicus)]* The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for the Pariette cactus and Uinta Basin hookless cactus, under the Endangered Species Act (ESA). The following avoidance and minimization measures have been developed to facilitate review and analysis of any submitted permits under the authority of this lease. In order to minimize effects to the federally threatened Pariette cactus and Uinta Basin hookless cactus, the BLM in coordination with the USFWS, developed the following avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production, and maintenance) are in compliance with the ESA. For the purposes of this document, the following terms are so defined: Potential habitat is defined as areas which satisfy the broad criteria of the species habitat description; usually determined by preliminary, in-house assessment. Suitable habitat is defined as areas which contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain Uinta Basin hookless cactus. Habitat descriptions can be found in the U.S. Fish and Wildlife Service's 1990 Recovery Plan and Federal Register Notices for the Uinta Basin hookless cactus (http://www.fws.gov/endangered/wildlife.html). Occupied habitat is defined as areas currently or historically known to support Uinta Basin hookless cactus; synonymous with "known habitat." The following avoidance and minimization measures should be included in the Plan of Development: 1. Pre-project habitat assessments will be completed across 100% of the project disturbance area within potential habitat prior to any ground disturbing activities to determine if suitable Pariette cactus and Uinta Basin hookless cactus habitat is present. 2. Within suitable habitat, site inventories will be conducted to determine occupancy. Inventories: a. Must be conducted by qualified individual(s) and according to BLM and Service accepted survey protocols, b. Will be conducted in suitable and occupied habitat for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected, and during appropriate flowering periods: i. *Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [sclerocactus glaucus (brevispinus and wetlandicus)] brevispinus* surveys should be conducted March 15th to June 30th, unless extended by the BLM ii. *Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [sclerocactus glaucus (brevispinus and wetlandicus)] wetlandicus* surveys can be done any time of the year, provided there is no snow cover,

c. Will occur within 300' from the edge of the proposed right-of-way for surface pipelines or roads; and within 300' from the perimeter of disturbance for the proposed well pad including the well pad,

d. Will include, but not be limited to, plant species lists and habitat characteristics, and

e. Will be valid until March 15th the following year for *Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [sclerocactus glaucus (brevispinus and wetlandicus)] brevispinus* and one year from the survey date for *Pariette Cactus (sclerocactus brevispinus) and Uinta Basin Hookless Cactus [sclerocactus glaucus (brevispinus and wetlandicus)] wetlandicus*.

3. Design project infrastructure to minimize impacts within suitable habitat2:

a. Reduce well pad size to the minimum needed, without compromising safety,

b. Limit new access routes created by the project,

c. Roads and utilities should share common right-of-ways where possible,

d. Reduce width of right-of-ways and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat,

e. Place signing to limit off-road travel in sensitive areas,

f. Stay on designated routes and other cleared/approved areas, and

g. All disturbed areas will be re-vegetated with native species comprised of species indigenous to the area and non-native species that are not likely to invade other areas.

4. Within occupied habitat3, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants:

a. Follow the above (3.) recommendations for project design within suitable habitats,

b. Buffers of 300 feet minimum between the edge of the right of way (roads and surface pipelines) or surface disturbance (well pads) and plants and populations will be incorporated,

c. Surface pipelines will be laid such that a 300 foot buffer exists between the edge of the right of way and the plants, use stabilizing and anchoring techniques when the pipeline crosses the habitat to ensure the pipelines don't move towards the population,

d. Before and during construction, areas for avoidance should be visually identifiable in the field (e.g., flagging, temporary fencing, rebar, etc.),

e. Where technically and economically feasible, use directional drilling or multiple wells from the same pad,

f. Designs will avoid concentrating water flows or sediments into occupied habitat,

g. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and

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	h. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible. 5. Occupied Pariette cactus and Uinta Basin hookless cactus habitats within 300' of the edge of the surface pipelines' right-of-ways, 300' of the edge of the roads' right-of-ways, and 100' from the edge of the well pad shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the USFWS. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the USFWS. 6. Re-initiation of Section 7 consultation with the USFWS will be sought immediately if any loss of plants or occupied habitat for the Pariette cactus and Uinta Basin hookless cactus is anticipated as a result of project activities. Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the USFWS to ensure continued compliance with the ESA.
T&E-20	**CLAY REED - MUSTARD** (*SCHOENCRAMBE ARGILLACEA*) The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for clay reed-mustard under the Endangered Species Act. The following avoidance and minimization measures have been developed to facilitate review and analysis of any submitted permits under the authority of this lease: In order to minimize effects to the federally threatened clay reed-mustard, the Bureau of Land Management (BLM) in coordination with the U.S. Fish and Wildlife Service (Service) developed the following avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production, and maintenance) are in compliance with the Endangered Species Act (ESA). For the purposes of this document, the following terms are so defined: Potential habitat is defined as areas which satisfy the broad criteria of the species habitat description; usually determined by preliminary, in-house assessment. Suitable habitat is defined as areas which contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain clay reed-mustard; habitat descriptions can be found in Federal Register Notice and species recovery plan links at <http://www.fws.gov/endangered/wildlife.html>. Occupied habitat is defined as areas currently or historically known to support clay reed-mustard; synonymous with "known habitat." The following avoidance and minimization measures should be included in the Plan of Development: 1. Pre-project habitat assessments will be completed across 100% of the project disturbance area within potential habitat prior to any ground disturbing activities to determine if suitable clay reed-mustard habitat is present. 2. Site inventories will be conducted within suitable habitat to determine occupancy. Where standard surveys are technically infeasible and otherwise hazardous due to topography, slope, etc., suitable habitat will be assessed and mapped for avoidance (hereafter, "avoidance areas"); in such cases, in general, 300-foot buffers will be maintained between surface disturbance and avoidance areas. However, site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat. Where conditions allow, inventories: 1. Must be conducted by qualified individual(s) and according to BLM and Service accepted survey protocols,

	2. Will be conducted in suitable and occupied habitat for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected (usually May 1st to June 5th, in the Uinta Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or FWS botanist or demonstrating that the nearest known population is in flower), 3. Will occur within 300 feet from the edge of the proposed right-of-way for surface pipelines or roads; and within 300 feet from the perimeter of disturbance for the proposed well pad including the well pad, 4. Will include, but not be limited to, plant species lists and habitat characteristics, and 5. Will be valid until May 1st the following year. 1. Design project infrastructure to minimize impacts within suitable habitat2: 1. Where standard surveys are technically infeasible, infrastructure and activities will avoid all suitable habitat (avoidance areas) and incorporate 300-foot buffers, in general; however, site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat, 2. Reduce well pad size to the minimum needed, without compromising safety, 3. Limit new access routes created by the project, 4. Roads and utilities should share common right-of-ways where possible, 5. Reduce the width of right-of-ways and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat, 6. Place signing to limit off-road travel in sensitive areas, and 7. Stay on designated routes and other cleared/approved areas. 1. Within occupied habitat3, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants: 1. Where standard surveys are technically infeasible, infrastructure and activities will avoid all suitable habitat (avoidance areas) and incorporate 300-foot buffers, , in general; however, site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat, 2. Follow the above recommendations (3.) for project design within suitable habitats, 3. To avoid water flow and/or sedimentation into occupied habitat and avoidance areas, silt fences, hay bales, and similar structures or practices will be incorporated into the project design; appropriate placement of fill is encouraged, 4. Construction of roads will occur such that the edge of the right of way is at least 300 feet from any plant and 300 feet from avoidance areas, 5. Roads will be graveled within occupied habitat; the operator is encouraged to apply water for dust abatement to such areas from May 1st to June 5th (flowering period); dust abatement applications will be comprised of water only,

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	6. The edge of the well pad should be located at least 300 feet away from plants and avoidance areas, in general; however, site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat, 7. Surface pipelines will be laid such that a 300-foot buffer exists between the edge of the right of way and plants and 300 feet between the edge of right of way and avoidance areas; use stabilizing and anchoring techniques when the pipeline crosses suitable habitat to ensure pipelines don't move towards the population; site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat, 8. Construction activities will not occur from May 1st through June 5th within occupied habitat, 9. Before and during construction, areas for avoidance should be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc., 10. Where technically and economically feasible, use directional drilling or multiple wells from the same pad, 11. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and 12. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible. 1. Occupied clay reed-mustard habitats within 300 feet of the edge of the surface pipelines' right of ways, 300 feet of the edge of the roads' right of ways, and 300 feet from the edge of the well pad shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the Service. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the Service. 2. Re-initiation of section 7 consultation with the Service will be sought immediately if any loss of plants or occupied habitat for the clay reed-mustard is anticipated as a result of project activities. Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the U.S. Fish and Wildlife Service to ensure continued compliance with the ESA.
T&E-21	**SHRUBBY REED - MUSTARD** (SCHOENOCRAMBE SUFFRUTESCENS) The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for shrubby reed-mustard under the Endangered Species Act. The following avoidance and minimization measures have been developed to facilitate review and analysis of any submitted permits under the authority of this lease. In order to minimize effects to the federally endangered shrubby reed-mustard, the Bureau of Land Management (BLM) in coordination with the U.S. Fish and Wildlife Service (Service) developed the following avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production, and maintenance) are in compliance with the Endangered Species Act (ESA). For the purposes of this document, the following terms are so defined: Potential habitat is defined as areas which satisfy the broad criteria of the species habitat description;

usually determined by preliminary, in-house assessment. Suitable habitat is defined as areas which contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain shrubby reed-mustard; habitat descriptions can be found in the Federal Register 52(193):37416-37420 and in the U.S. Fish and Wildlife Service's 1994 Utah Reed-Mustards Recovery Plan (http://www.fws.gov/endangered/wildlife.html). Occupied habitat is defined as areas currently or historically known to support shrubby reed-mustard; synonymous with "known habitat." The following avoidance and minimization measures should be included in the Plan of Development:

1. Pre-project habitat assessments will be completed across 100% of the project disturbance area within potential habitat prior to any ground disturbing activities to determine if suitable shrubby reed-mustard habitat is present.

2. Within suitable habitat, site inventories will be conducted to determine occupancy. Inventories:

    a. Must be conducted by qualified individual(s) and according to BLM and Service accepted survey protocols,

    b. Will be conducted in suitable and occupied habitat for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected (April 15th to August 1st, unless extended by the BLM),

    c. Will occur within 300 feet from the edge of the proposed right-of-way for surface pipelines or roads; and within 300 feet from the perimeter of disturbance for the proposed well pad including the well pad,

    d. Will include, but not be limited to, plant species lists and habitat characteristics, and

    e. Will be valid until April 15th the following year.

3. Design project infrastructure to minimize impacts within suitable habitat:

    a. Reduce well pad size to the minimum needed, without compromising safety,

    b. Limit new access routes created by the project,

    c. Roads and utilities should share common right-of-ways where possible,

    d. Reduce the width of right-of-ways and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat,

    e. Place signing to limit off-road travel in sensitive areas, and

    f. Stay on designated routes and other cleared/approved areas.

4. Within occupied habitat, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants:

    a. Follow the above (3.) recommendations for project design within suitable habitats,

    b. Construction of roads will occur such that the edge of the right of way is at least 300' from any plant,

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	c. Roads will be graveled within occupied habitat; the operator is encouraged to apply water for dust abatement to such areas from April 15th to May 30th (flowering period); dust abatement applications will be comprised of water only, d. The edge of the well pad should be located at least 300 feet away from plants, e. Surface pipelines will be laid such that a 300-foot buffer exists between the edge of the right of way and the plants, use stabilizing and anchoring techniques when the pipeline crosses the white shale strata to ensure the pipelines don't move towards the population, f. Construction activities will not occur from April 15th through May 30th within occupied habitat, g. Before and during construction, areas for avoidance should be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc., h. Where technically and economically feasible, use directional drilling or multiple wells from the same pad, i. Designs will avoid concentrating water flows or sediments into occupied habitat, j. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and k. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible. 5. Occupied shrubby reed-mustard habitats within 300 feet of the edge of the surface pipeline right of ways, 300 feet of the edge of the road right of ways, and 300 feet from the edge of well pads shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the Service. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the Service. 6. Re-initiation of section 7 consultation with the Service will be sought immediately if any loss of plants or occupied habitat for the shrubby reed-mustard is anticipated as a result of project activities. Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the U.S. Fish and Wildlife Service to ensure continued compliance with the ESA.
T&E-22	**UTE LADIES'-TRESSES** (*SPIRANTHES DILUVIALIS*) The Lessee/Operator is given notice that the lands in this parcel contain suitable habitat for Ute ladies'-tresses under the Endangered Species Act (ESA). The following avoidance and minimization measures have been developed to facilitate review and analysis of any submitted permits under the authority of this lease. In order to minimize effects to the federally threatened Ute ladies'-tresses, the BLM in coordination with the USFWS, developed the following avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production,

and maintenance) are in compliance with the ESA. Ute ladies'-tresses habitat is provided some protection under Executive Orders 11990 (wetland protection) and 11988 (floodplain management), as well as section 404 of the Clean Water Act. For the purposes of this document, the following terms are so defined: Potential habitat is defined as areas which satisfy the broad criteria of the species habitat description; usually determined by preliminary, in-house assessment. Suitable habitat is defined as areas which contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain Ute ladies'-tresses. Habitat descriptions can be found in Recovery Plans and Federal Register Notices for the species at <http://www.fws.gov/endangered/wildlife.html>. Occupied habitat is defined as areas currently or historically known to support Ute ladies'-tresses; synonymous with "known habitat. Although plants, habitat, or populations may be afforded some protection under these regulatory mechanisms, the following conservation measures should be included in the Plan of Development:

1. Pre-project habitat assessments will be completed across 100% of the project disturbance area, including areas where hydrology might be affected by project activities, within potential habitat prior to any ground disturbing activities to determine if suitable Ute ladies'-tresses habitat is present.

2. Within suitable habitat, site inventories will be conducted to determine occupancy. Inventories:

1. Must be conducted by qualified individual(s) and according to BLM and USFWS accepted survey protocols,

2. Will be conducted in suitable and occupied habitat for all areas proposed for surface disturbance or areas that could experience direct or indirect changes in hydrology from project activities,

3. Will be conducted prior to initiation of project activities and within the same growing season, at a time when the plant can be detected, and during appropriate flowering periods (usually August 1st and August 31st in the Uinta Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or USFWS

4. botanist or demonstrating that the nearest known population is in flower),

5. Will occur within 300' from the edge of the proposed right-of-way for surface pipelines or roads; and within 300' from the perimeter of disturbance for the proposed well pad including the well pad,

6. Will include, but not be limited to, plant species lists, habitat characteristics, source of hydrology, and estimated hyroperiod, and

7. Will be valid until August 1st the following year.

1. Design project infrastructure to minimize direct or indirect impacts to suitable habitat both within and of the project area:

1. Alteration and disturbance of hydrology will not be permitted,

2. Reduce well pad size to the minimum needed, without compromising safety,

3. Limit new access routes created by the project,

4. Roads and utilities should share common right-of-ways where possible,

5. Reduce width of right-of-ways and minimize the depth of excavation needed for the road bed,

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	6. Construction and right-of-way management measures should avoid soil compaction that would impact Ute ladies' tresses habitat, 7. Off-site impacts or indirect impacts should be avoided or minimized (i.e. install berms or catchment ditches to prevent spilled materials from reaching occupied or suitable habitat through either surface or groundwater), 8. Place signing to limit off-road travel in sensitive areas, 9. Stay on designated routes and other cleared/approved areas, and 10. All disturbed areas will be re-vegetated with species approved by USFWS and BLM botanists. 1. Within occupied habitat, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants: 1. Follow the above (#3) recommendations for project design within suitable habitats, 2. Buffers of 300 feet minimum between right of way (roads and surface pipelines) or surface disturbance (well pads) and plants and populations will be incorporated, 3. Surface pipelines will be laid such that a 300-foot buffer exists between the edge of the right of way and the plants, using stabilizing and anchoring techniques when the pipeline crosses habitat to ensure the pipelines don't move towards the population, 4. Before and during construction, areas for avoidance should be visually identifiable in the field (e.g., flagging, temporary fencing, rebar, etc.), 5. Where technically and economically feasible, use directional drilling or multiple wells from the same pad, 6. Designs will avoid altering site hydrology and concentrating water flows or sediments into occupied habitat, 7. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, with berms and catchment ditches to avoid or minimize the potential for materials to reach occupied or suitable habitat, and 8. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible. 1. Occupied Ute ladies'-tresses habitats within 300' of the edge of the surface pipelines' right-of-ways, 300' of the edge of the roads' right-of-ways, and 300' from the edge of the well pad shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Habitat impacts include monitoring any changes in hydrology due to project related activities. Annual reports shall be provided to the BLM and the USFWS. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the Service. 2. Re-initiation of section 7 consultation with the USFWS will be sought immediately if any loss of plants or occupied habitat for the Ute ladies'-tresses is anticipated as a result of project activities.

	Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the USFWS to ensure continued compliance with the ESA.

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Appendix B. Maps

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Appendix C. Interdisciplinary Checklist

INTERDISCIPLINARY TEAM CHECKLIST

Project Title: November 2016 Vernal Competitive Oil and Gas Lease Sale

NEPA Log Number: DOI-BLM-UT-G010-2016-033-EA

Project Leader: Melissa Wardle

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DETERMINATION OF STAFF: (Choose one of the following abbreviated options for the left column)

NP = not present in the area impacted by the proposed or alternative actions

NI = present, but not affected to a degree that detailed analysis is required

PI = present with potential for relevant impact that need to be analyzed in detail in the EA

NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section D of the DNA form. The Rationale column may include NI and NP discussions.

Determination	Resource/Issue	Rationale for Determination	Signature	Date
RESOURCES AND ISSUES CONSIDERED (INCLUDES SUPPLEMENTAL AUTHORITIES APPENDIX 1 H-1790-1)				
PI	Air Quality & Greenhouse Gas Emissions	Leasing itself would not have impacts to air quality. However, should development occur on issued leases, emissions from earth-moving equipment, vehicle traffic, drilling and completion activities, separators, oil storage tanks, dehydration units, and daily tailpipe and fugitive dust emissions could adversely affect air quality. No standards have been set by EPA or other regulatory agencies for greenhouse gases. In addition, the assessment of greenhouse gas emissions and climate change is still in its earliest stages of formulation. Global scientific models are inconsistent, and regional or local scientific models are lacking so that it is not technically feasible to determine the net impacts to climate due to greenhouse gas emissions.	Leonard Herr	10/6/2016
NP	BLM Natural Areas	None of the proposed lease parcels occur within any BLM Natural Areas as per GIS and VFO RMP [BLM 2008b] review.	Melissa Wardle	4/4/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
PI	Cultural: Archaeological Resources	A complete inventory of the proposed lease parcels is in progress and will be attached to the final EA; cultural resources have been identified within and adjacent to the parcels. Cultural resource information and data has been considered including: the VFO Resource Management Plan, previous cultural reports and surveys, archaeological site forms, geography, vegetation, topography, site visits, and personal knowledge and experience of the proposed parcels; and it has been determined that reasonable development could occur without adverse impacts to cultural properties in most parcels. However, it is likely that additional cultural resources will be located within the proposed lease parcels. Six Parcels are proposed near Steinaker Reservoir or Nine Mile Canyon. Those areas are more sensitive because of their proximity to water sources and the high numbers of cultural sites already recorded in that area. Many of these parcels may also have indirect impacts to cultural site setting, and the development of parcels in those areas may increase the cumulative impacts of the area as well. The BLM will not approve any ground disturbing activities that may affect such properties or resources until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized or mitigated.	David Christensen	8/3/2016
PI	Cultural: Native American Religious Concerns	Two parcels are on or near Nine Mile Canyon; an area that is considered sensitive to Native Americans. A letter was sent on May 24, 2016 to the following tribes regarding this proposed project and there concerns or comments will be added. Ute Mountain Ute Tribe, Ute Indian Tribe, Goshute Indian Tribe, Zia Pueblo, White Mesa Ute Tribe, Navajo Nation, Laguna Pueblo, Northwest Band of Shoshone, Southern Ute Tribe, Eastern Shoshone, Santa Clara Pueblo, Hopi Tribe, Jemez Pueblo. Maps of the parcels were provided to each of the tribes. they were asked to identify traditional cultural places or any other areas of traditional cultural importance that need to be considered within the APE. The Hopi Tribe responded on June 13, 2016. They wished for more information on cultural	David Christensen	8/3/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
		resources in proposed parcels. A letter with the cultural report was sent to the Hopi Tribe on August 16, 2016.		
PI	Designated Areas: Areas of Critical Environmental Concern	Parcels 009, and 010 occur within the Nine Mile ACEC, relevance and importance values include high value scenery, cultural resources, and special status species.	Rene Arce	4/22/2016
NP	Designated Areas: Wild and Scenic Rivers	None present within the project area as per the VFO RMP [BLM 2008b] and GIS review.	Rene Arce	4/22/2016
NP	Designated Areas: Wilderness Study Areas	None present within the project area as per the VFO RMP [BLM 2008b]and GIS review.	Rene Arce	4/22/2016
NI	Environmental Justice	As defined in EO 12898, minority, low income populations and disadvantaged groups may be present within the counties involved in this lease sale. However, all citizens can file an expression of interest or participate in the bidding process (43 CFR §3120.3-2). The stipulations and notices applied to the subject parcels do not place an undue burden on these groups. Leasing the nominated parcels would not cause any disproportionately high and adverse human health or environmental effects on minority populations, low-income populations, or Native American Tribes because the minerals are federal and or the surface is private or BLM.	Melissa Wardle	5/16/2016
NI	Farmlands (prime/unique)	None of the proposed Lease Parcels occur within prime or unique Farmlands as defined by the NRCS.	Melissa Wardle	4/4/2016
NI	Fuels/Fire Management	Fuels Management: Any new disturbance and additional traffic will increase the amount of *Bromus tectorum*. An increase in *Bromus tectorum* may lead to a changing fire regime and an increase in fire frequency. Implementing the Green River District reclamation standards and ensuring the standards are met will minimize any new populations of *Bromus tectorum*.	Blaine Tarbell	3/09/2016
NI	Geology/Minerals/Energy Production	All or portions of parcels 009, and 010 are spatially located within the Sunnyside Special Tar Sands Area (STSA) portions of parcel 052 within the Asphalt Ridge STSA. There is the potential for Gilsonite to be encountered within parcel 122. Leasing of parcels spatially located within STSA's would singly retain the right to develop oil and gas mineral resources as a separate entity from potential tar sand commodities, nor retain the rights on that commodity within parcels established as combined hydrocarbon leases. Leasing will also have no direct impact on geologic conditions or other mineral resources contained within those parcels. At the development stage,	Joseph Islas	6/10/2016

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		compliance with "Onshore Oil and Gas Order No. 2, Drilling Operations" would assure that the proposed development would not adversely affect other mineral resources. The guidelines of this Order specifies the following: "…proposed casing and cementing programs should be conducted as approved to protect and/or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use." Prospectively valuable deposits of minerals would include Gilsonite, oil shale, and tar sands for example, in addition to the oil and gas resource. ——————————— The underground injection of 'fracking waste water' in Utah presents little potential for inducing seismic activity. The majority of fracking waste 'fluids' are recycled and reused for future frack jobs. There have been no reported earthquakes in Utah that were suspected of being produced (induced) from injecting fluids into oil and gas disposal wells. (Personal communication from Brad Rogers, Utah Division of Oil, Gas and Mining ("UDOGM"), August 10, 2015). This fluid is predominantly produced water with a high salt brine content. As stated above in order to analyze and predict the potential for earthquakes associated with oil and gas disposal wells three kinds of data will be necessary: (1) seismic data: high-quality, real-time earthquake locations, which require dense seismic instrumentation; (2) geologic data: hydrological parameters, orientation and magnitude of the stress field, and the location and orientation of known faults; and (3) industrial data: injection rates and downhole pressures sampled and reported frequently. This data is not currently available, with the exception of industrial injection data reported to UDOGM, with which to do the analysis.	Mike McKinley	6/9/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
NI	Invasive Plants/Noxious Weeds, Soils & Vegetation	The lease sale alone would not affect Invasive Plants/Noxious Weeds. However, there is an expectation that development will occur in the future, at which time additional NEPA would be conducted. At the development stage, mitigation measures and best management practices will need to be incorporated to avoid the spread of undesirable non-native plant species. Required mitigation measures will need to at a minimum meet the standards set forward within the Vernal Field Office Surface Disturbance Weed Policy (IM-UTG010-10-001). Future site specific NEPA should discuss the non-native species present, the likelihood they would spread, the developed mitigation measures, and information on chemical weed control and how it tiers to the National and local programmatic guidance. Soils: The Vernal VFO RMP [BLM 2008b] requires application of CSU and NSO stipulations on parcels with slopes greater than 21%. of the parcels contain slopes greater than 21%. Inclusion of the stipulations UT-S-96 NSO slopes >40% and UT-S-100 CSU slopes 21–40% should be sufficient to notify the operator of any potential future development restrictions.	Melissa Wardle	5/16/2016
NI	Lands/Access	The proposed area is located within the Vernal Field Office Resource Management Plan area, which allows for oil and gas development with associated road and pipeline right-of-ways. Current land uses, within the area identified in the proposed action and adjacent lands, consist of existing oil and gas development, wildlife habitat, recreational use, and sheep and cattle ranching. No existing land uses would be changed or modified by the implementation of the proposed action. Master Title Plats have been checked for conflicts with Public Water Reserves. No PWRs were identified. There are Uintah and Duchesne roads on the proposed parcels. They have been identified on the Counties' Transportation Maps as Class B and D roads.	Margo Roberts	5/18/2016

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Determination	Resource/Issue	Rationale for Determination	Signature	Date
PI	Lands with Wilderness Characteristics (LWC)	Several proposed lease parcels are located in lands found to possess wilderness characteristics. Parcels (ID#) 009, and 010 occur partially or fully within Currant Canyon wilderness character inventory unit. Parcels (ID#) 032, 038, 039, and 049 occur partially or fully within the Desolation Canyon wilderness inventory unit.	Rene Arce	4/22/2016
PI	Livestock Grazing & Rangeland Health Standards	Livestock Grazing: The current parcels available for leasing are located within numerous active grazing allotments. The use on these allotments vary seasonally and with livestock type (sheep/cows). Many of these allotments have been evaluated for grazing use through the NEPA process. The leasing process does not determine the actuality or amount of ground disturbance due to the nature of energy development. The site specific NEPA document for the exploration and/or development application is the process for further potential analysis regarding possible fragmentation, forage loss and/or other operational impacts. Assumptions are not valid due to the volatility of the energy market and other issue regarding full production of leases within the allotted time-frames Rangeland Health Standards: Rangeland health issues such as invasive weeds, soil loss, and lack of native species diversity do exist in areas within the Vernal Field Office associated grazing allotments. Leasing of the proposed parcels would not, by itself, authorize any ground disturbances. Site-specific effects of land health standards cannot be analyzed until an exploration or development application is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to analysis for impact on rangeland health standards. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels.	Dusty Carpenter	3/04/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
NI	Paleontology	There is a potential for the proposed lease locations to be spatially on or near areas designated as high PYFC zones for in-situ fossil localities. Evaluation of paleontological sensitivity of all geological formations along proposed access roads, pipeline right-of-ways and well sites is requested by the Department of the Interior and the Bureau of Land Management by the mandates outlined in NEPA (P.L. 91–190; 31 Stat. 852, 42 U.S.C. 4321–4327); FLPMA (P.L. 94–579; 90 Stat. 2743, U.S.C. 1701–1782; OPLM-Subtitle D, Paleontological Resources Protection, Sections 6301–6312, PL 111–11, Congressional Record-House, p. H3900–H3901; BLM Paleontology Resources Management Manual and Handbook H-8270–1, 1998, BLM IM 2008–09; BLM IM 2009–11. Paleontological surveys should be performed by licensed and permitted companies experienced in completing specialized surveys for exploration companies, with reports of research to accompany APD applications to the Vernal field office in Vernal, Utah.	Joseph Islas	2/24/2015
PI	Plants: BLM Sensitive	The following BLM-Sensitive plant species and their habitat have been identified, or have the potential to occur, within one or more of the proposed lease parcels: rock columbine (*Aquilegia scopulorum* var. *goodrichii*), Horseshoe milkvetch (*Astragalus equisolensis*), Hamilton milkvetch (*Astragalus hamiltonii*), Graham catseye (*Cryptantha grahamii*), Untermann fleabane (*Erigeron untermannii*), Goodrich blazingstar (*Mentzelia goodrichii*), Goodrich beardtongue (*Penstemon goodrichii*), Graham beardtongue (*Penstemon grahamii*), White River beardtongue (*Penstemon scariosus* var. *albifluvis*), Argyle phacelia (*Phacelia argylensis*), Green River greenthread (*Thelesperma subnudum* var. *caespitosum*),and sterile yucca (*Yucca sterilis*). Application of lease notices UT-LN-49, UT-LN-51, UT-LN-89, and UT-LN-90 is required for these parcels. In addition, there are eight parcels that overlap with portions of the Penstemon Conservation Agreement areas. These parcels will be subject to the stipulations and conservation measures outlined in the Penstemon Conservation Agreement. Additionally, pursuant to BLM Handbook 3120-1 – Competitive Leases (P) (H-3120), the following stipulation is attached to all of the lease parcels: *The lease may now*	Matt Lewis	2/23/2016

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		and hereafter contain plants, animals, and their habitats determined to be threatened, endangered, or other special status species. BLM may recommend modifications to exploration and development proposals to further its conservation and management objectives to avoid BLM approved activity that will contribute to a need to list such a species or their habitat. BLM may require modification to or disapprove a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligation under requirements of the Endangered Species Act, as amended, 16 U. S. C. § 1531 et seq., including completion of any required procedure for conference or consultation (H-3120 at 35).		
PI	Plants: Threatened, Endangered, Proposed, or Candidate	The following federally listed plant species and their habitat occur, or have the potential to occur, within one or more of the proposed lease parcels: clay reed-mustard (*Hesperidanthus argillaceus*), shrubby reed-mustard (*Hesperidanthus suffrutescens*), Pariette cactus (*Sclerocactus brevispinus*), Uinta Basin hookless cactus (*Sclerocactus wetlandicus*), and Ute ladies'-tresses (*Spiranthes diluvialis*). Application of lease notices T&E-05, T&E-12, T&E-20, T&E-21, and T&E-22 is required for these parcels. In addition, stipulation UT-S-314 and the Endangered Species Act Section 7 Consultation Stipulation would be attached to the parcels as required by BLM Handbook 3120-1 – Competitive Leases (P) (H-3120). During the development of the proposed lease parcels, and including proposed or required conservation and mitigation measures, any impacts to these species will be analyzed during Section 7 consultation with the US Fish and Wildlife Service.	Matt Lewis	2/23/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
NI	Plants: Wetland/Riparian	Although leasing of the parcels will not directly affect wetlands or riparian zones, if oil and gas development occurs the small portions of the mapped 100 year floodplains and wetlands that are found in parcels (ID#s) 005, 012, 013, 038, 069, 071, 094, 103, 105, and 122 which tend to exhibit wetland and riparian type functions could be affected. Impacts to these areas will be mitigated by Lease Stipulation UT-S-123 and Lease Notice UT-LN-53.	Melissa Wardle	5/16/2016
PI	Recreation	Parcels (ID#) 009, and 010 occur partially or fully within the Nine Mile SRMA.	Rene Arce	4/22/2016
NI	Socio-Economics	No impact to the social or economic status of the counties or nearby communities would occur from the leasing of these parcels due to their small size of this project in relation to ongoing development throughout the Uinta Basin.	Melissa Wardle	5/18/2016
PI	Visual Resources	Parcel (ID#) 038, falls partially or fully within lands that are managed as VRM class II. The objective of this class is to retain the existing character of the landscape. The level of change to the landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes to the landscape must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape. Parcels (ID#) 004, 009, 010, 012, 013, 014, 015, 032, 038, 067, 070, 094, 103, 121, 122, 151, and 152 fall partially or fully within lands that are managed as VRM class III. The objective of this class is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate. Management activities may attract the attention of the casual observer, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape. Parcels 006, 009, 010, 012, 013, 014, 015, 016, 032, 039, 049, 070, and 071 occur partially or fully within lands that are managed as VRM class IV. The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of attention. However, every attempt should be made to minimize the impact of these activities through careful	Rene Arce	4/22/2016

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		location, minimal disturbance, and repeating the basic elements of the landscape.		
NI	Wastes (hazardous/solid)	The analysis in the VFO RMP [BLM 2008b] is sufficient. No hazardous or solid waste sites are known to be present. No hazardous or solid waste sites are anticipated to occur as a result of leasing. No stipulations or lease notices apply.	Melissa Wardle	4/4/2016
NI	Water: Floodplains	Floodplains are associated with Parcels 012, 013, 038, 069, 071, and 094. Leasing of the proposed parcels would not, by itself, authorize any ground disturbances. Site-specific effects cannot be analyzed until an exploration or development application is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to the standard lease terms, the protective lease notices and stipulations identified in Appendix A, and all applicable laws, regulations and onshore orders in existence at the time of lease issuance. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels. In light of existing knowledge regarding resource values on the subject parcels, which is based upon the analysis in the VFO RMP [BLM 2008b], BLM VFO resource specialist knowledge and parcel site-visits, and the protective measure that would be applied to the parcels if leased, significant impacts beyond those already addressed in the VFO RMP [BLM2008bBLM 2008b] are not anticipated to occur as a result of leasing the proposed parcels. Application of UT-S-123 should be sufficient to notify the operator of any potential future development restrictions.	Melissa Wardle	4/4/2016
NI	Water: Groundwater Quality	Spatial position of proposed leasing allotments will not affect groundwater resources, conditional to compliance with "Onshore Oil and Gas Order 1" and federal regulations outlined in 43 CFR, part 3160, to assure that downhole operations will protect and isolate all useable waters through the use of steel casing and hardened cement settings from the subsurface up onto surface operations. No EPA Sole Source Aquifers or State of Utah Drinking Water Source Protection Zones underlie the proposed parcels. The potential to encounter useable groundwater with <10,000 ppm Total Dissolved Solids during drilling operations throughout the leasing area is a possibility and subject to mitigation procedures.	Joseph Islas	6/10/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
		EPA stated in the draft June 2015, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources* ("EPA Draft" http://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=244651), that "We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States…The number of identified cases where drinking water resources were impacted are small relative to the number of hydraulically fractured wells…There is insufficient pre- and post-hydraulic fracturing data on the quality of drinking water resources. This inhibits a determination of the frequency of impacts. Other limiting factors include the presence of other causes of contamination, the short duration of existing studies, and inaccessible information related to hydraulic fracturing activities. There is not sufficient evidence to support the contention that hydraulic fracturing negatively impacts ground water to an unacceptable degree…The potential impacts to surface and/or ground water from hydraulic fracturing activities has not been shown to reach a level requiring detailed analysis." *See* EPA Draft at ES-23.	Mike McKinley	6/9/2016
NI	Water: Hydrologic Conditions (stormwater)	Hydrologic conditions do exist in the Vernal Field Office, Leasing of the proposed parcels would not, by itself, authorize any ground disturbances. Site-specific effects cannot be analyzed until an exploration or development application is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to the standard lease terms, the protective lease notices and stipulations identified in Appendix A, and all applicable laws, regulations and onshore orders in existence at the time of lease issuance. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels. In light of existing knowledge regarding resource values on the subject parcels, which is based upon the analysis in the VFO RMP [BLM 2008b] resource specialist knowledge and parcel site-visits, significant impacts beyond those already addressed in the Record of Decision VFO RMP [BLM2008bBLM 2008b]are not anticipated to occur as a result of leasing the proposed parcels.	Melissa Wardle 2016 DEC 12 PM 2:44 U.S. DEPT OF INTERIOR BUREAU OF LAND MGMT COLO STATE OFFICE DENVER	4/4/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
NI	Water: Surface Water Quality	Leasing of the proposed parcels would not, by itself, authorize any ground disturbances which could contribute runoff affecting surface water quality. Site-specific effects cannot be analyzed until an exploration or development application is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to the standard lease terms, the protective lease notices and stipulations identified in Appendix A, and all applicable laws, regulations and onshore orders in existence at the time of lease issuance. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels. In light of existing knowledge regarding resource values on the subject parcels, which is based upon the analysis in the VFO RMP [BLM 2008b], BLM VFO resource specialist knowledge and parcel site-visits, significant impacts beyond those already addressed in the VFO RMP [BLM 2008b] are not anticipated to occur as a result of leasing the proposed parcels.	Melissa Wardle	4/4/2016
NP	Water: Waters of the U.S.	No waters of the US are present in the project area per GIS information.	Melissa Wardle	4/4/2016
NP	Wild Horses	Approximately 12 parcels are within or adjacent to the historic Hill Creek Herd Area boundary. Although, appropriate management level targets were removed from the herd in 2008, the horses within the Hill Creek HA are still recognized as free-roaming wild horses protected under the FRWHB Act. These horses fall within the jurisdiction of the BLM for management until such time that each horse is removed from the herd area - effectively zeroing out the population. The document to analyze the leasing of the parcels will not create an impact to the existing horses in this HA. However, impacts will be determined to this resource through the site specific documents that may be subsequently developed.	Dusty Carpenter	5/17/2016
PI	Wildlife: Migratory Birds	Migratory bird foraging and nesting habitat is present in all parcels. Application of lease notice UT-LN-45 is required all parcels. There are known or documented raptor nests within ½ miles of several parcels. Application of lease notice and/or stipulation UT-LN-49, UT-LN-40, UT-S-261, UT-S-278 is required for all parcels.	Daniel Emmett	5/11/2016

Determination	Resource/Issue	Rationale for Determination	Signature	Date
PI (Aquatics NI)	Wildlife: Non-USFWS Designated	Designated elk crucial year long and winter habitat within several parcels. Designated deer crucial year long and winter habitat within several parcels. Application of lease notice and/or stipulation UT-S-247, UT-S-230, UT-S-247, UT-S-230 is required for parcels (ID#) 004, 005, 006, 009, 012, 013,014, 015, 016, 038, 070, 094, 103, 121, 122, 152. The following conservation agreement fish species and their habitat have been identified, or have the potential to occur, within one or more of the proposed lease parcels: Roundtail Chub (Gila robusta), Bluehead Sucker (Catostomus discobolus), and Flannelmouth Sucker (Catostomus Latipinnis)Application of lease notice UT-LN-49 is required for parcels (ID#) 094, and 103.	Jerrad Goodell Daniel Emmett	5/11/2016 5/16/2016
PI (Aquatics NI)	Wildlife: Special Status Species	MSO habitat exists within some parcels. Application of lease notice and/or stipulation T&E-06 is required for parcels (ID#) 004, 005, 009, 010. Yellow-billed cuckoo potential habitat exists within parcels. Application of lease notice and/or stipulation UT-LN-49, UT-LN-113, UT-LN-115 is required for parcels (ID#) 038, 094, 103. No parcels are within or partially within Primary but 3 parcels are within General Greater Sage Habitat, as designated in the 2015 *Record of Decision and Approved Resource Management Plan Amendments for the Great Basin Region, Including the Greater Sage-Grouse Sub-Regions of Idaho and Southwestern Montana, Nevada and Northeastern California, Oregon and Utah* (GRSG ROD) and the *Utah Greater Sage-Grouse Approved Resource Management Plan Amendment* (GRSG ARMPA). Application of lease notice and/or stipulation UT-LN-49, UT-LN-132, UT-S-195, UT-S-205, UT-S-206, UT-S-207 is required for parcels (ID#) 032, 067, 152.[BLM 2015] Should analysis at the time of development indicate the need, Conditions of Approval to protect Sage-Grouse can be added in accordance with the Sensitive Species lease notice. The following federally listed fish species and their habitat occur, or have the potential to occur, within one or more of the proposed lease parcels: Razorback Sucker (Xryauchen texanus), Colorado pikeminnow (Ptycheilus lucius), Humpback Chub (Gila cypha), and Bonytail Chub (Gila elegans)Application of lease notice T&E-03 is required for these parcels (ID#) 094, and 103. Per the	Jerrad Goodell Daniel Emmett	5/11/2016 5/16/2016

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		notice T&E-03: Water depletions from any portion of the Upper Colorado River drainage basin above Lake Powell are considered to adversely affect or adversely modify the critical habitat of the four resident endangered fish species and must be evaluated with regard to the criteria described in the Upper Colorado River Endangered Fish Recovery Program. Formal consultation with USFWS is required for all depletions. All depletions amounts must be reported to BLM		
NI	Woodlands/Forestry	Woodlands are present in areas of the proposed lease parcels. Leasing of the proposed parcels would not, by itself, authorize any ground disturbing activities that could affect woodlands. Site-specific effects cannot be analyzed until an exploration or development application is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to the standard lease terms, the protective lease notices and stipulations identified in Appendix A, and all applicable laws, regulations and onshore orders in existence at the time of lease issuance. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels. In light of existing knowledge regarding resource values on the subject parcels, which is based upon the analysis in the VFO RMP [BLM 2008b], BLM VFO resource specialist knowledge and parcel site-visits, and the protective measure that would be applied to the parcels if leased, significant impacts beyond those already addressed in the VFO RMP[BLM 2008b] are not anticipated to occur as a result of leasing the proposed parcels.	David Palmer	5/17/2016

Appendix D. Deferred Parcels

BLM_Sale ID	Legal Description of Deferred Parcel and deferred Sections	Reason for Deferral
UT1116 - 001	T. 10 S., R. 13 E., Salt Lake Sec. 31: Lot 1; Sec. 33: Lots 1-4, S2SW; Sec. 34: Lot 1. 246.85 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 002	T. 11 S., R. 13 E., Salt Lake Sec. 1: All; Sec. 11: E2, NENW; Sec. 12: All. 980.79 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 003	T. 11 S., R. 13 E., Salt Lake Secs. 3, 4 and 5: All. 1,878.18 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

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UT1116 - 007	T. 11 S., R. 14 E., Salt Lake Sec. 8: All. 258.40 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 008	T. 11 S., R. 14 E., Salt Lake Sec. 11: S2; Sec. 12: SW; Sec. 14: E2. 800.00 Acres Duchesne County, Utah Vernal Field Office	BLM identified lands with wilderness characteristics in the Currant Canyon Inventory Unit in 2011 and additions in 2015, post-RMP EIS analysis. This parcel is within both the 2011 Inventory Unit and the 2015 addition and was deferred due to staff and time limitations to sufficiently evaluate the impacts to the Unit. Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 010	*partial deferral - deferred section:* T. 11 S., R. 14 E., Salt Lake Sec. Sec. 33: NW, N2SW, SESW, 280.00 Acres Duchesne County, Utah Vernal Field Office	BLM identified lands with wilderness characteristics in the Currant Canyon Inventory Unit in 2011 and additions in 2015, post-RMP EIS analysis. This parcel is within both the 2011 Inventory Unit and the 2015 addition and was deferred due to staff and time limitations to sufficiently evaluate the impacts to the Unit.
UT1116 - 011	T. 11 S., R. 14 E., Salt Lake Sec. 30: Lots 3, 4, 7-9, 12; Sec. 31: Lot 6, NENE, NESE. 402.26 Acres Duchesne County, Utah Vernal Field Office	BLM identified lands with wilderness characteristics in the Currant Canyon Inventory Unit in 2011 and additions in 2015, post-RMP EIS analysis. This parcel is within both the 2011 Inventory Unit and the 2015 addition and was deferred due to staff and time limitations to sufficiently evaluate the impacts to the Unit.

UT1116 - 012	*partial deferral — deferred section:* T. 10 S., R. 15 E., Salt Lake Sec. 1: All; 641.04 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Big Wash, Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed.
UT1116 - 013	*partial deferral — deferred section:* T. 10 S., R. 15 E., Salt Lake Sec. 22: NE; Sec. 23: W2E2, NW. 480.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Sheep Wash Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed.
UT1116 - 015	*partial deferral — deferred section:* T. 10 S., R. 15 E., Salt Lake Sec. 28: SENE, NESE. 80.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Big Wash Additions in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed.
UT1116 - 017	T. 10 S., R. 15 E., Salt Lake Sec. 33: Lots 1-4; Sec. 34: Lots 1-4, NWNE, SENW; Sec. 35: All. 1,020.76 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

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UT1116 - 018	T. 11 S., R. 15 E., Salt Lake Sec. 1: All; Sec. 11: NE, S2; Sec. 12: All; 1, 761.40 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 019	T. 11 S., R. 15 E., Salt Lake Sec. 3: S2N2, S2; Sec. 4: All; 1,222.72 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 020	T. 11 S., R. 15 E., Salt Lake Sec. 28: NESE, S2SE; Sec. 31: Lot 4; Sec. 33: Lots 1-3, SENE, NW, N2SE. 567.37 Acres Duchesne County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 021	T. 10 S., R. 16 E., Salt Lake Sec. 1: All; Sec. 10: SENE, E2SW, SE; Secs. 11 and 12: All. 2,199.60 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1),

		the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 022	T. 10 S., R. 16 E., Salt Lake Secs. 13, 14 and 15: All; Sec. 23: E2E2. 2,080.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Sheep Wash Additions in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed.
UT1116 - 023	T. 10 S., R. 16 E., Salt Lake Sec. 25: N2, N2SW, SESW, SE. 600.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Sheep Wash Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 states, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings (using the forms provided in BLM Manual 6310, Appendix B) available to the public as soon as practicable after their completion and **before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed.
UT1116 - 024	T. 10 S., R. 16 E., Salt Lake Sec. 27: N2; Sec. 28: N2. 640.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Sheep Wash Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings (…**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed. Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

UT1116 - 025	T. 10 S., R. 16 E., Salt Lake Sec. 35: SENE, SESE. 80.00 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Sheep Wash Additions in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 states, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed. Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 026	T. 11 S., R. 16 E., Salt Lake Sec. 1: All; Sec. 11: S2; Sec. 12: W2; Sec. 13: N2N2, SE; Sec. 14: N2; Sec. 15: N2. 2,234.48 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Badlands Cliffs Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 states, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed. Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

UT1116 - 027	T. 11 S., R. 16 E., Salt Lake Sec. 6: Lots 1-7, S2NE, SENW; Sec. 7: All. 853.78 Acres Duchesne County, Utah Vernal Field Office	BLM received submissions for the Badlands Cliffs Addition in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. While field work has been performed, BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA. WO IM 2013-106 stated, "The BLM field offices should make finalized and signed wilderness characteristics inventory findings …**before the inventory data is used to inform decisions** [emphasis added]." BLM is unable to analyze and disclose impacts to wilderness characteristics until the presence or absence of the resource is determined. Therefore, the analysis necessary to make an informed decision could not be completed. Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 028	T. 11 S., R. 16 E., Salt Lake Secs. 25 and 26: All. 1,280.00 Acres Duchesne County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 – 029	T. 11 S., R. 16 E., Salt Lake Secs. 33, 34 and 35: All. 1,920.00 Acres Duchesne County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course
UT1116 - 030	T. 9 S., R. 17 E., Salt Lake Sec. 35: All. 640.00 Acres Duchesne County, Utah (183.24 Acres) Uintah County, Utah (456.76 Acres) Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.

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UT1116 - 031	T. 10 S., R. 17 E., Salt Lake Sec. 30: Lot 4; Sec. 31: Lots 1-4, E2W2. 359.20 Acres Duchesne County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 033	T. 11 S., R. 17 E., Salt Lake Sec. 19: Lots 2-4, S2NE, SENW, E2SW, SE; Sec. 20: All; Sec. 21: SWNW, S2. 1,464.42 Acres Duchesne County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 034	T. 11 S., R. 17 E., Salt Lake Sec. 23: S2S2; Sec. 24: S2S2; Secs. 25, 26 and 27: All. 2,240.00 Acres Duchesne County, Utah (1,104.10 Acres) Uintah County, Utah (1,135.90 Acres) Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 035	T. 11 S., R. 17 E., Salt Lake Sec. 28: S2; Sec. 29: S2; Sec. 30: Lots 3, 4, E2SW, SE; Sec. 31: Lots 1, 2, 4, W2NE, E2NW, SESW, SWSE. 1,295.33 Acres Duchesne County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 036	T. 11 S., R. 17 E., Salt Lake Secs. 33, 34 and 35: All. 1,920.00 Acres Duchesne County, Utah (1,653.97 Acres) Uintah County, Utah (266.03 Acres) Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.

UT1116 - 037	T. 9 S., R. 18 E., Salt Lake Sec. 33: S2. 320.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 040	T. 11 S., R. 18 E., Salt Lake Sec. 17: N2NE, SENE, NW; Sec. 18: N2NE, SWNE, NW, N2SW, NWSE. 680.00 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 041	T. 11 S., R. 18 E., Salt Lake Sec. 19: N2SW, N2SWSW, SESW, S2SE; Sec. 20: S2S2; Sec. 29: W2; Secs. 30 and 31: All. 1,980.00 Acres Uintah County, Utah Vernal Field Office	The Sand Wash Recreation Area was not fully analyzed in the Vernal RMP and therefore the parcel is being deferred until further analysis is completed.
UT1116 - 042	T. 11 S., R. 18 E., Salt Lake Sec. 25: SESW, S2SE; Secs. 26, 35 and 36: All. 1,442.00 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 043	T. 11 S., R. 18 E., Salt Lake Sec. 27: Lots 1-4, S2NW, W2SW; Sec. 28: S2NE, NWNW, SE; Sec. 33: N2NE. 649.49 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 044	T. 11 S., R. 18 E., Salt Lake Sec. 27: NESE, S2SE; Sec. 33: S2SW, NWSE; Sec. 34: N2NE, SWNE, S2NW, N2SW, SWSW. 560.00 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 045	T. 9 S., R. 19 E., Salt Lake Sec. 1: Lots 5-7; Sec. 13: Lot 5; Sec. 14: Lot 5. 59.78 Acres Uintah County, Utah Vernal Field Office	This parcel is in Yellow Billed Cuckoo habitat. The Yellow Billed Cuckoo is a federally listed species and therefore this parcel is being deferred because the RMP EIS did not analyze impacts to this species.
UT1116 - 046	T. 9 S., R. 19 E., Salt Lake Sec. 13: NENE, S2NE, E2SW, SE. 360.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.

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UT1116 - 047	T. 9 S., R. 19 E., Salt Lake Sec. 14: Lots 1-3, NW, N2SW; Sec. 15: All. 952.05 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 048	TT. 11 S., R. 19 E., Salt Lake Sec. 6: Lots 3-7, SENW, E2SW; Sec. 7: Lots 1-4, E2W2; Sec. 18: Lot 1. 669.09 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 050	T. 4 S., R. 20 E., Salt Lake Secs. 4, 5 and 6: All. 2,030.42 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 051	T. 4 S., R. 20 E., Salt Lake Secs. 7, 8 and 9: All. 1,985.12 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

UT1116 - 052	T. 4 S., R. 20 E., Salt Lake Sec. 10: All; Sec. 11: Lots 3-6, E2NE, SWNW, W2SW, SE; Sec. 13: Lots 2, 5-7, SWNE, SENW, E2SW, W2SE; Sec. 24: Lot 1. 1,483.10 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 053	T. 4 S., R. 20 E., Salt Lake Sec. 17: N2NE, SWNE, W2, W2SE, SESE; Secs. 18 and 19: All. 1,969.04 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 054	T. 4 S., R. 20 E., Salt Lake Secs. 20, 29 and 30: All. 1,982.80 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 055	T. 4 S., R. 20 E., Salt Lake Sec. 21: NE, W2NW, SENW, S2; Secs. 28 and 33: All. 1,880.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease

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		particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 056	T. 5 S., R. 20 E., Salt Lake Sec. 3: Lots 3, 4, S2NW, SW; Secs. 4 and 10: All. 1,575.70 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 057	T. 5 S., R. 20 E., Salt Lake Secs. 13, 14 and 24: All. 1,920.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 058	T. 6 S., R. 20 E., Salt Lake Sec. 30: Lots 1-4, E2W2; Sec. 31: All excluding ROW U16133 (77.06 ac.). 859.60 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 059	T. 6 S., R. 20 E., Salt Lake Secs. 33, 34 and 35: All. 1,920.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 063	T. 7 S., R. 20 E., Salt Lake Sec. 22: NWNW; Sec. 23: NENE, SWNE, E2NW, NESW, NWSE; Sec. 27: E2NW. 360.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.

UT1116 - 068	T. 3 S., R. 21 E., Salt Lake Sec. 13: NE, NENW, S2NW, S2; Sec. 24: All; Sec. 25: NE, W2NW, SENW, S2. 1,840.16 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 072	T. 4 S., R. 21 E., Salt Lake Sec. 18: Lots 2-4, E2NW, NESW; Sec. 19: E2SESE; Sec. 30: SWNE, NENENW; Sec. 31: SE. 465.50 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 073	T. 5 S., R. 21 E., Salt Lake Sec. 15: Lots 1-8; Sec. 19: All; Sec. 22: Lots 1, 2, S2NE; Sec. 23: Lots 4, 5, S2NW, SW; Sec. 24: NESE. 1,474.55 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 074	T. 6 S., R. 21 E., Salt Lake Secs. 3, 10 and 15: All. 1,794.16 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 075	T. 6 S., R. 21 E., Salt Lake Secs. 6 and 7: All. 1,155.38 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 076	T. 6 S., R. 21 E., Salt Lake Sec. 11: All; Sec. 12: Lots 1, 2, 7, 8, S2; Sec. 14: Lots 7, 8, NENW, W2W2. 1,401.43 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 077	T. 7 S., R. 21 E., Salt Lake Sec. 14: NWSW; Sec. 15: W2NE, SENE; Sec. 20: SE. 320.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.

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UT1116 - 082	T. 12 S., R. 21 E., Salt Lake Sec. 7: Lot 1. 33.34 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 083	T. 12 S., R. 21 E., Salt Lake Sec. 17: W2; Sec. 18: E2; Sec. 28: All. 1,280.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 084	T. 3 S., R. 22 E., Salt Lake Secs. 17, 18 and 19: All. 1,986.84 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 085	T. 3 S., R. 22 E., Salt Lake Secs. 20 and 21: All; Sec. 22: W2W2NE, W2, W2SE. 1,728.41 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 086	T. 3 S., R. 22 E., Salt Lake Sec. 27: Lots 2-5, 8, 9, SWNE, SENW, E2SW, W2SE; Sec. 34: Lots 5-7, W2NE, NW, N2SW, NWSE. 973.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 087	T. 3 S., R. 22 E., Salt Lake Secs. 28, 29 and 33: All. 1,920.00 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.

UT1116 - 088	T. 3 S., R. 22 E., Salt Lake Secs. 30 and 31: All. 1,346.28 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 089	T. 4 S., R. 22 E., Salt Lake Secs. 3, 4 and 5: All. 1,919.12 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 090	T. 4 S., R. 22 E., Salt Lake Sec. 6: All; Sec. 7: Lots 1, 7, NE, E2NW, NESW, N2SE; Sec. 8: All. 1,793.43 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 092	T. 5 S., R. 22 E., Salt Lake Sec. 1: All; Sec. 11: NENE, S2NE, SE; Sec. 12: W2NW, SENW, SW, W2SE, SESE. 1,321.60 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 097	T. 8 S., R. 22 E., Salt Lake Sec. 6: Lots 1-5, S2NE, SENW. 317.92 Acres Uintah County, Utah Vernal Field Office	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 102	T. 5 S., R. 23 E., Salt Lake Sec. 5: S2NE, SW, SWSE; Sec. 6: Lots 5-7, SENW, E2SW, W2SE, SESE; Sec. 7: Lots 1-4, NE, E2NW, NESW, NESE; Sec. 18: Lots 7, 8, E2NENWNE, NESWNWNE, S2SWNWNE, SENWNE, E2NESENW, SESENW. 1,175.42 Acres Uintah County, Utah Vernal Field Office SENWNE, E2NESENW, SESENW.	The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis.
UT1116 - 106	T. 16 S., R. 23 E., Salt Lake Sec. 12: E2, NESW, S2SW; Sec. 13: N2NE, NW, N2SW. 760.00 Acres Grand County Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook

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		(H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 107	T. 8 S., R. 24 E., Salt Lake Sec. 1: Lots 1, 2, S2NE, SE. 320.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 108	T. 8 S., R. 24 E., Salt Lake Sec. 13: S2SE; Sec. 24: E2; Sec. 25: E2. 720.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 109	T. 8 S., R. 24 E., Salt Lake Sec. 15: N2SW, SESW, SE; Sec. 23: SENE, SWSE. 360.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

UT1116 - 110	T. 9 S., R. 24 E., Salt Lake Sec. 4: Lots 3, 4, S2N2, S2. 552.49 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 111	T. 15 1/2 S., R. 24 E., Salt Lake Secs. 33 and 34: All. 905.62 Acres Grand County Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 112	T. 16 S., R. 24 E., Salt Lake Sec. 3: All; Sec. 4: Lots 1, 2, S2NE, SE. 959.23 Acres Grand County Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

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UT1116 - 140	T. 11 S., R. 18 E., Salt Lake Sec. 27: S2NE, E2SW, NWSE; Sec. 33: S2NE, N2SW; Sec. 34: N2NW. 440.00 Acres Uintah County, Utah Vernal Field Office	At the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative (UPLI), was imminent; a public discussion draft was released in January 2016 and the bill was formally introduced on July 14, 2016. These nominated parcels were included in areas that would be protected from development under the UPLI. Offering and issuing new leases within areas protected by the UPLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels is the most prudent course of action.
UT1116 - 143	50% U.S. Mineral Interest T. 5 S., R. 21 E., Salt Lake Sec. 13: S2SE; Sec. 24: N2NE. 160.00 Acres Uintah County, Utah Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.
UT1116 - 151	*partial deferral — deferred section:* T. 11 S., R. 15 E., Salt Lake, Sec. 13: E2. 320.00 Acres, Uintah County, Utah, Vernal Field Office	Instruction Memorandums were not issued relative to Sage-Grouse habitat until after the 2016 Oil and Gas Lease Draft EA was published; however, the agency considered parcels that would focus potential disturbance outside the most important areas for Sage-Grouse conservation, consistent with the objectives and provisions of the GRSG plan. On September 1, 2016, Instruction Memorandum No. 2016-143 was issued regarding Oil & Gas Leasing and Development Sequential Prioritization in Sage-Grouse habitat, which states: The BLM's Authorized Officer, acting under the delegated authority of the Secretary of the Interior, has discretion to determine which public lands will be offered at a lease sale. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226(a) (emphasis added)). When evaluating Expressions of Interest (EOIs) to lease particular parcels, pursuant to the Competitive Leases Handbook (H-3120-1), the BLM will plan for leasing and development in accordance with the objectives and provisions in the GRSG Plans.

Appendix E. Public Comments and Responses

Comment	Comment Summary	Response
Center for Biological Diversity-01	The EA reveals the presence of numerous threatened, endangered, and sensitive species and their critical habitat within the areas proposed for leasing, but fails to provide any meaningful information regarding potential effects. BLM must not only evaluate the indirect and cumulative effects on special status species under NEPA, it must also (a) consult (and/or confer in the case of black-footed ferrets) with the Fish and Wildlife Service under Section 7 regarding the effects of oil and gas development and water use on listed species and critical habitat, and (b) evaluate the effects on sensitive species under its own sensitive species policy.	Impacts to these resources were considered and carried forward when warranted in the analysis. See the ID team checklist in Appendix C for determinations of potential impacts, Chapter 3 for a description of these resources, and Chapter 4 for the potential impacts and effects on these resources. There are no direct impacts from leasing. However, possible development scenarios, which are only hypothetical at this stage, were analyzed and the anticipated impacts were disclosed. As an action agency, we are required to initiate consultation for ferrets when a "may affect, likely to adversely affect" is determined through the NEPA process on a site specific basis. However, by applying lease stipulations/notices to the appropriate parcels for the purposes of analysis that determination was not necessary and the BLM is not required to consult USFWS. Section 7 determinations on site-specific oil and gas projects are not in the scope of this document.
Center for Biological Diversity-02	According to the EA, parcels 094 and 103 contain habitat and/or potential occurrences of reintroduced black-footed ferrets. The black-footed ferret, one of the most critically endangered mammals in North America, was reintroduced to the Coyote Basin in northeast Utah following near-extirpation in the wild. The species was reintroduced to Utah as a nonessential, experimental population pursuant to a rule promulgated under Section 10(j) of the ESA. Although nonessential experimental populations are not subject to the consultation requirement of ESA 7(a)(2), two provisions of ESA Section 7 still apply: (!)section 7(a)(1)—which requires all Federal agencies to use their authority to conserve listed species; and (2)section 7(a)(4)— which requires Federal agencies to confer with the Service on actions that are likely to jeopardize the continued existence of a proposed species throughout its range." Under the requirements of Section 7(a)(1) and 7(a)(4), BLM must still ensure that it is using its authority to conserve the black-footed ferret, and must confer with the Fish and Wildlife Service to determine whether its actions will jeopardize the continued existence of the species. Appendix D to the EA discloses that BLM deferred 23 nominated parcels from this lease sale based on the presence of white-tailed	Parcels UT-1116-94 and UT-1116-103 are included within the State's reintroduction area boundaries, but these leases are not located within the black-footed ferret management zone; therefore, additional mitigation is not required. In addition, the majority of these parcels are located on privately owned lands. There is a portion of parcel UT-1116-103 which is located on BLM-administered lands that contains suitable habitat for prairie dogs. There are historic burrows on this parcel; however, prairie dogs have not occupied these colonies for several years. For spatial references in relation to the parcels suitable habitat for these species occurs over one mile of the lease area and the nearest known ferret occurrence is located over 3 miles of the leases. These parcels were brought forward for analysis and not deferred because of the lack of suitable habitat and/or species.

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	prairie dog colonies. We commend the BLM on the deferral of those parcels, but the EA provides no explanation or justification for why parcels 094 and 103 are still proposed for sale, despite the possible presence of not only white-tailed prairie dogs but also black-footed ferrets. Absent additional information regarding the location and condition of white-tailed prairie dog colonies, black-footed ferret occurrence and habitat use, and site-specific potential impacts of well pads, roads, and traffic on habitat, prey, and mortality, the inclusion of parcels 094 and 103 in the proposed lease sale is arbitrary and unjustified.	
Center for Biological Diversity-03	The EA, and proposed stipulations, fail to adequately disclose or mitigate impacts to these five listed species (see table 3.5 in EA) from oil and gas leasing and development. BLM must take a hard look at impacts to listed plant species in an EIS, and must consult with the Fish and Wildlife Service under ESA Section 7(a)(2) to ensure its action will not cause jeopardy to these species or adverse modification of their critical habitat. For the Uinta Basin Hookless cactus, found on parcels 38, 49, 67, and 105, the Fish and Wildlife Service's recent GasCo BiOp found the 300 foot buffer proposed for the lease sale to be ineffective at minimizing impacts to the species: BLM must take a hard look at the effects of well pads, roads, and other ground disturbance on the Uinta Basin hookless cactus and other listed plant species, including effects on their pollinators and effects extending beyond the 300-foot buffer proposed in Stipulation TE-12. In addition, BLM must consult with the Fish and Wildlife Service, using best available scientific information, to determine whether the proposed action will jeopardize the continued existence of these species.	There are no direct impacts from leasing. Indirect impacts to these species were disclosed in the Vernal Field Office RMP EIS. Consultation occurred during the RMP EIS process and lease notices were developed. When development is proposed, site specific impacts will be analyzed in a separate EA document and additional Section 7 consultation will occur as appropriate for each proposal. The Vernal Field Office RMP EIS, analyzed impacts to water resources. This EA tiers to that EIS.
Center for Biological Diversity-04	Graham's and White River beardtongues, BLM sensitive species, are present on parcels 032, 121, and 122. Oil and gas development in the Uinta Basin threatens these sensitive beardtongues. As of July 2014, 27% and 13% of all known Graham's and White River beardtongue habitat, respectively, occurred on lands that already had been leased by BLM or the State of Utah for oil and gas development. Given rapidly increasing oil and gas production in the region over the past two decades and current exploration occurring in beardtongue habitat, FWS expects oil and gas activity	There are no direct impacts from leasing. Indirect impacts to these species were disclosed in the Vernal Field Office RMP EIS. Consultation occurred during the RMP EIS process and lease notices were developed. When development is proposed, site specific impacts will be analyzed in a separate EA document and additional Section 7 consultation will occur as appropriate for each proposal.

	to pose an increasing threat.69 Although the Fish and Wildlife Service withdrew these beardtongues from proposed ESA listing largely in reliance on a conservation agreement, the BLM still has a duty under its Manual and sensitive species policy to conserve the species.	
Center for Biological Diversity-05	All proposed sale parcels have the potential to impact the four Colorado River endangered fish species (bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker) through water depletions resulting from oil and gas development. Stipulation TE-03 requires consultation on and reporting of, but does not prohibit, such water depletions: Water depletions from *any* portion of the Upper Colorado River drainage basin above Lake Powell are considered to adversely affect or adversely modify the critical habitat of the four resident endangered fish species, and must be evaluated with regard to the criteria described in the Upper Colorado River Endangered Fish Recovery Program. Formal consultation with USFWS is required for all depletions. All depletion amounts must be reported to BLM. In addition, neither the 2008 VFO RMP nor the Draft EA considered the impacts of climate change on these water resources, such as the decline in stream flows. This is a significant omission, as numerous climate change models show anthropogenic climate change is profoundly impacting the Colorado River in ways that are altering temperature, streamflow, and the hydrologic cycle. Climate change is likely to have significant effects on the endangered fish species and the Colorado River ecosystem, and the effect of climate change on future flow regimes and water temperatures must be taken into account in the consultation process and considering the sufficiency of the existing Recovery Program.	In 2006 a programmatic water depletion biological opinion for oil and gas development administered or permitted by the Vernal Field Office, Bureau of Land Management was issued, and was updated in 2011. (FWS/R6ES/UT 06-F-0215R001) This consultation addressed the effects of water depletions on the endangered Colorado River fishes. A section 7 agreement was created with the Upper Colorado River Endangered Fish Recovery Program (UCRRP). Incorporated into this agreement is a requirement of financial contribution to the UCRRP (known as a depletion fee). After many years of successful implementation federal action agencies anticipate that these payments serve as the Reasonable and Prudent Alternative. The programmatic biological opinion goes on to state that the United States Fish and Wildlife Service (USFWS) no longer considers small depletions to jeopardize the continued existence of these species. The BLM is required to submit and annual report of water depletions associated with oil and gas development. At the conclusion of the biological opinion USFWS concurs that the oil and gas development may effect and is likely to affect the 4 endangered fish species, however they believe the recovery program will adequately address effects to this species. As indicated in Appendix C, Interdisciplinary Team Checklist, water resources would not be impacted to a degree that detailed analysis is required. Cumulative impacts from climate change were not considered because there was no incremental increase from indirect impacts.
Center for Biological Diversity-06	BLM must take a hard look, pursuant to NEPA, at the mounting evidence proving that oil and gas operations are a major cause of climate change. The EA quantifies only greenhouse gas emissions from the drilling of a single exploratory well. It arbitrarily and capriciously rejects any consideration of the foreseeable and intended downstream effects of oil and gas transport, distribution, processing, leakage, and, most importantly, combustion. The EA argues, contrary to reason, CEQ guidance, BLM practice, and judicial precedent, that "[i]n a leasing EA	The EA has been revised to reflect current guidance on analysis of Green House Gas (GHG) emissions.

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	there is no substantive difference between any possible alternative, including the no action alternative, when addressing GHG emissions and their potential to impact global climate."	
Center for Biological Diversity-07	The EA omits any mention of water resources from its analysis of Affected Environment (Chapter 3) and Environmental Effects (Chapter 4), despite the fact that the action area encompasses numerous streams, reservoirs, rivers and tributaries, some of which include critical habitat for endangered fish, as well as impaired waters. For example, Parcel UT-1116-009 intersects Ninemile Creek; Parcel UT-1116-067 intersects Willow Creek; Parcels UT-1116-094 and -103 intersect Green River; and Parcel UT-1116-142 overlaps the Steinaker Reservoir. Even BLM states in the draft EA that there are four parcels "near or adjacent to Steinaker Reservoir: 069, 070, 071, and 142." Yet BLM does not discuss at all, any of the foreseeable consequences that oil and gas development would have on the water resources present in the areas to be leased. An EA may be set aside if it fails to address "certain crucial factors, consideration of which is essential to a truly informed decision whether or not to prepare an EIS."	The Interdisciplinary Team Checklist, Appendix C, has been revised to better explain why water resources are not analyzed in detail in this Environmental Assessment (EA). In addition, this EA tiers to the Vernal Field Office RMP EIS, which analyzed impacts to water resources.
Center for Biological Diversity-08	The foreseeable impacts to water resources in the planning area, as well as the endangered species and their critical habitat are significant enough to warrant the preparation of an EIS. However, BLM's decision not to look at any of these glaring issues resulted instead in a "Finding of No Significant Impact" ("FONSI") and in the consequent decision not to prepare an EIS. In deciding so, BLM ignores both the high degree of uncertainty and substantial controversy regarding the effects that the proposed action will have on the quality of the environment, especially in regards to the water resources in the areas to be leased. BLM's finding appears to be based solely upon its refusal to look at any site-specific impacts. In essence, BLM concludes that there are no significant impacts because BLM will not analyze any of those impacts. That is not a proper basis for a FONSI, and BLM provides no other reasoned explanation or basis for the conclusion that none of the foreseeable environmental consequences of the proposed action are significant. In fact, BLM's finding is contrary to the growing body of scientific evidence, discussed above, showing the likely impacts of water contamination and depletion on not only endangered species but human health and safety as well.	The Vernal Field Office RMP EIS, analyzed impacts to water resources. This EA tiers to that EIS.

	Courts, including the Tenth Circuit, have repeatedly rejected BLM's claim that it does not have to perform site-specific NEPA analyses, or address mitigation measures, until an APD is received. As BLM acknowledges in its Draft EA, BLM is required to perform and disclose an analysis of environmental impacts *prior* to the irretrievable commitment of resources. N.M. ex rel. Richardson v. BLM, 565 F.3d 683, 716 (10th Cir. 2009) (Assessment of a given environmental impact must occur as soon as that impact is "reasonably foreseeable," citing 40 C.F.R. § 1502.22, and must take place before an "irretrievable commitment of resources" occurs, citing 42 U.S.C. § 4332(2)(C)(v)); See also Pennaco Energy, Inc. v. United States DOI, 377 F.3d 1147, 1160 (10th Cir. 2004) (Agencies are required to satisfy NEPA before committing themselves irretrievably to a given course of action, so that the action can be shaped to account for environmental values.). The point of irretrievable and irreversible commitment occurs at the point of lease issuance. S. Utah Wilderness All. v. Norton, 457 F. Supp. 2d 1253, 1256 (D. Utah 2006). Therefore, BLM's deferral of site-specific analysis until the APD stage is unlawful under NEPA, its implementing regulations, and legal precedents. BLM is therefore required to thoroughly analyze the impacts of the proposed lease sale at this time – which requires the agency to prepare an EIS.	
Center for Biological Diversity-09	BLM's finding of no significant impacts relies on outdated information and fails to take into account new and significant information regarding the effects of climate change on the Upper Colorado River Basin. For example, BLM's only mention of water resources is the generalized and unsubstantiated conclusion that surface waters are present in the areas to be leased "but not affected to a degree that detailed analysis is required." In light of "existing knowledge regarding resource values on the subject parcels," which is based upon highly generalized information contained in the VFO RMP from 2008, BLM concludes that "significant impacts beyond those already addressed in the VFO RMP [2008] are not anticipated to occur as a result of leasing the proposed parcels." However, neither the 2008 VFO RMP nor the Draft EA considered the impacts of climate change on these water resources, such as the decline in stream flows. This is a significant omission, as numerous climate change models show anthropogenic climate change is profoundly	As indicated in Appendix C, Interdisciplinary Team Checklist, water resources would not be impacted to a degree that detailed analysis is required. Cumulative impacts from climate change were not considered because there was no incremental increase from indirect impacts.

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	impacting the Colorado River in ways that are altering temperature198, streamflow, and the hydrologic cycle. Changes observed to date include rising temperatures, earlier snowmelt and streamflow, decreasing snowpack, and declining runoff and streamflow. Modeling studies project that these changes will only worsen, including continued declines in streamflow and intensification of drought. Climate change is likely to have significant effects on the endangered fish species and the Colorado River ecosystem. In sum, the best available scientific data indicates that climate change is resulting in higher temperatures in the Colorado River Basin, reduced snowpack, reduced runoff, and increased drought, *which have already reduced* and will continue to reduce stream flows in the Basin. BLM must consider this new information regarding current and future Green and Colorado River flows both in its NEPA analysis and in consultation with the Fish and Wildlife Service regarding effects to listed fish.	
Center for Biological Diversity-10	Executive Order 12898 requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." Despite substantial questions regarding air pollution from Uinta Basin drilling and its public health effects on communities in northeast Utah, BLM in the EA declines to address public health and environmental justice, stating…	As noted in Appendix C, Interdisciplinary Team Checklist, leasing the nominated parcels would not cause any *disproportionately* high and adverse human health or environmental effects on minority populations, low-income populations, or Native American Tribes because the minerals are federal and or the surface is private or BLM.
Center for Biological Diversity-11	Climate change is a problem of global proportions resulting from the cumulative greenhouse gas emissions of countless individual sources. A comprehensive look at the impacts of fossil fuel extraction, and especially fracking, across the planning area affected by the leases in an updated RMP is absolutely necessary. BLM has *never* thoroughly considered the cumulative climate change impacts of *all* potential fossil fuel extraction and fracking (1) within the planning area, (2) across the state, and (3) across all public lands. Proceeding with new leasing proposals *ad hoc* in the absence of a comprehensive plan that addresses climate change and fracking is premature and risks irreversible damage before the agency and public have had the opportunity to weigh the full costs of oil and gas and other fossil fuel extraction and consider necessary limits	The issue of global GHG emissions is beyond the scope of this document. The EA has been revised to reflect the current guidance.

	on such activities. Therefore BLM must cease all new leasing at least until the issue is adequately analyzed in a programmatic review of all U.S. fossil fuel leasing, or at least within amended RMPs.	
Nine Mile Canyon Coalition-01	Our comments and concerns relate to parcels 9 & 10 in the proposed lease sale. BLM makes no attempt to even guess about how these leases might be accessed. In terms of development, it is fairly obvious all the traffic would be on the Nine Mile Canyon Road. This road is a BLM Nationally designated, Backcountry Byway. There is no analysis of how increased heavy truck traffic on the road would affect the road itself or the backcountry byway experience. Likewise, if oil and gas is produced, there will be a need for new pipes, pumps, compressors to get the product out. The most likely route for this infrastructure is again in the bottom of Nine Mile Canyon, the area with the highest user sensitivity. Since these pipelines are typically varied, inadvertent discoveries of buried cultural resources are almost assured. These discoveries are an adverse effect that would have to be mitigated, preferably by avoidance. Avoidance is best achieved by not leasing these parcels.	Mention of the Nine Mile Canyon's designation as a backcountry byway will be included in the final EA. There are no direct impacts from leasing, but there may be indirect future impacts due to possible subsequent development. At this time it is unknown when, where, or if future well sites or roads might be proposed on any leased parcel or adjoining parcel. It is also unknown when, where or if future development might be proposed near any parcels with a No Surface Occupancy Stipulation such as parcels 9 and 10. Potential impacts to cultural resources can be speculated by use of a Reasonably Foreseeable Development Scenario (RFD). Pontential impacts from oil and gas development were disclosed in the RMP and the West Tavaputs Plateau EISs. See response to comment Southern Utah Wilderness Alliance-09 and Utah Rock Art Research Association-01.
Nine Mile Canyon Coalition-02	Cultural resources are abundant in the Nine Mile Canyon area. The EA discusses hundreds of sites surrounding parcels 9 & 10. It does not identify the sites that are present on the lease parcels or the potential for subsurface cultural resources where ancillary facilities are constructed off lease.	See Response to Comment Nine Mile Canyon Coalition-01.
Nine Mile Canyon Coalition-03	Recreation is totally, inadequately addressed in this EA. This is particularly disturbing for an SRMA. Instead of describing the market niche, opportunities and experiences, all the EA provides is a laundry list of recreational activities that may occur in the ACEC. Recreation activities are not the same as recreation opportunity and experience. The affected environment should describe the existing opportunities and experience available as well as the desired opportunity and experience called for in the RMP. Much of parcels 9 & 10 are within a semiprimitive non-motorized ROS Class. (Note, since the RMP was signed the terminology was changed so now the SPNM ROS Class is now "backcountry.")	Since the BLM prescribes special management measures that are specific to the values for which the ACEC is designated, what can and cannot occur in different ACECs may vary dramatically. While oil and gas leasing is allowed under "no surface occupancy" on ACECs, they are protected by prescriptions identified in the RMP. Recreation opportunities and experiences are qualitative values which are different for each individual recreationist. Listing some of the recreation activities that currently occur and/or could potentially occur is a way to convey the type of recreation opportunities available to the public within a specific area. Virtually all of Parcels 9 & 10 is within an NSO stipulation category which would protect the ROS class mentioned in the comment.

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Nine Mile Canyon Coalition-04	The document makes no mention of the fact the Nine Mile Canyon Road is a Back Country Byway. This is a national BLM designation. Nine Mile Canyon was one of the first backcountry byways, dedicated in person, on site by the BLM Director. We would expect this designation would still carry some importance for the BLM. In any case, the EA fails to identify the byway, the opportunity and experience available to users and their reasons for being there. The byway also helps point out the visitors to Nine Mile Canyon are very sensitive to changes in the environment.	Mention of the Nine Mile Canyon's designation as a backcountry byway will be included in the final EA.
Nine Mile Canyon Coalition-05	Visual Resources are correctly identified as being inventoried as Class II for parcels 9 & 10. Yet you have it in VRM Management Class III. This is curious situation for an ACEC that has scenic resources as one of the relevant and important values. There is no discussion of the scenic quality, distance zones and viewer sensitivity that is important in making determinations on impact to scenic resources. In this case, we have high quality scenery, most of the views are foreground and the users are highly sensitive.	Parcels 9 & 10 occur within an area open to leasing subject to major constraints such as NSO stipulations which would most likely eliminate negative impacts to the visual resource within the Nine Mile Canyon ACEC due to tighter constraints as compared to higher Visual Resource Management Classes. Potential future development within proposed lease parcels 9 & 10 would be analyzed in detail expressed in the comment. This level of analysis goes beyond the scope of this document due to the lack of variables such as detailed proposed development plans.
Nine Mile Canyon Coalition-06	ACEC Just how does leasing for Oil and Gas comport with managing to "enhance cultural, special status species, scenic vistas, recreation and wildlife" as stated in the RMP? It seems the proposed action not only would not enhance those values but would in fact lead to their degradation. It appears the RMP is in conflict with itself by also allowing for oil and gas leasing. Leasing is a discretionary action, BLM's RMP commitment to enhance those values is not. In this case, the conflict should be resolved in favor of the SRMA/ACEC by deferring the leases.	Oil and Gas lease stipulations such as No Surface Occupancy (NSO), Timing Limitations (TLs), and Conditional Surface Use (CSUs), are specifically outlined in the Vernal RMP in order to continue to protect and enhance the values mentioned in the comment. Except for a few acres along the edges of parcel 10, all proposed lease parcels within the Nine Mile Canyon ACEC specific to this EA are located within areas subject to an NSO stipulation.
Nine Mile Canyon Coalition-07	The analysis of Recreation is entirely inadequate. Curiously it identifies a loss of primitive recreation opportunity even though none is recognized in Chapter 3. There is no discussion of the impacts to the most common recreational visitor to Nine Mile Canyon, people driving the byway for pleasure and stopping to visit numerous road side attractions. There is no discussion is visitor sensitivity that we assert is high, or discussion of how the lights, noise, odors, dust and traffic would affect them. Instead we are told those impact would be mitigated to a level where they would not be as bad as they could be. This is hardly meaningful disclosure of the current situation regarding Nine Mile Canyon and how it would change under the proposed action.	BLM will include the dedicated motorist and sight seer in the EA. The addition of this recreation user group will not change the overall effects to recreation as a result of the proposed action due to the oil and gas leasing stipulations such as Timing Limitations (TLs), Conditional Surface Use (CSUs), and No Surface Occupancy (NSO), which are outlined in the Vernal RMP and apply to all proposed lease parcels within the Nine mile Canyon ACEC specific to the EA.

Parsons Behle & Latimer-01	Each of the parcels nominated by the undersigned are legally "open" for oil and gas leasing under the VFO RMP, either with standard stipulations, controlled surface use/timing stipulations or major constraints. In selecting the lands for inclusion within the EOI, our clients expended considerable resources identifying lands that are "open" for leasing under the VFO RMP and conform to the RMP's requirements for leasing, and screening out parcels that contain potential resource conflicts. For example, our clients were careful to ensure that none of the nominated lands embrace Areas of Critical Environmental Concern, Wilderness Study Areas, Wild and Scenic Rivers or Special Management Areas or designated critical habitat for species listed under the Endangered Species Act.4 Indeed, as shown in Exhibit D to the Draft EA, *none* of the 74 parcels that BLM failed to analyze in the Draft EA are closed to oil and gas leasing under the VFO RMP.	Although all of the nominated parcels are identified as open for leasing in the 2008 VFO RMP, the RMP cannot take into account recent resource issues or resource conflicts not identified in the RMP that may arise on a more detailed onsite review. These issues and conflicts can justify not offering a parcel for sale. Furthermore, the Secretary, through the authority she has delegated to her BLM State Directors, has the discretion to temporarily defer the sale of certain nominated parcels. See Parsons Behle & Latimer-05.
Parsons Behle & Latimer-02	The Draft EA Should Have Included an Alternative Analyzing all Parcels Legally Open for Leasing.	Analysis of parcels determined to have resources issues that were not ripe for decision in this document were not analyzed.
Parsons Behle & Latimer-03	Because the Sage-grouse LUPA has now been completed and implemented, consistent with BLM's position regarding prior deferrals, BLM should lease these parcels consistent with the LUPA, or, at the very least, evaluate their leasing consistent with the Sage-grouse LUPA. As stated in our EOI, the Utah State Offices' continued deferral of certain parcels in the Uinta Basin that are "open" to leasing under the VFRO RMP amounts to de facto land use planning, in violation of FLPMA public process requirements.	Language in Appendix D of the EA has been expanded to clarify the reasons for deferral. Per Objective MR-1 in the Greater Sage-Grouse Approved Resource Management Plan Amendment, the VFO prioritized proposed lease parcels outside of Sage-Grouse habitat for PHMA and GHMA. The BLM elected to consider for leasing three parcels within GHMA that were within designated federal oil and gas units. This prioritization approach minimizes conflicts with Greater Sage-Grouse habitat and is consistent with the amended VFO RMP.
Parsons Behle & Latimer-04	According to Appendix D to the Draft EA, BLM elected to defer 24 parcels because of the presence of white-tailed prairie dog colonies or yellow-billed cuckoo habitat. Neither the VFO RMP nor any other statute, regulation or BLM policy contains any authority either requiring or justifying BLM's failure to analyze nominated lease parcels because of the presence of ESA listed species or their habitat, whether designated as critical habitat or otherwise. Rather than declining to perform *any* analysis in the Draft EA of these 24 nominated parcels because they contain habitat for ESA-listed species, and consistent with the dictates of NEPA, BLM should have included an alternative in the Draft EA that evaluates the effects of leasing these parcels. This alternative would have allowed the public and BLM to understand whether application	The deferral language in the EA has been expanded to read: "The VFO RMP does not contain sufficient stipulations or analysis to address protection of white-tailed prairie dog habitat. BLM is deferring this parcel until appropriate protections can be applied through additional analysis." And "This parcel is in Yellow Billed Cuckoo habitat. The Yellow Billed Cuckoo is a federally listed species and therefore this parcel is being deferred because the RMP EIS did not analyze impacts to this species" "Appropriate restrictions" cannot be added at the leasing stage without an RMP amendment. The parcels were deferred due to staff and time limitations to sufficiently evaluate whether Conditions of Approval added at the

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	of appropriate restrictions could successfully mitigate any impacts to white-tailed prairie dog or western yellow-billed cuckoo habitat.	time of development would be sufficient to protect the species.
Parsons Behle & Latimer-05	According to Appendix D, 14 of the nominated parcels were deferred because of "State Director Discretion," with no additional information provided. As discussed above, while BLM retains some discretion as to lease issuance under the Mineral Leasing Act, this completely opaque determination cannot be used to justify BLM's failure to evaluate the offering of these parcels. While numerous statutes and regulatory regimes commit actions to agency discretion, this discretion cannot be arbitrary and capricious and must have some rational support. *See, e.g., Citizens to Preserve Overton Park v. Volpe,* 401 U.S. 402, 415 (1971); *Motor Vehicle Manufacturing Ass'n v. State Farm*, 463 U.S. 29, 43 (1985) (agency "must examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made").	Parcel 046 was incorrectly identified in Appendix D as having been deferred due to State Director Discretion. It was actually deferred due to conflicts with White Tailed prairie dog. The Secretary, through the authority she has delegated to her BLM State Directors, has the discretion to temporarily defer the sale of certain nominated parcels. The Utah State Director has appropriately chosen to exercise that discretion here. The Mineral Leasing Act of 1920 (MLA), as amended, provides that lands subject to disposition under the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary." (30 U.S.C. § 226 (a) (emphasis added)). Although lands identified as available for leasing are identified through the Land Use Planning process; BLM policy has established that nominated parcels within available lands may be temporarily deferred from leasing at the discretion of the State Director. As has been clarified in Appendix D of the EA, at the time of the preparation of the preliminary Environmental Assessment, the introduction of H.R. 5780, the Utah Public Lands Initiative H.R. 5780, the Utah Public Lands Initiative (PLI), was imminent; it was introduced on July 14, 2016. The 13 nominated parcels referred to in this comment were included in areas that would be protected from development under the PLI. Offering and issuing new leases within areas protected by the PLI could create additional conflicts to be resolved should the bill become law. Therefore, in the judgement of the Utah State Director, deferral of the parcels for one year would be a prudent course of action.
Parsons Behle & Latimer-06	Finally, 6 parcels were deferred or partially deferred from analysis either because of "unfinished wilderness inventories" or because they are "in [the] Currant Canyon inventory." Section 201 of FLPMA requires that BLM maintain a current inventory of land under its jurisdiction and identify within that inventory lands with wilderness characteristics. BLM refers to these areas as "lands with wilderness characteristics" or "LWCs." Under the VFO RMP, non-wilderness study area LWCs are broken into two categories: (1) those that are to be managed to "protect, preserve and maintain" wilderness characteristics, including closing the lands to oil and gas leasing; and (2) those that have no such management proscriptions. While we do not know the precise location of the Currant Canyon inventory and the Currant Canyon inventory is not discussed in the VFO RMP, it is our understanding that these lands are within the category of lands	Appendix D has been expanded to clarify the rationale for deferral. BLM received submissions for Big Wash, Sheep Wash and Badlands Cliffs Additions in July 2014 during the scoping period for the November 2014 Oil and Gas lease sale. BLM identified lands with wilderness characteristics in Currant Canyon in 2011 and additions in 2015, post-RMP. The Currant Canyon unit has not been analyzed in a land use plan, thus VFO RMP Management Decisions WC-1 and WC-2 do not apply to the Currant Canyon unit. In the absence of stipulations, the parcels were deferred due to staff and time limitation to sufficiently evaluate the impacts to the Unit. While field work has been performed, on the Big Wash, Sheep Wash and Badlands Cliffs Additions BLM was unable to complete an update to the wilderness characteristics inventory or finalize a determination of the presence or absence of wilderness characteristics in advance of the November 2016 Oil and Gas Lease Sale EA.

	with no management prescriptions, falling within VFO RMP Management Decisions WC-1 and WC-2. Similarly, as to the parcels deferred because of "unfinished wilderness inventories," the simple fact that BLM has not completed performing wilderness inventories of these lands does not justify BLM's refusal to perform any analysis of the effects of leasing these lands. Instead of performing *no* analysis of these parcels, BLM should analyze the effects of leasing both the un-inventoried parcels and the parcels within the Currant Canyon inventory in order to evaluate the effects of leasing these parcels subject to the constraints and stipulations outlined in the VFO RMP and federal statutes and regulations. This would be consistent with Department of Interior Secretarial Order 3310, *Protecting Wilderness Characteristics on Lands Managed by the Bureau of Land Management*, which requires the protection of the wilderness characteristics of "inventoried" lands. Here, as to the Currant Canyon inventoried lands, the Draft EA should analyze whether protection of wilderness characteristics is possible while still offering these parcels for oil and gas leasing. This could be accomplished by application of the management proscriptions contained in the VFO RMP, including application of no-surface occupancy restrictions. Had BLM performed this analysis, it would have discovered that all 6 parcels nominated by the undersigned that were deferred because of wilderness are directly adjacent to existing oil and gas leases. Thus, it is likely that at least some of these parcels could be developed with no surface disturbance or effect to wilderness characteristics. For the reasons stated in this letter, we ask that BLM revise the Draft EA to include an alternative that considers leasing each of the nominated parcels that are legally open for leasing.	BLM is unable to analyze and disclose impacts to wilderness characteristics until their presence or absence of is determined.

Rocky Mountain Wild-01	Parcels UT-116-009, 032, 067, 122, 152, are completely or partially within Sage-grouse Preliminary Priority Habitat areas ("PPH"). These parcels should be deferred. Limitation Stipulations proposed for Sage-grouse in this lease sale are ineffective in the face of standard oil and gas development practices. These stipulations have likewise been condemned as inadequate by the U.S. Fish and Wildlife Service and renowned Sage-grouse expert Dr. Clait Braun. We remain concerned that development activities on the Sage-grouse parcels noted above will result in significant impacts to Sage-grouse occupying these parcels and/or the habitats nearby, and the BLM's programmatic NEPA underlying this lease sale does not adequately address these significant impacts in light of new information. Therefore, the requisite NEPA analysis to support the leasing of the Sage-grouse parcels listed above in the absence of an Environmental Impact Statement does not exist.	Per Objective MR-1 in the Greater Sage-Grouse Approved Resource Management Plan Amendment, the Vernal Field Office prioritized proposed lease parcels outside of Sage-Grouse habitat for PHMA and GHMA. The BLM elected to consider for leasing three lease parcels within GHMA that were within designated federal oil and gas units. Other parcels within Sage-Grouse habitat were not prioritized for lease consideration in this lease sale. This prioritization approach minimizes conflicts with Greater Sage-Grouse and is consistent with the amended RMP. PPH is a term associated with the BLM's interim management Instruction Memorandum. That terminology and prioritization was superseded by the Record of Decision for the Greater Sage-Grouse Approved Resource Management Plan Amendment (GRSG ARMPA). The GRSG ARMPA established priorities for management of GRSG habitat in Priority and General Habitat Management Areas (see GRSG FEIS section 1.3.2), with management commensurate with the prioritization. No PHMA areas were considered for leasing in this lease sale, and the only areas in GHMA that are considered for lease are within designated oil and gas units where impacts to GRSG are already present, as described in the GRSG FEIS section 4.3.2 and section 4.3.7. Impacts to these resources were considered and carried forward when warranted in the analysis. See the ID team checklist in Appendix C for determinations of potential impacts, Chapter 3 for a description of these resources, and Chapter 4 for the potential impacts and effects on these resources. No surface disturbance will occur as a direct result of the leasing. However, possible development scenarios, which are only hypothetical at this stage, were analyzed and the anticipated impacts were disclosed.
Rocky Mountain Wild-02	BLM should not lease parcels that are within Areas of Critical Environmental Concern ("ACEC"). Parcels UT-116-009 and 010 are within the Nine Mile ACEC. Even with NSO stipulations for the ACEC, accessing and developing this parcel will impact the ACEC. This limited NSO stipulation will not ensure the ACEC's values are protected. The plan to "mitigate" anticipated impacts is uncertain and any such mitigation should be analyzed in this NEPA process. The resource values warrant and deserve better protection than that being afforded.	Whether or not BLM should lease parcels within an ACEC is an issue beyond the scope of this document. Oil and Gas leasing directives outlined in the VFO RMP state that zero acres will be unavailable for oil and gas leasing. Stipulations such as Timing Limitations (TLs), Conditional Surface Use (CSUs), and No Surface Occupancy (NSO) are set and apply in order to protect ACEC resources which include cultural, special status plants, and visual resources. In addition to these stipulations other stipulations would apply due to topography. These stipulations include: UT-S-96 – No surface occupancy for slopes greater than 40%, and UT-S-99- Controlled surface use for fragile soils/slopes from 21-40%. These stipulations would further aid in the protection of ACEC resources. Detailed environmental analysis which would include any site specific mitigations would be completed post leasing as potential proposed development plans are submitted by a proponent.

		See Nine Mile Canyon Coalition-06.
Rocky Mountain Wild-03	The Uinta hookless cactus and Pariette cactus occur primarily in the Uinta and Duchesne Counties in Utah. These counties are where a majority of the Vernal Field Office's November 2016 oil and gas parcels are to be leased. Specifically, parcels UT-116-032, 038, 039, 067, and 151 are entirely within recognized cactus habitat. We ask that the BLM defer these parcels and any other parcels within Uinta and Duchesne Counties since the development of these areas will undoubtedly lead to cactus habitat degradation, and a listing of "endangered" for the cactus species by the Fish and Wildlife Service ("FWS").	These species are currently listed as threatened with the U.S. Fish and Wildlife Service (USFWS). They are monitoring disturbance in cactus habitat and measures are being taken to prevent further endangerment and promote unlisting these species. Site specific NEPA analysis and mitigation would be applied if an application for permit to drill were received after leasing.
Rocky Mountain Wild-04	Graham's penstemon and White River beardtongue occur on parcels UT-116-032, 121, and 122, with parcels 121 and 122 occurring within a designated Conservation Agreement Area for the species that will require additional mitigation measures. It is in all parties' best interest, as well as mandated by the CEQ, that mitigation measures be promulgated at the earliest possible time so that all parties involved are aware of their responsibilities. We request that an alternative containing NSO for these parcels be considered in order to protect Graham's penstemon and White River beardtongue habitat. The EA references a penstemon stipulation, but it does not appear to exist.	An alternative containing NSO would not be in conformance with the current RMP for the VFO. Site specific NEPA analysis and mitigation would be applied if an application for permit to drill were received after leasing. Thank you for your comment. Appendix C, Interdisciplinary Team Checklist, has been changed to remove reference to stipulation UT-S-314 from the sensitive species rational and has been corrected to refer to the BLM Handbook 3120-1 – Competitive Leases (P) (H-3120).
Rocky Mountain Wild-05	The EA fails to consider the impacts of hydraulically fracturing of oil and gas wells. There is not adequate analysis of wildlife impacts, seismic activity, health impacts, or many of the other known impacts of hydraulic fracturing. Around 90 percent of wells have used hydraulic fracturing to get more gas flowing, according to the drilling industry. With the very high probability that this practice will occur on the specific parcels, it is arbitrary and capricious of BLM to neglect this highly controversial and impactful practice in its environmental analysis.	The ID Team Checklist (Appendix C) for Groundwater Quality has been revised to provide rationale for not analyzing that issue in detail. There are no known impacts to wildlife from hydraulic fracturing. Potential geologic hazards caused by hydraulic fracturing may include induced seismic activity. Earthquakes occur when energy is released due to blocks of the earth's crust moving along areas of weakness or faults. Earthquakes attributable to human activities are called "induced seismic events" or "induced earthquakes." A study conducted by the National Research Council (2013) studied the issue of induced seismic activity from energy development. The study found that: 1) The process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events; and, 2) Injection for disposal of waste water derived from energy technologies into the subsurface does pose some risk for induced seismicity, but very few events have been documented over the past several decades relative to the large number of disposal wells in operation. Also, out of the • 1.8 million treatments in over • 1 million wells, from 1947-2010 drilled in the United

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		States, there are only three reported cases of hydraulic fracturing-induced earth quakes. (Seismological Research Letters, Volume 86, Number 4, July/August 2015). The Utah Division of Oil, gas and Mining (UDOGM) has stated that there has been no reported ground water contamination or fracking-induced problems in Utah associated with oil and gas well drilling and/or completion, or form injection into disposal wells. Oil production in Oklahoma has been going on for over 100 years. Some activities related to oil production, particularly disposal of wastewater in deep injection wells, are known to potentially cause earthquakes. The rate of earthquakes has increased sharply since 2009 in the central and eastern United States, with growing evidence confirming that these earthquakes are primarily caused by human activity, namely the injection of wastewater in deep disposal wells contacting basement rocks. A new study by the U.S Geological Survey presents evidence that, in addition to these recent earthquakes, most of the larger earthquakes in Oklahoma in the past century may likely have been induced by industrial activities. Prior to the 2011 magnitude 5.7 Prague, Oklahoma earthquake, the largest historical earthquake in the area was the 1952 magnitude 5.7 El Reno earthquake, which the study concludes was likely induced by activities related to oil production near Edmond, Oklahoma. (*A Century of Induced Earthquakes in Oklahoma?* Bulletin of the Seismological Society of America, October 20, 2015. doi:10.1785/0120150109).
State of Utah-01	The BLM's failure to include 79 nominated land parcels in the upcoming lease sale leads to a checkerboard approach to production rather than allowing for a consolidation of operations. Disallowing this approach leads to unnecessary costs, increased emissions, and a hodgepodge of land use. Consolidating operations is the goal of every operator because it spawns important efficiencies, such as fewer facilities, fewer roads, less energy use, and lower emissions. The EA failed to consider the increase in carbon dioxide emissions and other ozone-emitting chemicals that occur as the result of staggered and un-consolidated production. BLM must include the negative environmental impacts of un-consolidated production in the analysis of this lease sale.	Efforts were made to include parcels that would make the leased lands uniform in areas of existing high development but due to the nature of some resources and of issues identified since the signing of the 2008 RMP this cannot be done for all parcels. The unpredictability of who would acquire leases and how they would be consolidated would make any analysis of unconsolidated production so speculative as to make the usefulness of the information to the decision making process beyond the "rule of reason."

State of Utah-02	The State made specific, practical requests in its May 6 comment letter for the protection of Sage-grouse habitat, and these requests should be incorporated into the EA. The State requested avoidance and minimization of disturbance impact within sagebrush habitats and compensatory mitigation for impacts which cannot be avoided. Mitigation methods should follow the State's 2013 Conservation Plan/or Greater Sage-grouse in Utah. The State also recommended seasonal stipulations to avoid construction and vehicle noise disturbances during brood-rearing activities, and seasonal stipulations in the winter to reduce impacts to wintering Sage-grouse. Topographic screening and the maintaining and enhancing of wet meadows and riparian habitat are also important management measures that could feasibly be used to mitigate and reduce impacts. As such, the parcels containing sagebrush habitat do not need to be defined in the lease sale, and the BLM should revisit the draft EA so that these recommendations can be incorporated.	The BLM applied notices and stipulations consistent with those contained in our existing Resource Management Plan as amended. Notices were applied to the parcels for Sage-Grouse conservation. Net conservation gain (including compensatory mitigation sites) for all areas which cannot be avoided, Required Design Features for avoidance and minimization of crucial Sage-Grouse habitat, and Sage-Grouse buffer distances apply to all identified parcels that contain Sage-Grouse habitat. In addition, seasonal restrictions will be applied in accordance with the Vernal Land Use Plan (2008). All mitigation that is not included in these notices (outside the scope of the Vernal Land Use Plan (2008) and Approved Resource Management Plan Amendment (2015)) will be applied at a site specific proposal and will be in coordination with the local UDWR sensitive species biologist.
State of Utah-03	The State reviewed the proposed preliminary list of lands considered for sale in a letter dated May 6, 2016. In that letter, the State, in conjunction with the Utah Division of Wildlife Resources (UDWR) recommended measures to minimize the impact to federally listed species, state sensitive species, game, and sportfish that occur on potential lease parcels. The State's recommendations for sensitive parcels included a prohibition on construction during certiain periods of the year, mitigation of construction activities, and best management practices. At no point did the State request or recommend that any parcels be deferred in the lease sale. The State's review of the BLM's preliminary list is a courtesy provided by the State, in the spirit of FLPMA's requirement for coordination between the State and the BLM. It is an opportunity for the BLM to benefit from the State's expertise in the field of wildlife management. Unfortunately, when the BLM uses the State's recommendations in the preliminary review as cause to defer parcels from the lease sale, it disincentives the State from providing a helpful, thorough review of future lease sales. The State will not continue to coordinate with the BLM in providing wildlife recommendations if that information is used to further stonewall oil and gas leasing. The BLM must incorporate the State's specific recommendations contained in the preliminary review.	We appreciate UDWR recommendations. In Section 1.8 of the EA, BLM stated: "The Utah Division of Wildlife Resources (UDWR) provided recommendations regarding wildlife species and habitat and resulted in the addition of lease notices to multiple parcels." None of the parcels were deferred as a consequence of UDWRs letter. Resource Specialists evaluated parcels and determined that some parcels would require EIS level analysis to be brought forward. The State Director determined via her authority to defer additional parcels. BLM cannot add stipulations simply based on the recommendation of the State of Utah. BLM must develop stipulations through the Land Use Planning process. As stated previously, BLM did add lease notices upon the recommendation of UDWR. However, recommendations will be considered during site specific NEPA analysis as warranted.

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	The BLM should offer all 79 parcels for lease, while incorporating the specific stipulations request by the State. This would allow for responsible development of oil and gases resources while protecting wildlife habitat and recreation. The State's proposal would allow for a balanced approach to these competing demands. Unfortunately, the BLM's deferral of 79 parcels is a one-sided approach that is neither necessary nor appropriate to the BLM' s mission.	
State of Utah-04	BLM has failed to consider the impacts of the deferments in the socio-economic section of the environmental analysis. The State receives fifty percent of the leasing bonus money from these federal sales and there is strong interest among bidders for parcels in the Uintah Basin. By not offering parcels that are legally available, the BLM will harm the economic viability of the Uintah Basin and the State of Utah, and will cost the United States millions of dollars in lost revenue. BLM must consider include these impacts in the EA.	It is debatable that the deferred parcels are "legally available" if by offering them the BLM has not complied with NEPA. Further analysis and/or guidance are needed to determine if they are actually legally available, which is why they were deferred. Additionally, there is no way to predict the monetary value that may result if offering these parcels. Bonuses can run from hundreds to millions of dollars per lease. The unpredictability of the monetary result would make any analysis of the socio-economic impacts so speculative as to make the usefulness of the information to the decision making process beyond the "rule of reason."
Southern Utah Wilderness Alliance-01	The BLM has failed "to make a reasonable and good faith effort" to identify cultural resources that may be affected by this undertaking, as required by Section 106 of the NHPA. 36 C.F.R. § 800.4(b)(1). Likewise, BLM's conclusion that the lease sale will not adversely affect cultural resources is arbitrary and capricious. BLM also failed to take a hard look at the project's effects on cultural resources, as required by NEPA.	Section 106 of the NHPA. 36 C.F.R. § 800.4(b)(1) states that "the agency official shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey". The BLM has made a reasonable and good faith effort according to what may be included as appropriate identification efforts, and has been discussed in the EA. Those efforts are continued through the NHPA process which runs parallel to the NEPA process and is in progress at this time. The cultural resource report results will be added to the final EA. The undertaking in this case is to lease the parcels. There are no adverse effects to historic properties from this lease sale. Whereas NHPA does require consideration of "reasonably foreseeable effects" that may occur in an undertaking, (36 C.F.R. § 800.5) without specific development plans what those adverse effects may be are speculative, not reasonably foreseen. Undertakings that will occur after the issuance of the lease will follow the Section 106 process, and determinations of effects to historic properties will be made at that time. Therefore, the No Adverse Effect finding is valid. There are no direct impacts from leasing, but there may be future indirect impacts due to possible subsequent development. Potential impacts to cultural resources can be speculated by use of a Reasonably Foreseeable Development Scenario (RFD). These potential impacts to cultural resources from oil and gas development were

		disclosed in the RMP EIS. BLM has made a meaningful effort at this lease sale phase to address available information regarding historic and cultural properties located on the individual parcels and to take appropriate steps to protect them through assigning protective lease stipulations.
Southern Utah Wilderness Alliance-02	Second, BLM's modified conclusion (i.e., that adverse impacts can be avoided in most parcels) is arbitrary due to the agency's overwhelming dearth of information and analysis. For example, BLM has never performed a Class 1, 2, or 3, survey for parcels 4, 5, 49, and 151 – and has performed only minimal surveys for parcels 9, 10, 32, 38, 39, and 49 – but acknowledges that oil and gas development could, at a minimum, indirectly impact cultural resources in these areas. Compare id. Appendix H, Sheet 1, with id. at 37 ("Indirect impacts to cultural resources could result from future lease actions, such as exploration and development.").	There is no modified conclusion in regards to NHPA. In regards to NEPA, BLM's finding is not arbitrary and capricious, rather it is based on professional judgement of BLM's cultural resource staff, background research, the survey and research results in similar environments, the known site locations in the specific and general area and environmental factors such as topography, elevation, and water resources. Furthermore, the agency official and staff experience of permitting development and managing recreation in this area and the permitting of thousands of oil and gas projects within the Green River District, has provided an overwhelming amount of experience in making this conclusion. BLM's cultural resource staff evaluated the potential for direct and indirect impacts of the parcels while determining what potential they have for cultural resources. The undertaking in this case is to lease the parcels. There are no adverse effects to historic properties from this lease sale. (See Response to Southern Utah Wilderness Alliance-01).
Southern Utah Wilderness Alliance-03	Third, to the extent BLM analyzes impacts to cultural resources in the EA; the agency only does so for six of the twenty-eight lease parcels. See EA at 37 (analyzing impacts to "[t]wo parcels . . . within or adjacent to Nine Mile Canyon [i.e., parcels 9, 10]" and "four parcels located adjacent to Steinaker Reservoir [i.e., parcels 69-71, 142]."); id. at 21 ("Of the twenty-eight parcels for lease there are six that are in areas with potential for adverse impacts [to cultural resources]."). The EA acknowledges that there are likely yet to be discovered cultural sites in each of the twenty-eight lease parcels and NEPA and the NHPA require BLM to analyze the direct, indirect, and cumulative impacts to these resource values and consult with interested parties to minimize impacts to such values. See id. at 37 ("all [proposed parcels] have a potential to contain cultural resources."); id. Appendix C at 108 ("it is likely that additional cultural resources will be located within the proposed lease parcels.").	The EA explains that the six parcels in question have higher potential for cultural resources due to research and previous survey in those areas. The EA mentions the six parcels specifically because the other parcels, even though they are likely to contain cultural resources, could reasonably be developed without adverse impacts. The cultural resource report results will be added to the final EA. Appendix A lists each parcel with the following cultural resource notices: UT-LN-67, UT-LN-68, UT-LN-69, UT-LN-70 The EA explains that the six parcels in question have higher potential for cultural resources due to research and previous survey in those areas. The EA mentions the six parcels specifically because the other parcels, even though they are likely to contain cultural resources, could reasonably avoid impacts to cultural resources while being developed . . Potential impacts to cultural resources from oil and gas development were disclosed in the RMP EIS. Appendix A lists each parcel with the following cultural resource notices: UT-LN-67, UT-LN-68, UT-LN-69, UT-LN-70 Potential impacts to all cultural sites, documented and undiscovered, were disclosed in the RMP EIS. NHPA does not require speculative analysis. If and when

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		development occurs on a lease, surveys are undertaken to discover any unknown cultural sites, and the effects of the development are determined at that time. The undertaking in this case is to lease the parcels. There are no adverse effects to historic properties from this lease sale. (See Response to Southern Utah Wilderness Alliance-01).
Southern Utah Wilderness Alliance-04	Fourth, BLM's conclusion that the issuance of non-no surface occupancy ("non-NSO") leases will likely not adversely impact cultural resources is not the same as a "no adverse effect" determination. See, e.g., EA at 22 (impacts to cultural resources could likely be avoided). SUWA maintains that even with these stipulations the sale of non-NSO leases may result in adverse effects to cultural resources. Thus, BLM is required to assess and disclose adverse effects now, see 36 C.F.R. § 800.5, and work with the SHPO, Native American tribes, and consulting parties to resolve those adverse effects. See id. § 800.6. The plain language of the referenced stipulations makes clear that subsequent undertakings may be approved even if they result in "minimized" adverse effects. Because BLM admits that it may allow subsequent undertakings to proceed if adverse effects are "minimized" or "mitigated," the agency's "no adverse effects" determination is baseless.	The no adverse effects determination is not baseless, rather it is a recognition that for this undertaking (lease sale) no adverse effect to historic properties. Undertakings that will occur after the issuance of the lease will follow the Section 106 process. Therefore there is no need at this time to assess and disclose adverse effects. At this time it is unknown when, where, or if future well sites or roads might be proposed on any leased parcel or adjoining parcel. It is also unknown when, where or if future development might be proposed near any parcels with a No Surface Occupancy Stipulation. See Cultural Resource Report, Appendix H, for details as to how BLM came to a No Adverse Effect determination. The commenter is trying to intermingle the requirements of NEPA and NHPA. In the case of this proposed action (NEPA) or undertaking (NHPA) the purpose of the analysis of the EA is to determine whether or not significant impacts may occur in this case from the indirect future impacts of leasing. The purpose of the NHPA analysis is to determine if leasing would result in reasonably foreseeable effects. As stated in the response to the commenter's first comment, without a development scenario effects are speculative, not reasonably foreseen, unless a cultural resource density in a parcel is so high that any development is likely to result in adverse effects. The no adverse effects determination is not baseless, rather it is a recognition that for this undertaking (lease sale) no adverse effect to historic properties. Undertakings that will occur after the issuance of the lease will follow the Section 106 process. Therefore there is no need at this time to assess and disclose adverse effects in the NHPA report. At this time it is unknown when, where, or if future well sites or roads might be proposed on any leased parcel or adjoining parcel. It is also unknown when, where or if future development might be proposed near any parcels with a No Surface Occupancy Stipulation. See Cultural Resource Report, Appendix H, for details as to how BLM came to a No Adverse Effect determination. The undertaking in this case is to lease the parcels. There are no adverse effects to historic properties from this lease sale. (See Response to Southern Utah Wilderness Alliance-01).

Southern Utah Wilderness Alliance-05	Finally, the EA states that consultation with SHPO is "ongoing." EA at 59. Regardless, SHPO's concurrence (if received) does not excuse BLM from complying with the NHPA: While the NEPA requires BLM to consult with the Utah SHPO, its consultation with SHPO merely satisfies the procedural requirement of doing such a consultation. A concurrence from the SHPO *does not satisfy the other procedural requirements of NHPA*. There is nothing in the NHPA or Section 106 that excuses the BLM's failure to comply with the other procedures based on a concurrence from the SHPO. *S. Utah Wilderness Alliance v. Burke*, 981 F.Supp.2d 1099, 1109 (D. Utah 2013) (emphasis added). SUWA requests to participate as a consulting party for this undertaking and that BLM provide it with a copy of this Class I Cultural Inventory and reserves the right to supplement these comments upon review of this document.	The BLM still recognizes the regulations for *No adverse effect* found at 36CFR800.5(d)(1), which states ". . .Implementation of the undertaking in accordance with the finding as documented fulfills the agency official's responsibilities under section 106 and this part." The procedural requirements of NHPA have been fulfilled. See Cultural Resource Report, Appendix H, for details as to how BLM came to a No Adverse Effect determination.
Southern Utah Wilderness Alliance-06	The EA fails to take a hard look at the indirect, direct, and cumulative impact on local, regional, and national climate change from leasing the above-listed parcels. While stating that oil and gas exploration and development activities are a large contributor of greenhouse gas ("GHG") emissions, the EA does not even attempt to analyze – quantitatively or qualitatively – the potential impacts of such emissions. *See, e.g.*, EA at 18-19 ("The most likely cause of elevated PM2.5 . . . are those common to other areas of the western U.S. (combustion and dust) plus nitrates and organics from oil and gas activities in the [Uinta] Basin."); *id.* at 20 (oil and gas activities "contribute to the regional, national, and global pool of GHG emissions"). Instead, BLM essentially punts on the issue, citing to the low amount of expected GHG emissions: There are no direct impacts related to GHG emissions and climate change from leasing . . . Estimated GHG emissions can be calculated using a generic emissions calculator . . . which shows emissions of 1,192 tons per year CO_2-e for a single operational well, and 2,305 tons per year CO_2-e for a single drill rig. Based on this analysis a single exploratory well is unlikely to exceed the 25,000 ton per year reference point recommended by [CEQ], and no further analysis is warranted at this stage.	The EA has been revised to reflect current guidance on analysis of Green House Gas (GHG) emissions.

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Southern Utah Wilderness Alliance-07	The EA fails to take a hard look at the social cost of carbon from leasing the above-listed parcels. CEQ has instructed federal agencies, including the BLM, to consider the social cost of carbon when reviewing proposed actions under NEPA. *See* CEQ Climate Change Guidance at 16. While developed initially to assess the costs and benefits of alternatives in rulemaking, the social cost of carbon "offers a harmonized interagency metric that can provide decisionmakers and the public with some context for meaningful NEPA review."	The EA has been revised to reflect current guidance on analysis of social cost of carbon.
Southern Utah Wilderness Alliance-08	The EA does not comply with Instruction Memorandum No. 2010-117, *Oil and Gas, Planning, and National Environmental Policy Act (NEPA)* (May 17, 2010) ("IM 2010-117") Specifically, the EA does not analyze alternative(s) in which oil and gas lease parcels are not offered in BLM-identified LWCs. *Compare* Lease Sale EA, Appendix C at 111 (Parcels 9, 10, 32, 38, 39, and 49 each are located in BLM-identified LWC), *with id.* at 13 (the EA considered the Proposed Action and No Action alternatives only). Such an alternative is required by IM 2010-117: The EA *will* analyze [1] a no action alternative (no leasing), [2] a proposed leasing action (lease the parcel(s) in conformance with the land use plan), *and* [3] any alternatives to the proposed action that may address unresolved resource conflicts.	All parcels in BLM identified LWCs have been through the RMP planning process, therefore, there are no unresolved resource conflicts. The no action alternative addresses not leasing and would eliminate any impact to the resource.
Southern Utah Wilderness Alliance-09	BLM designated the Nine Mile Canyon ACEC to protect the area's relevant and important values such as cultural, high quality scenic, and special status plant species. *See* Vernal ROD at 36. ACECs are defined as "areas within the public lands where special management attention is required . . . to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes." 43 U.S.C. § 1702(a). A potential ACEC must have: (1) "relevance," meaning it possesses "a significant historic, cultural, or scenic value [or] a fish or wildlife resource or other natural system or process," and (2) "importance," meaning the relevant values, resources, or processes have "substantial significance." 43 C.F.R. § 1610.7-2(a). Once BLM has identified areas which contain relevant and important values within the planning area, it must ensure their protection, either through special management (by designating an area as an ACEC), *see* 43 U.S.C. § 1702(a), or through standard management prescriptions.	The commenter has offered no basis for the statement: "Once BLM has identified areas which contain relevant and important values within the planning area, it must ensure their protection, either through special management (by designating an area as an ACEC), *see* 43 U.S.C. § 1702(a), or through standard management prescriptions. Decisions to protect resources are made through the Land Use Planning Process.

Southern Utah Wilderness Alliance-10	The EA failed to take a hard look at the direct, indirect, and cumulative impacts to the potential Four Mile Wash and Nine Mile Canyon Extension ACECs from leasing the above-listed parcels. These potential ACECs contain BLM-identified relevant and important values such as high value scenery, important riparian ecosystems, and significant cultural resources, among others. *See* Vernal RMP at 3-89 to 3-90. Parcels 32, 38, and 39, are in the potential Four Wile Wash ACEC which contains "[s]pectacular scenery viewed by increasing numbers of visitors" and "lush riparian vegetation [which] is rare in this desert ecosystem." *Id.* at 3-89. Similarly, Parcels 4, 5, and 151, are in the Nine Mile Canyon Extension ACEC which contains relevant and important values on par with those in the designated Nine Mile Canyon ACEC such as "[n]ationally significant Fremont, Ute, and Archaic rock art and structures." *Id.* at 3-88, 3-90.	See the response to comment Southern Utah Wilderness Alliance-09. The RMP EIS disclosed the impacts to the relevant and important values from oil and gas development. Internal scoping for the lease sale did not reveal any new information that would require additional analysis for the resources listed in the comment.
Southern Utah Wilderness Alliance-11	The EA fails to protect the BLM-identified resource values in the Nine Mile Canyon SRMA from leasing Parcels 9 and 10. BLM must manage the SRMA to "protect high-value cultural values and scenic quality." Vernal RMP at 4-321; Vernal ROD at 35 (same). However, BLM has yet to complete a management plan for the SRMA to ensure protection of these values. *See* Vernal RMP Five-Year Review at 1 ("No program-specific or integrated activity level plans have been completed" for designated SRMAs).10 No SRMA management plan has been prepared; meaning that oil and gas leasing in this area remains a "unresolved resource conflict[]" which – pursuant to IM 2010-117 – requires BLM to consider an alternative in the EA to address this issue such as prohibiting and/or restricting oil and gas leasing in this area. *See* IM 2010-117 § III.E. The EA fails to do so. *See, e.g.*, Lease Sale EA at 13 (EA considered the Proposed Action and No Action alternatives only). Furthermore, leasing Parcels 9 and 10 prior to completion of the management plan will foreclose and/or limit management options such as restricting oil and gas development activities, in violation of NEPA. *See, e.g.*, 40 C.F.R. § 1506.1(c)(3). Therefore, the EA fails to protect resource values in the Nine Mile Canyon SRMA.	The oil and gas leasing decisions were made in the VFO RMP ROD and are independent of the Nine Mile Canyon SRMA plan. However, the SRMA plan has to be consistent with the RMP decision. A SRMA (Special Resource Management Area) plan is not a master leasing plan. The SRMA plan will manage recreation activity.

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Southern Utah Wilderness Alliance-12	The EA failed to take a hard look at the direct, indirect, and cumulative impacts to water quality/resources from leasing Parcels 4, 5, 9, 10, and 38, among others. In particular, the EA does not analyze or disclose impacts to *any* surface water let alone to Argyle Creek, Ninemile Creek, and the Green River. *See, e.g.*, Lease Sale EA, Appendix C at 117 (surface water quality is "present, but not affected to a degree that detailed analysis is required").	Leasing of the proposed parcels would not, by itself, authorize any ground disturbances which could contribute runoff affecting surface water quality. Site-specific effects cannot be analyzed until an exploration or development application (APD) is received, after leasing has occurred. However, any development proposal on the lease parcels would be subject to the standard lease terms, the protective lease notices and stipulations identified in Appendix A, and all applicable laws, regulations and onshore orders in existence at the time of lease issuance. Site-specific analysis would be required prior to the approval of any ground disturbance proposal on the parcels. In light of existing knowledge regarding resource values on the subject parcels, which is based upon the analysis in the VFO RMP, BLM VFO resource specialist knowledge and parcel site-visits, significant impacts beyond those already addressed in the VFO RMP are not anticipated to occur as a result of leasing the proposed parcels.
Southern Utah Wilderness Alliance-13	The EA fails to prioritize oil and gas leasing outside of greater Sage-grouse General Habitat Management Areas ("GHMA"). GHMA is BLM-managed lands where special management is needed to sustain greater Sage-grouse populations and viability. *See* BLM, Utah Greater Sage-grouse Approved Resource Management Plan Amendment at 1-6 (Sept. 2015). Notably, BLM is required to "[p]rioritize the leasing and development of fluid mineral resources *outside* of" GHMAs. *Id.* at 1-11 (emphasis added); *id.* at 2-25 (same). In addition, FLPMA requires BLM to manage public lands pursuant to and in compliance with approved land use plans. *See* 43 U.S.C. § 1732(a). The EA does not meet these requirements. First, Parcels 32, 67, and 152, are located in GHMAs. *See* Lease Sale EA at 31. Furthermore, there is no record evidence in the EA that BLM prioritized the leasing of areas outside of GHMAs before resorting to inclusion of Parcels 32, 67, and 152, in the lease sale. The EA does not contain any discussion regarding the need for these parcels or why other parcels outside of GHMA were not prioritized, among other things. Instead, the EA contains only a few generic statements regarding the location of each parcel at issue and then concludes that oil and gas activities in these areas would adversely impact greater Sage-grouse and the species' habitat – a factor that cuts against BLM's decision to offer leases in GHMA and in favor of prioritizing leasing *outside* of such areas. *See id.* at 31-32, 44-46. Therefore, BLM has failed to prioritize oil and gas leasing outside of GHMA in violation	Per Objective MR-1 in the Greater Sage-Grouse Approved Resource Management Plan Amendment, the Vernal Field Office prioritized proposed lease parcels outside of Sage-Grouse habitat for PHMA and GHMA. The BLM elected to consider for leasing three lease parcels within GHMA that were within designated federal oil and gas units. Other parcels within Sage-Grouse habitat were not prioritized for lease consideration in this lease sale. This prioritization approach minimizes conflicts with Greater Sage-Grouse and is consistent with the amended RMP.

	of its relevant land management plans and FLPMA.	
Southern Utah Wilderness Alliance-14	SUWA herein incorporates and adopts the comments and analysis submitted by the Center for Biological Diversity for the Lease Sale EA with regard to Graham's beardtongue (*Penstemon grahamii*) and White River beardtongue (*Penstemon scariosus*).	There are no direct impacts from leasing. Indirect impacts to these species were disclosed in the Vernal Field Office RMP EIS. Consultation occurred during the RMP EIS process and lease notices were developed. When development is proposed, site specific impacts will be analyzed in a separate EA document and additional Section 7 consultation will occur as appropriate for each proposal.
Utah Rock Art Research Association -01	We oppose the inclusion of leases 009 and 010 located within the Nine Mile Canyon corridor. The EA notes the following: Two proposed parcels are within the Nine Mile Canyon corridor. Nine Mile Canyon is significant for the numerous cultural resources and the archaeological information that has been acquired from that area. These parcels, 009 and 010 are surrounded by over 100 cultural resources within one mile of the parcel boundaries with hundreds of more sites throughout the canyon. Many of these resources have been or are being listed on the National Registry of Historic Places because of their significance as part of the archaeological record. However, this description fails to note the additional 40 sites, eligible for the National Register of Historic Places, within the lease borders themselves. We appreciate that non-surface occupancy stipulations associated with these leases provide protection of sites within the lease parcels. However, the BLM must also consider indirect impacts associated with potential development of these leases. It is unclear to us where the actual drilling will occur, where roads will be developed for drilling, where pipelines and other gathering facilities will be located, how traffic associated with development and maintenance of potential wells will be routed, and the associated visual and auditory impacts associated with all of these activities.	See Response to Comment Nine Mile Canyon Coalition-01. There are no direct impacts from leasing, but there are indirect impacts due to possible subsequent development. Impacts to cultural resources from oil and gas development were disclosed in the RMP EIS. Impacts of development of the Nine Mile Canyon road were analyzed in the Final EIS West Tavaputs Plateau Natural Gas Full Field Development Plan, UT-070-05-055 signed July 2010. This EA incorporates that analysis by reference.
Utah Rock Art Research Association -02	We are concerned about leases 004 and 005 in the Argyle Canyon area. We are not aware of cultural sites associated with these leases but are concerned about indirect impacts associated with roads, gathering lines, pipelines, and traffic. If these were routed north through Argyle Canyon then we would be supportive of these leases. However, we expect that they will be routed through Nine Mile Canyon. If this is the case, we oppose these leases.	The act of leasing these parcels has no direct impact on cultural resources. In addition, parcels 4 and 5 are covered by NSO stipulations and any impacts from oil and gas development would be analyzed through the NHPA process when those parcels are up for development. This analysis includes research of previous surveys as well as 100% survey of any proposed well pads, pipelines, and roads. The final cultural resource report results will be added to the final EA. Impacts of development of the Nine Mile Canyon road were analyzed in the Final EIS West Tavaputs

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		Plateau Natural Gas Full Field Development Plan, UT-070-05-055 signed July 2010. This EA incorporates that analysis by reference.
Utah Rock Art Research Association -03	We are concerned about leases 069, 070, 071, and 142 in the Steinaker Reservoir area. This is an area of high cultural site concentration. We appreciate that non-surface occupancy stipulations associated with these leases provide protection of sites within the lease parcels but are concerned about indirect impacts associated with roads, gathering lines, pipelines, and traffic. We appreciate that the proximity of these leases to Vernal means that the public has access to, and has likely impacted, sites in the lease area. But we do not think that lease development should increase access or impact to sites in the area.	The act of leasing these parcels has no direct impact on cultural resources. The NSO stipulations and any impacts from oil and gas development would be analyzed through the NHPA process when those parcels are up for development. This analysis includes research of previous surveys as well as 100% survey of any proposed well pads, pipelines, and roads. The final cultural resource report results will be added to the final EA.
Western Energy Alliance-01	BLM originally received Expressions of Interest (EOI) for 102 parcels totaling 95,880 federal mineral acres in the planning area. BLM is now only offering 28 parcels totaling 12,344 acres, as more than 87% of the nominated acres have been deferred. We strongly disagree with BLM's decision to defer 74 nominated parcels, especially as many of these parcels have been nominated in past years and are again being deferred. Companies rely upon regular lease sales in order to plan future development, and years-long delays only further discourage oil and natural gas development on federal lands. Parcels deferred in the EA will not be available for leasing until at least November 2017 if BLM continues its current rotational leasing practice, and any parcels that are deferred will experience an unacceptable delay of several years. Instead, BLM should make these parcels available at the earliest possible lease sale, in February 2017.	Parcels were deferred until further analysis and/or guidance are received to determine if they are actually legally available for oil and gas leasing. The BLM cannot commit to making these parcels available by February 2017 because resolution of the reasons for deferral and new NEPA analysis cannot be completed in that timeframe.
Western Energy Alliance-02	We are especially concerned that 28 parcels are being deferred because of Greater Sage-grouse (GrSG). In September 2015 BLM finalized an amendment to the 2008 land use plan for the Vernal Field Office to specifically provide for GrSG protections in the planning area. The plan amendment provided protections such as timing stipulations and buffers which should allow oil and natural gas development to proceed forward. The plan took years to develop, and leasing in GrSG habitat was repeatedly delayed while the plans were being finalized. Now that the Record of Decision has been signed and the plans are in force with strong protections, leasing in GrSG should proceed forward. The justification offered for further delays is illegitimate:	Per Objective MR-1 in the Greater Sage-Grouse Approved Resource Management Plan Amendment, the Vernal Field Office prioritized proposed lease parcels outside of Sage-Grouse habitat for PHMA and GHMA. The BLM elected to consider for leasing three lease parcels within GHMA that were within designated federal oil and gas units. Other parcels within Sage-Grouse habitat were not prioritized for lease consideration in this lease sale. This prioritization approach minimizes conflicts with Greater Sage-Grouse and is consistent with the amended RMP.

	"[t]his deferral was made consistent with the BLM's Sage-grouse conservation plans and strategy, which direct the BLM to prioritize oil and gas leasing and development in a manner that minimizes resource conflicts in order to protect important habitat." BLM is using the plans to enact a de facto ban on oil and natural gas development in sage grouse habitat.	
Western Energy Alliance-03	Furthermore, the remaining 51 deferrals are the result of the state director's discretion, recreation concerns, and other wildlife species. As discussed above, however, the land use plan for the Vernal Field Office contains stipulations on oil and natural gas leasing that provide protections for wildlife and recreation concerns. Oil and natural gas development can coexist with other land uses, as the plan rightly indicates. We urge BLM to reconsider and offer these parcels for lease.	As conflicts are resolved, parcels will be offered for lease.
Wild Earth Guardians-01	A programmatic EIS is necessary. Put simply, BLM is failing to describe or to analyze climate impacts from its oil and gas program and this document is no exception. The repeated pattern and practice of such failure suggests that only a programmatic analysis at the national level can address this shortcoming. In fact, a programmatic analysis is exactly what the CEQ Guidance calls for. The Guidance suggests that for "long-range energy" actions, "it would be useful and efficient to provide an aggregate analysis of [greenhouse gas] emissions or climate change effects in a programmatic analysis and then incorporate by reference that analysis into future NEPA review." CEQ Guidance at 29. The lack of climate analysis of this long-range energy action demonstrates that this office, along with other state offices as demonstrated in other recent oil and gas leasing EAs, is incapable or unwilling to undertake adequate review of greenhouse gas ("GHG") emissions or climate change effects. This is exactly why the CEQ Guidance is correct in calling for programmatic analysis of climate emissions and effects for programs like the BLM oil and gas leasing program.1 In fact, when listing examples of "site-specific actions that can benefit from a programmatic NEPA review," authorizing leases for oil and gas drilling is specifically mentioned. CEQ Guidance at 30. Thus, the CEQ Guidance creates an expectation that BLM would undertake a programmatic EIS of its oil and gas program, which it has thus far failed to do.	There is merit to the suggestion that climate change would be best analyzed through development of a programmatic EIS, and various entities have recognized this, including CEQ and Utah BLM air staff. Whether to pursue such a programmatic EIS for this project, however, is beyond the decision space of the Vernal Field Office, and also not within the scope of the EA.

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Wild Earth Guardians-02	A complete estimate and analysis of climate emissions and impacts from this project is required, but missing. NEPA has a mandate to assess impacts at the earliest opportunity. Having already ignored such impacts by failing to analyze them in a programmatic analysis or in the analysis for RMPs, BLM cannot claim it will undertake analysis at the last possible moment, during an application for permit to drill analysis, rather than the earliest opportunity. "We will do it later" doesn't cut it under NEPA, even the less so when the claim of later analysis is not true.	The EA has been revised to reflect current guidance on analysis of Green House Gas (GHG) emissions.
Wild Earth Guardians-03	BLM Utah is now using the ePlanning system to provide the public with NEPA documents. On July 14, 2016, a search was performed for all VFO Fluid Minerals planning documents. DOI-BLM-UT-G010-2016-0055-EA is said to be an analysis of five proposed wells. The project status is listed as "Completed." The links to "Documents" leads to the following statement: "Document preparation underway. No documents are available at this time. However, at a minimum a signed NEPA document will be uploaded as soon as it is available." The exact same situation pertains to DOI-BLM-UT-G010-2016-0026-EA. The project is listed as completed and no documents are available. Thus, no adequate climate change analysis is available to the public as NEPA demands. Please provide this document to me and keep the November lease sale EA comment period open until I have a chance to review it and utilize it for comments on this sale. For DOI-BLM-UT-G010-2016-0025-EA, which is also listed as completed, the only documents that appear are maps. The "Documents" section contains no NEPA analysis. Please provide that document and time to comment on the November lease sale.	Thank you for bringing these to BLM's attention. These documents did not post to the ePlanning website due to technical errors. They are now available for your review on the website and a copy of each document was e-mailed to you 7/21/2016.
Wild Earth Guardians-04	The high costs to society from the leasing and subsequent burning of public lands fossil fuels must be properly analyzed and that analysis presented to the public and agency decision makers. Historically, BLM has ignored the costs of fossil fuel leasing on public lands, especially the costs to society that result from global warming. Proper consideration of these social costs of carbon is simply good governance and good stewardship of public resources, and such consideration is legally required.	The EA has been revised to reflect current guidance on analysis of the social cost of carbon.

Wild Earth Guardians-05	A recent consensus report, joined by more 190 countries, makes the basic science on global warming crystal clear. Global warming is unequivocal: since the 1950s the atmosphere and oceans have warmed, snow and ice have diminished, and seas have risen. Ex. 6, Climate Change 2013 – The Physical Science Basis - Summary for Policymakers, United Nation Intergovernmental Panel on Climate change (2013) ("AR5 summary") at 4. There is little doubt that pollution from human activities is the cause of this warming. Id. at 17. The U.S. government's own more recent report concludes that global warming is now affecting our country in far-reaching ways. Ex. 7, National Climate Assessment 2014 – Overview ("National Climate Assessment"). Climate pollution has warmed the U.S. almost 2°F, mostly since 1970, with another 2°F to 4°F expected in the next few decades. Id. Much greater warming in future decades is also possible, possibly up to an increase of 10°F above current temperatures by the end of the century. Id. These are not the estimates of "environmentalists." This is the scientific consensus accepted both in the U.S. and around the world.	Thank you for providing this information.
Wild Earth Guardians-06	The requirement to analyze the social cost of carbon is supported by the general requirements of the National Environmental Policy Act ("NEPA") and specifically supported in federal case law. NEPA requires agencies to take a "hard look" at the consequences of proposed agency actions. 42 U.S.C. § 4321 *et seq.*; *Morris v. U.S. Nuclear Regulatory Commission,* 598 F.3d 677, 681 (10th Cir. 2010). Consequences that must be considered include direct, indirect, and cumulative consequences. 40 C.F.R. §§ 1502.16, 1508.7, 1508.8. A cumulative impact is the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." 40 C.F.R. § 1508.7. Analysis of site specific impacts must take place at the lease stage and cannot merely be deferred until after receiving APDs to drill. *See New Mexico ex rel. Richardson v. Bureau of Land Management*, 565 F.3d 683, 717-18 (10th Cir. 2009); *Conner v. Burford,* 848 F.2d 1441 (9th	The EA has been revised to reflect current guidance on analysis of the social cost of carbon.

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	Cir. 1988); *Bob Marshall Alliance v. Hodel,* 852 F.2d 1223, 1227 (9th Cir. 1988). Any NEPA analysis of a fossil fuel development project that fails to use the government-wide protocol for assessing the costs to society of carbon emissions from the proposed action has failed to take the legally required "hard look."	
Wild Earth Guardians-07	The new Departmental Landscape-Scale Mitigation policy applies to BLM. 600 DM 6.2. Its purpose is to "avoid, minimize, and compensate for impacts to Department-managed resources." 600 DM 6.1. The BLM is required to apply a "no net loss" policy to agency resources, including those impacted by oil and gas leasing and development. 600 DM 6.5. BLM is empowered to decline authorization of projects where mitigation and compensation cannot be achieved. 600 DM 6.6. Specifically, BLM is required to "[i]dentify and promote mitigation measures that help address the effects of climate change" and to consider "greenhouse gas emissions in design, analysis, and development of alternatives."*Id.* These policies and principles should be employed "when developing and approving strategies and plans, reviewing projects, and issuing permits." 600 DM 6.8.	Landscape scale mitigation policy is beyond the scope of this document.
Wild Earth Guardians-08	The EA largely ignores wastewater created by oil and gas extraction. This itself renders the EA inoperable. Despite BLM ignoring the issue however, it is well known that much fracking wastewater is injected into underground wells. That practice is known or suspected of causing earthquakes in Oklahoma, Texas, Ohio, Pennsylvania, California, and Canada and has been restricted for just that reason in some of those areas. BLM must, in a supplemental analysis, analyze the likelihood of such impacts before they occur and require mitigation before this project can proceed.	Injection of fluids associated with oil and gas production has caused induced seismic events. However, the underground injection of 'fracking waste water' in Utah presents little potential for inducing seismic activity. The majority of fracking waste 'fluids' are recycled and reused for future frack jobs. There have been no reported earthquakes in Utah that were suspected of being produced (induced) from injecting fluids in disposal wells (Class II UIC permitted by Utah Department of Oil, Gas and Mining (DOGM)), which fluid is predominantly produced water with a high salt brine content. In order to analyze the potential for earthquakes associated with oil and gas disposal wells three kinds of data will be necessary: (1) seismic data: high-quality, real-time earthquake locations, which require dense seismic instrumentation; (2) geologic data: hydrological parameters, orientation and magnitude of the stress field, and the location and orientation of known faults; and (3) industrial data: injection rates and downhole pressures sampled and reported frequently (see following link). However this data is not currently available, with the exception of industrial injection data reported to DOGM, to do the analysis. <footnote> <para>https://profile.usgs.gov/myscience/upload_folder/ci2015Jun1012005755600Induced_EQs_Review.pdf</para> </footnote>

		Potential geologic hazards caused by hydraulic fracturing may include induced seismic activity. Earthquakes occur when energy is released due to blocks of the earth's crust moving along areas of weakness or faults. Earthquakes attributable to human activities are called "induced seismic events" or "induced earthquakes." A study conducted by the National Research Council (2013) studied the issue of induced seismic activity from energy development. The study found that: 1) The process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events; and, 2) Injection for disposal of waste water derived from energy technologies into the subsurface does pose some risk for induced seismicity, but very few events have been documented over the past several decades relative to the large number of disposal wells in operation. Also, out of the • 1.8 million treatments in over • 1 million wells, from 1947-2010 drilled in the United States, there are only three reported cases of hydraulic fracturing-induced earth quakes. (Seismological Research Letters, Volume 86, Number 4, July/August 2015). The Utah Division of Oil, gas and Mining (UDOGM) has stated that there has been no reported ground water contamination or fracking-induced problems in Utah associated with oil and gas well drilling and/or completion, or form injection into disposal wells. Oil production in Oklahoma has been going on for over 100 years. Some activities related to oil production, particularly disposal of wastewater in deep injection wells, are known to potentially cause earthquakes. The rate of earthquakes has increased sharply since 2009 in the central and eastern United States, with growing evidence confirming that these earthquakes are primarily caused by human activity, namely the injection of wastewater in deep disposal wells contacting basement rocks. A new study by the U.S Geological Survey presents evidence that, in addition to these recent earthquakes, most of the larger earthquakes in Oklahoma in the past century may likely have been induced by industrial activities. Prior to the 2011 magnitude 5.7 Prague, Oklahoma earthquake, the largest historical earthquake in the area was the 1952 magnitude 5.7 El Reno earthquake, which the study concludes was likely induced by activities related to oil production near Edmond, Oklahoma. (*A Century of Induced Earthquakes in Oklahoma?* Bulletin of the Seismological Society of America, October 20, 2015. doi:10.1785/0120150109).
Wild Earth Guardians-09	Parcels 032, 067, 152 are completely or partially within Sage-grouse Priority Habitat Management Areas ("PHMAs") according to our maps. Yet BLM asserts that they are within General Habitat Management Areas ("GHMA"). EA at 31-32. According	Per Objective MR-1 in the Greater Sage-Grouse Approved Resource Management Plan Amendment, the Vernal Field Office prioritized proposed lease parcels outside of Sage-Grouse habitat for PHMA and GHMA. The BLM elected to consider for leasing three lease parcels within GHMA that were within

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	to BLM, these parcels are within existing units and are surrounded by other leases. EA at 9. All restrictions and stipulations included in the Utah Greater Sage-grouse RMP Amendment must be attached to these parcels should they be offered at auction. Yet we remain concerned that Sage-grouse stipulations prescribed in BLM land-use plan amendments and revisions to protect greater Sage-grouse are scientifically unsound, legally invalid, and fail to grant an adequate level of protection to allow for the survival of greater Sage-grouse in the context of development on oil and gas leases, and therefore protest these parcels. Under BLM's greater Sage-grouse plan amendments and revisions, the agency made an explicit commitment to prioritize oil and gas leasing and development outside PHMAs (which include SFAs) and General Habitat Management Areas ("GHMAs"). Particularly relevant to this lease sale: "Objective MR-1: Priority will be given to leasing and development of fluid mineral resources, including geothermal, outside of PHMA and GHMA. When analyzing leasing and authorizing development of fluid mineral resources, including geothermal, in PHMA and GHMA, and subject to applicable stipulations for the conservation of GRSG, priority will be given to development in non-habitat areas first and then in the least suitable habitat for GRSG." Utah Greater Sage-grouse Approved RMP Amendment at 2-25.	designated federal oil and gas units. Other parcels within Sage-Grouse habitat were not prioritized for lease consideration in this lease sale. This prioritization approach minimizes conflicts with Greater Sage-Grouse and is consistent with the amended RMP. PPH is a term associated with the BLM's interim management Instruction Memorandum. That terminology and prioritization was superseded by the Record of Decision for the Greater Sage-Grouse Approved Resource Management Plan Amendment (GRSG ARMPA). The GRSG ARMPA established priorities for management of GRSG habitat in Priority and General Habitat Management Areas (see GRSG FEIS section 1.3.2), with management commensurate with the prioritization. Within GHMA, conservation measures do not include additional stipulations as are included for PHMA. Rather, this lease includes management for a net conservation gain for development and application of required design features and buffers during project implementation to minimize impacts in these areas. No PHMA areas were considered for leasing in this lease sale, and the only areas in GHMA that are considered for lease are within designated oil and gas units where impacts to GRSG are already present, as described in the GRSG FEIS section 4.3.2 and section 4.3.7. Impacts to these resources were considered and carried forward when warranted in the analysis. See the ID team checklist in Appendix C for determinations of potential impacts, Chapter 3 for a description of these resources, and Chapter 4 for the potential impacts and effects on these resources. No surface disturbance will occur as a direct result of the leasing. However, possible development scenarios, which are only hypothetical at this stage, were analyzed and the anticipated impacts were disclosed.

Appendix F. Parcel Pictures

Figure F.1. Lease Parcel UT-1116-004

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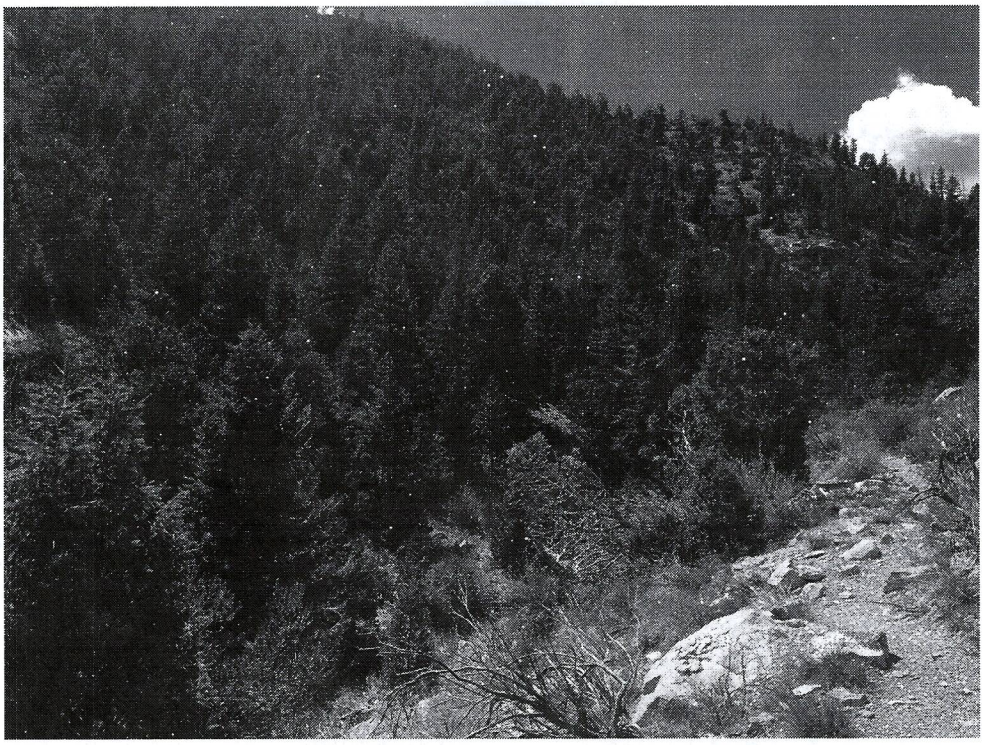

Figure F.2. Lease Parcel UT-1116-005

Figure F.3. Lease Parcel UT-1116-006

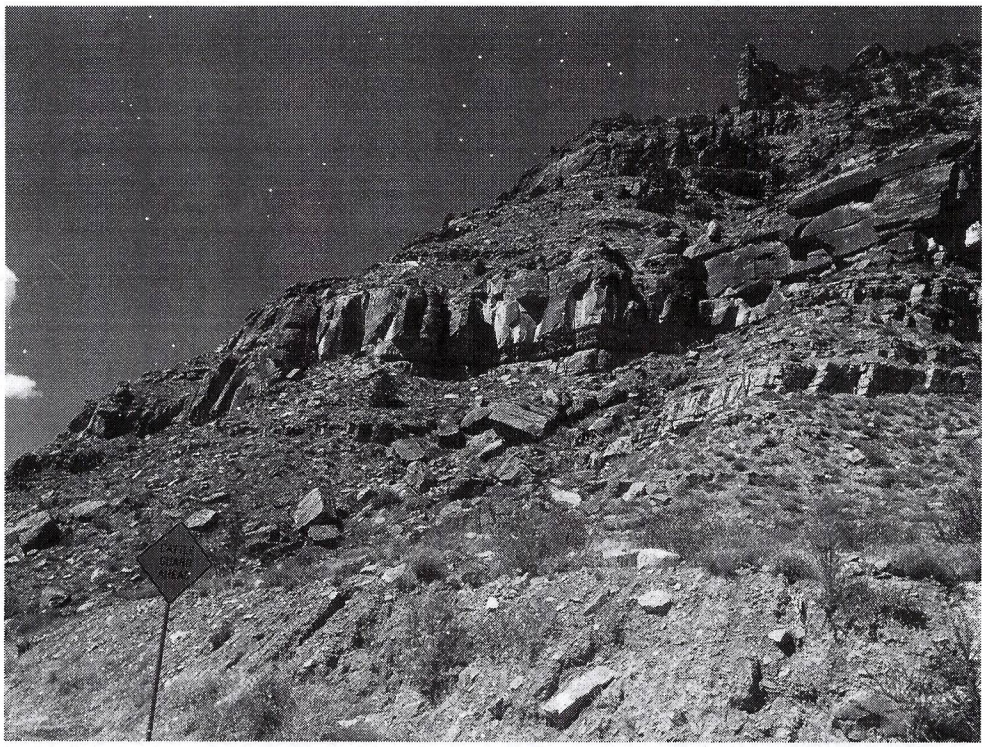

Figure F.4. Lease Parcel UT-1116-009

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Figure F.5. Lease Parcel UT-1116-010

Figure F.6. Lease Parcel UT-1116-012

Figure F.7. Lease Parcel UT-1116-013

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Figure F.8. Lease Parcel UT-1116-014

Figure F.9. Lease Parcel UT-1116-015

Figure F.10. Lease Parcel UT-1116-016

Figure F.11. Lease Parcel UT-1116-032

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Figure F.12. Lease Parcel UT-1116-038

Figure F.13. Lease Parcel UT-1116-039

Figure F.14. Lease Parcel UT-1116-049

Figure F.15. Lease ParcelUT-1116-067

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Figure F.16. Lease Parcel UT-1116-069

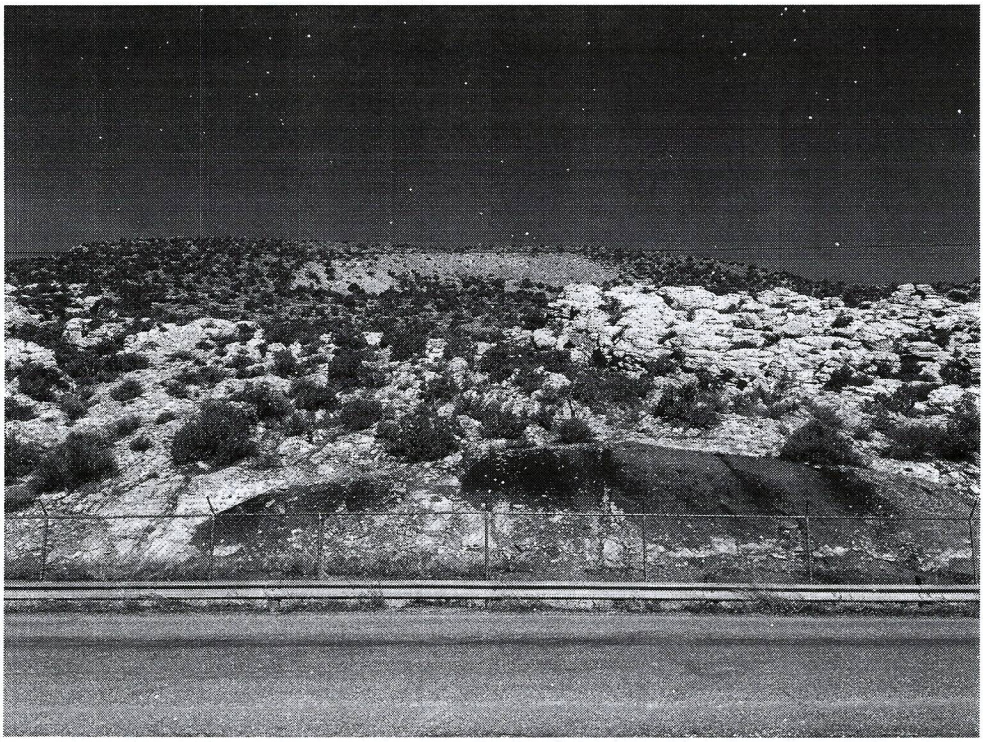

Figure F.17. Lease ParcelUT-1116-070

Figure F.18. Lease Parcel UT-1116-071

Figure F.19. Lease Parcel UT-1116-093

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Figure F.20. Lease Parcel UT-1116-094

Figure F.21. Lease Parcel UT-1116-103

Figure F.22. Lease Parcel UT-1116-105

Figure F.23. Lease Parcel UT-1116-121

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Figure F.24. Lease Parcel UT-1116-122

Figure F.25. Lease Parcel UT-1116-123

Figure F.26. Lease Parcel UT-1116-142

This is a picture of parcel 143.

Figure F.27. Lease Parcel UT-1116-143

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Figure F.28. Lease Parcel UT-1116-151

Figure F.29. Lease Parcel UT-1116-152

Appendix G. Unit Maps

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Appendix H. Cultural Resources Summary

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Exhibit 3

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Attachment F

DRAFT OIL AND GAS AIR EMISSIONS INVENTORY REPORT FOR SEVEN LEASE PARCELS IN THE BLM ROYAL GORGE FIELD OFFICE

Prepared for:

BLM
Colorado State Office and Royal Gorge Field Office
Colorado

Prepared by:

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July 2013

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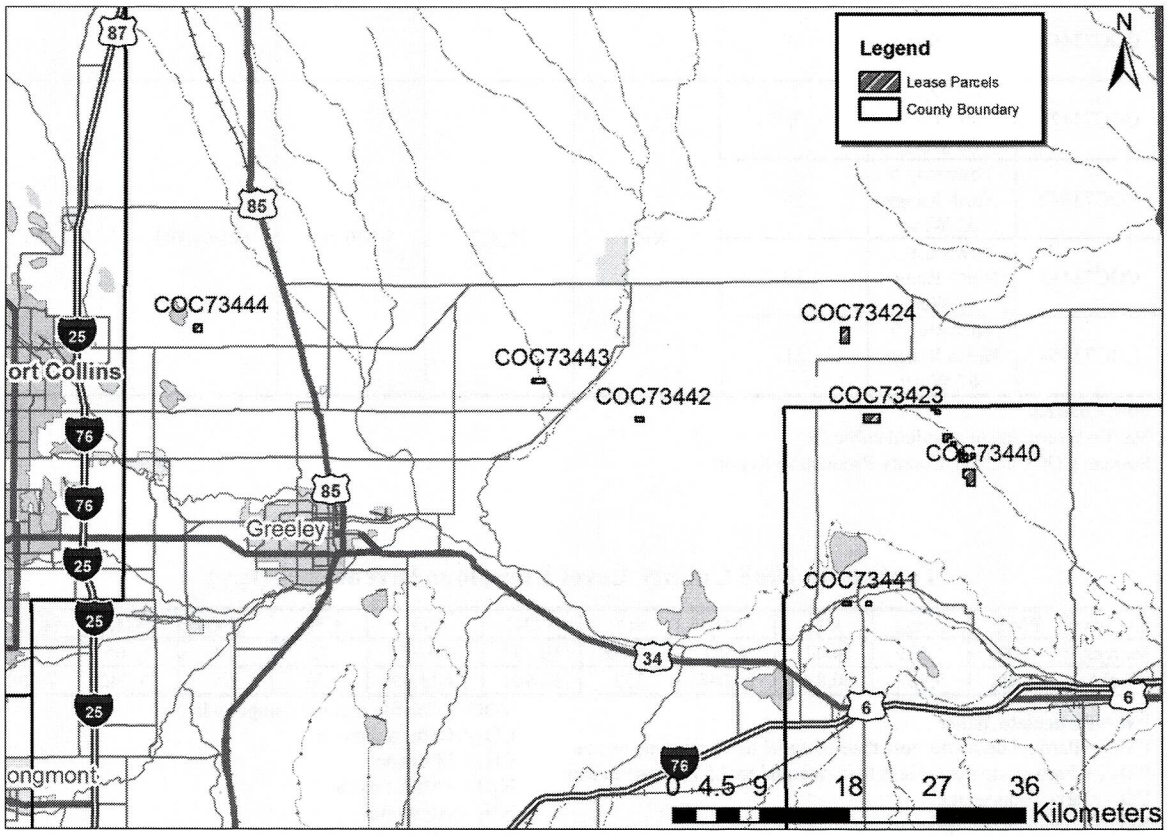
LIST OF ACRONYMS AND ABBREVIATIONS

AP-42	*Compilation of Air Pollutant Emission Factors*
APD	Application for Permit to Drill
API	American Petroleum Institute
bbls	Barrels
BLM	Bureau of Land Management
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
COGCC	Colorado Oil and Gas Conservation Commission
CSO	Colorado State Office
Mscf	Thousands of standard cubic feet
NAA	Non-Attainment Area
NH_3	Ammonia
N_2O	Nitrous oxides
NO_x	Oxides of nitrogen
O&G	Oil and Gas
PM	Particulate matter
PM_{10}	Particulate matter less than or equal to 10 microns in size
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns in size
PSICC	Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands
RFD	Reasonably foreseeable development
RGFO	Royal Gorge Field Office
SO_2	Sulfur dioxide
tpy	Tons per year
URS	URS Group, Inc.
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

PROJECT INTRODUCTION AND STUDY AREA

This oil and gas (O&G) emissions inventory report identifies the data and methodologies used in developing air emissions inventories for potential oil and gas development and production activities on seven (7) specific lease parcels in the Bureau of Land Management (BLM) Royal Gorge Field Office (RGFO). These seven parcels are part of the twelve (12) lease parcels in eastern Colorado referred to in the Stipulation and Order entered into by WildEarth Guardians and the BLM (WildEarth 2012) and for this report will further be known as "Study" or "Project". The emissions inventories include quantified potential emissions based on the 2012 BLM RGFO Reasonable Foreseeable Development (RFD) document (BLM 2012).

For emissions inventory domain purposes, the Study Area focuses on the seven lease parcels in the BLM RGFO in Colorado. The RGFO administers over 680,000 surface acres of public land along the Colorado Front Range and 6.8 million sub-surface acres. This Field Office covers approximately the eastern half of Colorado and includes a variety of terrain. The Project emissions inventory development will focus on potential oil and gas activities on the seven lease parcels in the RGFO. A map showing the locations of the seven BLM lease parcels is presented below (Map 1-1).



Map 0-1. Locations of Seven BLM Lease Parcels

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The number of active wells for each Township that contains one of the seven lease parcels is shown below in Table 1-1 (data taken from Figure 5b of the RFD [BLM 2012]). Also shown in this table are the number of active wells in the county in 2011, as well as the 2011 oil, gas, and water production for each of the two counties containing the seven lease parcels (COGCC 2013). In order to provide a background of the emissions levels in the area of the lease parcels, Table 1-2 provides county level emissions inventories in tons per year (tpy) for Weld and Morgan counties taken from the 2008 National Emissions Inventory (USEPA 2013).

Table 0-1. Active Wells and Production Values

Parcel Serial #	Township	Number of Active Wells in Township in 2011	County	Number of Active Wells in County in 2011	2011 Average Monthly Oil Production (bbls)	2011 Average Monthly Gas Production (Mscf)	2011 Average Monthly Water Production (bbls)
COC73423	Township 6 North Range 60 West	6	Morgan	252	9,159	10,946	265,862
COC73440	Township 6 North Range 59 West	4					
COC73441	Township 4 North Range 60 West	0					
COC73424	Township 7 North Range 60 West	8	Weld	22,323	2,220,768	19,964,793	954,887
COC73442	Township 6 North Range 62 West	54					
COC73443	Township 7 North Range 63 West	50					
COC73444	Township 7 North Range 67 West	21					

bbls = barrels
Mscf = thousands of standard cubic feet
Source: COGCC 2011 County Production Report

Table 0-2. 2008 County Level Emissions Inventories (tpy)

County	PM_{10}	$PM_{2.5}$	CO	NO_x	SO_2	VOC	CO_2	CH_4	N_2O	NH_3	HAPs
Morgan	6,880	1,529	10,471	9,561	13,466	10,234	306,257	22	10	5,765	2,232
Weld	28,851	5,962	60,876	20,088	352	52,991	1,683,038	137	66	17,042	7,389

PM = Particulate matter
PM_{10} = Particulate matter less than or equal to 10 microns in size
$PM_{2.5}$ = Particulate matter less than or equal to 2.5 microns in size
CO = Carbon monoxide
NO_x = Oxides of nitrogen
SO_2 = Sulfur dioxide
VOC = Volatile organic compounds
CO_2 = Carbon dioxide
CH_4 = Methane
N_2O = Nitrous oxide
NH_3 = Ammonia
HAPs = Hazardous air pollutants
Source: USEPA 2008 NEI

EMISSIONS INVENTORY METHODOLOGY

This section describes the data sources and methods that were used to develop the seven lease parcel-specific emission inventories.

POTENTIAL WELL DEVELOPMENT

Potential well development was estimated using data from the 2012 BLM RGFO RFD and is shown in Table 2-1. Map 2-1 shows oil and gas development potential and projected drilling densities for the years 2011 through 2030 for each Township in the RGFO (Figure 17, 2012 BLM). The minimum and maximum number of potential wells per Township was determined for each lease parcel based on this figure. The average acres disturbed per well was calculated using Table 14a of the RFD document along with the expected percentages of multi-well and single-well pads found on page 31. Parcels must have at least one well in order to retain a lease; therefore, the potential minimum wells developed for each of the lease parcels is one. To determine the potential maximum wells developed for each lease parcel, the area of each parcel in acres was divided by the average acres disturbed for each well. If the result was greater than the maximum wells per Township, the potential maximum was set to the maximum wells per Township; otherwise, the result was used.

Table 0-3. Potential Conventional Well Development for the Seven Lease Parcels

Parcel Serial #	In Non-attainment Area? [1]	Development Category	Minimum Wells per Township	Maximum Wells per Township	Area of Parcel (acres)	Average Acres Disturbed per Well [2]	Potential Minimum Wells Developed in Parcel [3]	Potential Maximum Wells Developed in Parcel [4]
COC73444	Y	Moderate	5	9	160	7.6	1	9
COC73443	Y	High	21	50	123	7.6	1	16
COC73442	Y	Very High	51	150	80	7.6	1	10
COC73424	Y	Moderately High	10	20	320	7.6	1	20
COC73423	N	Low	1	4	320	2.1	1	4
COC73441	N	Low	1	4	120	2.1	1	4
COC73440	N	Low	1	4	879	2.1	1	4

(1) Parcels are either within the Greater Wattenberg Non-Attainment Area (NAA) or to the east of the NAA.
(2) Average acres disturbed is determined from values in the RFD.
(3) Parcels must have at least one well to retain lease.
(4) Potential maximum wells developed is either the number of wells that will fit in the parcel, or the maximum per Township, if the former is greater.

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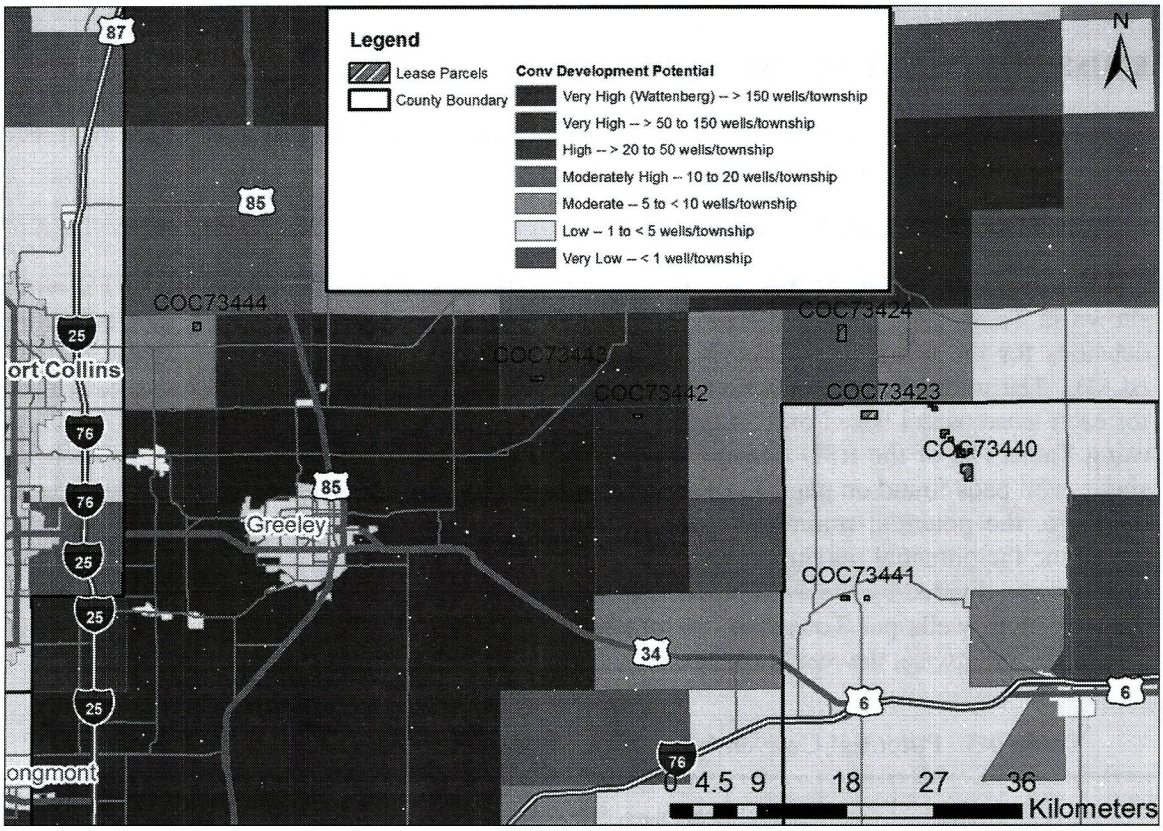

Map 0-2. Conventional O&G Development Potential

POTENTIAL OIL AND GAS ACTIVITIES

Potential oil and gas activities on the lease parcels range from land disturbance from construction and drilling, to well completion activities from venting and flaring, and production activities. Particulate emissions could be generated from the construction of new well pads, roads and pipelines. Construction emissions will also include criteria pollutants from exhaust emissions from construction traffic and drilling engines. At times, during completion, well workovers, or blowdowns, gas may be vented or flared.

Potential oil and gas activity levels for the seven lease parcels were estimated from a variety of sources. Potential oil, gas, condensate, and water produced from wells that could be developed on the lease parcels were estimated by the BLM Colorado State Office (BLM-CSO) from Applications for Permit to Drill (APD) submissions from other sites in the area of the seven lease parcels.

Data requests were sent out to oil and gas operators that work in the area of the seven lease parcels. Only one operator sent back a response. This data was used to supplement the data from the APDs.

Another source of data was the Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands (PSICC) Air Quality Study. The data from this study was used to fill in any data gaps left after the APD and operator data had been entered.

PER-WELL EMISSIONS INVENTORY

The per-well emissions were calculated using the activity data listed in the above section along with emission factors taken from AP-42 (USEPA 1998, 2000, 2006), the American Petroleum Institute's Compendium (API 2009), the USEPA's *Protocol for Equipment Leak Emissions Estimates*, as well as, emissions factors developed for the Piceance Basin in western Colorado.

Emissions calculations took into account all current EPA and Colorado regulations on the oil and gas industry. The latest EPA regulations that affect this project include the following (USEPA 2012):

- High-bleed pneumatic controllers must have a gas bleed limit of 6 cubic feet of gas per hour, and
- Storage tanks with VOC emissions of 6 tons per year or more are required to reduce emissions by at least 95%.

The estimated per-well emissions for the seven lease parcels are listed in Table 2-2 below.

Table 0-4. Per-Well Emissions Estimates

Resource/Phase	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOC	HAPs	CO_2	CH_4	N_2O
	tpy	tpy	tpy	tpy	tpy	tpy	tpy	tpy	tpy	tpy
Oil										
Construction	28.51	3.61	11.16	0.03	2.63	0.75	0.08	1,518.74	0.03	0.01
Operation	15.62	1.64	10.58	0.01	6.26	20.96	2.01	1,149.23	20.86	0.02
Maintenance	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.00
Reclamation	0.06	0.01	0.02	0.00	0.01	0.00	0.00	1.73	0.00	0.00
Total	44.27	5.27	21.75	0.03	8.90	21.72	2.09	2,670.32	20.89	0.03
Natural Gas										
Construction	28.62	3.63	11.18	0.03	2.77	0.76	0.08	1,563.51	0.03	0.01
Operation	14.68	1.65	4.53	0.01	8.06	33.30	3.65	1,211.83	31.69	0.01
Maintenance	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.00
Reclamation	0.06	0.01	0.02	0.00	0.01	0.00	0.00	1.73	0.00	0.00
Total	43.45	5.30	15.73	0.03	10.84	34.06	3.73	2,777.69	31.72	0.03

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SUMMARY

Per-well emissions estimates have been calculated for seven parcels in Weld and Morgan Counties in Colorado. These estimates were calculated using the most current data available and included the most current rules and regulations. Colorado has published recommended modeling thresholds for new sources of emissions (CDPHE 2011). These thresholds are exceeded by the per-well emissions estimates for short-term and long-term PM_{10} and $PM_{2.5}$, and short-term NO_x. Approximately half of the estimated emissions of PM_{10}, $PM_{2.5}$, NO_x and CO_2 come from construction related activities. These activities are expected to last a few weeks per well. The BLM may also require additional controls as conditions of approvals at the permitting stage, which could further reduce emissions. These additional controls may include, but are not limited to, Tier 4 engines and fugitive dust control for construction and traffic.

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Exhibit 4

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ENVIRON

COLORADO AIR RESOURCE MANAGEMENT MODELING STUDY (CARMMS) 2021 MODELING RESULTS FOR THE HIGH, LOW AND MEDIUM OIL AND GAS DEVELOPMENT SCENARIOS

Final

Prepared for:
Bureau of Land Management (BLM)
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1.0 INTRODUCTION

1.1 Background

The Bureau of Land Management (BLM) is in the process of developing new Resource Management Plans (RMPs) for several Field Offices in Colorado. The draft RMP for the Grand Junction Field Office (GJFO) was released in January 2013[1]. In May 2013, a draft RMP for the Dominguez-Escalante National Conservation Area (D-E NCA) was released[2]. The draft RMP for the Uncompahgre Field Office (UFO[3]), the RMP revision for the Royal Gorge Field Office (RGFO[4]), and the Roan Plateau Planning Area Supplemental Environmental Impact Statement (SEIS[5]) are all in preparation, or pre-planning. As part of these RMPs, BLM is estimating the air quality (AQ) and air quality related value (AQRV) impacts due to the projected BLM-authorized mineral development activities. The analysis includes the cumulative AQ and AQRV impacts due to all Reasonable Foreseeable Development (RFD) sources in the region. In the past, individual RMPs have generally performed their own AQ/AQRV analysis for a long-term year (e.g., 20 years out) when the maximum RMP development is projected to occur. This has resulted in inefficiencies and potential inconsistencies in the RMP's AQ/AQRV analysis and a possibility for a failure to adequately assess the effects of cumulative development across all BLM planning areas on AQ/AQRV in the region. In addition, making emissions projections for such a long-term future year results in increased uncertainties and may create potential inconsistencies in the RMP planned and actual development activities. Thus, the BLM GJFO RMP Air Resource Management Plan (ARMP[6]) contains a commitment to perform a unified regional air quality modeling study to address the AQ/AQRV impacts due to development activities within the GJFO planning area as well as all of BLM Colorado's development activities for a short-term year approximately 10 years in the future.

To address this commitment, the BLM has contracted with Environmental Management Planning and Solutions Inc. (EMPSi), and their Subcontractors ENVIRON International Corporation (ENVIRON) and Carter Lake Consulting (CLC), to perform the Colorado Air Resource Management Modeling Study (CARMMS). The first step in the CARMMS air quality modeling was the development of a Photochemical Grid Model (PGM) and far-field dispersion Modeling Protocol (ENVIRON, Carter Lake and EMPSi, 2014). The Modeling Protocol describes procedures for addressing potential AQ and AQRV impacts due to BLM-authorized mineral development and other BLM-authorized activities in Colorado and in particular within the GJFO and other BLM FOs planning areas in Colorado. AQRVs include visibility, sulfur and nitrogen deposition and lake acid neutralizing capacity (ANC).

The BLM New Mexico State Office (NMSO) is also looking at preparing a RMP for oil and gas development within the Mancos Shale development area in northwestern New Mexico that resides

[1] http://www.blm.gov/co/st/en/fo/gjfo/rmp/rmp.html
[2] http://www.blm.gov/co/st/en/nca/denca/denca_rmp.html
[3] http://www.blm.gov/co/st/en/fo/ufo/uncompahgre_rmp.html
[4] http://www.blm.gov/pgdata/etc/medialib/blm/co/field_offices/royal_gorge_field/oil_and_gas.Par.16932.File.dat/RoyalGorgeFinal_RFD_August_2012%20web.pdf
[5] http://www.blm.gov/co/st/en/BLM_Programs/land_use_planning/rmp/roan_plateau.html
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primarily within the BLM New Mexico Farmington Field Office (NMFFO). Given that the Mancos Shale development area is adjacent to some of the Colorado BLM Planning Areas and resides within the CARMMS modeling domain, the BLM decided to add the Mancos Development area to the CARMMS analysis.

The BLM Colorado State Office (COSO) convened an Interagency Air Quality Review Team (IAQRT) that consists of U.S. Environmental Protection Agency (EPA) Region 8, Colorado Department of Health and Environment (CDPHE) Air Pollution Control Division (APCD), National Park Service (NPS), Fish and Wildlife Service (FWS) and United States Forest Service (USFS) to review and comment on the Modeling Protocol in accordance with the June 23, 2011 Memorandum of Understanding (MOU[7]) between the United States Department of Interior (USDOI), United States Department of Agriculture (USDA) and United States Environmental Protection Agency (EPA) on procedures for assessing the AQ and AQRV impacts due to on-land oil and gas development activities on Federal lands under the National Environmental Policy Act (NEPA). With the addition of the NMFFO Mancos Shale development to CARMMS, the IAQRT was expanded to include EPA Region 6 and the New Mexico Environmental Department (NMED).

1.2 Purpose

This document presents the final 2021 modeling results for the CARMMS High, Low and Medium Development Scenarios source apportionment modeling. Presented are the individual AQ and AQRV impacts due to oil and gas (O&G) development on Federal lands within 13 separate Colorado BLM planning areas and the NMFFO Mancos Shale development area as well as the combined assessment of O&G development on Federal and non-Federal lands. In addition, the AQ and AQRV impacts due to mining within the 13 Colorado BLM planning areas and all O&G development within the 4 km CARMMS domain is presented. The 2021 modeling results are compared against National and State Ambient Air Quality Standards (NAAQS and SAAQS) throughout the 4 km modeling domain. The contributions of O&G development to AQ and AQRV at Class I and sensitive Class II areas are presented and compared to PSD increment concentrations and visibility and deposition thresholds of concern.

The CARMMS modeling was performed following procedures documented in a Modeling Protocol. A first draft CARMMS air assessment Modeling Protocol was prepared in August 2013. The BLM and their contractors presented the results of the first draft CARMMS Modeling Protocol to the IAQRT at the BLM COSO office in Denver on October 30, 2013. The IAQRT provided comments on the first draft Modeling Protocol that were incorporated into a draft final Modeling Protocol that was released in January 2014 (ENVIRON, CLC and EMPSi, 2014) along with a Response-to-Comments document that was also dated January 2014. Another meeting with the IAQRT was held at the BLM COSO office on February 28, 2014. IAQRT provided several comments that were addressed in a March 4, 2014 Response-to-Comments document and incorporated into this document. A preliminary draft CARMMS modeling report was prepared in May 2014 that included results for just the 2021 High Development Scenario. Based on comments from BLM, the preliminary draft CARMMS report was updated in an interim draft CARMMS report dated October 2014 that included the 2021 High and Low Development Scenarios modeling results. After

[7] http://www.epa.gov/compliance/resources/policies/nepa/air-quality-analyses-mou-2011.pdf

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completion of the 2021 Medium Development Scenario source apportionment modeling this final reported was prepared in December 2014 that includes the 2021 High, Low and Medium Development Scenarios results.

1.3 Overview of Modeling Approach

CARMMS is using a photochemical grid model (PGM) to assess the AQ and AQRV impacts associated with BLM-authorized mineral development on Federal lands within BLM Colorado and the New Mexico Farmington Field Office Planning Areas. CARMMS will not assess the near-source AQ impacts of the O&G and other development activities; that will be addressed at the Project level in the future. The development of a PGM database is quite resources intensive. Thus, to the extent possible, CARMMS has leveraged two studies that have or are developing PGM modeling databases for the western states:

1. The West-wide Jump-start Air Quality Modeling Study (WestJumpAQMS) has performed meteorological, emissions and air quality modeling using a 36 km CONUS, 12 km WESTUS and 4 km Intermountain West modeling domains for the 2008 calendar year. Details on the WestJumpAQMS modeling approach, the PGM 2008 base case modeling and model performance evaluation are available on the WestJumpAQMS website[8] and contained within the WestJumpAQMS Modeling Protocol (ENVIRON, Alpine and UNC, 2013a[9]) and final report (ENVIRON, Alpine and UNC, 2013b[10]).

2. The Three-State Air Quality Study (3SAQS) used the WestJumpAQMS 2008 PGM modeling platform and is developing a new PGM modeling database for the western U.S. and the 2011 calendar year. 3SAQS performed 2020 emissions scenario modeling on the 36/12 CONUS/WESTUS domains using the 2008 modeling platform. 3SAQS is also developing a 2011 modeling platform and performing 2011 and 2020 emission scenario modeling with the 2011 modeling platform. The 3SAQS 2011 modeling platform was not ready in time for the CARMMS modeling.

For CARMMS, WestJumpAQMS developed a stand-alone 2008 4 km CAMx PGM modeling database for the CARMMS 4 km modeling domain shown in Figure 2-1. Boundary Conditions (BCs) for the 4 km CARMMS domain were obtained from a CAMx 2008 36/12 km simulation conducted by WestJumpAQMS. WestJumpAQMS has conducted a model performance evaluation for the WRF 2008 36/12/4 km meteorological simulation and the CAMx 2008 36/12/4 km base case simulation that are summarized for the CARMMS 4 km domain in, respectively, Appendices A and B with more details available on the WestJumpAQMS website[11].

The CARMMS CAMx modeling of the CARMMS 4 km modeling domain (Figure 2-1) for a 2021 future year emission scenario using the WestJumpAQMS 2008 meteorological inputs involved the following activities:

[8] http://www.wrapair2.org/WestJumpAQMS.aspx
[9] http://www.wrapair2.org/pdf/WestJumpAQMS_Modeling_Protocol_and_Source%20Apportionment_Design_FinalMay.pdf
[10] http://www.wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf
[11] http://www.wrapair2.org/WestJumpAQMS.aspx

- Develop a 2021 Future Year emissions scenario using the CARMMS estimates of oil and gas and other mineral development within the Colorado and northern New Mexico BLM planning areas and the EPA/3SAQS 2020 emission estimates for all other source categories.
  - For O&G emissions in the western Colorado BLM Planning Areas, CARMMS developed emissions calculators (Appendix C) with data specific to each area. BLM COSO provided 2021 oil and gas activity projections for a High, Low and Medium Development Scenarios.
  - 2021 mining emissions within western Colorado BLM Planning Areas were also estimated using CARMMS emissions calculators (Appendix D).
  - O&G emissions for eastern Colorado BLM Planning Areas were developed in a study for the BLM Royal Gorge Field Office (RGFO) and provided by the BLM COSO.
  - The CARMMS emissions calculators were adapted to estimate emissions for the Mancos Shale development area using information provided by the BLM NMFFO.
  - O&G emissions for the Uinta Basin were developed for the Air Resource Management Study (ARMS) and were provided by the BLM Utah State Office (UTSO).
  - O&G emissions for the Wyoming were based on recent future year emission developed for the BLM Wyoming State Office (WYSO) Continental Divide-Creston Draft EIS[12] modeling.
  - O&G emissions for the remainder of the region were based on recent 2020 emission projections developed by the Three State Air Quality Study (3SAQS)
  - Future year anthropogenic emissions for the remainder of the source categories were based on a 2020 emissions inventory developed by EPA for the $PM_{2.5}$ NAAQS rulemaking and updated by 3SAQS.
  - Future year emissions for biogenic sources, fires, windblown dust, sea salt and lightning were kept constant at 2008 levels and were based on the WestJumpAQMS.
- The future year emissions were processed using the SMOKE emissions model to generate 2020/2021 emissions for the WestJumpAQMS 36/12 km domain and 4 km CARMMS domain.
- CAMx modeling was performed for the 36/12 km domains and the 2020/2021 emissions scenario using the 2008 WestJumpAQMS modeling platform.
- 2020/2021 Boundary Condition (BC) inputs for the CARMMS 4 km modeling domain were generated using output from the 36/12 km CAMx model simulation for the 2020/2021 emissions scenario using the 2008 WestJumpAQMS 2008 meteorological inputs.
- CAMx ozone and particulate matter source apportionment simulations were performed for the 2021 High, Low and Medium Development Scenarios and 4 km CARMMS modeling domain using the 2008 CARMMS modeling platform.

[12] http://www.blm.gov/wy/st/en/info/NEPA/documents/rfo/cd_creston.html

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- The CAMx 2021 4 km CARMMS domain source apportionment output for the High, Low and Medium Development Scenarios were post-processed to obtain the separate AQ and AQRV impacts due to mineral development activities on Federal lands within each of the 13 Colorado and the northern New Mexico BLM planning areas.
- The CAMx 2021 High, Low and Medium O&G Development Scenarios output was also post-processed to obtain the cumulative AQ and AQRV impacts due to mineral development on Federal and non-Federal lands within all of the Colorado and the northern New Mexico BLM planning areas as well as O&G development throughout the CARMMS 4 km modeling domain.

- The AQ and AQRV impacts of BLM-authorized oil and gas development on Federal lands within each BLM Colorado planning areas alone and cumulative impacts across all planning areas for the 2021 High, Low and Medium Development Scenarios are summarized in this final report.

1.4 Air Quality Standards and AQRV Thresholds

1.4.1 Federal and State Air Quality Standards and PSD Increments

EPA sets National Ambient Air Quality Standards (NAAQS) for six pollutants, which are called criteria air pollutants (CAPs). The CAPs are: ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), suspended Particle Pollution (particulate matter with a mean aerodynamic diameter of less than or equal to 10 and 2.5 microns; PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2) and lead (Pb). States may also set their own ambient air quality standards, which must be as stringent as the NAAQS but may be more stringent.

Federal air quality regulations adopted and enforced by the states limit incremental emission increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class II areas are less strict. PSD Class I and Class II increments are defined for NO_2, PM_{10}, $PM_{2.5}$ and SO_2. Please note the PSD increments are project level thresholds, and are not an appropriate metric for reference against field office level impacts.

Table 1-1 summarizes the NAAQS, the Colorado Ambient and Quality Standards (CAAQS) and the New Mexico Ambient Air Quality Standards (NMAAQS). PSD Class I and Class II increments are also shown in Table 1-1.

Table 1-1. Applicable National and State Ambient Air Quality Standards and PSD concentration increments.

Pollutant/Averaging Time	NAAQS	CAAQS[13]	NMAAQS[14]	PSD Class I Increment[1]	PSD Class II Increment[1]
CO					
1-hour[2]	35 ppm	--	13.1 ppm	--	--
8-hour[2]	9 ppm	--	8.7ppm	--	--
NO_2					
1-hour[3]	100 ppb	--	--	--	--
24-hour	--	--	0.10 ppm	--	--
Annual[4]	53 ppb	--	0.05 ppm	2.5	25
O_3[15]					
8-hour[5]	0.075 ppm	--	--	--	--
PM_{10}					
24-hour[6]	150 µg/m^3	--	--	8	30
Annual[7]	--	--	--	4	17
$PM_{2.5}$					
24-hour[8]	35 µg/m^3	--	--	2	9
Annual[9]	12 µg/m^3	--	--	1	4
SO_2					
1-hour[10]	75 ppb	--	--		
3-hour[11]	0.5 ppm	700 µg/m^3	--	25	512
24-hour[12]	--	--	0.10 ppm	5	91
Annual[4]	--	--	0.02 ppm	2	20

1. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2. No more than one exceedance per calendar year; for MAAQS - No more than one exceedance per consecutive 12 months
3. 98th percentile, averaged over 3 year; for MAAQS - not to be exceeded more than once over any 12 consecutive months
4. Annual mean not to be exceeded; for MAAQS - arithmetic average over any four consecutive quarters not to be exceeded
5. Fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years
6. Not to be exceeded more than once per calendar year on average over 3 years.
7. 3 year average of the arithmetic means over a calendar year
8. 98th percentile, averaged over 3 years
9. Annual mean, averaged over 3 years, NAAQS promulgated December 14, 2012
10. 99th percentile of daily maximum 1-hour concentrations in a year, averaged over 3 years
11. No more than one exceedance per calendar year (secondary NAAQS) and no more than one exceedance in 12 consecutive months (CAAQS)
12. For areas in New Mexico not within 3.5 miles of the Chino Mines Company
13. http://www.colorado.gov/cs/Satellite/CDPHE-Main/CBON/1251601911433
14. http://www.nmcpr.state.nm.us/nmac/parts/title20/20.002.0003.htm
15. In December 2014 EPA proposed a new primary 8-hour ozone NAAQS that would lower the threshold to somewhere in the 65-70 ppb range that will be promulgated in October 2015.

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1.4.2 Air Quality Related Value (AQRV) Thresholds

The impacts of each BLM authorized oil and gas and other activities within each BLM Planning area, as well as cumulative impacts of all activities together, at Class I and sensitive Class II areas will be assessed for three AQRVs: visibility, deposition and acid neutralizing capacity (ANC). The June 23, 2011 MOU between EPA, USDOI and USDA states that the project and cumulative AQRV impacts at Class I and sensitive Class II areas should be assessed by comparing against thresholds of concern defined by the Federal Land Manager (FLM) for the given Class I or sensitive Class II area in question. In the CARMMS first draft Modeling Protocol and at the October 30, 2013 meeting with the Interagency Air Quality Review Team (IAQRT) we presented the following threshold of concern for AQRVs in Class I and sensitive Class II areas and there were no disagreements in the comments received from the IAQRT:

- Visibility impacts for BLM-authorized oil and gas sources within each BLM Planning Area are assessed using the FLAG (2010) procedures that use the new IMPROVE equation, annual average natural visibility background and monthly relative humidity adjustment factors [f(RH)] (see Section 4.6.1). The visibility impacts from mineral development on Federal lands within each separate BLM planning area are compared against a 0.5 and 1.0 change in deciview (dv) haze index threshold of concern and any exceedances will be reported. Please note the dv thresholds are project level thresholds, and not an appropriate metric to reference against field office level or cumulative impacts.
- Cumulative sources visibility impacts from multiple BLM Planning Areas are assessed using a new visibility approach and metrics developed by the FLMs based on the regional haze rule visibility metrics for the best and worst 20% visibility days as discussed in Section 4.6.2.
- Acid deposition impacts due to mineral development on Federal lands within each separate BLM Planning Area for annual total sulfur (S) and total nitrogen (N) deposition are compared against the 0.005 kg/ha/yr Deposition Analysis Threshold (DAT) for the western states. Please note the DAT is a project level threshold, and not an appropriate metric to reference against field office level or cumulative impacts.
- Total N and S deposition impacts due to all emissions in the 2008 and 2021 emissions scenarios (i.e., cumulative) are compared to Critical Load values of 2.2 kg/ha/yr for N in Wyoming, 2.3 kg/ha/yr for N in Colorado except for Dinosaur National Monument where a 3.0 kg/ha/yr Critical Load value for N is used. For S, a 5.0 kg/ha/yr critical load value is used everywhere (see Section 4.7).
- The predicted annual deposition fluxes of sulfur and nitrogen at sensitive lake receptors due to Federal O&G development from individual BLM Planning Areas are used to estimate the change in ANC in accordance with the January 2000, USFS Rocky Mountain Region's Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide (USFS, 2000). The predicted changes in ANC are compared with the USFS's Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 μeq/l and 1 μeq/l for lakes with background ANC values of 25 μeq/l and less (see Section 4.8). Please note the LAC is a project level threshold, and not an appropriate metric to reference against field office level or cumulative impacts.

2.0 CARMMS DATABASE DEVELOPMENT

2.1 Modeling System

The CARMMS 2008 modeling database was based on the WestJumpAQMS so the same modeling system was adopted. The justification for the model selection is given in the CARMMS Modeling Protocol (ENVIRON, Cater Lake and EMPSi, 2014). Table 2-1 lists the main models selected for the BLM CARMMS modeling with a brief summary of the reasons for their selection as follows:

- The WRF meteorological model was selected because it contains more recent updates and features compared to the MM5 alternative that is no longer supported by its developer.
- The SMOKE emissions model is the most current and up-to-date emissions modeling system and has performance improvements over the alternatives.
- The MOVES on-road mobile emissions modeling system is the recommended modeling system by the EPA.
- The MEGAN biogenic emissions model has been updated by WRAP specifically for simulating biogenic emissions in the western states.
- The CAMx photochemical grid model (PGM) includes a source apportionment capability that is critically important for the CARMMS and was not available in the version of CMAQ PGM alternative at the time the study was initiated.

Table 2-1. Summary of models selected for the BLM CARMMS modeling.

Model Type	Selected Model
Meteorological Model	Weather Research Forecasting (WRF)
Emissions Model	Sparse Matrix Operator Kernel Emissions (SMOKE)
Emissions Model – On Road Sources	Motor Vehicle Emissions Simulator (MOVES2010)
Emissions Model – Biogenic Sources	Model for Emissions of Gases and Aerosols in Nature (MEGAN)
Photochemical Grid Model	Comprehensive Air-quality Model with extensions (CAMx)

2.2 Episode Selection

Since the CARMMS will need to address annual average air quality issues (e.g., $PM_{2.5}$) and deposition issues, a full year is selected for modeling. Due to computational requirements and resource constraints, a single meteorological baseline year will be modeled. The entire 2008 calendar year was selected for the CARMMS modeling because it satisfied the most episode selection criteria of recent years:

1. The entire 2008 calendar year includes a variety of meteorological conditions. The year appears to have higher than average photochemical production potential so was not an atypical low year for secondary ozone and PM formation.

2. 2008 had observed ozone and $PM_{2.5}$ concentrations that were close to and even above the ozone and $PM_{2.5}$ Design Values in Colorado.

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3. The 2008 year did not include any special study data in Colorado. Note that enhanced monitoring of the Front Range region and vicinity was collected for the summer of 2014, but that was after most of the CARMMS modeling was completed.

4. By modeling a full year (366 days) there should be sufficient number of days to calculated Relative Response Factors (RRFs) following EPA's guidance document (EPA, 2007).

5. The 2008 calendar year was already modeled as part of the Denver ozone modeling and in the WestJumpAQMS and 3SAQS. In particular, the ability to leverage the CARMMS database development off of WestJumpAQMS is critical to the success of the study.

6. Ozone nonattainment areas under the March 2008 0.075 ppm 8-hour ozone NAAQS were designated using 2008-2010 observations, which includes the selected 2008 modeling period.

7. The entire 2008 calendar year dataset includes both weekdays and weekend days.

8. Of the recent years, 2008 fulfills more of the episode selection criteria than other recent years available at the time the project was initiated.

2.3 CARMMS Modeling Domains

To leverage modeling data from other studies, the CARMMS adopted the so-called RPO Lambert projection that uses a longitude/latitude origin at (-97, 40) and standard latitude parallels of 33 and 45 degrees. Figure 2-1 displays the 4 km modeling domain used in the CARMMS emissions and photochemical modeling. An initial 4 km modeling domain was identified by including all Class I areas for which any part of the Class I area is within 200 km of a western Colorado BLM Field Office Planning Area. While developing the Modeling Protocol, the BLM New Mexico State Office (NMSO) indicated that they would like to include their Mancos Shale Oil development in the CARMMS modeling. The Mancos Shale Oil development area would be within the New Mexico BLM Farmington Field Office area, but would primarily reside in San Juan County with portions potentially stretching into neighboring Rio Arriba, Sandoval and McKinley Counties. Thus, the CARMMS 4 km domain was extended southward to include all Class I areas within 300 km of the Mancos Shale development area.

Figure 2-1 also shows the Class I areas throughout the domain that were analyzed for air quality and AQRV impacts. More details on the Class I and sensitive Class II areas where the AQ and AQRV impacts due to oil and gas and other activities within the BLM planning areas will be assessed is given in Chapter 4.

The CAMx vertical domain definitions will depend on the definition of the WRF vertical layer structure. WRF was run with 37 vertical levels (36 vertical layers using CAMx definition of layer thicknesses) from the surface up to 50 mb (~19-km high above mean sea level) (ENVIRON and Alpine, 2012[13]). The WRF model employs a terrain following coordinate system defined by pressure, using multiple layers that extend from the surface to 50 mb (approximately 19 km

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

above mean sea level). CARMMS is adopting the same layer collapsing strategy as used by WestJumpAQMS whereby multiple WRF layers are combined into one CAMx layer to reduce the air quality model computational time. Table 2-2 displays the approach for collapsing the WRF 36 vertical layers to 25 vertical layers in CAMx for CARMMS and WestJumpAQMS. The WRF layer collapsing scheme in Table 2-2 is collapsing two WRF layers into one CAMx/CMAQ layer for the lowest four layers in CAMx/CMAQ. In the past, the lowest layers of MM5/WRF were mapped directly into CAMx/CMAQ with no layer collapsing. However, in those applications the MM5/WRF layer 1 was much thicker (20-40 m) than used in this WRF application (12 m). Use of a 12 m lowest layer may trap emissions in a too shallow layer and may result in overstated surface concentrations. For example, NO_X emissions are caused by combustion so are buoyant and have plume rise that in reality could take them out of the first layer if it is defined too shallow.

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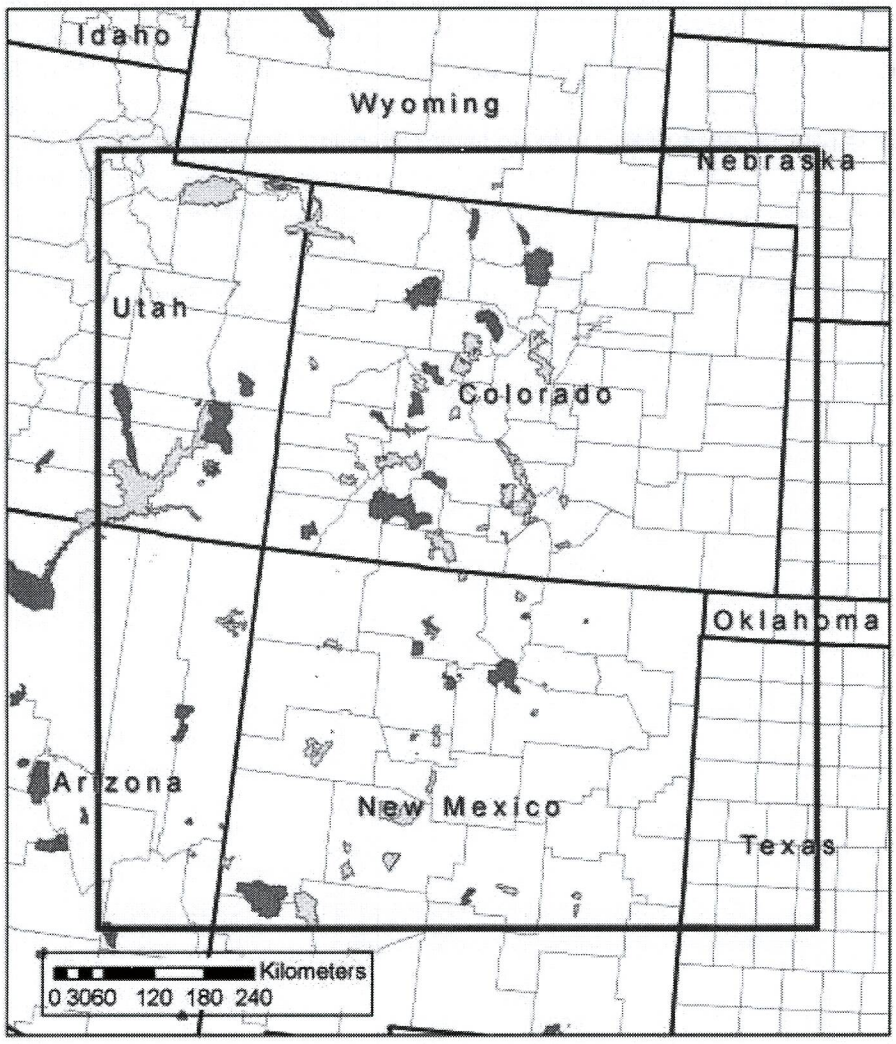

Figure 2-1. 4 km modeling domain used in the Colorado Air Resource Management Modeling Study (CARMMS).

Table 2-2. 37 Vertical layer interface definition for WRF simulations (left most columns), and approach for reducing to 25 vertical layers for CAMx by collapsing multiple WRF layers (right columns).

WRF Meteorological Model					CAMx Air Quality Model		
WRF Layer	Sigma	Pressure (mb)	Height (m)	Thickness (m)	CAMx Layer	Height (m)	Thickness (m)
37	0.0000	50.00	19260	2055	25	19260.0	3904.9
36	0.0270	75.65	17205	1850			
35	0.0600	107.00	15355	1725	24	15355.1	3425.4
34	0.1000	145.00	13630	1701			
33	0.1500	192.50	11930	1389	23	11929.7	2569.6
32	0.2000	240.00	10541	1181			
31	0.2500	287.50	9360	1032	22	9360.1	1952.2
30	0.3000	335.00	8328	920			
29	0.3500	382.50	7408	832	21	7407.9	1591.8
28	0.4000	430.00	6576	760			
27	0.4500	477.50	5816	701	20	5816.1	1352.9
26	0.5000	525.00	5115	652			
25	0.5500	572.50	4463	609	19	4463.3	609.2
24	0.6000	620.00	3854	461	18	3854.1	460.7
23	0.6400	658.00	3393	440	17	3393.4	439.6
22	0.6800	696.00	2954	421	16	2953.7	420.6
21	0.7200	734.00	2533	403	15	2533.1	403.3
20	0.7600	772.00	2130	388	14	2129.7	387.6
19	0.8000	810.00	1742	373	13	1742.2	373.1
18	0.8400	848.00	1369	271	12	1369.1	271.1
17	0.8700	876.50	1098	177	11	1098.0	176.8
16	0.8900	895.50	921	174	10	921.2	173.8
15	0.9100	914.50	747	171	9	747.5	170.9
14	0.9300	933.50	577	84	8	576.6	168.1
13	0.9400	943.00	492	84			
12	0.9500	952.50	409	83	7	408.6	83.0
11	0.9600	962.00	326	82	6	325.6	82.4
10	0.9700	971.50	243	82	5	243.2	81.7
9	0.9800	981.00	162	41	4	161.5	64.9
8	0.9850	985.75	121	24			
7	0.9880	988.60	97	24	3	96.6	40.4
6	0.9910	991.45	72	16			
5	0.9930	993.35	56	16	2	56.2	32.2
4	0.9950	995.25	40	16			
3	0.9970	997.15	24	12	1	24.1	24.1
2	0.9985	998.58	12	12			
1	1.0000	1000	0			0	

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2.4 Meteorological Modeling Approach

The CARMMS meteorological inputs for the CAMx modeling are based on the WRF modeling performed as part of the WestJumpAQMS. The WRF computational domains were defined to be slightly larger than the CAMx and SMOKE modeling domains to eliminate the occurrence of boundary artifacts in the CAMx meteorological inputs. Such boundary artifacts can occur when the boundary conditions (BCs) for the meteorological variables come into dynamic balance with WRF's atmospheric equations and numerical methods.

The WRF model contains many different physics options, and achieving the best model performance for any particular year and region is accomplished by performing model sensitivity tests using different options. As part of the post-2008 Denver ozone SIP modeling, Alpine Geophysics, LLC and ENVIRON conducted numerous WRF meteorological sensitivity simulations to determine the best performing configuration for simulating meteorology in the Inter-Mountain West region (Morris et al., 2011). The final WRF configuration was used for the 2008 Denver ozone modeling as well as for the WestJumpAQMS WRF modeling results that are used in CARMMS.

2.4.1 2008 WRF Modeling Methodoiogy

The WestJumpAQMS 2008 WRF modeling methodology is described below. More details are provided in the WestJumpAQMS WRF Application/Evaluation report (ENVIRON and Alpine, 2012[14]).

Horizontal Domain Definition: The computational domain on which WRF was applied for WestJumpAQMS included a 36 km CONUS, 12 km WESTUS and 4 km Inter-Mountain West Domain (IMWD). The 4 km domain includes the 4 km CARMMS domain shown in Figure 2-1. The grid projection is Lambert Conformal with a pole of projection of 40 degrees North, -97 degrees East and standard parallels of 33 and 45 degrees, the so-called RPO projection. The datum (size and shape of earth) is a perfect sphere with radius 6370.0 km.

Vertical Domain Definition: The WRF modeling was based on 37 vertical layers with an approximately 12 meter deep surface layer. The vertical domain is presented in both sigma and height coordinates in Table 2-2.

Topographic Inputs: Topographic information for WRF were developed using the standard WRF terrain databases. The 36 km domain is based on the 10 minute (18 km) global data. The 12 km domain is based on the 2 minute (~4 km) data. The 4 km domain is based on 30 second (~900 m) data.

Vegetation Type and Land Use Inputs: Vegetation type and land use information were developed using the most recently released WRF databases provided with the WRF distribution. Standard WRF surface characteristics corresponding to each land use category were employed.

Atmospheric Data Inputs: The first guess fields were taken from the 12 km North American Model (NAM) database.

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

Diffusion Options: Horizontal Smagorinsky first-order closure (km_opt = 4) with sixth-order numerical diffusion and suppressed up-gradient diffusion (diff_6th_opt = 2) were used.

Lateral Boundary Conditions: Lateral boundary conditions were specified from the initialization dataset (12 km NAM) on the 36 km domain with continuous updates nested from the 36 km domain to the 12 km domain and continuous updates nested from the 12 km domain to the 4 km domain, using one-way nesting (feedback = 0).

Top and Bottom Boundary Conditions: The top boundary condition was selected as an implicit Rayleigh dampening for the vertical velocity. Consistent with the model application for non-idealized cases, the bottom boundary condition was selected as physical, not free-slip.

Water Temperature Inputs: The water temperature data were taken from the National Centers for Environmental Prediction (NCEP) Real Time Global (RTG) global one-twelfth degree analysis[15].

FDDA Data Assimilation: The WRF model was run with a combination of analysis and observation nudging (i.e., Four Dimensional Data assimilation [FDDA]). Analysis nudging was used on the 36 km and 12 km domain using the 12 km NAM dataset. For winds and temperature, analysis nudging coefficients of $5x10^{-4}$ and $3.0x10^{-4}$ were used on the 36 km and 12 km domains, respectively. For mixing ratio, an analysis nudging coefficient of $1.0x10^{-5}$ was used for both the 36 km and 12 km domains. The nudging uses both surface and aloft nudging with nudging for temperature and mixing ratio not performed in the lower atmosphere (i.e., within the boundary layer and at the surface). Observation nudging was performed on the 4 km grid domain using the Meteorological Assimilation Data Ingest System (MADIS)[16] observation archive. The MADIS archive includes the National Climatic Data Center (NCDC)[17] observations and the National Data Buoy Center (NDBC) Coastal-Marine Automated Network C-MAN[18] stations. The observational nudging coefficients for winds, temperatures and mixing ratios were $1.0x10^{-4}$, $1.0x10^{-4}$, and $1.0x10^{-5}$, respectively and the radius of influence was set to 50 km.

Physics Options: The WRF model contains many different physics options. The physics options chosen for the WestJumpAQMS application are presented in Table 2-3.

Application Methodology: The WRF model was executed in 5½ day blocks initialized at 12Z every 5 days. Model results were output every 60 minutes. The first twelve (12) hours of each 5 ½ day block is used for model spin-up and not used in the PGM model inputs or in the WRF model performance evaluation. WRF was configured to run in distributed memory parallel mode.

[15] Real-time, global, sea surface temperature (RTG-SST) analysis. http://polar.ncep.noaa.gov/sst/oper/Welcome.html
[16] Meteorological Assimilation Data Ingest System. http://madis.noaa.gov/
[17] National Climatic Data Center. http://lwf.ncdc.noaa.gov/oa/ncdc.html
[18] National Data Buoy Center. http://www.ndbc.noaa.gov/cman.php

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Table 2-3. Physics options used in the WestJumpAQMS WRF 2008 simulation modeling.

WRF Treatment	Option Selected	Notes
Microphysics	Thompson scheme	New with WRF 3.1.
Longwave Radiation	RRTMG	Rapid Radiative Transfer Model for GCMs includes random cloud overlap and improved efficiency over RRTM.
Shortwave Radiation	RRTMG	Same as above, but for shortwave radiation.
Land Surface Model (LSM)	NOAH	Two-layer scheme with vegetation and sub-grid tiling.
Planetary Boundary Layer (PBL) scheme	YSU	Yonsie University (Korea) Asymmetric Convective Model with non-local upward mixing and local downward mixing.
Cumulus parameterization	Kain-Fritsch in the 36 km and 12 km domains. None in the 4 km domain.	4 km can explicitly simulate cumulus convection so parameterization not needed.
Analysis nudging	Nudging applied to winds, temperature and moisture in the 36 km and 12 km domains	Temperature and moisture nudged above PBL only.
Observation Nudging	Nudging applied to surface wind only in the 4 km domain	Surface temperature and moisture observation nudging can introduce instabilities.
Initialization Dataset	12 km North American Model (NAM)	Also used in analysis nudging

2.4.2 Meteorological Model Performance Evaluation

The WestJumpAQMS performed a comprehensive and detailed model performance evaluation of the 2008 WRF 36/12/4 km model simulation. The WestJumpAQMS WRF model performance evaluation is documented in a WRF Application/Evaluation report that is available on its website (ENVIRON and Alpine, 2012[19]). The WRF evaluation consisted of the following:

- Evaluation against surface meteorological observations of wind direction, wind speed, temperature and water vapor mixing ratio (humidity) with monthly performance statistics calculated using the METSTAT program:
  - Surface meteorological performance statistics were calculated across the 36 km CONUS, 12 km WESTUS and 4 km Inter-Mountain West domains, across each individual western state and at individual monitoring sites within each western state, including Colorado[20] that is the main focus of the CARMMS.
  - The surface meteorological model performance statistics were compared against model performance evaluation benchmarks in order to help interpret the WRF model performance and compare it with other studies that were used to develop the benchmarks. The 2008 WRF model performance was compared against both the

[19] http://www.wrapair2.org/pdf/WestJumpAQMS_2008_Annual_WRF_Final_Report_February29_2012.pdf
[20] http://www.wrapair2.org/pdf/westjump.wrf.site.co.2012-04-04.pdf

simple (simple terrain and/or simple meteorological conditions) and complex (complex terrain and/or more complex meteorological conditions) model performance benchmarks.

- The WRF 2008 precipitation estimates were compared with monthly analysis fields generated by the Climate Prediction Center (CPC) in a qualitative evaluation.

Appendix A summarizes some of the WestJumpAQMS WRF model performance evaluation products as they relate to WRF performance within the CARMMS 4 km modeling domain. The WestJumpAQMS 2008 WRF model performance within the CARMMS region is as good or better than meteorological model performance seen in past photochemical modeling studies of the region (e.g., WRAP regional haze modeling and Denver 2008 ozone State Implementation Plan modeling). Thus, the WestJumpAQMS 2008 WRF meteorological fields were judged to be appropriate for use in the CARMMS.

2.5 2008 BASE CASE EMISSIONS

The 2008 Base Case emissions were developed by the WestJumpAQMS. The primary source for the 2008 Base Case emissions is Version 2.0 of the National Emissions Inventory (NEIv2.0[21]). For most source categories, the SMOKE emissions modeling system was used to process the emissions into the hourly gridded speciated emissions needed as input for CAMx. The comprehensive and detailed documentation for the WestJumpAQMS 2008 Base Case emissions inventory is available on the WestJumpAQMS website[22] and includes a final report (ENVIRON, Alpine and UNC, 2013) and 16 Emissions Technical Memorandums that provide details on the 2008 emissions for each source category as well as for the parameters used in the emissions modeling.

2.5.1 Source of 2008 Base Case Emissions

Table 2-4 summarizes the emission models and sources of 2008 Base Case emissions that are based primarily on the 2008 NEIv2.0 with the following enhancements:

- Major (≥25 MW) Electrical Generating Units (EGUs) point source SO_2 and NO_X emissions used Continuous Emissions Monitor (CEM) measurement data that are available online from the EPA Clean Air Markets Division (CAMD[23]). These data are hour-specific for SO_2, NO_x and heat input. The temporal variability of other pollutant emissions (e.g., PM) for the CEM sources were estimated using the hourly CEM heat input data to allocate the annual emissions from the NEIv2.0 to each hour of the year. Emissions, locations and stack parameters for point sources without CEM devices were based on the 2008 NEIv2.0.
- The WRAP-IPAMS Phase III 2006 oil and gas emission inventories were projected to 2008 for all Phase III basins that were available at the time of the WestJumpAQMS 2008 emissions development. In addition, under WestJumpAQMS new oil and gas emissions

[21] http://www.epa.gov/ttnchie1/net/2008inventory.html
[22] http://www.wrapair2.org/WestJumpAQMS.aspx
[23] http://www.epa.gov/airmarkets/

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inventory was developed for the Permian Basin in southeastern New Mexico/northwestern Texas.

- On-road mobile source emissions were based on the MOVES2010[24] model with county-specific weekday and weekend day VMT and monthly meteorology for the 2008 base case modeling year.
- The WRAP windblown dust (WBD) model [25] was used to generate WBD emissions using day-specific hourly meteorology from the 2008 WRF simulation.
- Sea salt and lightning emissions were generated using the 2008 WRF model hourly gridded output.
- Emissions from fires (wildfires, prescribed burns and agricultural burning) are based on the 2008 fire emissions inventory developed in the Joint Fire Sciences Program (JFSP) Deterministic and Empirical Assessment of Smoke's Contribution to Ozone (DEASCO3[26]) study.
- Biogenic emissions were generated using an enhanced version of the Model of Emissions of Gases and Aerosols in Nature (MEGAN[27]) that was updated by WRAP to better represent biogenic emissions for the western states.
- Mexico emissions were based on the 2008 projections from the 1999 Mexico national emissions inventory.
- The Environment Canada 2006 emissions inventory based on the National Pollutant Release Inventory (NPRI) was used for Canada.
- New spatial surrogates for the emissions were developed using the latest 2010 Census and other data that are now available and includes population and housing statistics for 2010. Details on the new spatial surrogates used for allocating county-level emissions to the 4 km grid cells can be found in the WestJumpAQMS Emissions Technical Memorandum Number 13[28].

[24] http://www.epa.gov/otaq/models/moves/
[25] http://www.wrapair.org/forums/dejf/fderosion.html
[26] https://www.firescience.gov/projects/11-1-6-6/proposal/11-1-6-6_11-1-6_attachment_1_primary.pdf
[27] http://acd.ucar.edu/~guenther/MEGAN/MEGAN.htm
[28] http://www.wrapair2.org/pdf/Memo13_Parameters_Sep30_2013.pdf

Table 2-4. Summary of sources of emissions and emission models used to generate 2008 base case emissions for use in CARMMS.

Emissions Component	Configuration	Details
Model Code	SMOKE Version 3.1	http://www.smoke-model.org/index.cfm
Oil and Gas Emissions	Update WRAP Phase III 2006 to 2008	Seven WRAP Phase III Basins in CO, NM, UT and WY plus add 2008 Permian Basin O&G Emissions
Area Source Emissions	2008 NEI Version 2.0	Western state updates, then SMOKE processing of http://www.epa.gov/ttn/chief/net/2008inventory.html
On-Road Mobile Sources	MOVES2010	County specific emissions run for monthly weekday and weekend days. California based on EMFAC2011.
Point Sources	2008 CEM and Non-CEM Sources	Use 2008 day-specific hourly measured CEM for SO_2 and NO_X emissions for CEM sources, 2008 NEIv2.0 for other pollutants and non-CEM sources
Off-Road Mobile Sources	2008 NEIv2.0	Based on EPA NONROAD model http://www.epa.gov/oms/nonrdmdl.htm
Wind Blown Dust Emissions	WRAP Wind Blown Dust (WBD)	WRAP WBD Model with 2008 WRF meteorology adjusted to be consistent with 2002 WBD modeling
Ammonia Emissions	NEIv2.0	Based on CMU Ammonia Model. Review and update spatial allocation if appropriate.
Biogenic Sources	MEGAN	Enhanced version of MEGAN Version 2.1 from WRAP Biogenics study http://www.wrapair2.org/pdf/WGA_BiogEmisInv_FinalReport_March20_2012.pdf
Fires	2008 DEASCO3	2008 DEASCO3 fire inventory used. http://www.wrapair2.org/pdf/JSFP_DEASCO3_TechnicalProposal_November19_2010.pdf
Temporal Adjustments	Seasonal, day, hour	Based on latest collected information
Chemical Speciation	CB05 Chemical Speciation	CB6 considered but was too new at time study was initiated.
Gridding	Spatial Surrogates based on landuse	Develop new spatial surrogates using 2010 census data and other data
Quality Assurance	SMOKE QA Tools; PAVE, VERDI plots; Summary reports	Follow WRAP emissions QA/QC plan.

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2.5.2 On-Road Mobile Sources

The Motor Vehicle Emissions Simulator (MOVES[29]) is EPA's current tool to construct on-road mobile source emissions estimates for national, state, and county level inventories of criteria air pollutants, greenhouse gas emissions, and some mobile source air toxics from highway vehicles. In addition, MOVES can make projections for energy consumption (total, petroleum-based, and fossil-based). EPA requires that all new regulatory modeling studies use the MOVES model for mobile source emissions and MOVES is also recommended for NEPA studies (EPA, 2012c).

The CARMMS/WestJumpAQMS 2008 on-road mobile source emission modeling was conducted using MOVES2010 (EPA, 2012a). On July 31, 2014, EPA released a new version of MOVES (MOVES2014; EPA, 2014a,b). The CARMMS mobile source emissions modeling was conducted in 2013 using MOVES2010, well before the release of MOVES2014. As stated in EPA's MOVES2014 Policy Guidance (EPA, 2014c) "All states other than California should use MOVES2014 for future SIPs in order to take full advantage of the improvements incorporated in this version. However, state and local agencies that have already completed significant work on a SIP with MOVES2010 can continue to use it"[30] (EPA, 2014c).

The WestJumpAQMS ran MOVES2010 configured to estimate 2008 mobile source emissions directly (i.e., emissions inventory mode) at a county level basis by month using the monthly average diurnally varying 2008 WRF meteorological conditions. However, the 3SAQS updated the 2008 and 2020 mobile source emissions using MOVES2010 in the emissions factor mode to generate a lookup table of emissions factors that was used with SMOKE-MOVES and the 2008 WRF gridded hourly meteorological data to generate day-specific hourly gridded on-road mobile source emission inputs. The CARMMS 2021 High, Low and Medium Development Scenarios CAMx source apportionment modeling used the 3SAQS 2020 SMOKE-MOVES on-road mobile source emissions. SMOKE-MOVES spatially allocated the mobile source activity data to the 36/12/4 km modeling domains using spatial surrogates developed using the 2010 census and other data. This includes new spatial surrogate categories specific to new source categories in MOVES (e.g., heavy duty truck idling at rest stops. SMOKE-MOVES also chemically speciated the emissions to the CB05 chemical mechanism using CB05 chemical speciation profiles based on the SPECIATE4.3 database. More details on the 2008 on-road mobile source emissions can be found in the 3SAQS 2008 base case modeling report (Adelman, Shanker, Yang and Morris, 2014).

2.5.3 Area and Non-Road Mobile Sources

The 2008 NEIv2.0 area and non-road emissions were processed using the SMOKE emissions model with new 2010 census spatial surrogates and default temporal and CB05 speciation adjustments. Several source categories within the area and non-road category were removed from the NEIv2.0 so that they could be replaced or updated and separately processed, which allows a more thorough QA/QC analysis. The source categories that were extracted from the NEIv2.0 area and non-road sources for separate treatment or replacement were as follows:

[29] http://www.epa.gov/otaq/models/moves/
[30] http://www.epa.gov/otaq/models/moves/documents/420b14008.pdf

- Oil and gas (O&G) exploration and production sources for locations covered by most of the WRAP Phase III O&G Basins and the Permian Basin were removed from the 2008 NEIv2. They were replaced by the WRAP Phase III 2006 emissions projected to 2008 (see Section 2.5.4). New 2008 O&G emissions were developed for the Permian Basin in southeastern New Mexico/northwestern Texas. The 2008 NEIv2.0 O&G emissions were used for the remainder of the U.S. locations, which includes the Williston and Great Plains Basins (North Dakota and Montana) whose WRAP Phase III emissions were not available at the time of the 2008 emissions inventory development.
- Ammonia emissions due to livestock and fertilizer sources were removed from the NEIv2.0 and processed separately.
- Aircraft, locomotive and marine (ALM) sources were processed separately as their own source group in the emissions modeling. The marine sources do not include large ocean going (Class 3) vessels (Commercial Marine Vessels, CMV) that were processed under the off-shore shipping category.
- Fire emissions were removed from the NEIv2.0 and were replaced by 2008 fire emissions developed as part of the DEASCO3 study.
- Fugitive dust emissions were removed from the NEIv2.0 for separate processing.

Below we summarize the processing area and non-road emissions used from the 2008 NEIv2 in the CARMMS 2008 base case, more details can be found in WestJumpAQMS Technical Memorandum No.2 Area and Non-Road Emissions (Loomis, Morris and Adelman, 2013[31]).

2.5.3.1 Area Sources

The NEI Area (or Non-Point) data category contains emission estimates for sources which individually are too small in magnitude or too numerous to inventory as individual point sources, and which can often be estimated more accurately as a single aggregate source for a County or Tribal area. Area source (non-point) emissions are emissions sources that are summed over a geographic region, rather than specifically located. Examples of area sources include small industrial, residential, consumer product, and agricultural emissions. For emissions modeling purposes, these types of emissions are defined by state and county (or tribal) identifiers, and SCC codes. After extracting the area source categories from the NEIv2.0 as indicated above, the remaining area sources in the NEIv2.0 were processed by SMOKE as their own source category.

2.5.3.2 Non-Road Sources

The NEI Non-Road data categories contain mobile sources which are estimated for version 2.0 of the 2008 NEI using the EPA NONROAD[32] model, run within the National Mobile Inventory Model (NMIM[33]). The non-road emissions have been compiled as both annual total emissions, and average day emissions by month. In order to take the best advantage of the monthly and seasonal variability of the non-road emissions sources, we used the monthly options for SMOKE modeling inputs.

[31] http://www.wrapair2.org/pdf/Memo_2_Area_Jan22_2013%20review%20draft.pdf
[32] http://www.epa.gov/otaq/nonrdmdl.htm
[33] http://www.epa.gov/otaq/nmim.htm

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Note that emissions data for aircraft, locomotives, and commercial marine vessels are not included in the NEI non-road data category starting with the 2008 NEI. These three non-road mobile source categories were handled as special cases, with separate input processing streams. Aircraft engine emissions occurring during Landing and Takeoff Operations (LTO) and the Ground Support Equipment (GSE) and Auxiliary Power Units (APU) associated with the aircraft are now included in the point data category at individual airports in the 2008 NEI. Emissions from locomotives that occur at rail yards are also included in the point data category. In-flight aircraft emissions, locomotive emissions outside of the rail yards, and commercial marine vessel emissions (both underway and port emissions) are included in the Non-Point data category.

2.5.4 2008 Oil and Gas Emissions

For Basins covered by the WRAP-IPAMS Phase III 2006 oil and gas (O&G) emissions available at the time of the 2008 base case emissions development, the WRAP Phase III O&G 2006 emissions were projected to 2008. WestJumpAQMS also developed new 2008 O&G emissions for the Permian Basin in southeastern New Mexico/northwestern Texas. For all other Basins in the U.S. (including Williston and Great Plains Basins whose WRAP Phase III emissions were not available at the time of the 2008 base case development) the 2008 O&G emissions from the NEIv2.0 were used and processed as area and point sources.

2.5.4.1 2008 Phase III O&G Emissions Update

The WRAP Phase III 2006 baseline O&G inventories were projected to 2008 for the following eight WRAP Phase III Basins:

- Denver-Julesburg Basin (CO)
- Piceance Basin (CO)
- Uinta Basin (UT)
- North San Juan Basin (CO)
- South San Juan Basin (NM)
- Wind River Basin (WY)
- Powder River Basin (WY)
- Greater Green River Basin (WY)

The 2008 O&G emission update for the WRAP Phase III and Permian Basins used 2008 O&G production statistics from the Enerdeq database published by IHS Global, also referred to as the "PI Dwight's" database. This database contains production statistics that are consistent and typically of higher quality than the primary data in individual state O&G Commission databases.

Processing of the IHS data for the 2008 projections followed the same methodology as used in the WRAP Phase III study[34]. Summaries of production statistics were extracted from the IHS database, including well count by well type and location, spud count, production of gas by well type and well location, production of liquid petroleum (oil or condensate) by well type and well

[34] http://www.wrapair2.org/PhaseIII.aspx

location, and production of water by well type and well location. All data were summarized at the county and basin level, for tribal and non-tribal land separately as applicable to each basin. No new survey work was conducted for the 2008 O&G emissions update so the analysis did not include any updates of company-specific production statistics as was done in the development of the Phase III 2006 O&G emission inventories. The resulting production statistics data were summarized at the county, tribal and basin levels for all basins including the Permian Basin.

The 2008 production statistics from the IHS database were used to project the Phase III baseline 2006 O&G inventories. The projections will be developed as scaling factors that represented the ratio of the value of a specific activity parameter in 2008 to the value in 2006. The scaling factors were developed at the county and tribal levels for all basins. Scaling factors were then matched to all source categories considered as part of the Phase III inventories, using the same cross-referencing analysis conducted as part of the midterm (2012) projections in the Phase III study. The 2008 to 2006 scaling factors were used to adjust the activity data for the oil and gas emissions.

Where specific scaling factors are estimated to be less than one (1), indicating a reduction in an activity parameter from 2006 to 2008, all emissions factors and activity data will be assumed to be identical in 2008 as in 2006 and the 2006 emissions will be reduced and no emission controls assessment is needed (i.e., when activity is reduced between 2006 and 2008 we are assuming that the same equipment is being used in the field, it is just producing less). In this case, the 2008 emissions will be developed assuming the direct application of the scaling factor with no additional controls.

Where scaling factors are estimated to be greater than one (1), it is assumed that some growth in activity has occurred in the 2006-2008 time period and that new equipment may have been deployed in the field. A controls analysis was conducted specific to each basin and utilizing the control measures identified as part of the WRAP Phase III midterm O&G projections work. The controls analysis only considered broad control factors, rather than detailed analyses as conducted in the Phase III midterm projections. Where no significant impact of controls from federal or state regulations are anticipated in the 2006-2008 time period, no control factors for the specific source category will be assumed.

For Colorado Basins, the permitted O&G 2008 emissions were based on the CDPHE 2008 APEN database rather than projected from the WRAP Phase III 2006 O&G emissions, whose permitted O&G emissions were based on the CDPHE 2006 APEN database. In addition, the Colorado Department of Health and Development (CDPHE) has determined that not all condensate flash VOC emissions that were assumed to be controlled 95% by flares make it to the flare and are instead vented to the atmosphere. Thus, CDPHE has introduced the concept of a Capture Efficiency (CE) for condensate flare control that assumes only 75% of the condensate flash VOC emissions are actually controlled by the flare and the other 25% is released directly to the atmosphere. The CDPHE 75% CE assumption was adopted in the CARMMS/WestJumpAQMS 2008 base case O&G emissions in Colorado. The WRAP Phase III 2006 unpermitted condensate tank O&G emissions are either projected to 2008 (D-J Basin) or the 2008 APEN condensate tank emissions are reduced (Piceance Basin) in order for the total 2008 condensate production in the inventory to match the 2008 IHS database production statistics.

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Details on the development of the 2008 O&G emissions for the Colorado Basins, the Uinta and South San Juan Basins and the Wyoming Basins can be found in three WestJumpAQMS Technical Memorandums by, respectively, Bar-Ilan and Morris (2012a[35]), Bar-Ilan and Morris (2012b[36]) and Bar-Ilan and Morris (2012c[37]).

2.5.4.2 2008 Emission Inventory for the Permian Basin

A study prepared by Applied EnviroSolutions, Inc. (AES) on 2007 O&G emissions in the New Mexico portion of the Permian Basin along with 2008 O&G emissions from the Texas Commission on Environmental Quality (TCEQ) was used to develop a comprehensive O&G emissions inventory of the Permian Basin. The Permian Basin lies outside of the CARMMS modeling domain, although Permian Basin emissions are used in the CAMx 36/12 km modeling to provide BCs for the CARMMS 4 km domain. Details on the development of the 2008 O&G emissions for the Permian Basin can be found in WestJumpAQMS Emissions Technical Memorandum Number 4d (Bar-Ilan and Morris, 2013[38]).

2.5.4.3 2008 O&G Emissions for the Remainder of the U.S.

The WRAP Phase III Basins and Permian Basin O&G emissions described above covers most of an area including northwestern TX, NM, CO, UT and WY and all of the 4 km CARMMS domain. For areas within these states not covered by the WRAP Phase III and Permian Basins, and O&G emissions outside of this region, the O&G emissions from the 2008 NEIv2.0 were used. Details on the O&G emissions used in the 2008 base case not covered by the WRAP Phase III Basins can be found in WestJumpAQMS Technical Memorandum No. 4e (Loomis, Adelman, Morris and Bar-Ilan, 2013[39]).

2.5.5 Fire Emissions

2008 emissions from wild fires, prescribed burns and agricultural burning were based on the comprehensive 2008 fire emissions inventory developed as part of the DEASCO3[40] project sponsored by the Joint Fire Science Program (JFSP). The WestJumpAQMS emissions Technical Memorandum Number 5 (Morris, Tai, Loomis and Adelman, 2012[41]) discusses and compares available fire emissions data for 2008. Details on the DEASCO3 fire emissions development methodology[42] and the methodology for fire plume rise and speciation[43] is available on the DEASCO3 website.

2.5.6 Ammonia Emissions

Ammonia emissions were based on the 2008 NEIv2.0 emissions inventory. A vast majority of the ammonia emissions in the 2008 NEIv2.0 were from livestock and fertilizer application that

[35] http://www.wrapair2.org/pdf/Memo_4a_OG_Jun06_2012_Final.pdf
[36] http://www.wrapair2.org/pdf/Memo_4b_OG_June06_2012_Final.pdf
[37] http://www.wrapair2.org/pdf/Memo_4c_OG_Jan23_2013_RevisedFinal.pdf
[38] http://www.wrapair2.org/pdf/Memo_4d_OG_Apr24_2013_Final.pdf
[39] http://www.wrapair2.org/pdf/Final_Memo_4e_RemainderOG_Mar6_2013.pdf
[40] http://www.wrapair2.org/pdf/JSFP_DEASCO3_TechnicalProposal_November19_2010.pdf
[41] http://www.wrapair2.org/pdf/Memo_5_Fires_Apr27_2012_Final.pdf
[42] https://wraptools.org/pdf/ei_methodology_20130930.pdf
[43] https://wraptools.org/pdf/DEASCO3_Plume_Rise_Memo_20131210.pdf

were based on the CMU ammonia model[44]. Updated spatial surrogates for locations of Concentrated Animal Feeding Operations (CAFOs) in Colorado developed as part of the NPS ROMANS study were used to spatially allocate the NEIv2.0 livestock ammonia emissions in Colorado, which greatly improves the ammonia emissions within the CARMMS domain. Details on the development of the ammonia emissions used in the CARMMS 2008 base case can be found in the WestJumpAQMS Technical Memorandum No. 8 (Loomis, Wilkinson, Adelman and Morris, 2013[45]).

2.5.7 Ocean Going Vessels

The 2008 off-shore shipping emissions inventory was based on the 2008 NEIv2.0. These emissions are developed and carried as point sources, rather than the area-level files generally used for off-road mobiles sources, including marine emissions sources. Details on the Off-Shore Shipping emissions are provided in a report "Documentation for the Commercial Marine Vessel Component of the National Emissions Inventory – Methodology" prepared by Eastern Research Group (ERG, 2010[46]) dated March 30, 2010. The WestJumpAQMS emissions Technical Memorandum Number 7 (Loomis, Morris and Adelman, 2012[47]) describes the off-shore shipping emissions and how they were processed for input into the photochemical grid model.

2.5.8 Biogenic Emissions

WRAP performed a Western Biogenic Emissions Update Study that enhanced the MEGAN biogenic emissions model to better simulate biogenic emissions in the western U.S. The CARMMS used the new enhanced version of MEGAN along with the 2008 WRF 36/12/4 km data to generate hourly gridded speciated biogenic emission inputs for 2008 and the CARMMS 4 km domain. Details on the WRAP Biogenic Emissions Update Study can be found in the study's final report (Sakulyanontvittaya, Yarwood and Guenther, 2012[48]) with a summary provided in the WestJumpAQMS emissions Technical Memorandum Number 9 on biogenic emissions (Sakulyanontvittaya et al., 2012[49]).

2.5.9 Spatial Allocation

New spatial allocation surrogates were developed at 4 km resolution for the CONUS domain using the latest 2010 CENSUS and other new data. The 4 km surrogate distributions were used directly for disaggregating the county-level emissions to the 4 km grid cells in the CARMMS modeling domain, as well as collapsed to 36 and 12 km resolution for spatial allocation to the 36 km CONUS and 12 km WESTUS domains used in WestJumpAQMS modeling. Table 2-5 summarizes the spatial surrogates to be used for spatial allocation in the CARMMS/WestJumpAQMS SMOKE emissions modeling. More details are provided in the WestJumpAQMS emissions Technical Memorandum Number 13 on SMOKE modeling parameters (Adelman, Loomis and Morris, 2013[50]).

[44] http://www.cmu.edu/ammonia/
[45] http://www.wrapair2.org/pdf/Memo8_AmmoniaSources_Feb28_2013review_draft.pdf
[46] http://www.epa.gov/ttn/chief/net/nei08_alm_popup.html
[47] http://www.wrapair2.org/pdf/OffshoreShippingEmissionsMemo_7WestJumpAQMS_Jan23_2012.pdf
[48] http://www.wrapair2.org/pdf/WGA_BiogEmisInv_FinalReport_March20_2012.pdf
[49] http://www.wrapair2.org/pdf/Memo_9_Biogenics_May9_2012_Final.pdf
[50] http://www.wrapair2.org/pdf/Memo13_Parameters_Feb28_2013review_draft.pdf

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Table 2-5. Spatial surrogate distributions to be used in the SMOKE emissions modeling spatial allocations.

Shapefile	Description	Type	Year	Source
cty_pophu2k_revised	U.S. County Boundaries	Polygon	2005	U.S. Census Bureau
pophu_bg2010	Population/ Housing	Polygon	2010	U.S. Census Bureau
rd_ps_tiger2010	Roadways	Line	2010	U.S. Census Bureau
waterway_ntad2011	Waterways	Line	2010	U.S. Bureau of Transport Statistics
rail_tiger2010	Railways	Line	2010	U.S. Census Bureau
exits**	Highway Exits	Point	2010	ESRI
mjrrds**	Major Roads	Line	2010	ESRI
transterm**	Transportation Terminals	Point	2010	ESRI
fema_bsf_2002bnd	Building footprints	Polygon	2010	FEMA
heating_fuels_acs0510_c2010	Home heating fuels	Polygon	2010	U.S. Census Bureau

2.5.10 Temporal Allocation

Temporal profiles are available from the U.S. EPA for a wide range of emissions sources. While the majority of the temporal profiles available from the EPA represent nationally averaged emissions sources, state-specific monthly profiles exist for prescribed fires, wildfires, livestock, and some mobile sources. For most sources the emissions modeling temporal allocations were based on the U.S. EPA temporal profiles distributed with the 2008 NEIv2.0[51] (filename: amptpro_2008aa_us_can_revised_06oct2011_v0.txt). Several source categories use episode emissions that already have hourly emissions so will not use the temporal allocation profiles. These emissions categories include: large point sources with measured hourly CEM emissions; on-road mobile sources that use the MOVES monthly weekday/weekend day hourly emissions; biogenic emissions from MEGAN; and fire emissions from DEASCO3. The EPA default cross walk file between SCC codes and temporal allocations is available on the NEIv2.0 website[52].

2.5.11 Chemical Speciation

The U.S. EPA develops speciation profiles from information stored in the SPECIATE database[53]. The SPECIATE database is the official repository of volatile organic compound (VOC) and particulate matter (PM) emissions source profiles for different categories of emissions sources. CARMMS SMOKE emissions modeling used the SPECIATE Version 4.3 database released in September 2011 that contains 5,592 profiles of chemical mass fractions from source testing conducted by EPA, state agencies, or published in the literature since the 1970's. Of the profiles in SPECIATE V4.3, 3,570 are for PM sources, 1,775 are for VOC sources, and 247 are for other gases, such as mercury. The most recent update to the SPECIATE database occurred with the release of version 4.4 in February 2014 that includes 5,728 speciation profiles for VOC, PM and mercury. SPECIATE 4.4 was released after CARMMS conducted most of its emissions modeling.

Part of the speciation process for VOCs includes converting inventory reactive organic gases (ROG) to total organic gases (TOG). This step is required because inventoried VOC excludes ethane and methane in the mass of total VOC while the speciation profiles include ethane and

[51] http://www.epa.gov/ttnchie1/net/2008inventory.html
[52] ftp://ftp.epa.gov/EmisInventory/2008v2/doc/scc_eissector_xwalk_2008neiv2.xlsx
[53] http://www.epa.gov/ttnchie1/software/speciate/

methane. Before the speciation profiles can be applied to the inventory, the inventory VOC must be scaled up to account for the missing methane mass. SCC-specific ROG-to-TOG conversion factors are included with the speciation profiles to prepare the inventories for speciation.

The CARMMS CAMx photochemical grid modeling used the Carbon Bond version 05 (CB05) chemical mechanism (Yarwood et al., 2005[54]). The SMOKE emissions modeling was performed using CB05 speciation profiles, based on the SPECIATE V4.3 database, and ROG-to-TOG conversion factors. The Speciation Tool is an interface to the SPECIATE database that develops CB05 VOC speciation profiles for use in the SMOKE emissions modeling. The exception to using the SPECIATE V4.3 VOC speciation profiles was for the WRAP Phase III Basins where Basin-specific CB05 VOC speciation profiles were used for O&G VOC emissions.

2.5.12 Emissions Quality Assurance and Quality Control

The emissions modeling quality assurance (QA) and quality control (QC) procedures developed as part of the WRAP Regional Modeling Center are being used in the CARMMS and WestJumpAQMS emissions modeling (Adelman, 2004). The 2008 base case emissions are processed by major source category in several different "streams" of emissions modeling. This is done in order to assist in the QA/QC of the emissions modeling as it is much easier to identify potential issues in the emissions fields when analyzing single source categories at a time. Each stream of emissions modeling generates a pre-merged CAMx-ready emissions model input with all pre-merged emissions inputs merged together to generate the final CAMx-ready two-dimensional gridded low-level (layer 1) and point source emission inputs. Table 2-6 lists an example of separate streams of emissions modeling by source category that can be used. Also shown in Table 2-6 are the source of the emissions, processing comments and the temporal allocation strategy whose options are as follows:

- Single day per year (aveday_yr)
- Single day per month (aveday_mon)
- Typical Monday, Weekday, Saturday, Sunday per year (mwdss_yr)
- Typical Monday, Weekday, Saturday, Sunday per month (mwdss_mon)
- Emissions estimated for each model simulation day (daily)
- Emissions estimated for each model simulation day with temporal profiles generated with average daily meteorology (daily met)
- Emissions estimated for each model simulation day with temporal profiles generated with hourly meteorology (hourly met)

[54] http://www.camx.com/publ/pdfs/cb05_final_report_120805.aspx

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Table 2-6. Emissions processing categories and temporal allocation approach for 2008 Base Case emissions modeling.

No.	Emissions Processing Category (Abbr)	Inventory Source	Temporal	Processing Comments
1	Nonpoint/Area (nonpt)	NEI	mwdss_mon	Remove oil & gas, agricultural NH3, and dust,; includes commercial marine and rail
2	Livestock NH3 (lv)	NEI	mwdss_mon	Do not apply met-based temporal profiles; separate out for possible sensitivity later
3	Fertilizer NH3 (ft)	NEI	mwdss_mon	Group with lv as a full agricultural NH3 sector (ag)
4	Fugitive and Road Dust (fd)	NEI	mwdss_mon	Includes paved and unpaved road dust; apply transport factors but not met factors
5	Residential Wood Combustion (rwc)	NEI	mwdss_mon	Do not apply met-based temporal profiles; separate out for possible sensitivity later
6	Area Oil & Gas from P3 (ogp3)	WRAP P3	mwdss_mon	Basin specific speciation profiles and spatial surrogates (includes Permian Basin)
7	Area Oil and Gas from NEI (ognei)	NEI	MWDSS_mon	Use default speciation and allocations
8	Nonroad mobile (nr)	NEI	mwdss_mon	Includes NMIM commercial marine and rail
9	MOVES RPD (rpd)	MOVES	hourly met	
10	CEM Point (ptcem)	NEI08/CAMD	daily	Anomalies removed from 2008 CAMD data
11	Non-CEM Point (ptncem)	NEI08	mwdss_mon	Removed oil & gas sources from NEI and transferred to ptognei sector
12	Point Oil & Gas from P3 (ptogp3)	WRAP P3	mwdss_mon	WRAP Phase III inventory and Permian Basin
13	Point Oil & Gas from NEI (ptognei)	WRAP NEI	mwdss_mon	Remove NEI oil and gas emissions for counties in WRAP P3/Permian Basins
14	Point Fires (ptfire)	FINN or SMARTFIRE	daily	
15	Commercial Marine (ptseca)	NEI	aveday_mon	Latest version from Emissions Control Area (ECA) rule
16	Lightning NO_X (lnox)		hourly met	Gridded hourly NO emissions tied to WRF convective rainfall (optional)
17	Sea salt (ss)		hourly met	Surf zone and open ocean PM emissions (Optional)
18	Windblown Dust (wbd)	TBD	hourly met	WRAP WBD model one option
19	MEGAN Biogenic (bg)	MEGAN2.1	hourly met	Use new versions of MEGAN V2.10 updated by WRAP for the western U.S.
20	Mexico Area (mexar)	Mexico NEI	mwdss_mon	Mexico inventory projected from 1999 to 2008
21	Mexico Point (mexpt)	Mexico NEI	mwdss_mon	Mexico inventory projected from 1999 to 2013
22	Mexico Mobile (mexmb)	Mexico NEI	mwdss_mon	Mexico inventory projected from 1999 to 2013
23	Canada Area (canar)	Canada NPRI	mwdss_mon	Latest Environment Canada Inventory
24	Canada Point (canpt)	Canada NPRI	mwdss_mon	Latest Environment Canada Inventory
25	Canada Mobile (canmb)	Canada NPRI	mwdss_mon	Latest Environment Canada Inventory
26+	BLM Planning Areas	BLM	Mwdss_mon	Separate processing of O&G and mining emissions in each BLM Planning Area

Separate QA/QC is performed for each separate stream of emissions processing and in each step. SMOKE includes advanced quality assurance features that include error logs when emissions are dropped or added. The QA/QC procedures developed under the WRAP RMC will be used (Adelman, 2004) that includes visual displays that such as:

- Spatial plots of the hourly emissions for each major species (e.g., NO_X, VOC, some speciated VOC, SO_2, NH_3, PM and CO);
- Vertical average emissions plots for major species and each of the grids;
- Diurnal plots of total emissions by major species and by state; and
- Summary tables of emissions for major species for each grid and by major source category.

This QA information will be examined against the original point and area source data and summarized in an overall QA/QC assessment.

Scripts to perform the emissions merging of the appropriate biogenic, on-road, non-road, area, low-level, fire, and point emission files were written to generate the CAMx-ready two-dimensional day-specific hourly speciated gridded emission inputs. The point source and, as available, elevated fire emissions were processed into the day-specific hourly speciated emissions in the CAMx-ready point source format.

The resultant CAMx model-ready emissions were subjected to a final QA using spatial maps, vertical plots and diurnal plots to assure that: (1) the emissions were merged properly; (2) CAMx inputs contain the same total emissions; and (3) to provide additional QA/QC information.

2.6 2008 Base Case Modeling and Model Performance Evaluation

WestJumpAQMS performed a CAMx 2008 4 km Base Case simulation for the CARMMS 4 km modeling domain and conducted a model performance evaluation. The CARMMS model performance evaluation was documented in Section 4.5.3 in the WestJumpAQMS final report (ENVIRON, Alpine and UNC, 2013[55]). The CARMMS study intended to rely on the WestJumpAQMS CAMx model performance evaluation that focused on monthly and annual model performance statistics across the 4 km CARMMS domain for ozone, $PM_{2.5}$ and related species. However, when presenting the CARMMS 2008 Base Case modeling and model performance evaluation results to the IAQRT at a February 28, 2014 meeting, the IAQRT requested that more model performance information be provided. In particular, the IAQRT requested that ozone model performance statistics be calculated using a 60 ppb observed ozone cut-off concentration instead of 40 ppb as used by WestJumpAQMS, and that model performance statistics be provided down to an individual monitoring site. Thus, CARMMS calculated additional ozone model performance statistics using the 60 ppb ozone cut-off and packaged up all of the WestJumpAQMS model performance products for the 4 km CARMMS domain and 2008 Base Case simulation. The result was a 72 Mb zipped file of model performance products that had over 4,500 model performance statistics and displays that

[55] http://www.wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf

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summarized model performance down to the individual monitoring site for each month and for each day of 2008 across the 4 km CARMMS domain. The zipped file of model performance products was provided to the IAQRT.

Appendix B summarizes the CARMMS CAMx 2008 Base Case simulation and model performance evaluation across the 4 km CARMMS domain, including ozone model performance statistics using a 60 ppb observed ozone cut-off threshold as recommended by EPA. The CARMMS CAMx Base Case simulation achieved EPA's ozone model performance goals, except in the winter months (Jan, Feb, Nov and Dec) when a 60 ppb observed ozone cut-off is used. The highest winter ozone events in the CARMMS 4 km domain occur during the winter ozone episodes in the Uinta Basin under cold pool shallow inversion conditions or stratospheric ozone intrusions events that the CARMMS modeling system was either not configured to simulate or has difficulty simulating, respectively. The CARMMS CAMx Base Case simulation also mostly achieved the PM Model Performance Criteria. More details on the CARMMS 2008 4 km base case simulation and model performance evaluation are provided in Appendix B.

3.0 FUTURE YEAR EMISSIONS

The meteorological base year for the CARMMS modeling is 2008. The development of the 2008 Base Case modeling database and emissions scenario was described in Chapter 2. In this section, we describe the development of the future year emissions scenario. The future year emissions scenario modeled is 2021. Projecting future year oil and gas (O&G) emissions has many uncertainties as it depends on economic conditions (e.g., price of natural gas and oil), identification of new O&G plays, availability of exploration and development equipment and regulatory requirements. For CARMMS, future year O&G emissions were developed for a range of potential outcomes that would hopefully bound the actual future year O&G development in the region. CARMMS developed three levels of 2021 future year O&G development within the BLM Colorado Planning Areas:

- High Development Scenario;
- Low Development Scenario; and
- Medium Development Scenario, which is a mitigated version of the High Development Scenario.

There are four general types of future year emissions addressed in CARMMS:

1. BLM-authorized (Federal lands) and other (non-Federal lands) oil and gas and mining emissions within the Colorado BLM planning areas (as well as the BLM Farmington Field Office in northern New Mexico);
2. Oil and gas and other development areas outside of Colorado/northern New Mexico BLM Planning Areas;
3. Remainder future year anthropogenic emissions; and
4. Emissions related to the 2008 base year that remained unchanged in the future year scenarios.

3.1 Western Colorado BLM Planning Area Oil and Gas Emissions

To address emissions from future BLM-authorized (Federal lands) and non-BLM-authorized (non-Federal lands) oil and gas development in the western Colorado planning areas, CARMMS has developed several emission calculators. Existing emissions calculators were improved under CARMMS and representative calculators for "typical" crude oil, conventional gas (with condensate), coal bed natural gas (CBNG), and shale gas within the region have been developed. New information has been incorporated for drilling times; engine configurations; condensate and produced water production; well pad versus offsite gas treatment and storage; well-head, infield, and pipeline compression; and gas/oil production. The ability to readily modify input assumptions, such as production parameters, emission control assumptions, and wellhead equipment configurations, has also been incorporated into the calculators.

The refined emission calculators were used to develop the 2021 future-year O&G emissions inventories for the eight western Colorado BLM planning areas. The O&G emission calculators were also updated using information provided by the BLM New Mexico Farmington Field Office (FFO) petroleum engineers to estimate future year O&G emissions for the Mancos Shale Development area in northern New Mexico.

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The following sections summarize the emission calculators used to estimate the O&G and mining emissions for western Colorado and northern New Mexico. Details on the emission calculators are provide in two Technical Memorandums (Grant, Zapert and Morris, 2013a,b) that are included as Appendices C and D.

3.1.1 Overview of Calculators

Emission calculators have been developed for each of the following well types.

- Conventional gas
- Conventional oil
- Shale gas
- Coalbed natural gas (CBNG)

For each well type, a separate self-contained emission calculator spreadsheet contains all of the inputs and calculations need to generate well site emissions.

Additionally, a calculator has been developed to estimate midstream emissions for each area. The midstream emission calculator draws upon Colorado Department of Public Health (CDPHE) Air Pollutant Emission Notice (APEN) emissions for base year emission estimates. Future year midstream emission projections are dependent on the change in oil and gas production in a given planning area which can be updated based on linkages to the by well type emission calculators.

3.1.2 Pollutants

The emission calculators include estimates of emissions of criteria air pollutants (CAPs), greenhouse gases (GHGs), and hazardous air pollutants (HAPs) as follows:

- Criteria Pollutants
  - Carbon monoxide (CO)
  - Nitrogen oxides (NO_X)
  - Particulate matter less than or equal to 10 microns in diameter (PM_{10})
  - Particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$)
  - Sulfur dioxide (SO_2)
  - Volatile Organic Compounds (VOCs)
- Greenhouse Gases[56]
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
- Hazardous Air Pollutants (HAPs)[57]

[56] Note that the CARMMS PGM modeling does not use Greenhouse Gas (GHG) emissions, but the emission calculators provide GHG emission estimates so they can be reported in the RMPs.

While lead (Pb) is a criteria pollutant, emissions of lead in the BLM western Colorado planning areas due to O&G and mining activities are extremely low and are therefore not included in this analysis.

HAP emissions were estimated for each emissions source. For oil and gas emissions sources, HAP emissions from venting and combustion source categories were estimated for formaldehyde, n-hexane, benzene, toluene, ethylbenzene, and xylenes (BTEX).

Anthropogenic greenhouse gas emission inventories typically include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Fluorinated gases are not expected to be emitted in appreciable quantities by any category considered in this emission inventory and were therefore not included in this analysis.

Although the CARMMS emissions calculators calculate HAP and GHG emissions for oil and gas sources, the CARMMS PGM modeling do not use these emissions so they are not included in this report.

3.1.3 Temporal

The calculators estimate annual emissions associated with oil and gas exploration. Baseline emissions are estimated for 2011 with annual emission forecasts made for every year out to 10 years (2021).

3.1.4 Calculator Inputs

The emission calculator for each well type allows for specification of the following inputs.

- Base year oil and gas activity (gas production, oil production, spud counts, active well counts)
- Well decline estimates
- Level of control by source category
- Gas composition
- Equipment configurations (e.g. drill rigs, fracing rigs)
- Gas venting activity (e.g. completions, blowdowns)

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The midstream emission calculator includes estimates of base year 2011 gas plant and compressor station emissions are taken from CDPHE APEN data. Base year midstream emissions are projected to future years based upon the gas production in each planning area.

3.1.5 Emission Calculations

Emission calculations for all emission-generating activities were developed based on typical emission inventory methodology. Methods used to estimate emissions from each source category are explained in detail in Appendix C (Grant, Zapert and Morris, 2013a). For each source category, emissions for the 2011 baseline were estimated. Emissions were then

[57] Note that the CARMMS PGM modeling does not use HAPs emissions, but the emission calculators provide HAPs emission estimates so they can be reported in the RMPs.

forecasted to future years, accounting for activity growth and for applicable sources emissions controls.

The methodologies described here are used consistently in all four calculators by well type; however the input data of each calculator was selected to best reflect the operational characteristics of each well type (oil, gas, CBNG, and shale gas) and thus obtained from literature sources including the following Air Quality Technical Support Documents (AQTSD) from Colorado field office planning areas and BLM emission calculators:

- White River AQTSD (URS, 2012a)
- Colorado River Valley AQTSD (URS, 2012b)
- Grand Junction AQTSD (BLM, 2012b)
- Uncompahgre AQTSD (in preparation)
- BLM Crude Oil Well Gas Emission Calculator
- BLM Coalbed Natural Gas Well Emission Calculator

Emissions are generated in three main phases of oil and gas systems:

- Emissions from Well Construction and Development
- Emissions from the Production Phase (occurring at-or-nearby the well pad)
- Emissions from Midstream Sources (Central Gas Compression and Processing)

The methodologies implemented to estimate base year and future year emissions from oil and gas sources are explained in Appendix C (Grant, Zapert and Morris, 2013a) and covered the following source categories:

- Well pad construction and development:
  - Well pad, access road and pipeline construction equipment;
  - Well pad, access road and pipeline construction traffic;
  - Drilling and completion equipment;
  - Fracing equipment;
  - Refracing equipment;
  - Drilling and well completion traffic;
  - Well pad, access road and pipeline construction wind erosion; and
  - Well completion venting.

- Production phase emissions:
  - Well workover equipment;
  - Production traffic;
  - Blowdown venting;
  - Well recompletion venting;
  - Pneumatic devices and fugitive components;

  - Water injection pumps;
  - Compressor station maintenance traffic exhaust and fugitive dust;
  - Condensate or oil tanks flashing and working and breathing losses;
  - Loading emissions from condensate and oil tanks;
  - Haul trucks traffic emissions;
  - Heaters; and
  - Dehydrators;

- Midstream sources:
  - Natural gas processing facilities;
  - Natural gas compressor stations; and
  - Gas sweetening.

The oil and gas emission calculators are designed to estimate emissions from both BLM-authorized and non-BLM-authorized activities within the western Colorado BLM planning areas. Emissions were also estimated for coal and uranium mines on federal lands in the western Colorado BLM planning areas. However, unlike the oil and gas emissions, emissions from mines not on federal lands were not estimated and were obtained from the EPA 2020 projections. The emissions for mines on federal lands were estimated for the baseline (2011) and future years and were based on the CDPHE APEN database and available EISs and EAs. Details on the mining emissions are given in Appendix D (Grant, Zapert and Morris, 2013b). Emissions were estimated for the following mines (BLM field office in parenthesis):

- Book Cliffs Area (Grand Junction).
- McClane (Grand Junction).
- Oak Mesa Area (Uncompahgre).
- King (Tres Rios).
- Foidel (Kremmling).
- Deserado (White River).
- Trapper (Little Snake).
- Colowyo (Little Snake).
- Sage Creek (Little Snake).
- West Elk (Uncompahgre).
- Elk Creek (Uncompahgre).

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3.2 Oil and Gas Emissions outside of the BLM Western Colorado Planning Areas

The following three sections describe the procedures for estimating baseline and future year oil and gas emissions for areas within the CARMMS 4 km modeling domain but outside of the western Colorado BLM planning areas.

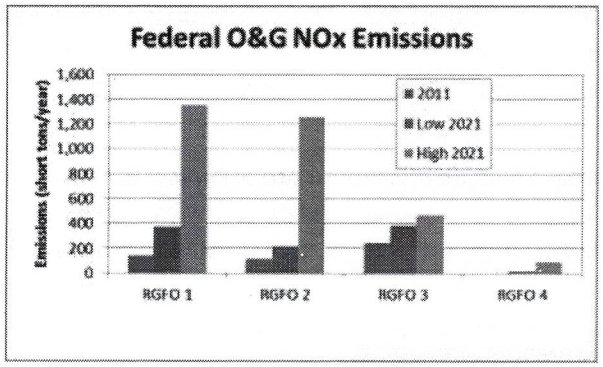
3.2.1 Colorado Royal Gorge Field Office

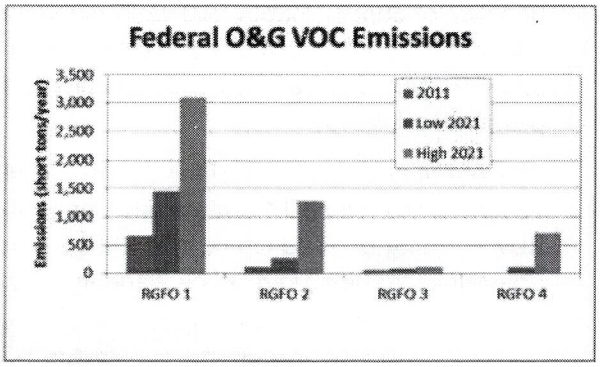
Baseline and future year oil and gas emissions for the BLM Royal Gorge Field Office[58] (RGFO) planning area in eastern Colorado were developed by the BLM COSO using RGFO specific oil and gas RFD estimates and air pollutant emissions calculators designed specifically for eastern Colorado oil and gas development / operations. Due to the geographic size and diversity of the RGFO, the RGFO was divided into four unique geographic areas and baseline and projected emissions inventories were developed for each RGFO area. Future year 2021 oil and gas emissions estimates were developed for future "permitted" and "non-permitted" activities. To develop the year 2021 "permitted" oil and gas emissions estimates, the year 2011 APENs emissions for each RGFO area was scaled using the year 2011 oil and gas production data with projected year 2021 oil and gas production data. The APENs based projections account for all permitted source types but do not include non-permitted sources such as pneumatics, small tanks and some fugitives. To account for "non-permitted" activities in the DJ Basin, WRAP Phase III emissions inventories for non-permitted sources and production data were used to develop production average emissions factors for non-permitted sources / activities and these emissions factors were then used with future projected year 2021 production rates to develop a future year 2021 non-permitted oil and gas emissions inventory for the DJ Basin. For eastern and southeastern portions of the RGFO, a CENRAP oil and gas emissions inventory report was used with projected future year 2021 production data to develop future non-permitted oil and gas emissions estimates similar to what was completed for the DJ Basin. For the Raton Basin, oil and gas operators were specifically queried for operations / activities that are not routinely permitted and future projected year 2021 non-permitted emissions estimates for these activities were made using that information. In addition to the "permitted" and "non-permitted" RGFO emissions inventories described above, oil and gas development and production related traffic emissions were developed for year 2021. The "RFD / High" and "Low" emissions scenarios assumed on-the-books controls and the "RFD-Controlled / Medium" scenario assumes the following enhanced emissions controls for future projected Federal oil and gas: no venting during blow-downs, 30% electrification, Tier 4 drill and completion engines, 80% dust control to unpaved roads, 50% dust controls for well-pad and road construction disturbed areas and 50% of small non-permitted condensate tanks are assumed controlled.

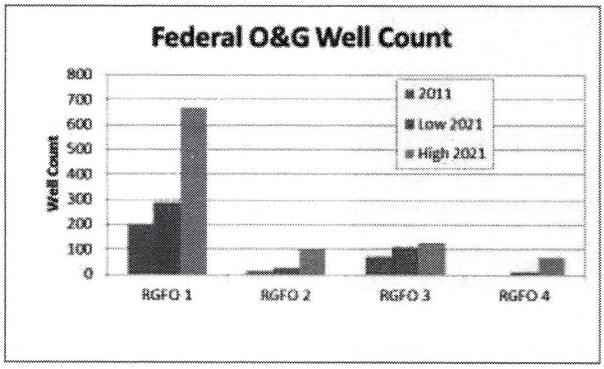
The following charts show year 2011 and projected year 2021 RGFO NOx and VOC emissions estimates and well counts for the CARMMS Low and High modeling scenarios. As shown in the plots, projected year 2021 Federal O&G related emissions for the RFD / High Scenario are higher than projected year 2021 Federal O&G emissions estimates for the Low scenario. For the cumulative plots, future year 2021 cumulative (Federal and non-Federal) emission estimates for the Low Scenario (projected development based on recent development rates) are higher than the RFD / High Scenario and are being driven by the non-Federal oil and gas projection estimates. The current annual non-Federal oil and gas development rates are higher than the

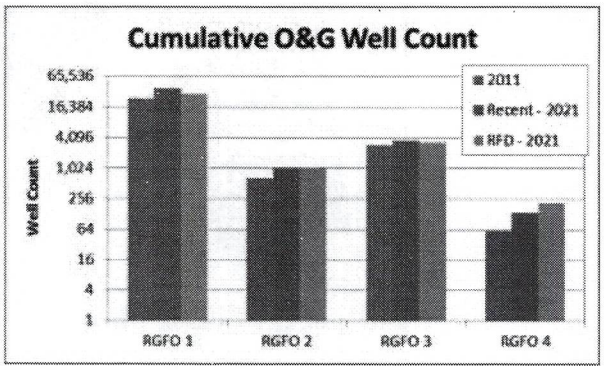
[58] http://www.blm.gov/co/st/en/fo/rgfo.html

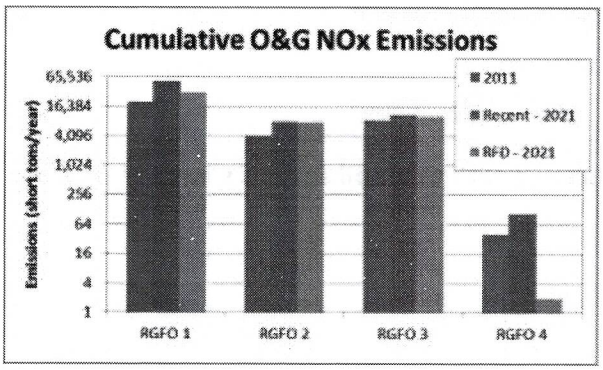
RFD projected estimates primarily because the RFD analysis assumes that current annual non-Federal development rates are not sustainable.

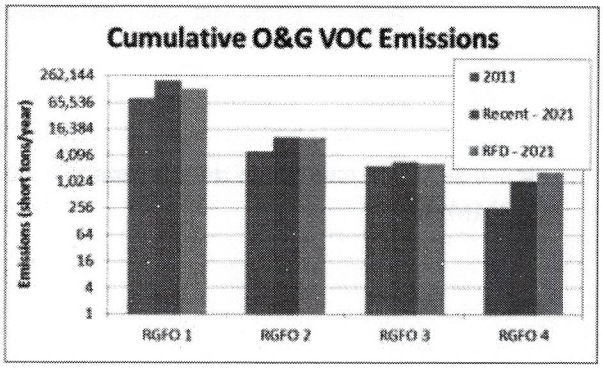












3.2.2 South San Juan Basin, New Mexico

Oil and gas emissions for the New Mexico BLM Farmington Field Office in the South San Juan Basin that includes San Juan, Rio Arriba, Sandoval and McKinley Counties were estimated based on oil and gas activity provided by the New Mexico BLM State and Farmington Field Office for the Mancos Shale Play and 2012 WRAP Phase III inventories for oil and gas emissions in the South San Juan basin. Figure 3-1 displays the Mancos Shale oil and gas development area in

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northwestern New Mexico in relation to BLM Planning Areas (note that the Mancos Shale extends into southern Colorado Tres Rios Field Office Planning Area). Figure 3-2 displays a detailed map of the Mancos Shale development area; the formation is split into an oil prone area in the south and a gas prone area to the north. The oil development is expected to occur at a rate of approximately 200 wells per year starting around 2015. The development of the gas prone area to the north (dry gas with little or no fluids) is dependent on the price of natural gas and is expected to be intensively developed starting approximately four years after the oil prone area (~2019).

70% of the new O&G emissions due to the Mancos Shale development are assumed to occur on Federal lands (i.e., BLM-authorized) and these emissions will be attributed to the New Mexico BLM Farmington Field Office even though there are small amounts of emissions within the BLM Colorado Tres Rios Field Office Planning Area.

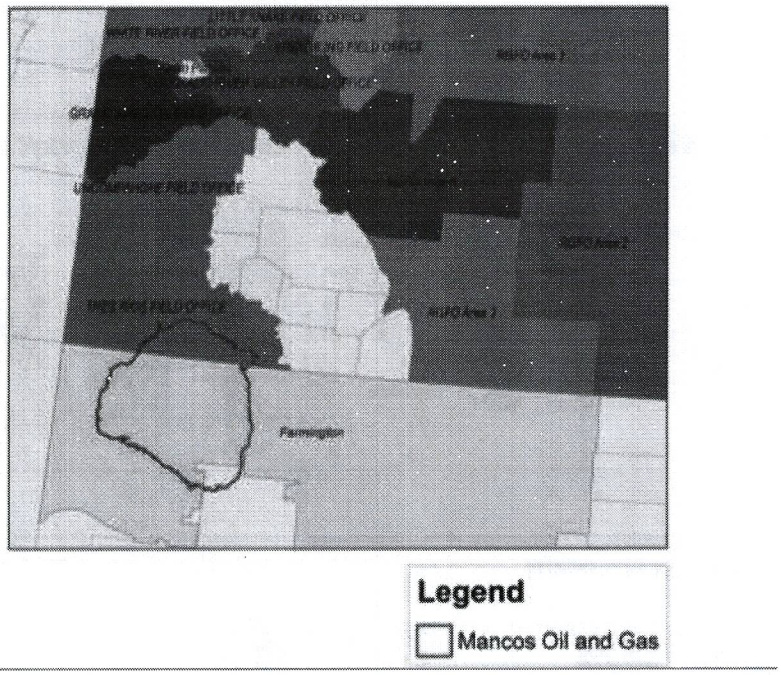

Figure 3-1. Mancos Shale development area (shown with other oil and gas source areas from CARMMS).

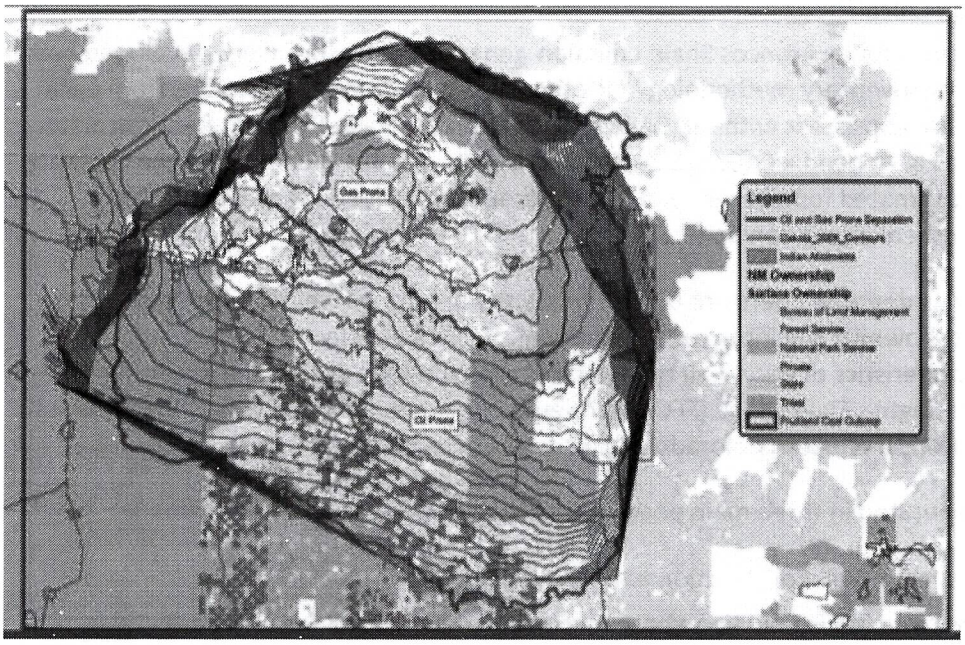

Figure 3-2. Map of oil and gas prone development areas within the Mancos Shale Oil formation primarily in the New Mexico BLM FFO planning area.

To address emissions from future BLM-authorized (Federal lands) and non-BLM-authorized (non-Federal lands) oil and gas development in the South San Juan Basin, BLM commissioned development of Mancos Shale emission calculators. CARMMS emission calculators were modified and adapted to develop two new Mancos Shale emission calculators, one for oil wells and another for gas wells drilled in the Mancos Shale formation. Mancos Shale oil and gas well information has been incorporated for all phases of well development and production emissions to the extent that Mancos Shale specific data was available based on information provided by the BLM New Mexico Farmington Field Office (FFO) petroleum engineers. The ability to readily modify input assumptions, such as production parameters, emission control assumptions, and wellhead equipment configurations, has also been incorporated into the calculators.

The Mancos Shale emission calculators were used to develop the 2021 future-year O&G emissions inventories for oil and gas activity associated with the Mancos Shale formation. The oil and gas emission calculators are designed to estimate emissions from both BLM-authorized and non-BLM-authorized activities for the Mancos Shale formation emissions.

Pollutants included in the Mancos Shale calculators, temporal considerations, and calculator inputs are all consistent with the CARMMS calculators as described in Sections 3.1.2, 3.1.3, and 3.1.4, respectively.

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3.2.2.1 Emission Calculations

Emission calculations for all Mancos Shale emission-generating activities were developed based on typical emission inventory methodology. Methods used to estimate emissions from each source category are consistent with the CARMMS Western Colorado Planning Area calculators explained in detail in Appendix C (Grant, Zapert and Morris, 2013a). For each source category, emissions were estimated for all years of activity, accounting for activity growth and for applicable sources, emissions controls.

The methodologies described here are used consistently in both oil well and gas well Mancos Shale calculators; however the input data of each calculator was selected to best reflect the operational characteristics of each well type (oil and gas) and thus obtained from either BLM New Mexico Farmington Field Office (FFO) petroleum engineers provided well characteristics data or from CARMMS Western Colorado oil and gas calculators.

Emissions are generated in three main phases of oil and gas systems:

- Emissions from Well Construction and Development
- Emissions from the Production Phase (occurring at-or-nearby the well pad)
- Emissions from Midstream Sources (Central Gas Compression and Processing)

The methodologies implemented to estimate base year and future year emissions from oil and gas sources are explained in Appendix C (Grant, Zapert and Morris, 2013a) using the emissions calculators for source categories discussed in Section 3.1.5.

Recent trends in gas production in the South San Juan Basin show consistent decline since 2006 (Figure 3-3). Average decline over the 2006 to 2013 period is about 42 billion cubic-feet (BCF) per year, with the largest drop in production occurring from 2012 to 2013 (64 BCF). Over the ten year period from 2011 to 2021, the average annual historical rate of decline would result in a loss of 420 BCF and the most recent, maximum rate of annual decline would result in a loss of 640 BCF. The total gas production estimated to be added to 2021 for the Mancos Shale for the high development scenario is about 510 BCF per year. Given existing midstream capacity and recent declines in gas production in the South San Juan Basin, additional emissions at midstream sources (i.e. compressor stations and gas plants) were assumed negligible for the Mancos Shale development.

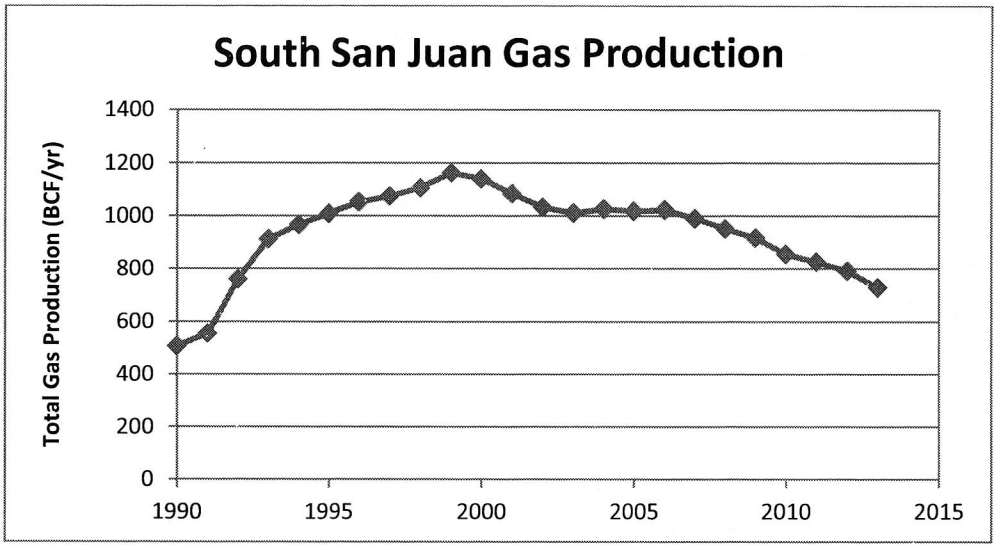

Figure 3-3. Historical gas production in the South San Juan Basin (including Rio Arriba, San Juan, Sandoval, and McKinley Counties).

3.2.3 Uinta Basin, Utah

Baseline and future year emissions associated with oil and gas development in the Uinta Basin have been estimated by AECOM for the BLM Utah State Office (UTSO[59]) under the UTSO Air Resource Management Study (ARMS). The UTSO ARMS is using a 2010 baseline year. More details on the oil and gas emissions for the Uinta Basin are available in the UTSO ARMS documentation (AECOM, 2013[60]).

3.2.4 Southwestern Wyoming

Oil and gas development emissions for southwestern Wyoming were based on recent BLM Environmental Impact Statements (EISs), including those compiled as part of the draft EIS for the Continental Divide-Creston Natural Gas Project[61].

3.3 Other Anthropogenic Emissions

Other anthropogenic emissions (i.e., non O&G and BLM authorized mining sources) for the 2021 future year were based on 2020 emission projections compiled by the 3SAQS that were based on EPA's 2020 projections used in the $PM_{2.5}$ NAAQS rulemaking, which used EPA's 2007v5 modeling platform[62]. Emissions associated with oil and gas emissions within the western Colorado, Royal Gorge, North San Juan Basin, Uinta Basin and southwest Wyoming Basin described in Section 3.2 above were removed from the 2020 3SAQS/NEI to avoid double counting. Similarly, mining emissions on federal lands in the western Colorado BLM planning areas were also removed from the 2020 NEIs and replaced by estimates from the CARMMS calculators.

[59] http://www.blm.gov/ut/st/en.html
[60] http://www.blm.gov/pgdata/etc/medialib/blm/ut/natural_resources/airQuality.Par.34346.File.dat/UTSO_EmissionsTSD121913.pdf
[61] http://www.blm.gov/wy/st/en/info/NEPA/documents/rfo/cd_creston.html
[62] http://www.epa.gov/ttnchie1/emch/

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Details on the development of the 2020 NEI can be found in the 2020 Emissions Technical Support Document (TSD) for the $PM_{2.5}$ NAAQS rule (EPA, 2012d[63]).

3.4 Emissions that Remain at 2008 Levels

The following emission categories from the 2008 Base Case emissions scenario (see Section 2.5) were assumed to remain unchanged for the 2021 future year emission scenarios:

- Biogenic emissions.
- Wildfires, Prescribed Burns and Agricultural Burning emissions.
- Lightning emissions.
- Sea Salt emissions.
- Windblown Dust emissions.
- Emissions from Canada, Mexico and offshore sources (used in the 2021 36/12 km simulation used to provide boundary conditions for the 4 km CARMMS domain).

3.5 Western Colorado BLM Planning Area Oil and Gas Emissions

The emission calculators were used to generate O&G emissions for the eleven-year period of 2011-2021 for 8 western Colorado BLM Planning Areas:

- Roan Plateau portion of the Colorado River Valley Field Office (CRVFO)
- CRVFO outside of the Roan Plateau
- Grand Junction Field Office (GJFO)
- Kremmling Field Office (KFO)
- Little Snake Field Office (LSFO)
- Tres Rios Field Office (TRFO)
- Uncompahgre Field Office (UFO)
- White River Field Office (WRFO)

For each year between 2011-2021, the emissions calculators were used to estimate O&G emissions for upstream (well site) and midstream emission sources and for O&G development on Federal and non-Federal lands within in each of the 8 western Colorado BLM Planning Areas listed above.

3.5.1 2021 High, Low and Medium Development Scenarios

The emissions calculators were used to generate O&G emissions within the 8 western Colorado BLM Planning Areas for 2021 High, Low and Medium Development Scenarios. The High Development Scenario is based on BLM COSOs estimates of RFD O&G future development within these 8 BLM Planning Areas. The Low Development Scenario is based on historical 5-year average O&G development over the 2008-2012 period that was used to grow O&G

[63] http://epa.gov/ttn/chief/emch/2007v5/2007v5_2020base_EmisMod_TSD_13dec2012.pdf

emissions to each year between 2011-2021. Applicable State and Federal controls are applied to the O&G emissions starting in the year that they are required.

The Low Development Scenario assumes 25,710 total active wells in 2021 within the 8 western Colorado BLM Planning Areas with 8,121 wells (32%) on Federal and 17,589 wells (68%) on non-Federal lands. The High Development Scenario assumes 41,033 total active wells, 1.6 times higher than the Low Development Scenario, that are split as 18,347 on Federal (45%) and 22,686 (55%) on non-Federal lands. The 2021 Medium Development Scenario has the same number of wells as the High Development Scenario but assumes additional levels of controls beyond the application of existing state and federal requirements. The Medium Development Scenario assumes additional control of engine and fugitive emission sources for all phases of well-site operation for wells drilled on Federal land after 2015 as follows:

- All development (drilling / completion / fracing) engines will be Tier 4. Tier 4 gen-set standards will be applied for all engines with a horsepower >750; final Tier 4 standards will be applied to all engines with horsepower <750.
- All condensate tank, oil tank, and dehydrator emissions are captured and controlled by VRUs (assumed 95% control efficiency attained by vapor recovery).
- All pneumatic devices are low-bleed or no bleed. Assumed 50% of devices are low-bleed (6 cfh) and 50% of devices are no-bleed.
- Assume that 30% of production engines are powered by electricity (applies to all well-site engines).
- Assume 80% dust control for unpaved road traffic.
- All truck loading emissions are captured and controlled by VRU.

Table 3-1 and Figure 3-4 compare the total emissions from the 8 western Colorado BLM Planning Areas for the 2021 High, Low and Medium Development emission scenarios.

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Table 3-1. Comparison of oil and gas emissions (tons per year, TPY) from the 8 western Colorado BLM Planning Areas for 2021 High, Low and Medium Development emission scenarios.

Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2
All Wells						
Low	44,025	22,715	25,078	4,425	1,270	259
Medium	78,654	45,453	51,983	7,224	2,355	1,145
High	95,427	46,014	56,666	9,482	2,714	1,145
Federal Emissions						
Low	13,950	7,369	7,939	1,233	424	190
Medium	30,254	22,811	26,003	2,763	1,118	971
High	47,007	23,371	29,879	4,996	1,452	972
Non-Federal Emissions						
Low	30,075	15,346	17,139	3,191	846	69
Medium	48,399	22,642	25,979	4,461	1,237	174
High	48,420	22,642	26,787	4,486	1,262	174

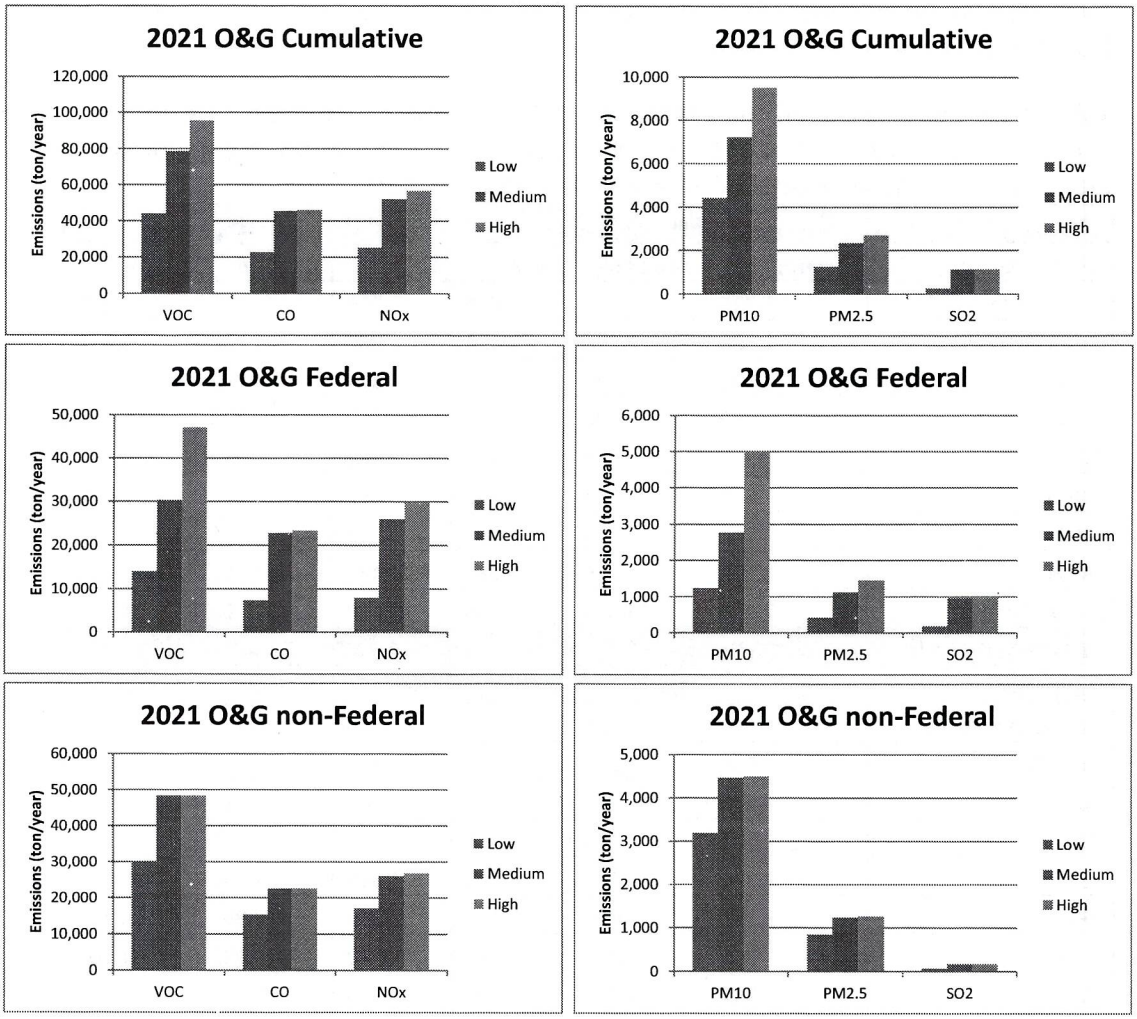

Figure 3-4. Comparison of total oil and gas emissions from the 8 western Colorado BLM Planning Areas for the 2021 High, Low and Medium Development Scenarios.

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3.5.2 2021 High, Low and Medium Development Scenarios

The CARMMS air quality modeling results for the 2021 High, Low and Medium Development Scenarios are presented in Chapter 5. In this section we summarize the emissions for the 8 western Colorado BLM Planning Areas and the three 2021 emission scenarios. Figure 3-5 and Table 3-2 display the NO_X and VOC O&G emissions for the 8 western Colorado BLM Planning Areas and the 2011 current year emissions and the three 2021 emission scenarios stratified by O&G emissions on Federal and non-Federal lands. Summary spreadsheets (not shown) also include emissions stratified by upstream vs. midstream and provide emissions per well. Across the 8 Colorado Planning Areas, the 2021 High Development Scenario O&G NO_X and VOC emissions are, respectively, 2.6 and 2.7 times greater than in 2011, whereas the 2021 Low Development Scenario are 1.1 and 1.3 times greater than 2011, so the 2021 Low Development Scenario emissions are very similar to 2011 O&G emission levels. The controls assumed in the

2021 Medium Development Scenario reduce O&G NO_X and VOC emissions by -8.2% and -17.6% from the 2021 High Development Scenario.

Table 3-2a. Summary of oil and gas NO_X and VOC emissions within the 8 western Colorado BLM Planning Areas for the 2011 current year and 2021 High Development emission scenarios (2021 emissions include both existing and new O&G sources).

2011	NO_X Emissions (TPY)			VOC Emissions (TPY)		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,036	3,575	4,611	2,596	10,407	13,003
Roan (CRVFO)	1,280	2,158	3,438	1,962	3,356	5,318
GJFO	535	2,976	3,511	634	4,032	4,665
KFO	69	40	108	150	138	288
LSFO	741	189	930	1,493	415	1,907
TRFO	879	4,551	5,431	837	3,243	4,080
UFO	61	76	137	55	65	120
WRFO	3,296	736	4,032	4,433	1,052	5,485
Grand Total	7,896	14,301	22,198	12,159	22,708	34,867
2021 High Scenario	NO_X Emissions (TPY)			VOC Emissions (TPY)		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,679	4,639	6,318	5,070	14,287	19,357
Roan (CRVFO)	1,835	1,856	3,692	2,971	3,425	6,395
GJFO	7,670	10,291	17,961	13,744	20,230	33,974
KFO	236	221	458	424	326	750
LSFO	2,320	1,723	4,042	3,334	2,349	5,683
TRFO	3,386	5,096	8,482	2,289	3,861	6,150
UFO	612	1,067	1,679	620	1,082	1,702
WRFO	12,141	1,893	14,034	18,556	2,859	21,415
Grand Total	29,879	26,787	56,666	47,007	48,420	95,427
Difference	NO_X Emissions (TPY)			VOC Emissions (TPY)		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	62%	30%	37%	95%	37%	49%
Roan (CRVFO)	43%	-14%	7%	51%	2%	20%
GJFO	1333%	246%	412%	2069%	402%	628%
KFO	244%	455%	322%	183%	136%	160%
LSFO	213%	813%	335%	123%	467%	198%
TRFO	285%	12%	56%	173%	19%	51%
UFO	903%	1302%	1124%	1025%	1565%	1317%
WRFO	268%	157%	248%	319%	172%	290%
Grand Total	278%	87%	155%	287%	113%	174%

Table 3-2b. Summary of oil and gas NO_X and VOC emissions within the 8 western Colorado BLM Planning Areas for the 2011 current year and 2021 Medium Development emission scenarios (2021 emissions include both existing and new O&G sources).

2011	NO_X Emissions (TPY)			VOC Emissions (TPY)		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,036	3,575	4,611	2,596	10,407	13,003
Roan (CRVFO)	1,280	2,158	3,438	1,962	3,356	5,318
GJFO	535	2,976	3,511	634	4,032	4,666
KFO	69	40	109	150	138	288
LSFO	741	189	930	1,493	415	1,908
TRFO	879	4,551	5,430	837	3,243	4,080
UFO	61	76	137	55	65	120
WRFO	3,296	736	4,032	4,433	1,052	5,485
Grand Total	7,896	14,301	22,197	12,159	22,708	34,867
2021 Medium Scenario	**NO_X Emissions (TPY)**			**VOC Emissions (TPY)**		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,428	4,459	5,887	3,174	14,283	17,457
Roan (CRVFO)	1,613	1,820	3,433	2,438	3,424	5,862
GJFO	6,517	9,927	16,444	6,158	20,221	26,379
KFO	197	213	410	245	326	571
LSFO	2,092	1,680	3,772	2,690	2,348	5,038
TRFO	2,984	5,033	8,017	1,876	3,860	5,735
UFO	486	1,012	1,498	531	1,081	1,611
WRFO	10,686	1,835	12,522	13,142	2,857	15,999
Grand Total	26,003	25,979	51,983	30,254	48,399	78,654
Difference	**NO_X Emissions (TPY)**			**VOC Emissions (TPY)**		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	38%	25%	28%	22%	37%	34%
Roan (CRVFO)	26%	-16%	0%	24%	2%	10%
GJFO	1118%	234%	368%	871%	402%	465%
KFO	185%	433%	276%	63%	136%	98%
LSFO	182%	789%	306%	80%	466%	164%
TRFO	239%	11%	48%	124%	19%	41%
UFO	696%	1232%	993%	865%	1563%	1243%
WRFO	224%	149%	211%	196%	172%	192%
Grand Total	229%	82%	134%	149%	113%	126%

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Table 3-2c. Summary of oil and gas NO_X and VOC emissions within the 8 western Colorado BLM Planning Areas for the 2011 current year and 2021 Low Development emission scenarios (2021 emissions include both existing and new O&G sources).

2011	NO_X Emissions (TPY)			VOC Emissions (TPY)		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,036	3,575	4,611	2,596	10,407	13,003
Roan (CRVFO)	1,280	2,158	3,438	1,962	3,356	5,318
GJFO	535	2,976	3,511	634	4,032	4,666
KFO	69	40	109	150	138	288
LSFO	741	189	930	1,493	415	1,908
TRFO	879	4,551	5,430	837	3,243	4,080
UFO	61	76	137	55	65	120
WRFO	3,296	736	4,032	4,433	1,052	5,485
Grand Total	7,896	14,301	22,197	12,159	22,708	34,867
2021 Low Scenario	**NO_X Emissions (TPY)**			**VOC Emissions (TPY)**		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	1,212	3,334	4,546	3,701	10,456	14,157
Roan (CRVFO)	1,248	1,856	3,104	2,208	3,425	5,633
GJFO	819	5,229	6,049	1,203	10,107	11,310
KFO	80	94	175	127	145	272
LSFO	592	389	980	972	536	1,508
TRFO	1,051	5,261	6,313	782	3,931	4,712
UFO	176	127	303	200	140	340
WRFO	2,760	849	3,609	4,758	1,336	6,093
Grand Total	7,939	17,139	25,078	13,950	30,075	44,025
Difference	**NO_X Emissions (TPY)**			**VOC Emissions (TPY)**		
BLM Area	Federal	non-Fed	Total	Federal	non-Fed	Total
CRVFO (No Roan)	17%	-7%	-1%	43%	0%	9%
Roan (CRVFO)	-3%	-14%	-10%	13%	2%	6%
GJFO	53%	76%	72%	90%	151%	142%
KFO	16%	136%	60%	-16%	5%	-6%
LSFO	-20%	106%	5%	-35%	29%	-21%
TRFO	20%	16%	16%	-7%	21%	15%
UFO	189%	67%	121%	264%	116%	184%
WRFO	-16%	15%	-11%	7%	27%	11%
Grand Total	1%	20%	13%	15%	32%	26%

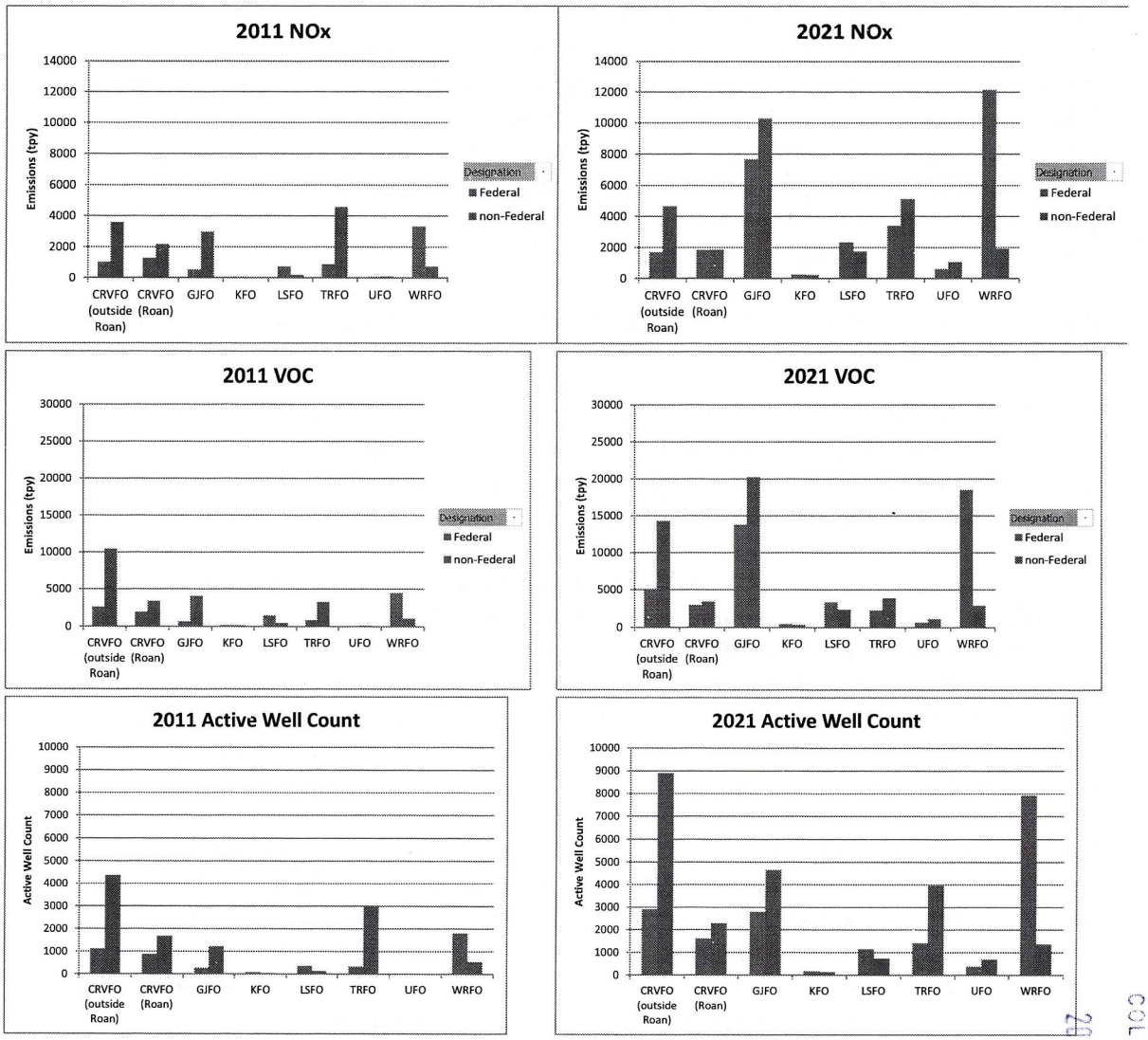

Figure 3-5. NO_X and VOC emissions and well counts from oil and gas development within the 8 western Colorado BLM Planning Areas and for the 2011 current (left) and 2021 High Development Scenario (right) emissions scenarios.

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3.6 Future Year Emissions Modeling Procedures

The 2021 future year emissions were processed using the SMOKE emissions model in a similar manner as used for the 2008 Base Case emissions scenario described in Section 2.5. One difference in the 2021 SMOKE emissions modeling was that each source category for which separate ozone and particulate matter contributions are needed was processed in a separate stream in the SMOKE emissions modeling. This resulted in many different streams of SMOKE emissions processing for the three 2021 emission scenarios to provide separate source groups so that the AQ/AQRV impacts can be isolated in the source apportionment modeling.

3.6.1 Non-Oil and Gas Future-Year Emissions Data

For most of the inventory sectors, the 2020 inventory and ancillary emissions data were obtained directly from the 3SAQS modeling platform, which in turn uses data from EPA's 2007v5 modeling platform (EPA, 2012d). Developed by EPA for use in the $PM_{2.5}$ NAAQS RIA, the 2020 inventory represent the best estimate of future year emissions without the implementation of any new controls necessary to attain the current $PM_{2.5}$ annual and 24-hr (35 $\mu g/m^3$ and 15 $\mu g/m^3$) and ozone 8-hr (75 ppb) standards (EPA, 2012d). These emissions reflect rule promulgated or under reconsideration as of July 2012.

A summary of the 2007v5 modeling platform 2020 inventory is provided below and additional details are available from EPA (EPA, 2012d).

CEM Point: For Electric Generating Units (EGUs) with Continuous Emissions Monitors (CEMs), EGU-specific emissions estimates were obtained from the Integrated Planning Model (IPM®[64]), version 4.10 accounting for controls from the Cross-State Air Pollution Rule (CSAPR[65]) and Mercury and Air Toxics Standard (MATS[66]) rulemakings.

Non-CEM Point: Projection factors and percent reductions reflect CSAPR comments and emission reductions due to national rules, control programs, plant closures, consent decrees and settlements and 1997 and 2001 ozone State Implementation Plans in NY, CT, and VA. EPA used projection approaches for corn ethanol and biodiesel plants, refineries and upstream impacts from the Energy Independence and Security Act of 2007 (EISA). Terminal area forecast (TAF) data aggregated to the national level were used for aircraft to account for projected changes in landing/takeoff activity.

Nonpoint/Area: Agricultural sector projection factors for livestock estimates based on expected changes in animal population from 2005 Department of Agriculture data, updated based on personal communication with EPA experts in July 2012; fertilizer application NH_3 emissions projections include upstream impacts EISA. Fugitive dust projection factors for dust categories related to livestock estimates based on expected changes in animal population and upstream impacts from EISA. Other nonpoint source projection factors that implement CSAPR comments and reflect emission reductions due to control programs. Residential wood combustion projections are based on growth in lower-emitting stoves and a reduction in higher emitting stoves. PFC projection factors reflecting impact of the final Mobile Source Air Toxics (MSAT 2) rule. Upstream impacts from EISA, including post-2007 cellulosic ethanol plants are also reflected.

Off-road Mobile: Other than for California, this sector uses data from a run of NMIM that utilized NONROAD2008a, using future-year equipment population estimates and control programs to the year 2020 and using national level inputs. Final controls from the final locomotive-marine and small spark ignition OTAQ rules are included. California-specific data were provided by California Air Resources Board (CARB).

[64] http://www.icfi.com/insights/products-and-tools/ipm
[65] http://www.epa.gov/crossstaterule/
[66] http://www.epa.gov/mats/

Aircraft/locomotive/marine: For all states except California, projection factors for Class 1 and Class 2 commercial marine and locomotives, which reflect final locomotive-marine controls. California projected year-2020 inventory data were provided by CARB.

Offshore shipping: Base-year 2007 emissions grown and controlled to 2020, incorporating controls based on Emissions Control Area (ECA) and International Marine Organization (IMO) global NO_X and SO_2 controls.

On-road Mobile, not including refueling: MOVES2010b emissions factors for year 2020 were developed using the same representative counties, state-supplied data, meteorology, and procedures that were used to produce the 2007 emission factors. California-specific data were provided by CARB. Other than California, this sector includes all non-refueling on-road mobile emissions (exhaust, evaporative, evaporative permeation, brake wear and tire wear modes).

On-road Refueling: Uses the same projection and processing approach as the on-road sector, except for California where EPA projected using MOVES2010b and did not include CARB data.

Canada Sources: Held constant and 2006 levels.

Mexico Sources: Projections from 1999 to 2018.

The ancillary data (spatial/temporal/chemical) were held unchanged from the 3SAQS platform for preparing the 2021 emissions for CAMx. In the 3SAQS platform, the base sets of ancillary data were taken directly from the EPA 2007v5 modeling platform. The 3SAQS made targeted improvements to the ancillary files for counties in the 3-state study region (Figure 3-6). The improvements were focused on the assignments of spatial/chemical/temporal profiles to inventory sources and on developing profiles that best represent the emissions patterns in the 3-state study region.

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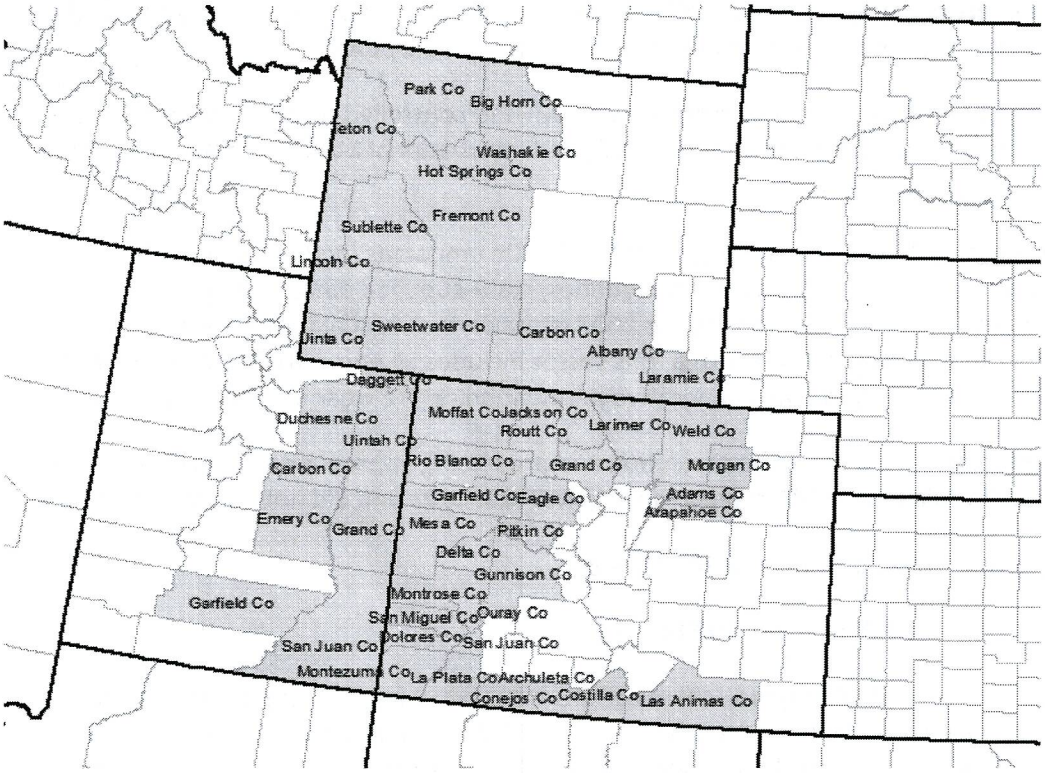

Figure 3-6. List of counties where the 3SAQS made targeted emission improvements to the EPA NEI.

The 3SAQS improvements over the EPA 2008, 2011 and 2020 National Emissions Inventory (NEI) for the CO/UT/WY counties include the following:

Utah

- Updated the 2007v5 spatial surrogates for land cover and building square footage with NLCD2006 and FEMA-HAZUS data
- Changed the ATV/ORV/Snowmobile surrogate assignment from rural land area to forest land
- Changed the livestock surrogate assignment from total agricultural land to pasture land
- Changed the fertilizer surrogate assignment from total agricultural land to crop land
- Created a state-specific, year 2011 monthly temporal profile for residential natural gas heating fuel use with Energy Information Administration data (Figure 3-7).
- Used point locations of rest areas and truck stops to allocation MOVES extended idling emissions to the modeling grid

Colorado

- Updated the 2007v5 spatial surrogates for land cover and building square footage with NLCD2006 and FEMA-HAZUS data
- Changed the ATV/ORV/Snowmobile surrogate assignment from rural land area to forest land
- Created CAFO spatial surrogates from data provided by CDPHE for livestock ammonia sources
- Changed the livestock surrogate assignment from total agricultural land to pasture land
- Changed the fertilizer surrogate assignment from total agricultural land to crop land
- Created a state-specific, year 2011 monthly temporal profile for residential natural gas heating fuel use with Energy Information Administration data (Figure 3-7).
- Developed 2008 vehicle miles traveled (VMT)-based spatial surrogates for on-road mobile sources. Figure 3-8 compares the U.S. Census year 2010 TIGER line roadway data with link-based VMT data from CO.
- Used point locations of rest areas and truck stops to allocation MOVES extended idling emissions to the modeling grid

Wyoming

- Updated the NEI08v2 spatial surrogates for land cover and building square footage with NLCD2006 and FEMA-HAZUS data
- Changed the ATV/ORV/Snowmobile surrogate assignment from rural land area to forest land
- Changed the livestock surrogate assignment from total agricultural land to pasture land
- Changed the fertilizer surrogate assignment from total agricultural land to crop land
- Created a state-specific, year 2011 monthly temporal profile for residential natural gas heating fuel use with Energy Information Administration data (Figure 3-7).
- Developed confined animal feeding operation (CAFO) spatial surrogates for livestock sources. The CAFOs locations data were provided by the state of Wyoming (Figure 3-9). The 3SAQS generated WY livestock surrogates for cattle, poultry, and swine.
- Used point locations of rest areas and truck stops to allocation MOVES extended idling emissions to the modeling grid

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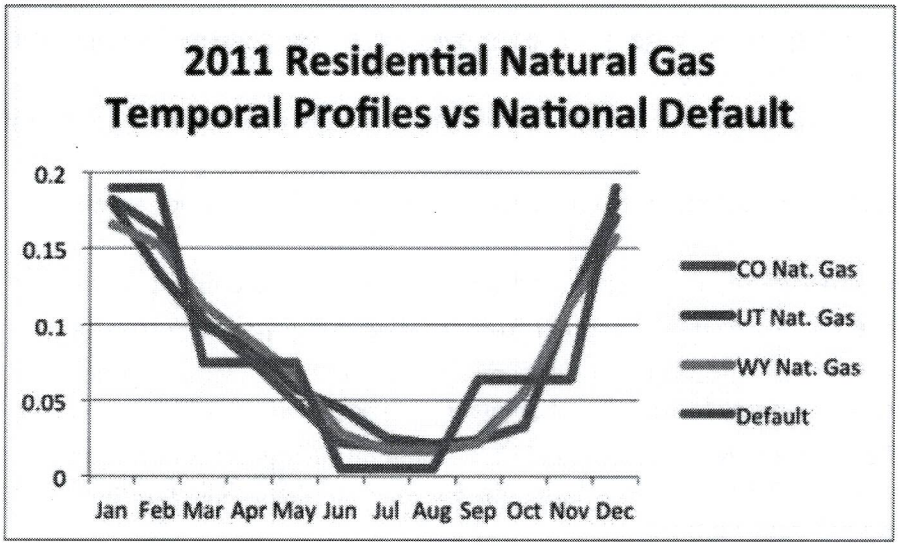

Figure 3-7. 3SAQS 2011 residential natural gas consumption monthly temporal profiles.

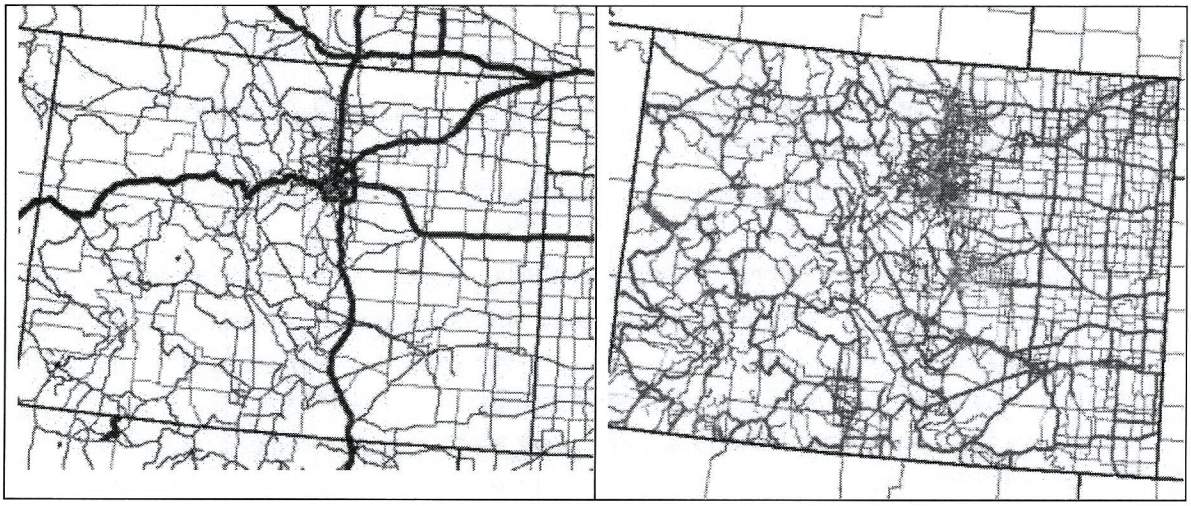

Figure 3-8. Colorado roadway spatial data improvement plots. Left: TIGER 2010 Shapefile of urban/rural primary/secondary roads. Right: CO 2008 VMT-based roadways.

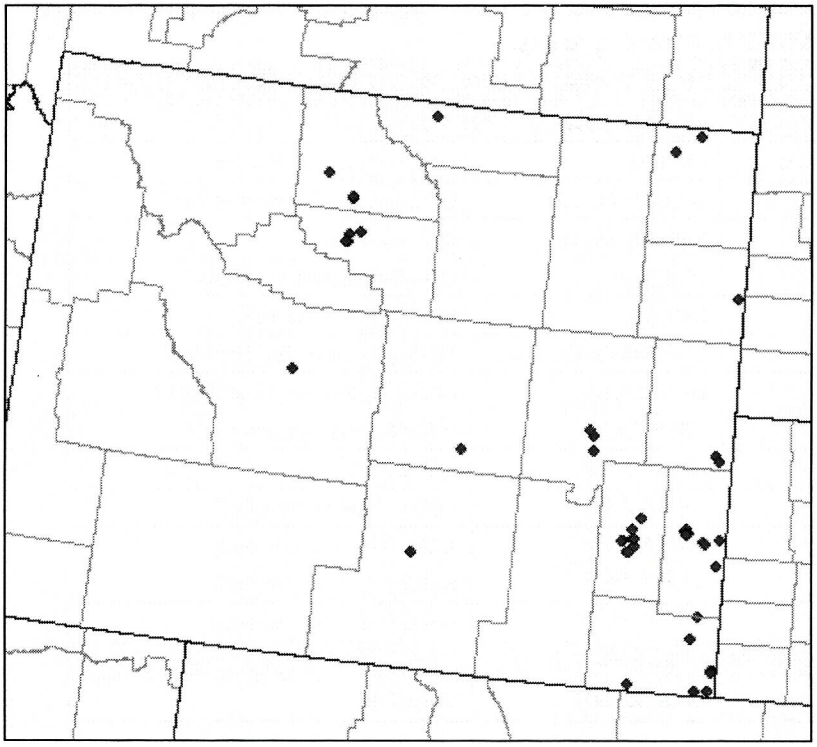

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Figure 3-9. Wyoming CAFO locations.

3.6.2 Oil and Gas Future-Year Emissions Data

For oil and gas sources, ENVIRON developed emissions inventories for the western Colorado BLM planning areas as described in Section 3.1 and South San Juan basin, NM as described in Section 3.2.2. The oil and gas emissions for all other planning areas were provided by BLM as described in Section 3.2.

Oil and gas sources within 14 BLM planning areas, emissions were divided into existing and RFD (new) source categories to facilitate CAMx source apportionment processing. The RFD sources were further divided into oil and gas development on the BLM-authorized land (Federal) and other (non-Federal) lands. The South San Juan basin existing emissions were obtained from the WRAP Phase III midterm projection.

For processing oil and gas emissions, we developed ancillary data (spatial/temporal/chemical) specific to planning areas. The area-specific spatial allocation profiles were developed from the data provided by BLM and chemical speciation profiles were prepared from the gas composition available in the emission calculator. Table 3-3 provides a list of speciation and gridding profiles developed by planning areas. The conventional (CG) and CBM gas speciation profile are assigned to source categories associated with the respective well type. For spatial allocation, gridding profiles were developed for each well type (i.e., conventional, CBM) and land type (Federal, non-Federal) combination.

Table 3-3. Source of VOC speciation profile and spatial surrogates used for gridding oil and gas emissions in the 14 CO/NM BLM Planning Areas.

Source Region	Speciation Profiles	Gridding Profiles
Colorado		
Colorado River Valley, without Roan	CRV{CG}	CRVFO {CG}{Fed,non-Fed}
Grand Junction FO	GJ {CBM,CG,SG}	GJFO {CG,CBM}{Fed,non-Fed}
Kremmling FO	K {CBM,CG,CO}	KFO shapefile
Little Snake FO	LS {CG,CO}	CRVFO {CG}{Fed,non-Fed}
Roan Plateau	CRV{CG}	CRVFO_Roan_Plateau.
Tres Rios FO	TR {CBM,CG,CO,SHL}	TRFO {CG,CBM}{Fed,non-Fed}
Uncompahgre FO	U {CBM,CG}	UFO {CG,CBM}{Fed,non-Fed}
White River FO	WR {CG,CO}	WRVFO {CG}{Fed,non-Fed}
Pawnee National Grasslands	DJ{FLA ,VNT}	RGFO {CG}{Fed}
Royal Gorge FO Area1	DJ{FLA ,VNT}	RGFO {CG}{Fed,non-Fed}
Royal Gorge FO Area2	DJ{FLA ,VNT}	RGFO {CG}{Fed,non-Fed}
Royal Gorge FO Area3	DJ{FLA ,VNT}	RGFO {CG}{Fed,non-Fed}
Royal Gorge FO Area4	DJ{FLA ,VNT}	RGFO {CG}{Fed,non-Fed}
New Mexico		
Farmington FO	MAN{SG, SO}	Shapefile

3.6.3 Mining Future-Year Emissions Data

For mining sources, emissions were estimated for coal and uranium mines on Federal lands in the western Colorado BLM Planning Areas. The emissions for mines on Federal lands were estimated based on the CDPHE APEN database and available EISs and EAs. The mining emissions not on federal lands were obtained from the 2020 EPA/3SAQS inventory. EPA default chemical speciation profiles were used in the SMOKE emissions modeling for mining.

The estimated coal mining sources were consolidated with the 2020 EPA/3SAQS inventory to avoid potential double counting. The western Colorado uranium mining emissions were modeled as "area" and spatially allocated using spatial surrogates developed from the data provided by BLM in a shapefile format.

3.7 Emissions Modeling Results

Table 3-4 lists the total NO_X, VOC, SO_2 and $PM_{2.5}$ emissions for the 20 Source Categories used in the CAMx 2021 High Development Scenario source apportionment simulation (see Section 4.1 and Table 4-1) plus three combined O&G source groups as well as total anthropogenic and all emissions within the 4 km CARMMS domain. These emissions were obtained from CAMx source apportionment diagnostic output file for each day of the annual simulation that were summed to obtain total annual emissions. The emissions in Table 3-4 differ from the ones presented earlier in Tables 3-1 and 3-2 in that they represent emissions after processing by SMOKE emissions model that performs spatial and temporal allocation and chemical speciation. Another important differences in the emissions presented in Table 3-4 from those in Tables 3-1 and 3-2 is that for the BLM Planning Areas (Numbers 1-14) the emissions are in Table 3-4 are

just for new O&G emissions on Federal lands, whereas Tables 3-1 and 3-2 Federal O&G emissions are for new and existing sources. For VOC, the differences in emissions between Tables 3-2 and Table 3-4 are even greater because SMOKE also does chemical speciation of the VOCs into the CB05 chemical mechanism that drops the unreactive portions of VOCs that do not participate in photochemistry.

For new Federal O&G within the 14 BLM Planning Areas and the 2021 High Development Scenario, the WRFO has the highest NO_X emissions (11,264 tons per year, TPY) followed by GJFO (7,293 TPY), FFO (3,321 TPY) and TRFO (2,665 TPY). Total 2021 O&G NO_X emissions in the 14 BLM Planning Areas is 178,447 TPY that is split 18 percent new Federal (32,566 TPY), 37 percent new non-Federal (65,713 TPY) and 45 percent existing O&G emissions (81,168 TPY). Outside of the 14 BLM Planning Areas, there is an additional 61,220 TPY O&G NO_X emissions for a total 2021 High Development Scenario O&G NO_X emissions across the entire 4 km CARMMS domain of 240,667 TPY that represents 34 percent of the total anthropogenic and 30 percent of the total (anthropogenic plus natural) NO_X emissions in the 4 km domain.

Total O&G VOC emissions in the 4 km CARMMS domain for the 2021 High Development Scenario are 835,785 TPY that represents 73 percent of the total anthropogenic and 39 percent of the total anthropogenic plus natural VOC emissions across the domain. Natural VOC emissions represent 46 percent of the annual VOC emissions across the 4 km CARMMS domain. Note that biogenic emissions are highly day-specific with higher emissions under warmer temperatures and higher light intensity. Thus, the contributions of biogenic VOC emissions to the total annual VOC emissions (46 percent) would be expected to be lower on cooler and higher on warmer days. Also note that the VOC emissions in Table 3-4 were obtained from the Carbon Bond chemical mechanism species that will be different than the VOC species input into the SMOKE emissions modeling system (for example, includes ethane and excludes nonreactive carbon in VOCs).

With one exception, SO_2 emissions from Federal O&G within the 14 BLM Planning Areas are fairly low (< 20 TPY). The exception is the WRFO Planning Area where the 904 TPY SO_2 emissions represent 95 percent of the 950 TPY SO_2 emissions from all 14 BLM Planning Areas combined in the 2021 High Development Scenario. A majority of the 2021 SO_2 emissions in the WRFO Planning Area come from two gas plants: the Enterprise Gas Proc – Meeker Gas Plant and the Williams Field – Willow Creek Gas Plant. These gas plant emissions were based on the CDPHE 2008 Air Pollution Emission Notice (APEN) database grown to 2021 using the change in gas production between 2008 and 2021 for the 2021 High, Low and Medium Development Scenarios. Total O&G SO_2 emissions across the CARMMS domain is 6,071 TPY that is primarily (75 percent) due to O&G from outside of the 14 BLM Planning Areas, these areas in the 4 km CARMMS domain outside of the 14 BLM Planning Areas includes the Uinta Basin where sour gas reserves occur.

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Total $PM_{2.5}$ emissions from O&G in the 14 BLM Planning Areas and the 2021 High Development Scenario is 7,849 TPY of which over half (58 percent) is due to new non-Federal O&G and the rest approximately split equally between new Federal and existing O&G. Mining within the 14 BLM Planning Areas contributes 6,957 TPY. By far the largest contribution of primary $PM_{2.5}$ emissions is the other (non O&G and mining) anthropogenic emissions category that

contributes 74 percent of the region-wide total with natural emissions (mostly due to wildfires) contributing most of the rest (23 percent).

Table 3-5a is like Table 3-4 only for the 2021 Low Development Scenario, with the percent reductions of emissions between the Low and High development Scenarios shown in Table 3-5b. The total new Federal O&G NO_X emissions across the 14 BLM Planning Areas for the low scenario (8,385 TPY) is 74% lower than the high scenario (32,566 TPY). Similar reductions are seen for the other species (-63 to -83 percent). The annual emissions for the 2021 Medium Development Scenario are shown in Table 3-6a with the percent reduction from the 2021 High Development Scenario given in Table 3-6b. Total O&G NO_X emissions across the 14 BLM Planning Areas for the 2021 Medium Development Scenario is 27,071 TPY that is -17% lower than the 201 High Development Scenario (Table 3-6b). Similarly, 2021 Medium Development Scenario O&G VOC emissions across the 14 BLM Planning Areas are 35% lower than the 2021 High Development Scenario.

Table 3-4. Total emissions (tons per year) for each Source Category (see Table 4-1) and combinations of Source Categories for the 2021 High Development Scenario from the CAMx source apportionment diagnostic output files after processing by SMOKE.

CARMMS 2021 High Development Scenario (tpy)						
Number	Group	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}
19	Natural (Biogenics + Fires)	113,165	992,560	1,132	79,453	574,255
1	LSFO	2,007	4,648	13	73	170
2	WRFO	11,264	27,258	904	597	1,368
3	CRVFO	1,311	6,076	2	71	250
4	RPPA	1,245	2,739	1	48	135
5	GJFO	7,293	18,108	15	310	1,496
6	UFO	586	870	1	35	140
7	TRFO	2,665	1,715	2	125	855
8	KFO	177	412	0	10	50
9	RGFO #1	303	875	1	29	225
10	PGPA	930	2,682	3	90	689
11	RGFO #2	1,151	1,526	1	22	58
12	RGFO #3	224	77	0	3	16
13	RGFO #4	90	944	0	16	134
14	FFO	3,321	8,747	5	314	1,824
15	New O&G from non-Fed BLM PAs	65,713	228,655	297	4,548	30,790
16	Existing O&G from BLM PAs	81,169	228,749	252	1,558	2,838
17	Mining from BLM PAs	686	46	8	6,957	6,977
18	All O&G outside 14 BLM PAs	61,220	301,705	4,572	2,680	2,822
20	Remaining anthro emissions	459,907	312,498	95,720	242,828	1,400,504
	14 BLM PAs Fed O&G	32,566	76,676	950	1,744	7,409
	14 PAs Total O&G	179,447	534,080	1,499	7,849	41,038
	Total O&G	240,667	835,785	6,071	10,530	43,859
	Total Anthropogenic	701,260	1,148,329	101,799	260,315	1,451,340
	Total All Emissions	814,425	2,140,889	102,931	339,768	2,025,594

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Table 3-5a. Total emissions (tons per year) for each Source Category (see Table 4-1) and combinations of Source Categories for the 2021 Low Development Scenario from the CAMx source apportionment diagnostic output files after processing by SMOKE.

CARMMS 2021 Low Development Scenario (tpy)						
Number	Group	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}
19	Natural (Biogenics + Fires)	113,165	992,560	1,132	79,453	574,255
1	LSFO	275	638	2	10	23
2	WRFO	1,861	4,502	149	99	226
3	CRVFO	844	3,916	1	46	161
4	RPPA	656	1,552	1	26	70
5	GJFO	425	965	1	20	72
6	UFO	150	270	0	10	45
7	TRFO	326	227	0	16	89
8	KFO	21	34	0	1	5
9	RGFO #1	61	262	0	5	42
10	PGPA	188	804	1	17	129
11	RGFO #2	104	191	0	2	6
12	RGFO #3	141	51	0	2	11
13	RGFO #4	14	135	0	2	20
14	FFO	3,321	8,747	5	314	1,824
15	New O&G from non-Fed BLM PAs	31,247	104,163	113	2,057	13,769
16	Existing O&G from BLM PAs	81,169	228,749	252	1,558	2,838
17	Mining from BLM PAs	686	46	8	6,957	6,977
18	All O&G outside 14 BLM PAs	61,220	301,705	4,572	2,680	2,822
20	Remaining anthro emissions	459,907	312,498	95,720	242,828	1,400,504
	14 BLM PAs Fed O&G	8,385	22,294	161	570	2,723
	14 PAs Total O&G	120,801	355,207	527	4,185	19,331
	Total O&G	182,021	656,912	5,099	6,865	22,152
	Total Anthropogenic	642,614	969,456	100,827	256,651	1,429,633
	Total All Emissions	755,779	1,962,016	101,958	336,104	2,003,888

Table 3-5b. Percent difference in 2021 High and Low Development Scenario emissions (High – Low) for each Source Category (see Table 4-1) and combinations of Source Categories from the CAMx source apportionment diagnostic output after processing by SMOKE.

CARMMS 2021 Low Scenario Percent Change from High Scenario (%)						
Number	Group	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}
19	Natural (Biogenics + Fires)	0.0%	0.0%	0.0%	0.0%	0.0%
1	LSFO	-86.3%	-86.3%	-86.4%	-86.3%	-86.4%
2	WRFO	-83.5%	-83.5%	-83.5%	-83.5%	-83.5%
3	CRVFO	-35.6%	-35.5%	-35.7%	-35.2%	-35.5%
4	RPPA	-47.3%	-43.3%	-46.8%	-46.3%	-48.2%
5	GJFO	-94.2%	-94.7%	-94.1%	-93.6%	-95.2%
6	UFO	-74.5%	-69.0%	-76.5%	-70.6%	-67.7%
7	TRFO	-87.8%	-86.8%	-83.8%	-87.1%	-89.6%
8	KFO	-88.2%	-91.7%	-88.8%	-89.2%	-89.8%
9	RGFO #1	-79.8%	-70.0%	-81.9%	-81.6%	-81.3%
10	PGPA	-79.8%	-70.0%	-81.9%	-81.2%	-81.2%
11	RGFO #2	-91.0%	-87.5%	-90.8%	-90.5%	-89.3%
12	RGFO #3	-37.0%	-34.0%	-37.5%	-33.0%	-31.0%
13	RGFO #4	-85.0%	-85.7%	-85.0%	-85.4%	-85.4%
14	FFO	0.0%	0.0%	0.0%	0.0%	0.0%
15	New O&G from non-Fed BLM PAs	-52.4%	-54.4%	-61.8%	-54.8%	-55.3%
16	Existing O&G from BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
17	Mining from BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
18	All O&G outside 14 BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
20	Remaining anthro emissions	0.0%	0.0%	0.0%	0.0%	0.0%
	14 BLM PAs Fed O&G	-74.3%	-70.9%	-83.1%	-67.3%	-63.2%
	14 PAs Total O&G	-32.7%	-33.5%	-64.9%	-46.7%	-52.9%
	Total O&G	-24.4%	-21.4%	-16.0%	-34.8%	-49.5%
	Total Anthropogenic	-8.4%	-15.6%	-1.0%	-1.4%	-1.5%
	Total All Emissions	-7.2%	-8.4%	-0.9%	-1.1%	-1.1%

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Table 3-6a. Total emissions (tons per year) for each Source Category (see Table 4-1) and combinations of Source Categories for the 2021 Medium Development Scenario from the CAMx source apportionment diagnostic output files after processing by SMOKE.

CARMMS 2021 Medium Development Scenario (tpy)						
Number	Group	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}
19	Natural (Biogenics + Fires)	113,165	992,560	1,132	79,453	574,255
1	LSFO	1,779	3,633	13	58	98
2	WRFO	9,809	18,803	904	500	810
3	CRVFO	1,060	3,253	2	51	123
4	RPPA	1,023	1,848	1	35	70
5	GJFO	6,149	8,345	15	196	673
6	UFO	460	733	1	24	66
7	TRFO	2,263	1,253	2	65	361
8	KFO	137	210	0	6	23
9	RGFO #1	193	679	1	10	52
10	PGPA	593	2,081	3	29	158
11	RGFO #2	846	1,468	1	15	25
12	RGFO #3	156	54	0	2	5
13	RGFO #4	51	679	0	5	30
14	FFO	2,552	6,808	4	185	745
15	New O&G from non-Fed BLM PAs	64,849	227,796	297	4,517	30,722
16	Existing O&G from BLM PAs	81,169	228,749	252	1,558	2,838
17	Mining from BLM PAs	686	46	8	6,957	6,977
18	All O&G outside 14 BLM PAs	61,220	301,705	4,572	2,680	2,822
20	Remaining anthro emissions	459,907	312,498	95,720	242,828	1,400,504
	14 BLM PAs Fed O&G	27,071	49,849	947	1,180	3,239
	14 PAs Total O&G	173,089	506,394	1,496	7,254	36,800
	Total O&G	234,309	808,100	6,068	9,935	39,621
	Total Anthropogenic	694,902	1,120,643	101,796	259,720	1,447,102
	Total All Emissions	808,067	2,113,203	102,928	339,173	2,021,356

Table 3-6b. Percent difference in 2021 High and Medium Development Scenario emissions (High – Medium) for each Source Category (see Table 4-1) and combinations of Source Categories from the CAMx source apportionment diagnostic output files after processing by SMOKE.

CARMMS 2021 Medium Scenario Percent Change from High Scenario (%)						
Number	Group	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}
19	Natural (Biogenics + Fires)	0.0%	0.0%	0.0%	0.0%	0.0%
1	LSFO	-11.3%	-21.8%	-1.4%	-20.7%	-42.7%
2	WRFO	-12.9%	-31.0%	0.0%	-16.4%	-40.8%
3	CRVFO	-19.1%	-46.5%	-0.4%	-27.9%	-50.6%
4	RPPA	-17.9%	-32.5%	-0.3%	-26.9%	-48.1%
5	GJFO	-15.7%	-53.9%	-0.6%	-36.8%	-55.0%
6	UFO	-21.5%	-15.7%	-5.2%	-32.4%	-52.5%
7	TRFO	-15.1%	-26.9%	-4.1%	-47.9%	-57.8%
8	KFO	-22.5%	-48.9%	-7.2%	-40.1%	-55.3%
9	RGFO #1	-36.2%	-22.4%	-20.6%	-67.0%	-77.0%
10	PGPA	-36.2%	-22.4%	-20.6%	-67.2%	-77.0%
11	RGFO #2	-26.5%	-3.8%	-24.8%	-33.2%	-56.2%
12	RGFO #3	-30.2%	-29.8%	-28.3%	-50.5%	-68.3%
13	RGFO #4	-43.5%	-28.0%	-1.0%	-71.0%	-77.4%
14	FFO	-23.1%	-22.2%	-21.4%	-41.0%	-59.2%
15	New O&G from non-Fed BLM PAs	-1.3%	-0.4%	-0.1%	-0.7%	-0.2%
16	Existing O&G from BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
17	Mining from BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
18	All O&G outside 14 BLM PAs	0.0%	0.0%	0.0%	0.0%	0.0%
20	Remaining anthro emissions	0.0%	0.0%	0.0%	0.0%	0.0%
	14 BLM PAs Fed O&G	-16.9%	-35.0%	-0.3%	-32.3%	-56.3%
	14 PAs Total O&G	-3.5%	-5.2%	-0.2%	-7.6%	-10.3%
	Total O&G	-2.6%	-3.3%	-0.1%	-5.7%	-9.7%
	Total Anthropogenic	-0.9%	-2.4%	0.0%	-0.2%	-0.3%
	Total All Emissions	-0.8%	-1.3%	0.0%	-0.2%	-0.2%

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Figure 3-10 displays spatial maps of NO_X, VOC and $PM_{2.5}$ emissions across the 4 km CARMMS domain by different source types for the 2021 High Development Scenario. The spatial maps for the Low and Medium Development Scenarios have the same locations as the High Development Scenario just with lower intensity. Figure 3-10a displays the total new Federal and new non-Federal O&G emissions across the 14 CO/NM BLM Planning Areas that shows a mixture of Federal and non-Federal O&G emissions in the western Colorado Planning Areas. Most of the new O&G emissions in the eastern Colorado Planning Areas (e.g., Weld County) are due to non-Federal O&G, except for the development within the Pawnee Grassland Planning Area. The differences in the new Federal and non-Federal O&G emissions for the Mancos Shale

Development area in northern New Mexico reflects the assumption that new O&G was split 70 percent Federal and 30 percent non-Federal.

Figure 3-10b top panel displays the spatial distribution of emissions that combines the existing O&G within the 14 CO/NM BLM Planning Areas with the remainder O&G (new Federal and non-Federal plus existing) within the 4 km CARMMS domain but outside of the 14 CO/NM BLM Planning Areas. In addition to the familiar Basins within the 14 CO/NM Planning Areas (Denver-Julesburg, Piceance and North and South San Juan), the Uinta Basin is clearly evident along with O&G emissions in southwest Wyoming and in the Texas panhandle. Mining within the Colorado BLM Planning Areas consist of mainly isolated grid cells that can have very high $PM_{2.5}$ emissions (Figure 3-10b, bottom panel). Figure 3-10c displays the other (remainder) anthropogenic emissions and natural emissions. Roadways and the major urban areas of Denver, Salt Lake City, Colorado Springs and Albuquerque are clearly evident in the other anthropogenic emissions NO_X and VOC maps. Whereas the spatial maps of other anthropogenic $PM_{2.5}$ emissions is more reflective of agricultural sources. Natural VOC emissions are dominated by forested areas, whereas the natural NO_X emissions are higher in agricultural areas and the locations of fires in 2008.

3.7.1 Mining PM Speciation Issues

The EPA default PM speciation profiles as provided with the SMOKE emissions modeling system were used to speciate PM emissions for mining sources. These PM speciation profiles convert total $PM_{2.5}$ emissions into particulate SO4, NO3, NH4, EC, OA and OPM2.5 (other $PM_{2.5}$) for the PGM modeling. In analyzing the AQ and AQRV impacts associated with mining on Federal lands in the CARMMS 2021 modeling results, we noticed sulfur deposition impacts and visibility impairment impacts due to SO4 that were higher than expected given the low SO_2 emissions from mining for the 2021 emission scenarios (8 TPY, see Tables 3-4 through 3-6). These higher than expected sulfur impacts from mining were due to primary SO4 emissions. Of the 6,957 TPY $PM_{2.5}$ emissions from mining (Table 3-4), 874 TPY (12.5%) is due to primary SO4 emissions.

Table 3-7 lists the mining source categories and emissions by Source Classification Code (SCC) and the PM speciation profile code used in the SMOKE modeling system that is used to speciate the mining PM emissions using a cross-reference with the SCC number. SMOKE speciates most of the mining PM emissions using the 92047 PM speciation profile that is for "Mineral Products – Avg – Simplified." Table 3-8 lists the $PM_{2.5}$ speciation profiles for the three profiles used to speciate the mining emissions in SMOKE. For the dominant 92047 PM profile for mining, 14.1% of the $PM_{2.5}$ emissions are speciated as primary SO4. The reference for the 92047 PM speciation profile in the SPECIATE database is "Shareef, G.S. Engineering Judgment, Radian Corporation. September 1987." In our search we could not find this reference.

For some types of above ground mining that uses blasting, higher sulfur emissions may be expected. However, in Colorado most of the mining is underground that would not include blasting so would be expected to have lower sulfur emissions, which is reflected in the low mining SO_2 emissions. Thus, it appears that mining primary SO4 emissions are overstated in the CARMMS 2021 modeling, which would result in overstated sulfur deposition and visibility impacts associated with mining. This issue will be discussed with EPA so that the SMOKE emissions modeling system can be updated in the future.

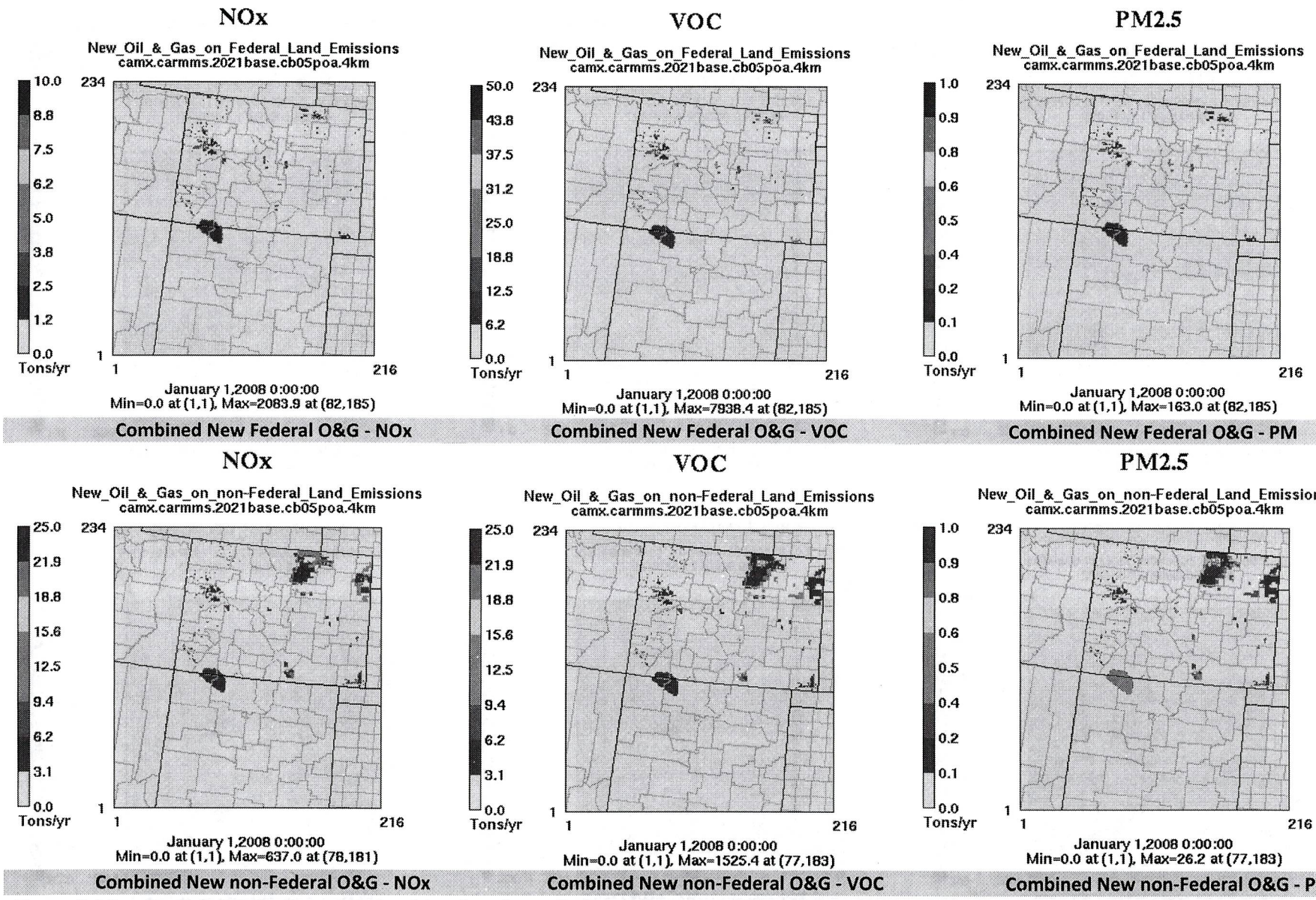

Figure 3-10a. Spatial distribution of Federal (top) and non-Federal oil and gas NO_X, VOC and $PM_{2.5}$ emissions (tons per year) for the 14 BLM Planning Areas and the 2021 High Development Scenario.

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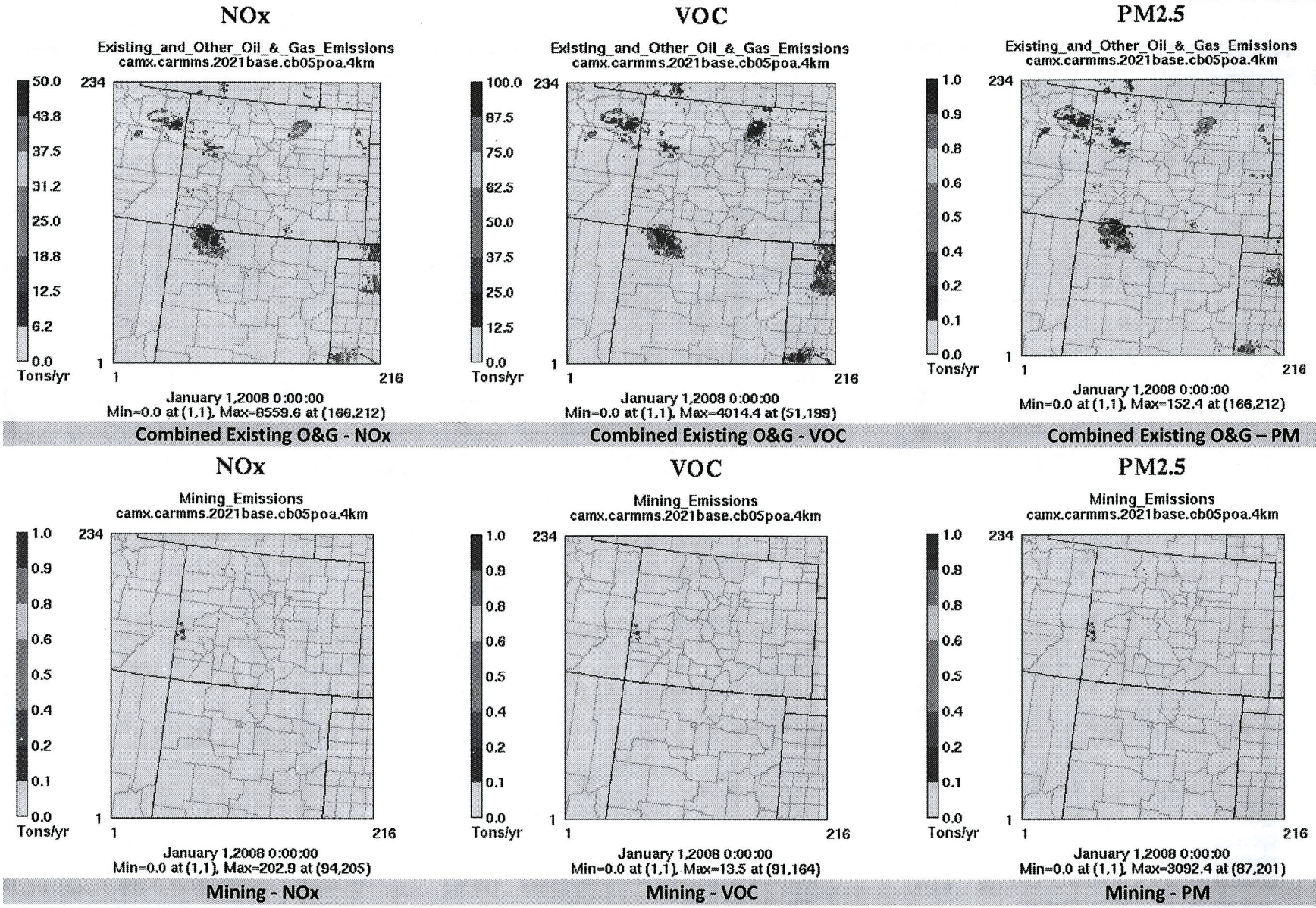

Figure 3-10b. Spatial distribution of Existing oil and gas (top) and mining on Federal lands NO_X, VOC and $PM_{2.5}$ emissions (tons per year) for the 14 BLM Planning Areas and the 2021 High Development Scenario.

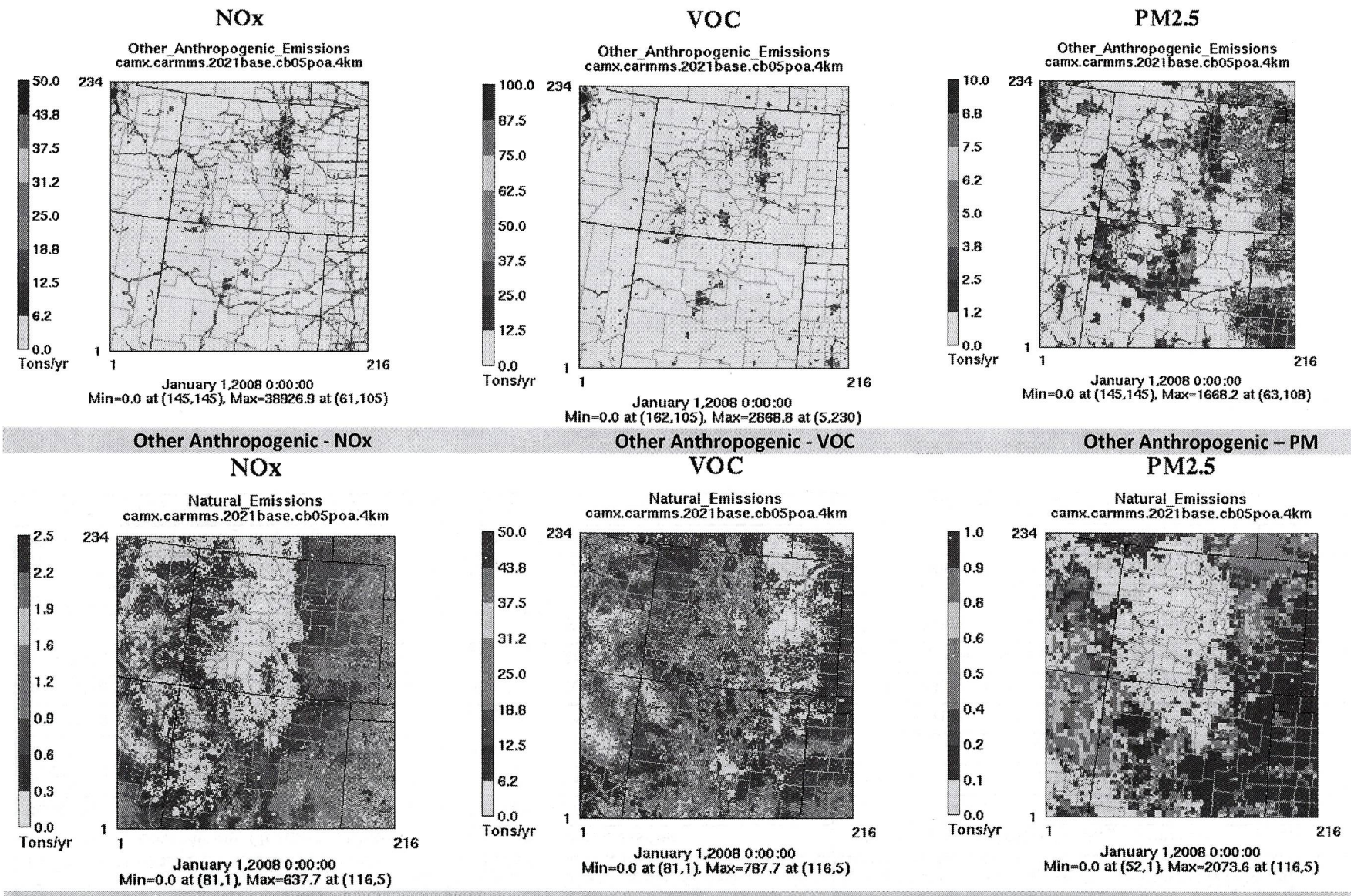

Figure 3-10c. Spatial distribution of other anthropogenic (top) and natural (biogenic, fires, lightning, sea salt and windblown dust) NO_X, VOC and $PM_{2.5}$ emissions (tons per year) for the 14 BLM Planning Areas and the 2021 High Development Scenario.

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Table 3-7. SCC number and description, $PM_{2.5}$ speciation profile code and name, and PM emissions for 95% of the mining emissions on Federal lands used in the CARMMS 2021 modeling

SCC	SCC Description	Profile	Profile name	PM2.5 (tpy)
30501099	Coal Mining, Cleaning & Material Handling /Other Not Classified	92047	Mineral Products - Avg - Simplified	1,717
30501022	Coal Mining, Cleaning & Material Handling /Drilling/Blasting	92047	Mineral Products - Avg - Simplified	1,460
30501011	Coal Mining, Cleaning & Material Handling /Coal Transfer	92047	Mineral Products - Avg - Simplified	1,449
30501015	Coal Mining, Cleaning & Material Handling /Loading	92047	Mineral Products - Avg - Simplified	457
30501049	Coal Mining, Cleaning & Material Handling /Wind Erosion: Exposed Areas	92022	Crustal Material - Simplified	403
30501038	Coal Mining, Cleaning & Material Handling /Truck Loading: Coal	92047	Mineral Products - Avg - Simplified	333
30501043	Coal Mining, Cleaning & Material Handling /Open Storage Pile: Coal	92047	Mineral Products - Avg - Simplified	113
30501024	Coal Mining, Cleaning & Material Handling /Hauling	92047	Mineral Products - Avg - Simplified	105
30504010	Mining & Quarrying Nonmetallic Minerals /Underground Ventilation	92073	Sand & Gravel - Simplified	72
30501040	Coal Mining, Cleaning & Material Handling /Truck Unloading: End Dump – Coal	92047	Mineral Products - Avg - Simplified	68
30501046	Coal Mining, Cleaning & Material Handling /Bulldozing: Coal	92047	Mineral Products - Avg - Simplified	67
30501009	Coal Mining, Cleaning & Material Handling /Raw Coal Storage	92047	Mineral Products - Avg - Simplified	61

Table 3-8. $PM_{2.5}$ speciation profiles used to speciate the mining PM emissions.

Profile	Pol	Species	Fraction
Mineral Products - Avg - Simplified			
92047	PM2_5	POA	7.4%
92047	PM2_5	PEC	1.5%
92047	PM2_5	PNO3	0.3%
92047	PM2_5	PSO4	14.1%
92047	PM2_5	PMFINE	76.8%
Crustal Material - Simplified			
92022	PM2_5	POA	7.5%
92022	PM2_5	PEC	0.2%
92022	PM2_5	PNO3	0.1%
92022	PM2_5	PSO4	0.2%
92022	PM2_5	PMFINE	92.0%
Sand & Gravel - Simplified			
92073	PM2_5	POA	0.0%
92073	PM2_5	PEC	0.0%
92073	PM2_5	PNO3	0.1%
92073	PM2_5	PSO4	0.3%
92073	PM2_5	PMFINE	99.7%

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4.0 FUTURE YEAR MODELING APPROACH

The CAMx source apportionment tool was used to obtain separate contributions of BLM authorized oil and gas development on Federal lands within 13 Colorado BLM Planning Areas plus the Mancos Shale Development area in northwestern New Mexico. This final report addresses the contributions to air quality (AQ) and air quality related value (AQRV) impacts associated with the 2021 High, Low and Medium Development Scenarios. The following sections describe how the CARMMS 2021 CAMx source apportionment modeling was conducted for the three scenarios and analyzed with the results presented in Chapter 5.

4.1 CARMMS Source Apportionment Modeling Approach

The CAMx Anthropogenic Precursor Culpability Assessment (APCA) version of the Ozone Source Apportionment Technology (OSAT) and the Particulate Source Apportionment Technology (PSAT) were used to obtain separate AQ and AQRV contributions due to BLM-authorized new oil and gas development on Federal lands for each of the 13 Colorado BLM Planning Areas and the Mancos Shale O&G development area within the New Mexico BLM Farmington Field Office (NMFFO) Planning Area (i.e., the 14 BLM Planning Areas). Separate source apportionment contributions from new oil and gas emissions on non-Federal lands and existing oil and gas within the combined 14 BLM Planning Areas was also obtained. Separate source apportionment of AQ/AQRV impacts associated with the 10 mines located within Colorado BLM Planning Areas discussed at the end of Section 3.1.5 was also obtained. Separate source apportionment contributions was also obtained for oil and gas emissions within the 4 km CARMMS domain outside of the 14 BLM Planning Areas, remainder anthropogenic emissions and natural emissions (i.e., biogenic sources, fires, lightning, windblown dust and sea salt).

4.1.1 Overview of Source Apportionment Tools

The CAMx OSAT/APCA ozone and PSAT PM source apportionment tools use reactive tracers that are released from each Source Group for which contributions are desired. These reactive tracers operate in parallel to the host photochemical grid model accessing the model's transport, dispersion, chemistry and deposition algorithms. For example, the OSAT/APCA ozone source apportionment tools represents each Source Group's ozone contributions using four reactive tracers that represent the Source Groups VOC emissions (V), NO_X emissions (N) and ozone attributed to the Source Group that is formed under more VOC-limited (O3V) and NO_X-limited (O3N) conditions. At each time step and in each grid cell, ozone formed is allocated to the Source Groups based on the Source Groups relative contribution of VOC or more NO_X emissions to the total VOC or NO_X concentrations after determination of whether ozone formation is more VOC-limited or more NO_X-limited. The APCA ozone source apportionment tool differs from OSAT in that it recognizes that some precursor emissions are not controllable so redirects ozone formed from the uncontrollable to the controllable Source Group. For example, when ozone is formed under VOC-limited conditions due to the interaction between biogenic VOC and anthropogenic NO_X emissions, a case OSAT would assign the ozone formed to the biogenic emissions Source Group, APCA redirects the ozone formed to the anthropogenic emissions Source Group recognizing that biogenic VOC emissions are not controllable and without the anthropogenic NO_X the ozone would not have been generated. In a CAMx APCA source apportionment run, the first Source Category specified in the run is

assumed to be the uncontrollable Source Group (typically natural emissions) and ozone will only be allocated to natural emissions when it is due to natural VOC and NO_X emissions interacting with each other (e.g., ozone formed due to reactions between biogenic VOC and biogenic NOx). For the CARMMS modeling, the natural emissions Source Group included biogenic, fires (wildfires, prescribed burns and agricultural burning), lightning, windblown dust and sea salt emissions. Although one could argue that emissions from prescribed burns and agricultural burning are not natural, emissions from wildfires dominate the fire emissions especially within the CARMMS 4 km domain.

For the CAMx PSAT PM source apportionment tool there are several families of PM source apportionment tracers that can be run separately or together that track the different components of PM. Each of these families has a different number of reactive tracers to track the pathway from the PM precursor emissions to the ultimate PM compounds. The five different families of PSAT source apportionment are as follows (number of tracers in parenthesis): Sulfate-SO4 (2); Nitrate/Ammonium-NO3/NH4 (7); Primary PM (6); Secondary Organic Aerosol-SOA (20) and Mercury-Hg (3). For CARMMS, we used the SO4, NO3/NH4 and Primary PM PSAT families of tracers so that 15 total reactive tracers are needed to track PM contribution for each Source Group. The Hg PSAT family was not used because mercury is not a focus of CARMMS and O&G sources have negligible Hg emissions. There are five SOA precursors treated in CAMx: toluene and xylene (aromatics), isoprene, terpene and sesquiterpene with biogenic sources contributing a majority of the SOA. O&G VOC emissions are dominated by light VOCs that do not form any SOA. We examined the speciation of the O&G emissions and found the five VOC species that are SOA precursors account for approximately 0.1 percent of the O&G VOC emissions. Thus, O&G emission VOCs would have a negligible contribution to SOA so the SOA family of PSAT source apportionment tracers was not used. The CARMMS annual source apportionment runs take over a month to complete and use of the SOA PSAT family would have more than doubled the number of tracers.

Thus, SOA is not included in the $PM_{2.5}$ and visibility impacts associated with Source Groups A through V that are based on the PSAT source apportionment modeling results. But SOA is included in the $PM_{2.5}$ and visibility impacts of Source Groups W and X that represents total emissions from the 2021 and 2008 emission scenarios.

4.1.2 CARMMS Source Apportionment Configuration

The APCA version of the OSAT and the SO4, NO3/NH4 and Primary PM (i.e., no SOA) families of PSAT source apportionment was used to track the AQ/AQRV contributions of new O&G development on Federal lands in 14 separate BLM Planning Areas for the 2021 High, Low and Medium Development Scenarios using the CARMMS 2008 4 km modeling platform. The 14 BLM Planning Areas where separate AQ/AQRV impacts due to new O&G development on Federal lands were simulated are shown in Figure 4-1. In total, the 2021 CAMx source apportionment modeling tracked AQ/AQRV contributions for 20 separate Source Categories in the order listed in Table 4-1. Because the APCA version of OSAT is being used, the first Source Category has to be natural emissions. The 2nd through 15th Source Categories correspond to new O&G emissions on Federal lands within the 13 Colorado BLM planning areas and the Mancos Shale development area within the BLM NMFFO lands (the 14 BLM Planning Areas).

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The 16th Source Category is the combined emissions from all new O&G within the 14 BLM Planning Areas on non-Federal lands. The 17th and 18th Source Categories are, respectively, existing O&G within the 14 BLM Planning Areas and mining on Federal lands within the 14 BLM Planning Areas[67]. The 19th Source Category is all O&G emissions (existing, new Federal and new non-Federal) outside of the 14 BLM Planning Areas (i.e., the yellow area in Figure 4-1). And the final (20th) Source Category is remaining anthropogenic emissions (e.g., point, mobile and area sources that are not O&G everywhere or mining on Federal lands within the 14 BLM Planning Areas).

Table 4-1. Ordering of the 20 Source Categories used in the CAMx 2021 source apportionment modeling.

1	Natural emissions (combined biogenic, fires, lightning, sea salt and WBD).
2	Little Snake FO
3	White River FO
4	Colorado River Valley FO (CRVFO)
5	Roan Plateau Planning area portion of CRVFO
6	Grand Junction FO
7	Uncompahgre FO
8	Tres Rios FO
9	Kremmling FO
10	Royal Gorge FO Area#1 (RGFO#1) -- North
11	Pawnee Grasslands portion of RGFO#1
12	RGFO#2 – West-Central/South
13	RGFO#3 – South
14	RGFO#4 – East-Central
15	New Mexico Farmington Field Office
16	Combined New O&G from non-Federal lands within the 14 BLM Planning Areas
17	Combined Existing O&G from 14 BLM Planning Areas
18	Mining from 14 BLM Planning Areas
19	All O&G (existing and new on Federal and non-Federal lands) in 4 km domain outside of the 14 BLM Planning Areas (see yellow region in Figure 1)
20	Remaining anthropogenic emissions (on-road and non-road mobile, point and area sources everywhere in 4 km domain)

[67] There were no mining emissions within the northern New Mexico Mancos Shale development area.

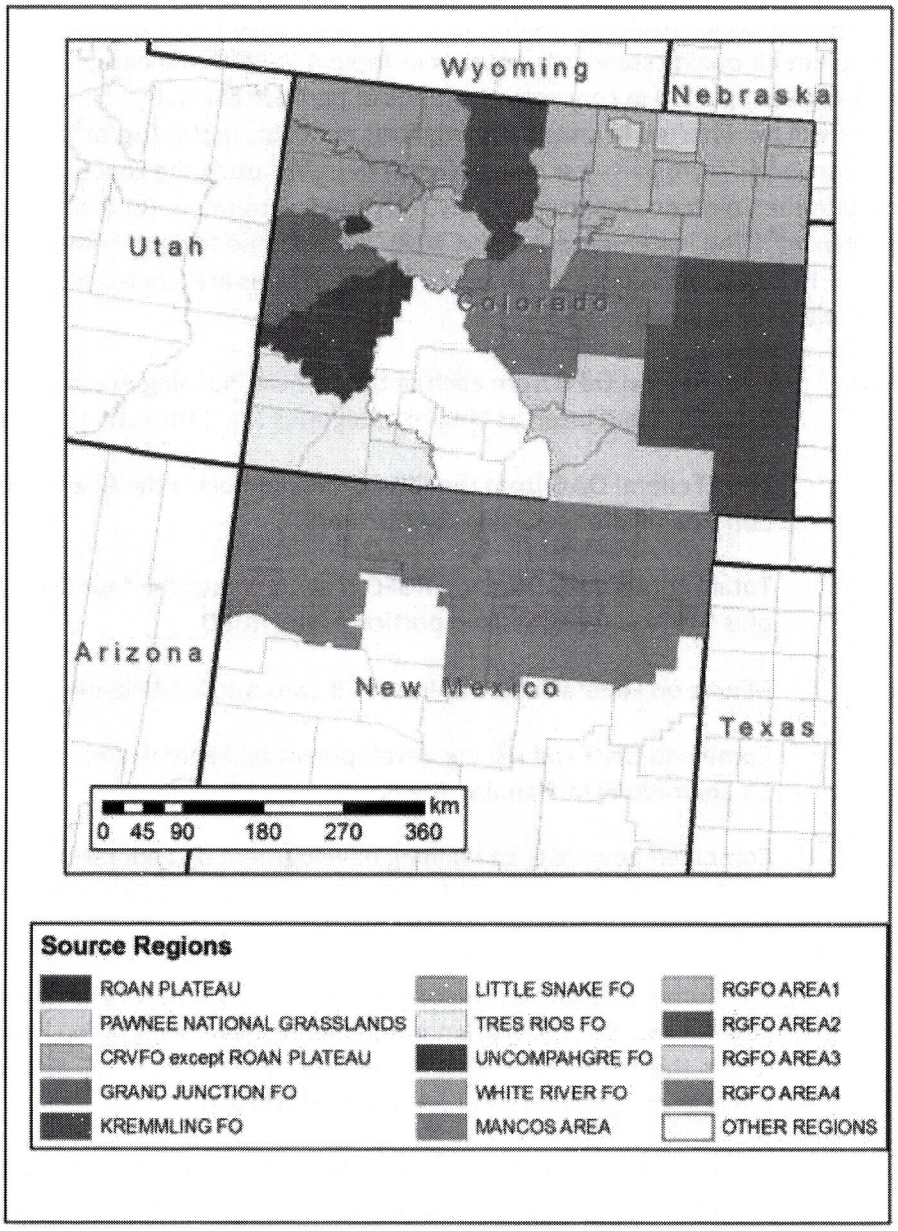

Figure 4-1. 13 Colorado and New Mexico BLM planning areas (the 14 BLM Planning Areas) where separate contributions of new O&G development on Federal lands was obtain for 2021 source apportionment modeling.

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4.2 Post-Processing of the CAMx 2021 Source Apportionment Modeling Results

The CAMx 2021 total concentrations results were post-processed for comparisons to the applicable ambient air quality standards as listed in Table 4-3. With the exception of ozone, where results will be reported in concentration units of part per billion by volume (ppb), all concentrations will be reported in units of micrograms per cubic meter ($\mu g/m^3$). Gas-phase species were converted from parts per million (ppm) to $\mu g/m^3$ using the conversion factor recommended in the Colorado Department of Health and Environment (CDPHE) air permit modeling guidance[68]. The incremental AQ and AQRV impacts due to each of the 24 Source Groups listed in Table 4-2 are reported. These 24 Source Groups are labeled A through X consist of the following sources:

(A - N) New Federal O&G from each of the 14 BLM Planning Areas as shown in Figure 4-1 and listed as Source Categories No. 2 through 15 in Table 4-1.

(O) Total Federal O&G from the CRVFO that combines the Roan Plateau and non-Roan Plateau portions of the CRVFO.

(P) Total Federal O&G from the RGFO that combines the four RGFO subregions plus the Pawnee Grassland portion of the RGFO.

(Q) Mining on Federal land within the 13 Colorado BLM Planning Areas.

(R) Combined O&G and mining development on Federal lands within all of the 13 Colorado BLM Planning Areas.

(S) Combined new O&G and mining development on Federal lands and new O&G development non-Federal lands within the 13 Colorado BLM Planning Areas.

(T) The Cumulative Emissions scenario that includes new O&G development on Federal and non-Federal lands and mining development on Federal lands within the 13 Colorado BLM Planning areas plus new O&G development for the Mancos Shale area in northern New Mexico.

(U) Emissions from all O&G development throughout the 4 km CARMMS domain (new Federal and non-Federal O&G through the domain plus Federal mining in Colorado).

(V) Natural emissions (biogenic, fires, lightning, WBD and sea salt).

(W) All emissions from the 2021 CAMx simulation (total concentrations).

(X) All emissions from the 2008 CAMx base case simulation (total concentrations).

[68] C [ppm] = C [$\mu g/m^3$] / (40.9 x MW), where MW = molecular weight in g/mole. This formula assumes 1 atmosphere pressure and 298 K temperature. http://www.colorado.gov/airquality/permits/guide.pdf

Table 4-2. 24 Source apportionment post-processing Source Groups that separate AQ/AQRV impacts at Class I and sensitive Class II areas will be disclosed for the 2021 emission scenarios and 2008 base case.

Processing Source Group	Source Group Name	Source Category No. (See Table 4-1)
A through N	See Table 4-1 for names of the new Federal O&G from the 14 BLM Planning Areas Source Categories #2 through #15	Separately #2 - #15
O	Total Colorado River Field Office	#4 and #5
P	Total Royal Gorge Field Office	#10, #11, #12 #13 and #14
Q	Mining from 13 Colorado BLM Planning Areas	#18
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	#2 -#14 and #18
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	#2 - #14 plus #16 and #18
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	#2 - #16 and #18
U	Combined O&G and Mining in 4 km domain	#2 - #19
V	Natural Emissions	#1
W	2021 All Emissions	#1 - #20
X	2008 Base Case All Emissions	--

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Table 4-3. Applicable National and State Ambient Air Quality Standards and PSD concentration increments (bold indicates units in which standard was defined, conversion to ppm/ppb following CDPHE modeling guidance and with the exception of ozone that will be reported in ppb, all modeled concentrations will be reported in $\mu g/m^3$).

Pollutant/Averaging Time	NAAQS	CAAQS[13]	NMAAQS[14]	PSD Class I Increment[1]	PSD Class II Increment[1]
CO					
1-hour[2]	**35 ppm** 40,000 $\mu g/m^3$	--	**13.1 ppm** 1,100 $\mu g/m^3$	--	--
8-hour[2]	**9 ppm** 10,000 $\mu g/m^3$	--	**8.7 ppm** 10,000 $\mu g/m^3$	--	--
NO_2					
1-hour[3]	**100 ppb** 188 $\mu g/m^3$	--	--	--	--
24-hour	--	--	**0.10 ppm** 1,953 $\mu g/m^3$	--	--
Annual[4]	**53 ppb** 100 $\mu g/m^3$	--	**0.05 ppm** 98 $\mu g/m^3$	2.5 $\mu g/m^3$	25 $\mu g/m^3$
O_3					
8-hour[5]	**0.075 ppm** 147 $\mu g/m^3$	--	--	--	--
PM_{10}					
24-hour[6]	**150 $\mu g/m^3$**	--	--	8 $\mu g/m^3$	30 $\mu g/m^3$
Annual[7]	--	--	--	4 $\mu g/m^3$	17 $\mu g/m^3$
$PM_{2.5}$					
24-hour[8]	**35 $\mu g/m^3$**	--	--	2 $\mu g/m^3$	9 $\mu g/m^3$
Annual[9]	**12 $\mu g/m^3$**	--	--	1 $\mu g/m^3$	4 $\mu g/m^3$
SO_2					
1-hour[10]	**75 ppb** 196 $\mu g/m^3$	--	--		
3-hour[11]	**0.5 ppm** 1,300 $\mu g/m^3$	**700 $\mu g/m^3$**	--	25 $\mu g/m^3$	512 $\mu g/m^3$
24-hour[12]	--	--	**0.10 ppm** 262 $\mu g/m^3$	5 $\mu g/m^3$	91 $\mu g/m^3$
Annual[4]	--	--	**0.02 ppm** 52 $\mu g/m^3$	2 $\mu g/m^3$	20 $\mu g/m^3$

1. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2. No more than one exceedance per calendar year; for NMAAQS - No more than one exceedance per consecutive 12 months
3. 98th percentile, averaged over 3 year; for NMAAQS - not to be exceeded more than once over any 12 consecutive months
4. Annual mean not to be exceeded; for NMAAQS - arithmetic average over any four consecutive quarters not to be exceeded
5. Fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years
6. Not to be exceeded more than once per calendar year on average over 3 years.
7. 3 year average of the arithmetic means over a calendar year
8. 98th percentile, averaged over 3 years
9. Annual mean, averaged over 3 years, NAAQS promulgated December 14, 2012
10. 99th percentile of daily maximum 1-hour concentrations in a year, averaged over 3 years
11. No more than one exceedance per calendar year (secondary NAAQS) and no more than one exceedance in 12 consecutive months (CAAQS)
12. For areas in New Mexico not within 3.5 miles of the Chino Mines Company
13. http://www.colorado.gov/cs/Satellite/CDPHE-Main/CBON/1251601911433
14. http://www.nmcpr.state.nm.us/nmac/parts/title20/20.002.0003.htm

4.3 Class I and Sensitive Class II Areas for Analysis

The BLM COSO and NMSO and their contractors worked with the IAQRT to identify the Class I and sensitive Class II areas where the AQ/AQRV impacts due to O&G development on Federal lands within the Colorado BLM Planning Areas would be assessed. With the addition of the Mancos Shale development area in northwest New Mexico in the CARMMS analysis, the BLM NMSO reached out to the IAQRT to assist in identifying additional Class I and sensitive Class II areas to analyze in the analysis. Responses were received from NPS, USFS and FWS and a Technical Memorandum was prepared dated September 2, 2014 (Parker and Morris, 2014) for the NMSO that identified the Class I and sensitive Class II areas for the CARMMS analysis. Although the Class I area list did not change, several additional sensitive Class II areas were added to the CARMMS post-processing list that were within 300 km of the Mancos Shale development area.

The Class I and sensitive Class II areas were also analyzed and a few areas that overlapped or were adjacent were consolidated. In addition, new shapefiles of the Class I/II areas were acquired and GIS analysis was performed to define the grid cell definition of the Class I/II areas. This resulted in changes to the grid cell definitions of the Class I/II areas (i.e., receptors) from what was used in the CARMMS May 2014 preliminary draft report. Section 4.3.1 describes the procedures used and examples on how the grid cell definitions of the Class II/II areas were performed.

4.3.1 Final Class I and Sensitive Class II Areas

The Class I areas where air quality and AQRV impacts were calculated within the 4 km CARMMS modeling domain are displayed in Figure 4-2 and listed in Table 4-4. The sensitive Class II areas used in the CARMMS post-processing are displayed in Figure 4-3 by FLM ownership and listed in Table 4-5. Note that several of the Class I areas are portions of a sensitive Class II area. In total, the CARMMS modeling results were post-processed using 26-27 and 58 Class I and sensitive Class II areas, respectively. Details on how the sensitive Class II areas were defined are provided in Parker and Morris (2014). Note that the Colorado side of Dinosaur National Monument is considered PSD Class I for just SO_2. Sensitive lakes in the region where acid neutralizing capacity (ANC) calculations will be made are listed in Table 4-6.

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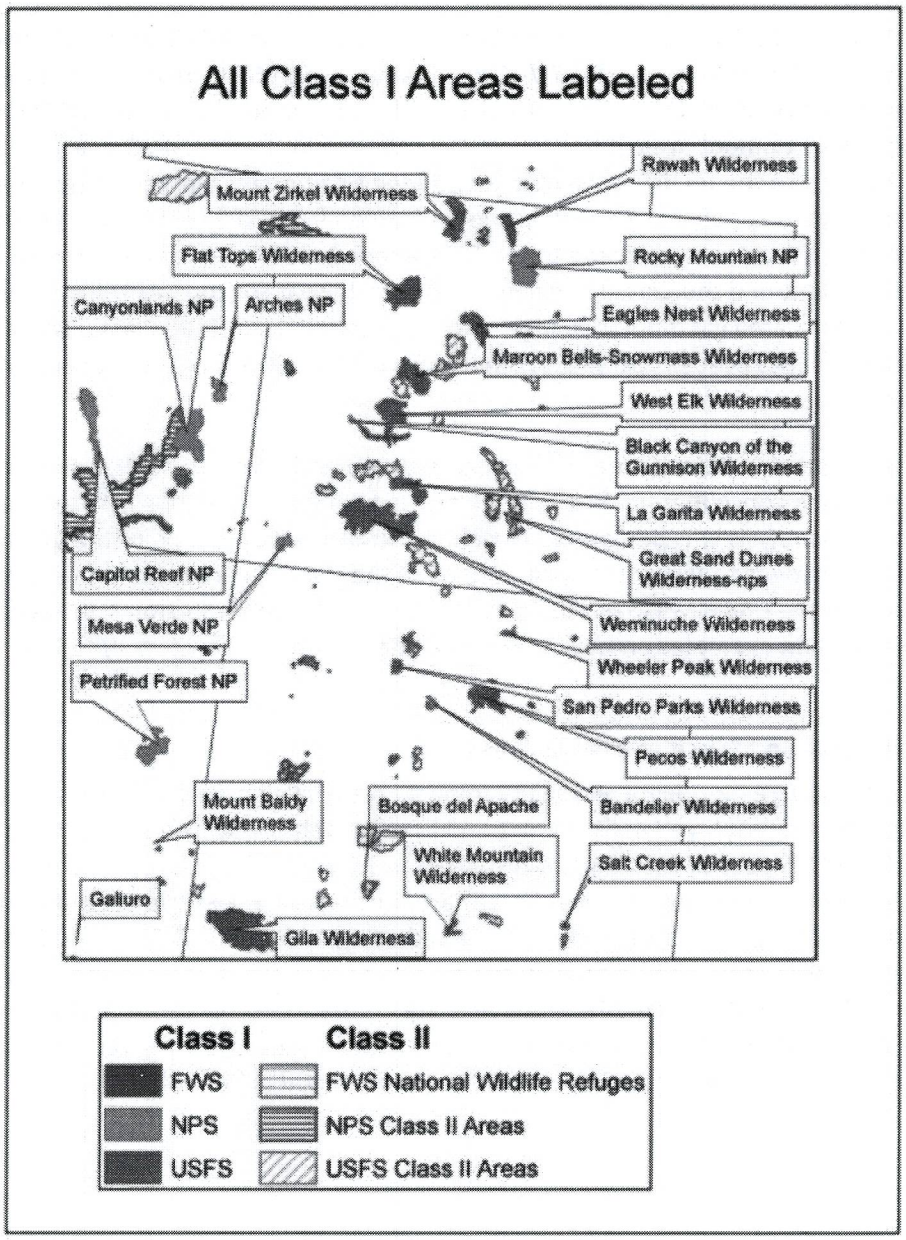

Figure 4-2. Locations of Class I (dark green) and sensitive Class II (light green) areas where air quality and AQRV impacts were assessed as well as sensitive lakes (blue dots) where ANC calculations will be made (Class I areas are labeled).

Table 4-4. List of Class I Areas for Impact Analysis

Class I Area	State	FLM
Arches NP	UT	NPS
Bandelier Wilderness	NM	NPS
Black Canyon of the Gunnison National Park	CO	NPS
Bosque del Apache Wilderness	NM	FWS
Canyonlands NP	UT	NPS
Capitol Reef NP	UT	NPS
Eagles Nest Wilderness	CO	USFS
Flat Tops Wilderness	CO	USFS
Galiuro Wilderness	AZ	USFS
Gila Wilderness	NM	USFS
Great Sand Dunes Wilderness-NPS	CO	NPS
La Garita Wilderness	CO	USFS
Maroon Bells-Snowmass Wilderness	CO	USFS
Mesa Verde NP	CO	NPS
Mount Baldy Wilderness	AZ	USFS
Mount Zirkel Wilderness	CO	USFS
Pecos Wilderness	NM	USFS
Petrified Forest NP	AZ	NPS
Rawah Wilderness	CO	USFS
Rocky Mountain NP	CO	NPS
Salt Creek Wilderness	NM	FWS
San Pedro Parks Wilderness	NM	USFS
Weminuche Wilderness	CO	USFS
West Elk Wilderness	CO	USFS
Wheeler Peak Wilderness	NM	USFS
White Mountain Wilderness	NM	USFS
Dinosaur NM[1]	UT & CO	NPS
1. The Colorado side of Dinosaur NM is PSD Class I for SO_2		

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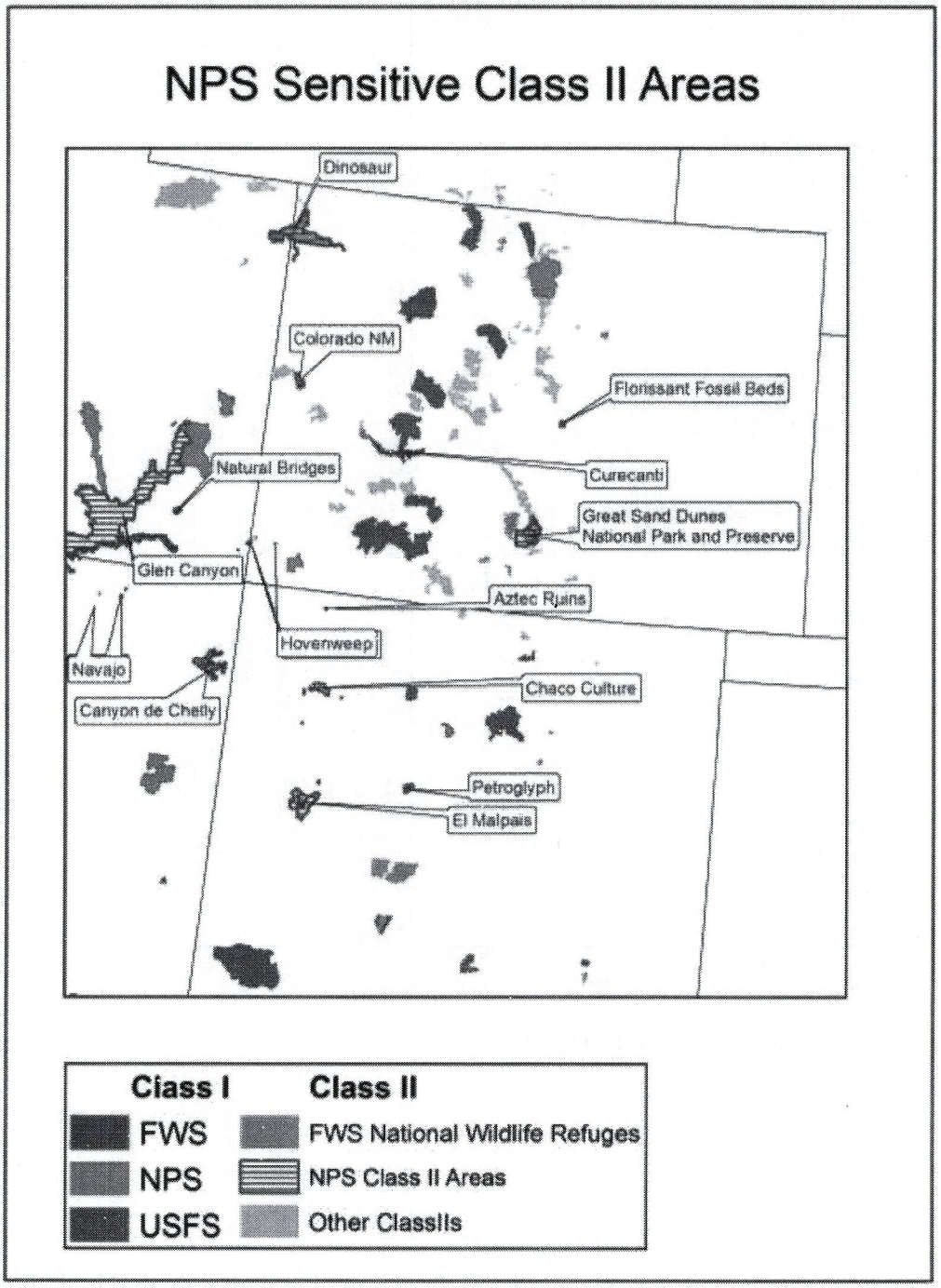

Figure 4-3a. NPS sensitive Class II areas for the CARMMS analysis labeled. Class I areas and non-NPS sensitive Class II areas unlabeled.

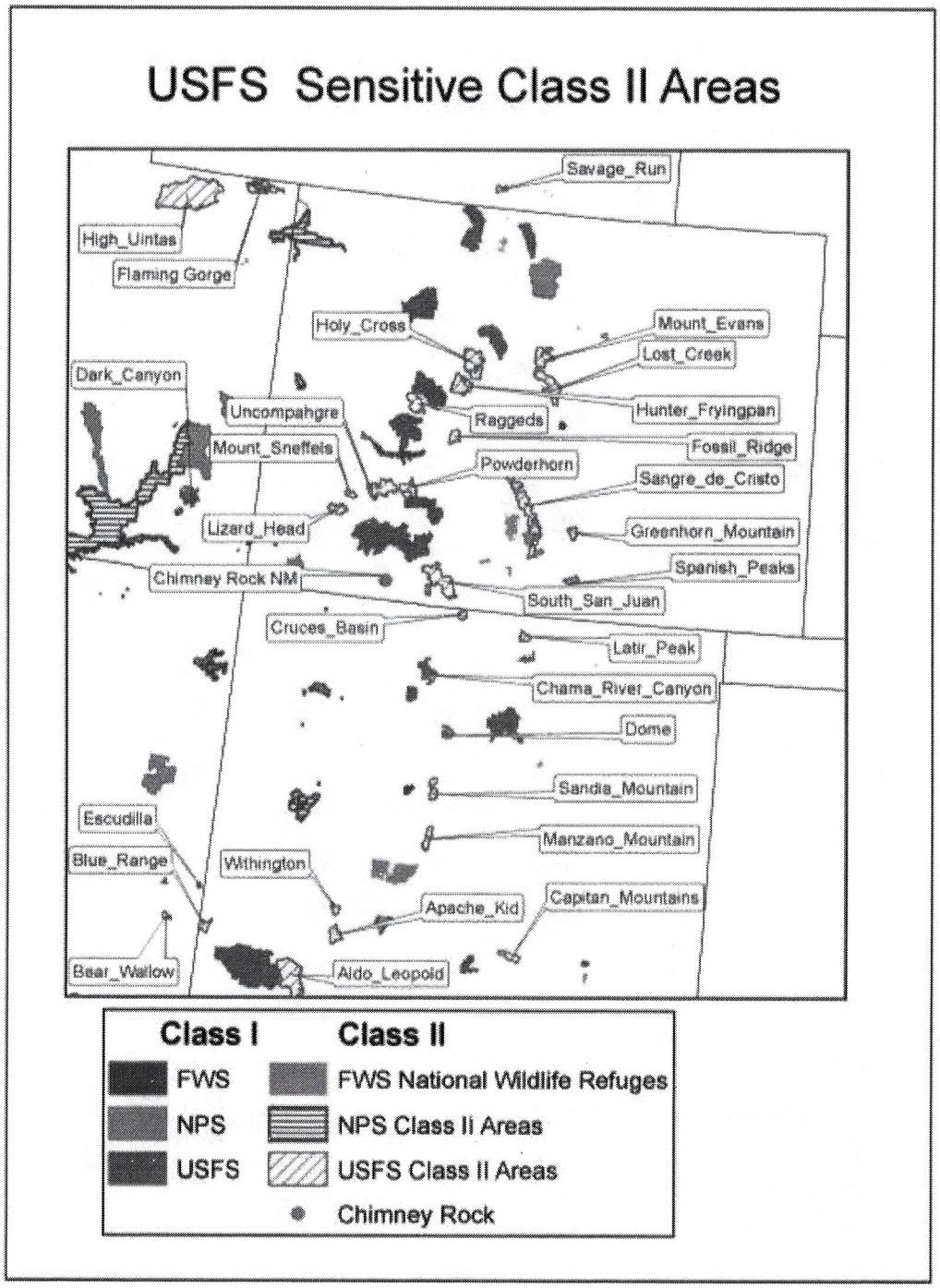

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Figure 4-3b. USFS sensitive Class II areas for the CARMMS analysis labeled. Class I area and non-USFS Class II areas displayed but not labeled.

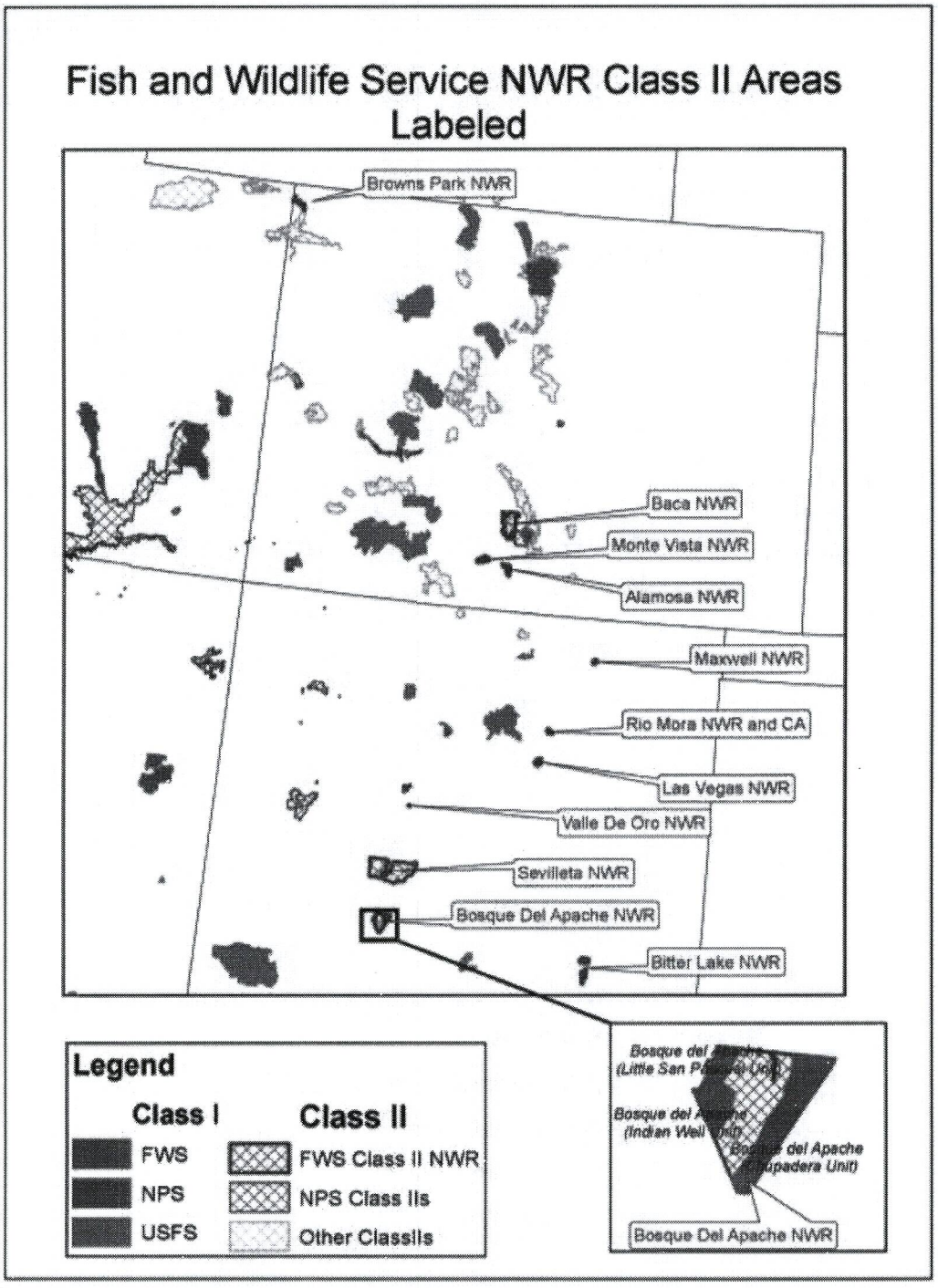

Figure 4-3c. FWS sensitive Class II areas for the CARMMS analysis labeled. Class I areas and non-FWS areas shown but not labeled.

Table 4-5. Sensitive Class II areas where air quality and AQRV impacts were assessed.

Sensitive Class II Area	State	FLM
Alamosa NWR	CO	FWS
Aldo Leopold Wilderness	NM	USFS
Apache Kid Wilderness	NM	USFS
Aztec Ruins NM	NM	NPS
Baca NWR	CO	FWS
Bear Wallow Wilderness	AZ	USFS
Bitter Lake NWR	NM	FWS
Blue Range Wilderness	NM	USFS
Bosque Del Apache NWR	NM	FWS
Browns Park NWR	CO	FWS
Canyon de Chelly NM	AZ	NPS
Capitan Mountains Wilderness	NM	USFS
Chaco Culture NHP	NM	NPS
Chama River Canyon Wilderness	NM	USFS
Chimney Rock NM	CO	USFS
Colorado NM	CO	NPS
Cruces Basin Wilderness	NM	USFS
Curecanti NRA	CO	NPS
Dark Canyon Wilderness	UT	USFS
Dinosaur NM	CO	NPS
Dome Wilderness	NM	USFS
El Malpais NM	NM	NPS
Escudilla Wilderness	AZ	USFS
Flaming Gorge	UT	USFS
Florissant Fossil Beds NM	CO	NPS
Fossil Ridge Wilderness	CO	USFS
Glen Canyon NRA	UT	NPS
Great Sand Dunes National Park	CO	NPS
Great Sand Dunes National Preserve	CO	NPS
Greenhorn Mountain Wilderness	CO	USFS
High Uintas Wilderness	UT	USFS
Holy Cross Wilderness	CO	USFS
Hovenweep NM	CO	NPS
Hunter-Fryingpan Wilderness	CO	USFS
Las Vegas NWR	NM	FWS
Latir Peak Wilderness	NM	USFS
Lizard Head Wilderness	CO	USFS
Lost Creek Wilderness	CO	USFS
Manzano Mountain Wilderness	NM	USFS
Maxwell NWR	NM	FWS
Monte Vista NWR	CO	FWS
Mount Evans Wilderness	CO	USFS
Mount Sneffels Wilderness	CO	USFS
Natural Bridges NM	UT	NPS
Navajo NM	AZ	NPS

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Table 4-6. Sensitive lakes where ANC calculations were made.

Lake	National Forest Name	Wilderness Name
Walk Up Lake	Ashley National Forest	
Tabor Lake	White River National Forest	Collegiate Peaks Wilderness
Brooklyn Lake	White River National Forest	Collegiate Peaks Wilderness
Booth Lake	White River National Forest	Eagles Nest Wilderness
Upper Willow Lake	White River National Forest	Eagles Nest Wilderness
Upper Ned Wilson Lake	White River National Forest	Flat Tops Wilderness
Lower Nwl Packtrail Pothole	White River National Forest	Flat Tops Wilderness
Ned Wilson Lake	White River National Forest	Flat Tops Wilderness
Upper Nwl Packtrail Pothole	White River National Forest	Flat Tops Wilderness
Dean Lake	Ashley National Forest	High Uintas Wilderness
No Name (Utah; Duchesne - 4d2-039)	Ashley National Forest	High Uintas Wilderness
Fish Lake	Wasatch-Cache National Forest	High Uintas Wilderness
Bluebell	ASHLEY NATIONAL FOREST	HIGH UINTAS WILDERNESS
Upper Coffin	Ashley National Forest	High Uintas Wilderness
Blodgett Lake, Colorado	White River National Forest	Holy Cross Wilderness
Upper Turquoise Lake	White River National Forest	Holy Cross Wilderness
Upper West Tennessee Lake	San Isabel National Forest	Holy Cross Wilderness
Blue Lake (Colorado; Boulder - 4e1-040)	Arapaho And Roosevelt National Forests	Indian Peaks Wilderness
No Name (Colorado; Boulder - 4e1-055)	Arapaho And Roosevelt National Forests	Indian Peaks Wilderness
King Lake (Colorado; Grand - 4e1-049)	Arapaho And Roosevelt National Forests	Indian Peaks Wilderness
Crater Lake (Colorado; Grand - 4e1-041)	Arapaho And Roosevelt National Forests	Indian Peaks Wilderness
Upper Lake	Arapaho And Roosevelt National Forests	Indian Peaks Wilderness
Small Lake Above U-Shaped Lake	Rio Grande National Forest	La Garita Wilderness
U-Shaped Lake	Rio Grande National Forest	La Garita Wilderness
Moon Lake (Upper)	White River National Forest	Maroon Bells-Snowmass Wilderness
Avalanche Lake	White River National Forest	Maroon Bells-Snowmass Wilderness
Capitol Lake	White River National Forest	Maroon Bells-Snowmass Wilderness
Upper Middle Beartrack Lake	Arapaho And Roosevelt National Forests	Mount Evans Wilderness
South Lake (Colorado)	Pike And San Isabel National Forests	Mount Evans Wilderness
Abyss Lake	Pike And San Isabel National Forests	Mount Evans Wilderness
North Lake (Colorado)	Pike And San Isabel National Forests	Mount Evans Wilderness
Frozen Lake	Pike And San Isabel National Forests	Mount Evans Wilderness
Seven Lakes (Lg.East)	Medicine Bow-Routt National Forest	Mount Zirkel Wilderness
Summit Lake (Colorado;	Medicine Bow-Routt National Forest	Mount Zirkel Wilderness

Lake	National Forest Name	Wilderness Name
Jackson - 4e2-060)		
Lake Elbert	Medicine Bow-Routt National Forest	Mount Zirkel Wilderness
Deep Creek Lake, Colorado	Gunnison National Forest	Raggeds Wilderness
Rawah Lake #4	Arapaho And Roosevelt National Forests	Rawah Wilderness
Island Lake	Arapaho And Roosevelt National Forests	Rawah Wilderness
Kelly Lake (Colorado)	Arapaho And Roosevelt National Forests	Rawah Wilderness
Upper Stout Lake	San Isabel National Forest	Sangre De Cristo Wilderness
Upper Little Sand Creek Lake	San Isabel National Forest	Sangre De Cristo Wilderness
Lower Stout Lake	San Isabel National Forest	Sangre De Cristo Wilderness
Crater Lake (Sangre De Cristo)	Rio Grande National Forest	Sangre De Cristo Wilderness
Lake South Of Blue Lakes	San Juan-Rio Grande National Forest	South San Juan Wilderness
Glacier Lake (Colorado)	San Juan-Rio Grande National Forest	South San Juan Wilderness
Little Eldorado Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
White Dome Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Lake Due South Of Ute Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Big Eldorado Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Small Pond Above Trout Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Upper Sunlight Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Upper Grizzly Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
West Snowdon Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Middle Ute Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Little Granite Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Lower Sunlight Lake	San Juan-Rio Grande National Forest	Weminuche Wilderness
Four Mile Pothole	San Juan-Rio Grande National Forest	Weminuche Wilderness
South Golden Lake	Grand Mesa, Uncompahgre And Gunnison National Forests	West Elk Wilderness

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4.3.2 Class I and Sensitive Class II Area Grid Cell Assignments

The list of CAMx grid cells that represent each Class I/II area changed slightly between the preliminary analysis as documented in the May 2014 report and the final analysis reported here. For some of the Class I/II areas, the CAMx grid cells used to represent the areas are identical in the preliminary and final analyses, these areas include Galiuro Wilderness, Mt Baldy Wilderness and Colorado NM. For some other Class I/II areas, the CAMx grid cells used to represent the areas differ by a single grid cell (of about 100 total grid cells). The final results for these areas are usually expected to be very close to the preliminary results, those areas include Canyonlands National Park and Rocky Mountain National Park. Some of the other Class I/II areas have more grid cell differences between the preliminary and final analysis.

Determining the grid cells that represent the Class I/II areas is achieved with Graphical Information System (GIS) software, and is performed by intersecting the CAMx model grid cells

with GIS shapefiles that define the Class I/II boundaries. Different GIS tools are available to perform the intersection that assigns a Class I/II designation to each grid cell, and different input shapefiles defining the boundaries are also available.

To generate the grid cells for the final analysis, we used official Class I boundary shapefiles that are available for download from the NPS website[69]. The GIS tool "spatial join" was used to assign a Class I/II area to each CAMx grid cell if any part of the Class I/II area intersects the grid cell, even if the Class I/II area only covers a small fraction of the grid cell. For example, Figure 4-4 displays the La Garita Wilderness Class I area boundary and grid cells (receptors) representing that area, the numbers displayed in the grid cells are the i and j coordinates of the CARMMS 4 km domain modeling grid. In Figure 4-4 it can be seen that many of the grid cells covering the boundary of La Garita have more than 50% of the grid cell area outside of the La Garita boundary, these grid cells may not have been used in the preliminary analysis. In fact there are numerous grid cells assigned to the La Garita Wilderness where the Class I area covers less than 10 percent of the grid cell. The inclusion of any grid cell that intersects any part of the Class I area no matter how small introduces conservatisms in the analysis. In addition, for the final processing, attention was paid to grid cells that cover more than one Class I/II area, in those cases, a particular grid cell was used twice to represent 2 different neighboring Class I/II areas. Figure 4-5 provides an example of a grid cell (56_153) that is used to represent both Black Canyon of the Gunnison Class I area and Curecanti NPS Class II area. Figure 4-6 displays a quality assurance (QA) plot showing all the Class I areas (including the Colorado side of Dinosaur NM, since it is considered a Class I area for SO_2), overlaid with the grid cells used to represent the Class I/II areas in the final analysis.

[69] http://www.nature.nps.gov/air/maps/classiloc.cfm

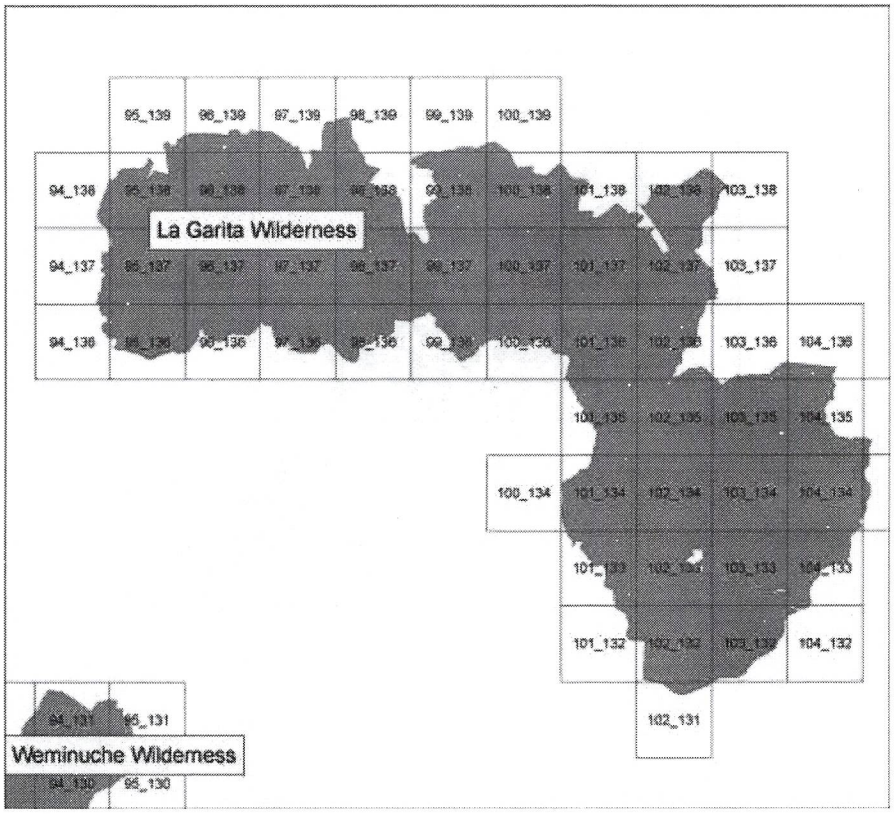

Figure 4-4. La Garita Wilderness Area represented by 4 km grid cells.

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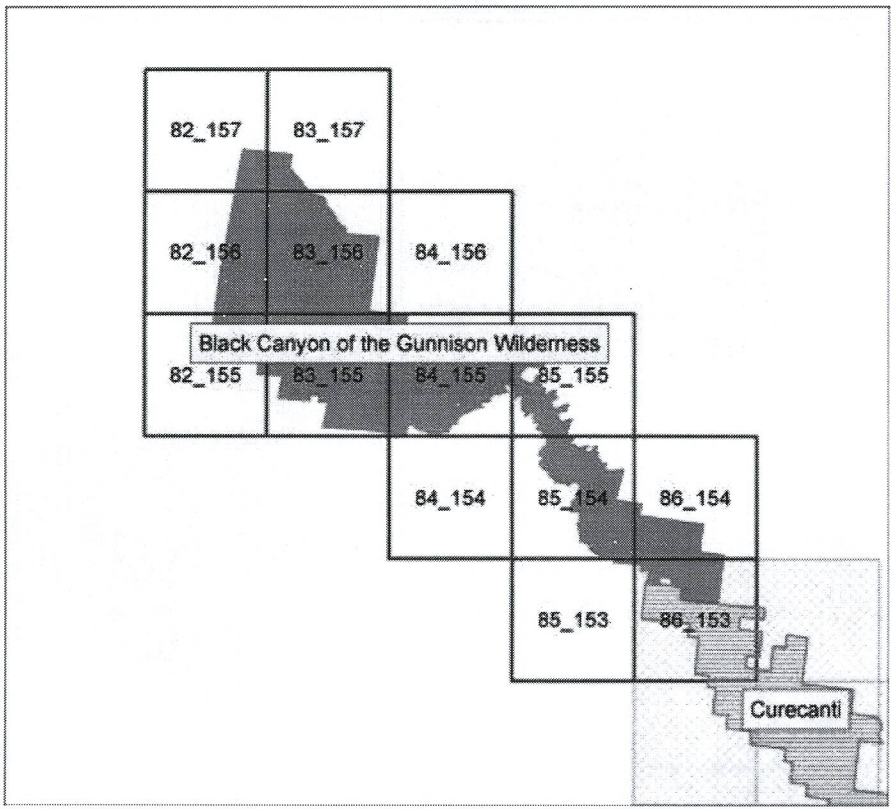

Figure4-5. Example of Black Canyon of the Gunnison Class I area grid cell overlap with Curecanti Class II area.

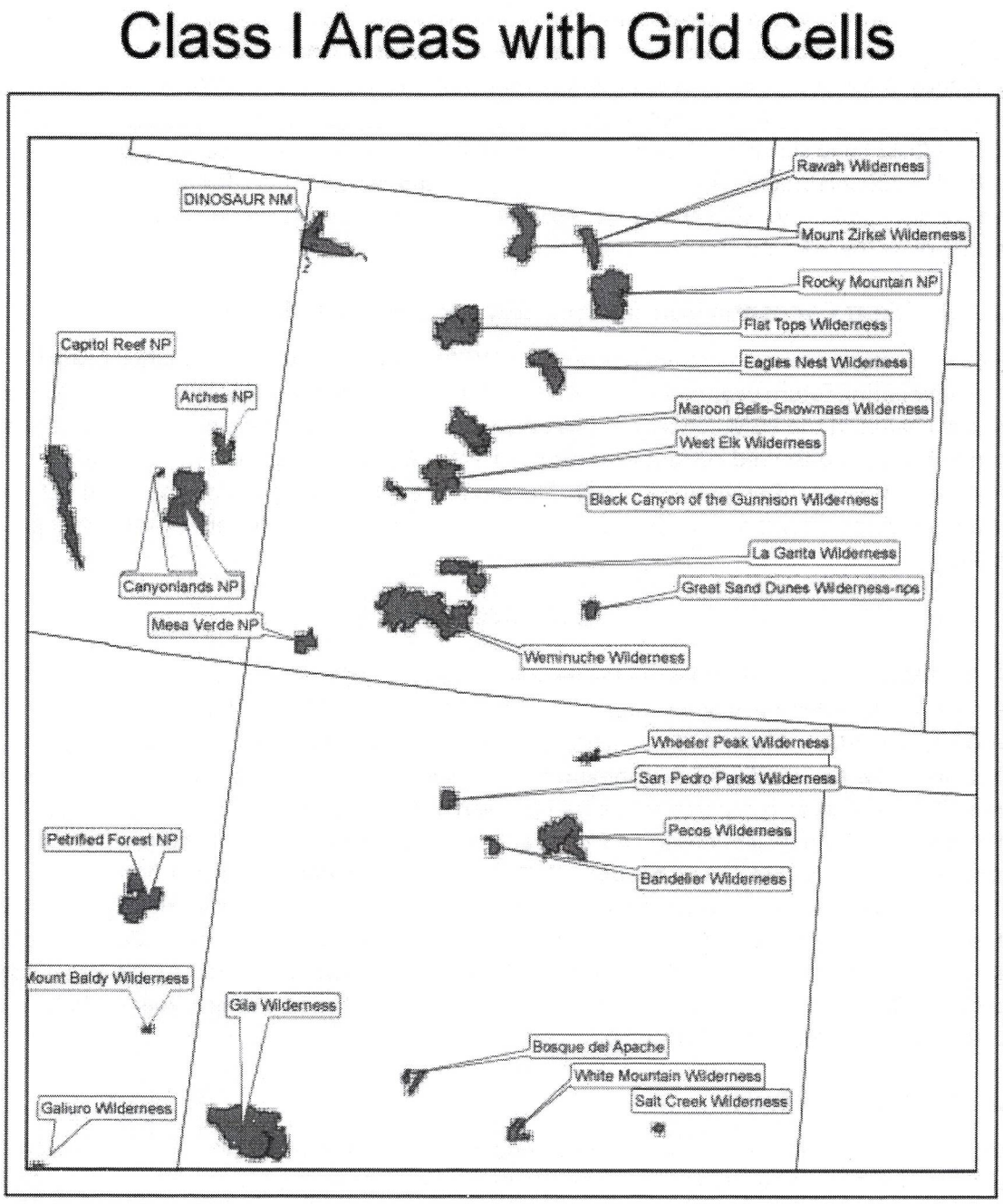

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Figure 4-6. QA Plot showing all Class I Areas and CARMMS 4 km grid cell receptors that represent the areas.

4.4 Ambient Concentration Analysis using Absolute Modeling Results

Modeled concentrations predicted by the CAMx due to all sources were compared against national and state standards (NAAQS, CAAQS and NMAAQS, see Table 4-3) throughout the 4 km modeling domain. When exceedances of the ozone or $PM_{2.5}$ NAAQS are estimated, the APCA and PSAT source apportionment results was used to determine the contribution of emissions from each of the Source Groups to determine the major cause of the modeled exceedance. The incremental air quality concentration contribution due to emissions from oil and gas on Federal lands at Class I and sensitive Class II areas for each BLM planning area were compared to applicable PSD increments (see Table 4-3). The PSD demonstrations are for information only and are not regulatory PSD Increment consumption analyses, which would be completed as necessary by the relevant state or other agency.

4.5 Ambient Concentration Analysis using Relative Modeling Results

EPA's modeling guidance recommends using the PGM modeling results in a relative fashion when comparing future year modeling results to the ozone and $PM_{2.5}$ NAAQS (EPA, 2007). The relative change in the PGM concentrations between the current and future year simulations are used to scale the observed current year ozone or $PM_{2.5}$ Design Value (DVC) to obtain a projected future year Design Value (DVF). The model derived scaling factors are called Relative Response Factors (RRFs) and are based on the ratio of future year to current year modeling results:

$$DVF = DVC \times RRF$$

EPA's PGM modeling guidance provides recommended procedures for calculating DVCs and RRFs (EPA, 2007) that have been implemented in EPA's Modeled Attainment Test Software (MATS[70]; Abt, 2012). The MATS projection tool was used with the CAMx 2008 Base Case and 2021 High, Low and Medium Development Scenarios modeling results to project future year ozone DVFs that were compared to the NAAQS. MATS also has a capability of projecting $PM_{2.5}$ DVFs but there is much less observed $PM_{2.5}$ data in the region so such projections would be extremely limited, so MATS was not used for $PM_{2.5}$. The MATS default settings for making future year ozone projections were used that includes using a current year Design Value (DVC) based on an average of three-years of Design Values (DVs) centered on the Base Case modeling year (2008) and constructing RRFs using at least 10 days of modeling results. As the Base Case year is 2008, then this means using a DVC based on DVs from the following 3-year periods, 2006-2008, 2007-2009 and 2008-2010.

4.6 Visibility Analysis

Visibility impacts were calculated for new oil and gas emissions on Federal lands within each BLM Planning Areas as well as for cumulative emissions sources. The approach used the incremental concentrations as quantified by the CAMx PSAT tool simulation of oil and gas and mining activities within each BLM planning area. Changes in light extinction from CAMx model

[70] http://www.epa.gov/ttn/scram/modelingapps_mats.htm

concentration increments due to emissions from oil and gas and other activity emissions were calculated for each day at grid cells that intersect Class I and sensitive Class II areas within the 4 km modeling domain (see Section 4.3.2). The FLAG (2010) procedures were used in the incremental BLM planning area-specific visibility assessment analysis.

The visibility evaluation metric used in this analysis is based on the Haze Index which is measured in deciview (dv) units and is defined as follows:

$$HI = 10 \times \ln[b_{ext}/10] .$$

b_{ext} is the atmospheric light extinction measured in inverse megameters (Mm^{-1}) and is calculated primarily from atmospheric concentrations of particulates. A more intuitive measure of haze is visual range (VR), which is defined as the distance at which a large black object just disappears from view, and is measured in km. Visual range is related to b_{ext} by the formula VR = 3912 / b_{ext}. Visual range will not be used as a threshold in the analysis, but could be back-calculated from extinction to give a more easily understood visibility metric.

The incremental concentrations due to BLM planning area emissions were added to background concentrations in the extinction equation (b_{ext}) and the difference between the Haze Index with added BLM planning area concentrations to the Haze Index based solely on background concentrations is calculated. This quantity is the change in Haze Index, which is referred to as "delta deciview" (Δdv) :

$$\Delta dv = 10 \times \ln[b_{ext(BLM+background)}/10] - 10 \times \ln[b_{ext(background)}/10]$$

$$\Delta dv = 10 \times \ln[b_{ext(BLM+background)}/b_{ext(background)}]$$

Here $b_{ext(BLM+background)}$ refers to atmospheric light extinction due to oil and gas and other activities in each BLM planning area plus background concentrations, and $b_{ext(background)}$ refers to atmospheric light extinction due to background concentrations only.

For each individual BLM Planning Areas, the estimated visibility degradation at the Class I areas and sensitive Class II areas due to new O&G emissions on Federal lands are presented in terms of the number of days that exceed a threshold change in deciview (Δdv) relative to background conditions. In the next section we describe the method for calculating the extinction, b_{ext}.

4.6.1 IMPROVE Reconstructed Mass Extinction Equations

The FLAG (2010) procedures for evaluating visibility impacts at Class I areas use the revised IMPROVE reconstructed mass extinction equation to convert PM species in μgm^{-3} to light extinction (b_{ext}) in inverse megameters (Mm^{-1}) as follows:

$$b_{ext} = b_{SO4} + b_{NO3} + b_{EC} + b_{OCM} + b_{Soil} + b_{PMC} + b_{SeaSalt} + b_{Rayleigh} + b_{NO2}$$

where

$$b_{SO4} = 2.2 \times f_S(RH) \times [\text{Small Sulfate}] + 4.8 \times f_L(RH) \times [\text{Large Sulfate}]$$

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$$b_{NO3} = 2.4 \times f_S(RH) \times [\text{Small Nitrate}] + 5.1 \times f_L(RH) \times [\text{Large Nitrate}]$$

$$b_{OCM} = 2.8 \times [\text{Small Organic Mass}] + 6.1 \times [\text{Large Organic Mass}]$$

$$b_{EC} = 10 \times [\text{Elemental Carbon}]$$

$$b_{Soil} = 1 \times [\text{Fine Soil}]$$

$$b_{CM} = 0.6 \times [\text{Coarse Mass}]$$

$$b_{SeaSalt} = 1.7 \times f_{SS}(RH) \times [\text{Sea Salt}]$$

$$b_{Rayleigh} = \text{Rayleigh Scattering (Site-specific)}$$

$$b_{NO2} = 0.33 \times [NO_2 \text{ (ppb)}] \{\text{or as: } 0.1755 \times [NO_2 (\mu g/m^3)]\}.$$

f(RH) are relative humidity adjustment factors that account for the fact that sulfate, nitrate and sea salt aerosols are hygroscopic and are more effective at scattering radiation at higher relative humidity. FLAG (2010) recommends using monthly average f(RH) values rather than the hourly averages recommended in the previous FLAG (2000) guidance document in order to moderate the effects of extreme weather events on the visibility results.

The revised IMPROVE equation treats "large sulfate" and "small sulfate" separately because large and small aerosols affect an incoming beam of light differently. However, the IMPROVE measurements do not separately measure large and small sulfate; they measure only the total $PM_{2.5}$ sulfate. Similarly, CAMx writes out a single concentration of particulate sulfate for each grid cell. Part of the definition of the new IMPROVE equation is a procedure for calculating the large and small sulfate contributions based on the magnitude of the model output sulfate concentrations; the procedure is documented in FLAG (2010). The sulfate concentration magnitude is used as a surrogate for distinguishing between large and small sulfate concentrations. For a given grid cell, the large and small sulfate contributions are calculated from the model output sulfate (which is the "Total Sulfate" referred to in the FLAG (2010) guidance) as:

For Total Sulfate < 20 $\mu g/m^3$:

$$[\text{Large Sulfate}] = ([\text{Total Sulfate}] / 20\ \mu g/m^3) \times [\text{Total Sulfate}]$$

For Total Sulfate ≥ 20 $\mu g/m^3$:

$$[\text{Large Sulfate}] = [\text{Total Sulfate}]$$

For all values of Total Sulfate:

$$[\text{Small Sulfate}] = [\text{Total Sulfate}] - [\text{Large Sulfate}]$$

The procedure is identical for nitrate and organic mass. Sulfate, nitrate and organic mass concentrations for the western U.S. are expected to be mainly in the small fraction.

The PSAT source apportionment algorithm does not separately track NO_2 concentrations but instead tracks total reactive nitrogen (RGN) that consistent mainly of NO plus NO_2. Thus for each hour and each grid cell representing a Class I/II area, a Source Group's incremental PSAT RGN contribution is converted to NO_2 by multiplying by the total (all emissions) CAMx model NO_2/RGN concentration ratio, which is then used in the IMPROVE visibility equation.

Although sodium and particulate chloride are treated in the CAMx core model, these species are not carried in the CAMx PSAT tool; neglecting sea salt in the visibility calculations in the 4 km CARMMS impact assessment domains does not compromise the accuracy of the analysis as IMPROVE measurements show that sea salt concentrations are negligible in this inland area and there would be no sea salt associated with any of the O&G emissions.

Predicted daily average modeled concentrations due to each BLM planning area for grid cells containing Class I and sensitive Class II area receptors were processed using the revised IMPROVE reconstructed mass extinction equation FLAG (2010) to obtain changes in b_{ext} at each sensitive receptor area that are converted to deciview and reported.

The FLAG (2010) method was used to estimate the visibility impacts from each Colorado and northern New Mexico BLM Planning Area. This method used the revised IMPROVE equation together with annual average natural conditions (see Table 6 in FLAG, 2010) and monthly relative humidity factors for each Class I area (see Tables 7-9 in FLAG, 2010). The Δdv was calculated for each grid cell that overlaps a Class I or sensitive Class II area for each day of the annual CAMx run. The highest Δdv across all grid cells overlapping a Class I or sensitive Class II area was selected to represent the daily value at that Class I/II area. Visibility impacts due to new O&G emissions on Federal lands within each BLM Planning Areas that are more than 0.5 and 1.0 dv will be reported.

4.6.2 Cumulative Visibility

The cumulative visibility impacts due to the development of oil and gas and other (e.g., mining) activities on all BLM Planning Areas were assessed following the recommendations from the FWS and NPS that was outlined in their February 10, 2012 letter to the Wyoming Department of Environmental Quality on recommended cumulative visibility method for the Continental Divide-Creston gas infill development EIS (FWS and NPS, 2012) and subsequent conversations with the FLMs. This approach is based on an abbreviated regional haze rule method that estimates the future year visibility at Class I and sensitive Class II areas for the average of the Worst 20% (W20%) and Best 20% (B20%) visibility days with and without the effects of the cumulative emissions on visibility impairment. The cumulative visibility impacts used CAMx model output from the 2008 Base Case and 2021 emissions scenarios in conjunction with monitoring data to produce cumulative visibility impacts at each Class I area in the CARMMS domain. EPA's Modeled Attainment Test Software (MATS[71]) was used to make the 2021 visibility projections for the W20% and B20% days. The basic steps in the recommended cumulative visibility method are as follows (FWS and NPS, 2012):

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[71] http://www.epa.gov/ttn/scram/modelingapps_mats.htm

1. Calculate the observed average 2008 current year cumulative visibility impact using the Haze Index (HI, in deciviews) at each Class I or associated sensitive Class II area to determine the 20% of days with the worst and 20% of days with the best visibility. The intent is to incorporate 5 years of monitoring data surrounding the 2008 Base Case year, which would include 2006-2010. MATS uses the IMPROVE data associate with each Class I area and modeling results at the location of the IMPROVE monitoring site will be used.

2. Estimate the relative response factors (RRFs) for each component of $PM_{2.5}$ and for coarse mass (CM) corresponding to the new IMPROVE visibility algorithm using the CAMx 2008 and 2021 model output.

3. Using the RRFs and ambient data, calculate 2021 future-year daily concentration data for the B20% and W20% days using the CAMx 2008 Base Case and 2021 standard model concentration estimates and PSAT source apportionment modeling results two ways:

    a. 2021 Total Emissions: Use total 2021 High, Low and Medium Development Scenario CAMx concentration results due to all emissions;

    b. 2021 No Cumulative Emissions: Use PSAT source apportionment results to eliminate contributions of PM concentrations associated with combined emission scenarios corresponding to Source Groups R,S,T and U in Table 4-2.

4. Use the information in step 3 to calculate the average 2021 visibility for the 20% Best and 20% Worst visibility days and the 2021 emissions.

5. Assess the average differences in cumulative visibility impacts for the four combined scenarios and also compare with the current observed Baseline visibility conditions.

4.7 Sulfur and Nitrogen Deposition

CAMx-predicted wet and dry fluxes of sulfur- and nitrogen-containing species were processed to estimate total annual sulfur (S) and nitrogen (N) deposition values at each Class I and sensitive Class II area as well as at each acid sensitive lake. The Maximum annual S and N deposition values from any grid cell that intersects a Class I or sensitive Class II receptor area was used to represent deposition for that area, in addition to the Average annual deposition values of all grid cells that intersect a Class I or sensitive Class II receptor area. Maximum and Average predicted S and N deposition impacts were estimated separately for each BLM planning area and together across all BLM planning areas using the Source Groups in Table 4-2.

Nitrogen deposition impacts were calculated by taking the sum of the nitrogen contained in the fluxes of all nitrogen species modeled by CAMx PSAT source apportionment tool. CAMx species used in the nitrogen deposition flux calculation are: reactive gaseous nitrate species, RGN (NO, NO_2, NO_3 radical, HONO, N_2O_5), TPN (PAN, PANX, PNA), organic nitrates (NTR), particulate nitrate formed from primary emissions plus secondarily formed particulate nitrate (NO_3), gaseous nitric acid (HNO_3), gaseous ammonia (NH_3) and particulate ammonium (NH_4). CAMx species used in the sulfur deposition calculation are primarily sulfur dioxide emissions (SO_2) and particulate sulfate ion from primary emissions plus secondarily formed sulfate (SO_4).

FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values ("Critical Loads") for each specific Class I area as these Critical Loads are completely dependent on local atmospheric, aquatic and terrestrial conditions and chemistry. Critical Load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. FLAG (2010) does not include any Critical Load levels for specific Class I areas and refers to site-specific critical load information on FLM websites for each area of concern. This guidance does, however recommend the use of deposition analysis thresholds (DATs[72]) developed by the National Park Service and the Fish and Wildlife Service. The DATs represent screening level values for nitrogen and sulfur deposition for individual projects with deposition impacts below the DATS considered negligible. DAT have been established for both nitrogen and sulfur deposition and in western Class I areas they are 0.005 kilograms per hectare per year (kg/ha/yr) for both nitrogen and sulfur deposition. As a screening analysis, results for oil and gas and mining activities for each BLM planning area, which is Source Groups A through P were separately compared to the DATs. Comparison of deposition impacts from combined Source Groups to the DAT is not appropriate.

For the combined Source Groups and total 2008 and 2021 emissions Source Groups W and X, the annual nitrogen and sulfur deposition were compared against Critical Load values established for the Rocky Mountain region to assess total deposition impacts. The NPS has provided recent information on nitrogen critical load values applicable for Wyoming and Colorado Class I and sensitive Class II areas (NPS, 2014). For Class I and sensitive Class II areas in Wyoming a critical load value of 2.2 kg/ha/yr for nitrogen deposition (estimated from a wet deposition critical load value of 1.4 kg N/ha/yr) is applicable, based on research conducted by Saros et. al.(2010) in the eastern Sierra Nevada and Greater Yellowstone ecosystems. This is a critical load value that is protective of high elevation surface waters. For Colorado Class I and sensitive Class II areas (with the exception of Dinosaur National Monument) a critical load value 2.3 kg N/ha/yr is applicable for total nitrogen deposition, based on research conducted by Jill Baron (Baron 2006) that estimated 1.5 kg/ha/yr as a critical loading value for wet nitrogen deposition for high-elevation lakes in Rocky Mountain National Park, Colorado. For Dinosaur National Monument, which is an arid region, a nitrogen deposition critical load value is based on research conducted by Pardo et al. (2011) which concluded that the cumulative critical load necessary to protect shrublands and lichen communities in Dinosaur NM is 3 kg N/ha/year.

For sulfur deposition, the critical load threshold published by Fox et al. (Fox 1989) for total sulfur deposition of 5 kg/ha/yr, for the Bob Marshall Wilderness Area in Montana and Bridger Wilderness Area in Wyoming, was used as critical load threshold for each of the Class I and sensitive Class II areas.

In summary, we will compare the total annual sulfur and nitrogen deposition amounts for the cumulative Source Groups Q through X to the following Critical Load values:

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[72] http://www.nature.nps.gov/air/Pubs/pdf/flag/nsDATGuidance.pdf

Nitrogen

- Wyoming – 2.2 kg/ha/yr
- Colorado – 2.3 kg/ha/yr, except for Dinosaur Monument that will use 3.0 kg/ha/yr

Sulfur

- 5.0 kg/ha/yr – all areas

4.8 Acid Neutralizing Capacity

In addition to calculation of total deposition fluxes, an additional analysis was performed to assess the change in water chemistry associated with atmospheric deposition from BLM oil and gas and mining activities and cumulative sources for each of the sensitive lakes listed in Table 4-5. This analysis assesses the change in the acid neutralizing capacity (ANC) of sensitive lakes. An estimate of potential changes in ANC was made by following the procedure developed by the USFS Rocky Mountain Region (USFS, 2000). Predicted changes in ANC are compared with the threshold (10 percent change in ANC for lakes with background ANC values greater than 25 micro equivalents per liter [μeq/L], and no more than a 1 μeq/L change in ANC for lakes with background ANC values equal to or less than 25 μeq/L). A list of sensitive lakes was obtained from the USFS (Table 4-5). The most recent lake chemistry background ANC data was obtained from the VIEWS website for each of the sensitive lakes in the 4 km CARMMS modeling domain.

5.0 2021 MODELING RESULTS

In this Chapter we present the CARMMS modeling results for the 2021 High, Low and Medium Development Scenarios following the procedures given in Chapter 4 using examples from the 24 Source Group contributions given in Table 4-2. Electronic attachments are provided that contain modeling results for all of the Source Groups with summaries provided in this Chapter. In this Chapter we present results for several Source Groups as examples given below, results for the rest of the Source Groups are provided in the interactive electronic attachments:

(E) New O&G on Federal lands within the BLM Grand Junction Field Office (GJFO) Planning Area;

(F) New O&G on Federal lands in the BLM Uncompahgre Field Office (UFO) Planning Area;

(J) New O&G on Federal lands within the U.S. Forest Service Pawnee Grasslands Planning Area(USFS-PG);

(R) New O&G and mining on Federal lands within the 13 Colorado Planning Areas;

(T) New O&G on Federal and non-Federal lands and mining on Federal lands within the 14 BLM Planning Areas (Colorado and northern New Mexico BLM Planning Areas0; and

(U) All O&G (new Federal and non-Federal as well as existing) and Federal mining in Colorado within the 4 km CARMMS domain.

5.1 PSD Pollutant Concentration Impacts at Class I and Sensitive Class II Areas

Attachment A-1, A-2 and A-3 are three Excel spreadsheets that contain the contributions of emissions from each Source Group listed in Table 4-2 to pollutant concentrations at the 27 Class I (Table 4-4) and 58 sensitive Class II (Table 4-5) areas for the, respectively, 2021 High, Low and Medium Development Scenarios. Results are presented for each PSD pollutant and averaging time given in Table 4-3. Attachment A contains two pivot table sheets:

The first pivot table sheet is "Summary" that lists the impacts of a user selected Source Group to all PSD pollutants across all Class I/II areas. It is controlled by selecting the Source Group in cell B1 and whether contributions of the maximum receptor or average across all receptors in a Class I/II area is desired in cell B2; we always select the "Maximum" option. If a concentration at a Class I or sensitive Class II area is above the, respectively, PSD Class I or II Increments, the cell is shaded yellow.

The second pivot table sheet is "MaxImpact" and for a user-selected PSD pollutant it lists the maximum concentration impact at any Class I and sensitive Class II area due to emissions from each Source Group along with the percentage the concentration is of the PSD Increment and the Class I and II area where the maximum occurs. The pivot table is

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controlled by selecting the pollutant and averaging time in cell B1 and whether maximum or average concentrations across the Class I/II area is desired in cell B2.

The sheet "Readme" has a brief explanation of the sheets in the spreadsheet and maps for the locations of the Class I and sensitive Class II areas.

The PSD incremental concentrations are reported for informational purposes only and the analyses presented in this section are not a comprehensive PSD increment consumption assessment, which must be performed by the appropriate state or federal agency.

5.1.1 Maximum PSD Concentration Impacts at any Class I or II Area

EPA has defined PSD Concentrations Increments for Class I and II areas for 8 different pollutant concentration/averaging time combinations (see Table 4-3). In this section we present the "Maximum" PSD concentration impacts at Class I and sensitive Class II areas due to each of the relevant 24 Source Groups from Table 4-2 (i.e., from the MaxImpact sheet in Attachments A-1 and A-2). The modeled impacts are based on the CAMx PSAT source apportionment contributions. For short-term averaging times (i.e., not annual), the highest second high concentration at each Class I/II area is selected for comparison with the PSD increment.

5.1.1.1 Annual NO_2 PSD Concentrations

The maximum (highest 2nd high) contribution to annual NO_2 concentrations at any Class I or sensitive Class II area due to emissions from the 24 Source Groups for the 2021 High, Low and Medium Development Scenarios are shown in Table 5-1, which was obtained from the MaxImpact sheet in Attachments A-1, A-2 and A-3. The Class I and II PSD Increments for annual NO_2 are 2.5 and 25 $\mu g/m^3$, respectively. The annual NO_2 contributions from each of the individual BLM Planning Areas in Colorado and northern New Mexico (i.e., Source Groups A through P) are all below the annual NO_2 PSD Increment in all Class I and sensitive Class II areas for all three 2021 emission scenarios. The BLM Planning Area with the highest annual NO_2 concentration contribution to any Class I area is the BLM Colorado Tres Rios Field Office (TRFO) Planning Area whose annual NO_2 concentration contribution at Mesa Verde National Park for the 2021 High Development Scenarios is 1.97 $\mu g/m^3$, which represents 79% of the Class I area Increment. The mitigation in the 2021 Medium Development Scenario reduces this impact by -16% to 1.66 $\mu g/m^3$, which represents 66% of the PSD Class I area annual NO_2 increment. The corresponding TRFO annual NO_2 impact for the Low Development Scenario is 0.24 $\mu g/m^3$, which represents 9% of the Class I increment. The maximum annual NO_2 contribution at any Class I area from any other of the 14 BLM Planning Areas are less than 5% of the Class I area NO_2 PSD Increment. The highest annual NO_2 concentration at any sensitive Class II area due to new O&G emissions on Federal lands in any of the 14 BLM Planning Areas is the New Mexico Farmington Field Office (NMFFO) with a 2.0 $\mu g/m^3$ annual NO_2 at the Aztec Ruins Class II area that represents 8% of the PSD Class II area Increment; recall that the same high emissions scenario was used for the BLM NMFFO Planning Area for both the CARMMS 2021 High and Low Development Scenarios. The NMFFO Planning Area new Federal O&G annual NO2 impacts at Mesa Verde for the 2021 Medium Development Scenario is 1.6 $\mu g/m^3$ that is -23% lower than seen for the 2021 High Development Scenario.

The maximum annual NO_2 contribution due to all new O&G and mining on Federal lands within the 13 Colorado BLM Planning Areas combined (i.e., Source Group R) for the High, Low and Medium Development Scenarios are, respectively, 1.98, 0.24 and 1.67 $\mu g/m^3$ at Mesa Verde National Park, which represents 79%, 10% and 67% of the NO_2 PSD Class I increment and is primarily due to Federal O&G emissions from the TRFO Planning Area as discussed above. For the Cumulative Emissions Scenario that represents all new O&G on both Federal and non-Federal lands and mining within the 14 CO/NM BLM Planning Areas (Source Group T) the maximum NO_2 contribution are 4.5, 2.9 and 4.1 $\mu g/m^3$ for the High, Low and Medium Development Scenarios, respectively, that are above the annual NO_2 PSD Class I Increment (2.5 $\mu g/m^3$). The maximum contribution of the Cumulative Emissions Scenario (T) to annual NO_2 at any sensitive Class II area is 4.1 $\mu g/m^3$ for the High Scenario at the South San Juan Class II area, 3.0 $\mu g/m^3$ at the Aztec Ruins Class II area for the Low Scenario and 3.7 $\mu g/m^3$ for the Medium Development Scenario all of which are below the Class II area annual NO_2 PSD Increment. Finally, the maximum annual NO_2 contribution at any Class I area due to the combined effects of all O&G development in the 4 km CARMS domain plus Federal mining in Colorado (Source Group U) is 4.8 $\mu g/m^3$ for the High, 3.1 $\mu g/m^3$ for the Low and 4.4 $\mu g/m^3$ for the Medium Development Scenarios both occurring at Mesa Verde.

Table 5-1a. Maximum annual NO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	NO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2.5	0.019	0.8%	Mount_Zirkel	25	0.031	0.1%	Dinosaur_all
B	White River FO	2.5	0.117	4.7%	Flat_Tops	25	0.451	1.8%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2.5	0.025	1.0%	Flat_Tops	25	0.010	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2.5	0.025	1.0%	Flat_Tops	25	0.009	0.0%	Holy_Cross
E	Grand Junction FO	2.5	0.079	3.2%	Arches	25	0.149	0.6%	Colorado
F	Uncompahgre FO	2.5	0.105	4.2%	Maroon_Bells	25	0.164	0.7%	Raggeds
G	Tres Rios FO	2.5	1.968	78.7%	Mesa_Verde	25	1.921	7.7%	South_San_Juan
H	Kremmling FO	2.5	0.036	1.4%	Rawah	25	0.011	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2.5	0.000	0.0%	Rocky_Mountain	25	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2.5	0.001	0.0%	Rocky_Mountain	25	0.001	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2.5	0.000	0.0%	Salt_Creek	25	0.001	0.0%	Maxwell_NWR
L	RGFO#3 – South	2.5	0.003	0.1%	Great_Sand_Dunes	25	0.190	0.8%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2.5	0.000	0.0%	Eagles_Nest	25	0.015	0.1%	Lost_Creek
N	New Mexico Farmington District	2.5	0.042	1.7%	Mesa_Verde	25	2.041	8.2%	Aztec_Ruins
O	Total Colorado River Field Office	2.5	0.050	2.0%	Flat_Tops	25	0.020	0.1%	Holy_Cross
P	Total Royal Gorge Field Office	2.5	0.003	0.1%	Great_Sand_Dunes	25	0.191	0.8%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2.5	0.011	0.4%	West_Elk	25	0.017	0.1%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2.5	1.979	79.1%	Mesa_Verde	25	1.927	7.7%	South_San_Juan
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2.5	4.477	179.1%	Mesa_Verde	25	4.033	16.1%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2.5	4.498	179.9%	Mesa_Verde	25	4.086	16.3%	South_San_Juan
U	Combined O&G and Mining in 4 km domain	2.5	4.779	191.2%	Mesa_Verde	25	20.535	82.1%	Aztec_Ruins
V	Natural Emissions	2.5	2.698	107.9%	Bandelier	25	1.226	4.9%	Dome
W	2021 All Emissions	2.5	6.100	244.0%	Mesa_Verde	25	26.453	105.8%	Aztec_Ruins
X	2008 All Emissions	2.5	15.638	625.5%	Eagles_Nest	25	23.759	95.0%	Aztec_Ruins

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Table 5-1b. Maximum annual NO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	NO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2.5	0.003	0.1%	Mount_Zirkel	25	0.004	0.0%	Dinosaur_all
B	White River FO	2.5	0.019	0.8%	Flat_Tops	25	0.071	0.3%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2.5	0.016	0.6%	Flat_Tops	25	0.006	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2.5	0.013	0.5%	Flat_Tops	25	0.005	0.0%	Holy_Cross
E	Grand Junction FO	2.5	0.004	0.2%	Maroon_Bells	25	0.008	0.0%	Colorado
F	Uncompahgre FO	2.5	0.031	1.2%	Maroon_Bells	25	0.050	0.2%	Raggeds
G	Tres Rios FO	2.5	0.236	9.4%	Mesa_Verde	25	0.236	0.9%	South_San_Juan
H	Kremmling FO	2.5	0.004	0.2%	Rawah	25	0.001	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2.5	0.000	0.0%	Rocky_Mountain	25	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2.5	0.000	0.0%	Rocky_Mountain	25	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2.5	0.000	0.0%	Salt_Creek	25	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	2.5	0.002	0.1%	Great_Sand_Dunes	25	0.118	0.5%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2.5	0.000	0.0%	Eagles_Nest	25	0.002	0.0%	Lost_Creek
N	New Mexico Farmington District	2.5	0.042	1.7%	Mesa_Verde	25	2.040	8.2%	Aztec_Ruins
O	Total Colorado River Field Office	2.5	0.029	1.2%	Flat_Tops	25	0.011	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	2.5	0.002	0.1%	Great_Sand_Dunes	25	0.118	0.5%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2.5	0.011	0.4%	West_Elk	25	0.017	0.1%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2.5	0.239	9.6%	Mesa_Verde	25	0.238	1.0%	South_San_Juan
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2.5	2.850	114.0%	Mesa_Verde	25	2.500	10.0%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2.5	2.870	114.8%	Mesa_Verde	25	2.971	11.9%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	2.5	3.146	125.8%	Mesa_Verde	25	20.491	82.0%	Aztec_Ruins
V	Natural Emissions	2.5	2.698	107.9%	Bandelier	25	1.226	4.9%	Dome
W	2021 All Emissions	2.5	5.620	224.8%	Petrified_Forest	25	26.407	105.6%	Aztec_Ruins
X	2008 All Emissions	2.5	15.638	625.5%	Eagles_Nest	25	23.759	95.0%	Aztec_Ruins

Table 5-1c. Maximum annual NO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	NO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2.5	0.016	0.6%	Mount_Zirkel	25	0.027	0.1%	Dinosaur_all
B	White River FO	2.5	0.089	3.6%	Flat_Tops	25	0.424	1.7%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2.5	0.019	0.8%	Flat_Tops	25	0.008	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2.5	0.020	0.8%	Flat_Tops	25	0.008	0.0%	Holy_Cross
E	Grand Junction FO	2.5	0.075	3.0%	Arches	25	0.137	0.5%	Colorado
F	Uncompahgre FO	2.5	0.071	2.9%	Maroon_Bells	25	0.111	0.4%	Raggeds
G	Tres Rios FO	2.5	1.660	66.4%	Mesa_Verde	25	1.627	6.5%	South_San_Juan
H	Kremmling FO	2.5	0.031	1.2%	Eagles_Nest	25	0.007	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2.5	0.000	0.0%	Rocky_Mountain	25	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2.5	0.001	0.0%	Rocky_Mountain	25	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2.5	0.000	0.0%	Salt_Creek	25	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	2.5	0.002	0.1%	Great_Sand_Dunes	25	0.132	0.5%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2.5	0.000	0.0%	Eagles_Nest	25	0.008	0.0%	Lost_Creek
N	New Mexico Farmington District	2.5	0.033	1.3%	Mesa_Verde	25	1.573	6.3%	Aztec_Ruins
O	Total Colorado River Field Office	2.5	0.040	1.6%	Flat_Tops	25	0.016	0.1%	Holy_Cross
P	Total Royal Gorge Field Office	2.5	0.002	0.1%	Great_Sand_Dunes	25	0.132	0.5%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2.5	0.011	0.4%	West_Elk	25	0.017	0.1%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2.5	1.669	66.8%	Mesa_Verde	25	1.631	6.5%	South_San_Juan
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2.5	4.087	163.5%	Mesa_Verde	25	3.679	14.7%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2.5	4.103	164.1%	Mesa_Verde	25	3.720	14.9%	South_San_Juan
U	Combined O&G and Mining in 4 km domain	2.5	4.383	175.3%	Mesa_Verde	25	20.080	80.3%	Aztec_Ruins
V	Natural Emissions	2.5	2.698	107.9%	Bandelier	25	1.226	4.9%	Dome
W	2021 All Emissions	2.5	5.703	228.1%	Mesa_Verde	25	26.011	104.0%	Aztec_Ruins
X	2008 All Emissions	2.5	15.638	625.5%	Eagles_Nest	25	23.759	95.0%	Aztec_Ruins

5.1.1.2 SO_2 PSD Concentrations

Tables 5-2 through 5-4 presents the comparison of the, respectively, maximum annual, 24-hour and 3-hour SO_2 concentrations at Class I/II areas with the PSD SO_2 increments for the 24 Source Groups. Note that the Colorado portion of the Dinosaur National Monument is Class I for SO_2 only, so it is included in the Class I area grouping in these Tables. None of the Source Groups exceed the annual PSD Class I Increment at any Class I/II area (Table 5-2). For 24-hour and 3-hour SO_2 contributions, there are wildfires that cause exceedances of the PSD Class I increment at the Bandelier Class I area for the Natural, total 2021 and total 2008 (Source Groups V, X and W) emission groups, but none of the other Source Groups exhibit any exceedances of the 24-hour and 3-hour SO_2 PSD Increments at any Class I or sensitive Class II area. Note that PSD Increments are not applicable for Natural or Total emissions. The contributions of the 14 BLM Planning Areas to SO_2 concentrations at Class I/II areas are extremely small, mostly much less than 1% of the PSD Increments. Of the 14 BLM Planning Areas, Federal O&G from the White River Field Office (WRFO) Planning Area has by far the largest contribution to annual, 24-hour and 3-hour SO_2 concentrations at any Class I area with maximum contributions of 5, 8 and 5 percent of the PSD Increment for the High and Medium Development Scenarios (the mitigation in the Medium Development Scenario did not address SO_2 emissions) and approximately 1 percent of the PSD Increment for the Low Development Scenarios that occurs at the Colorado portion of Dinosaur National Monument.

Table 5-2a. Maximum annual SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	SO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.000	0.0%	Mount_Zirkel	20	0.000	0.0%	Dinosaur_all
B	White River FO	2	0.089	4.5%	Dinosaur_CO	20	0.089	0.4%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
E	Grand Junction FO	2	0.000	0.0%	Arches	20	0.001	0.0%	Colorado
F	Uncompahgre FO	2	0.000	0.0%	Maroon_Bells	20	0.000	0.0%	Raggeds
G	Tres Rios FO	2	0.001	0.1%	Mesa_Verde	20	0.001	0.0%	South_San_Juan
H	Kremmling FO	2	0.000	0.0%	Rawah	20	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.000	0.0%	Salt_Creek	20	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	2	0.000	0.0%	Great_Sand_Dunes	20	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.000	0.0%	Eagles_Nest	20	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	2	0.000	0.0%	Mesa_Verde	20	0.003	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.000	0.0%	West_Elk	20	0.000	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.090	4.5%	Dinosaur_CO	20	0.090	0.4%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.102	5.1%	Dinosaur_CO	20	0.102	0.5%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.102	5.1%	Dinosaur_CO	20	0.102	0.5%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	2	0.108	5.4%	Dinosaur_CO	20	0.108	0.5%	Dinosaur_all
V	Natural Emissions	2	0.410	20.5%	Bandelier	20	0.171	0.9%	Dome
W	2021 All Emissions	2	1.857	92.8%	Galiuro	20	0.968	4.8%	Bitter_Lake_NWR
X	2008 All Emissions	2	1.240	62.0%	Petrified_Forest	20	1.143	5.7%	Aztec_Ruins

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Table 5-2b. Maximum annual SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	SO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.000	0.0%	Mount_Zirkel	20	0.000	0.0%	Dinosaur_all
B	White River FO	2	0.014	0.7%	Dinosaur_CO	20	0.014	0.1%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
E	Grand Junction FO	2	0.000	0.0%	Arches	20	0.000	0.0%	Colorado
F	Uncompahgre FO	2	0.000	0.0%	Maroon_Bells	20	0.000	0.0%	Raggeds
G	Tres Rios FO	2	0.000	0.0%	Mesa_Verde	20	0.000	0.0%	South_San_Juan
H	Kremmling FO	2	0.000	0.0%	Rawah	20	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.000	0.0%	Pecos	20	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	2	0.000	0.0%	Great_Sand_Dunes	20	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.000	0.0%	Eagles_Nest	20	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	2	0.000	0.0%	Mesa_Verde	20	0.003	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.000	0.0%	West_Elk	20	0.000	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.014	0.7%	Dinosaur_CO	20	0.014	0.1%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.018	0.9%	Dinosaur_CO	20	0.018	0.1%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.018	0.9%	Dinosaur_CO	20	0.018	0.1%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	2	0.024	1.2%	Dinosaur_CO	20	0.083	0.4%	Aztec_Ruins
V	Natural Emissions	2	0.410	20.5%	Bandelier	20	0.171	0.9%	Dome
W	2021 All Emissions	2	1.857	92.8%	Galiuro	20	0.968	4.8%	Bitter_Lake_NWR
X	2008 All Emissions	2	1.240	62.0%	Petrified_Forest	20	1.143	5.7%	Aztec_Ruins

Table 5-2c. Maximum annual SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	SO2, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.000	0.0%	Mount_Zirkel	20	0.000	0.0%	Dinosaur_all
B	White River FO	2	0.089	4.5%	Dinosaur_CO	20	0.089	0.4%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
E	Grand Junction FO	2	0.000	0.0%	Arches	20	0.001	0.0%	Colorado
F	Uncompahgre FO	2	0.000	0.0%	Maroon_Bells	20	0.000	0.0%	Raggeds
G	Tres Rios FO	2	0.001	0.1%	Mesa_Verde	20	0.001	0.0%	South_San_Juan
H	Kremmling FO	2	0.000	0.0%	Rawah	20	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.000	0.0%	Salt_Creek	20	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	2	0.000	0.0%	Great_Sand_Dunes	20	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.000	0.0%	Eagles_Nest	20	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	2	0.000	0.0%	Mesa_Verde	20	0.003	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.000	0.0%	Flat_Tops	20	0.000	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	2	0.000	0.0%	Rocky_Mountain	20	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.000	0.0%	West_Elk	20	0.000	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.090	4.5%	Dinosaur_CO	20	0.090	0.4%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.102	5.1%	Dinosaur_CO	20	0.102	0.5%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.102	5.1%	Dinosaur_CO	20	0.102	0.5%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	2	0.108	5.4%	Dinosaur_CO	20	0.108	0.5%	Dinosaur_all
V	Natural Emissions	2	0.410	20.5%	Bandelier	20	0.171	0.9%	Dome
W	2021 All Emissions	2	1.857	92.8%	Galiuro	20	0.968	4.8%	Bitter_Lake_NWR
X	2008 All Emissions	2	1.240	62.0%	Petrified_Forest	20	1.143	5.7%	Aztec_Ruins

Table 5-3a. Maximum 24-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	5	0.002	0.0%	Dinosaur_CO	91	0.002	0.0%	Dinosaur_all
B	White River FO	5	0.412	8.2%	Dinosaur_CO	91	0.412	0.5%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
E	Grand Junction FO	5	0.002	0.0%	Arches	91	0.003	0.0%	Colorado
F	Uncompahgre FO	5	0.001	0.0%	Maroon_Bells	91	0.001	0.0%	Raggeds
G	Tres Rios FO	5	0.003	0.1%	Mesa_Verde	91	0.003	0.0%	South_San_Juan
H	Kremmling FO	5	0.000	0.0%	Rawah	91	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	5	0.000	0.0%	Pecos	91	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	5	0.000	0.0%	Great_Sand_Dunes	91	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	5	0.000	0.0%	Eagles_Nest	91	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	5	0.001	0.0%	Mesa_Verde	91	0.009	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
P	Total Royal Gorge Field Office	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	5	0.001	0.0%	West_Elk	91	0.002	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	5	0.412	8.2%	Dinosaur_CO	91	0.412	0.5%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	5	0.469	9.4%	Dinosaur_CO	91	0.469	0.5%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	5	0.469	9.4%	Dinosaur_CO	91	0.469	0.5%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	5	0.487	9.7%	Dinosaur_CO	91	0.565	0.6%	Aztec_Ruins
V	Natural Emissions	5	50.751	1015.0%	Bandelier	91	20.045	22.0%	Dome
W	2021 All Emissions	5	51.160	1023.2%	Bandelier	91	20.791	22.8%	Dome
X	2008 All Emissions	5	50.921	1018.4%	Bandelier	91	20.894	23.0%	Dome

Table 5-3b. Maximum 24-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	SO2, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	5	0.000	0.0%	Dinosaur_CO	91	0.000	0.0%	Dinosaur_all
B	White River FO	5	0.067	1.3%	Dinosaur_CO	91	0.067	0.1%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
E	Grand Junction FO	5	0.000	0.0%	Arches	91	0.000	0.0%	Colorado
F	Uncompahgre FO	5	0.000	0.0%	Maroon_Bells	91	0.000	0.0%	Raggeds
G	Tres Rios FO	5	0.001	0.0%	Mesa_Verde	91	0.001	0.0%	South_San_Juan
H	Kremmling FO	5	0.000	0.0%	Rawah	91	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	5	0.000	0.0%	Pecos	91	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	5	0.000	0.0%	Great_Sand_Dunes	91	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	5	0.000	0.0%	Eagles_Nest	91	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	5	0.001	0.0%	Mesa_Verde	91	0.009	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
P	Total Royal Gorge Field Office	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	5	0.001	0.0%	West_Elk	91	0.002	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	5	0.067	1.3%	Dinosaur_CO	91	0.067	0.1%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	5	0.085	1.7%	Dinosaur_CO	91	0.085	0.1%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	5	0.085	1.7%	Dinosaur_CO	91	0.085	0.1%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	5	0.125	2.5%	Mesa_Verde	91	0.561	0.6%	Aztec_Ruins
V	Natural Emissions	5	50.751	1015.0%	Bandelier	91	20.045	22.0%	Dome
W	2021 All Emissions	5	51.158	1023.2%	Bandelier	91	20.790	22.8%	Dome
X	2008 All Emissions	5	50.921	1018.4%	Bandelier	91	20.894	23.0%	Dome

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Table 5-3c. Maximum 24-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	SO2, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	5	0.002	0.0%	Dinosaur_CO	91	0.002	0.0%	Dinosaur_all
B	White River FO	5	0.412	8.2%	Dinosaur_CO	91	0.412	0.5%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
E	Grand Junction FO	5	0.002	0.0%	Arches	91	0.003	0.0%	Colorado
F	Uncompahgre FO	5	0.001	0.0%	Maroon_Bells	91	0.001	0.0%	Raggeds
G	Tres Rios FO	5	0.003	0.1%	Mesa_Verde	91	0.003	0.0%	South_San_Juan
H	Kremmling FO	5	0.000	0.0%	Rawah	91	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	5	0.000	0.0%	Pecos	91	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	5	0.000	0.0%	Great_Sand_Dunes	91	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	5	0.000	0.0%	Eagles_Nest	91	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	5	0.001	0.0%	Mesa_Verde	91	0.007	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	5	0.000	0.0%	Flat_Tops	91	0.000	0.0%	Colorado
P	Total Royal Gorge Field Office	5	0.000	0.0%	Rocky_Mountain	91	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	5	0.001	0.0%	West_Elk	91	0.002	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	5	0.412	8.2%	Dinosaur_CO	91	0.412	0.5%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	5	0.468	9.4%	Dinosaur_CO	91	0.468	0.5%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	5	0.468	9.4%	Dinosaur_CO	91	0.468	0.5%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	5	0.487	9.7%	Dinosaur_CO	91	0.563	0.6%	Aztec_Ruins
V	Natural Emissions	5	50.751	1015.0%	Bandelier	91	20.045	22.0%	Dome
W	2021 All Emissions	5	51.160	1023.2%	Bandelier	91	20.791	22.8%	Dome
X	2008 All Emissions	5	50.921	1018.4%	Bandelier	91	20.894	23.0%	Dome

Table 5-4a. Maximum 3-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	SO2, 3-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	25	0.005	0.0%	Dinosaur_CO	512	0.005	0.0%	Dinosaur_all
B	White River FO	25	1.262	5.0%	Dinosaur_CO	512	1.262	0.2%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	25	0.001	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	25	0.001	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
E	Grand Junction FO	25	0.003	0.0%	Arches	512	0.006	0.0%	Colorado
F	Uncompahgre FO	25	0.002	0.0%	Maroon_Bells	512	0.002	0.0%	Raggeds
G	Tres Rios FO	25	0.006	0.0%	Mesa_Verde	512	0.005	0.0%	South_San_Juan
H	Kremmling FO	25	0.000	0.0%	Rawah	512	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	25	0.001	0.0%	Rocky_Mountain	512	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	25	0.000	0.0%	Pecos	512	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	25	0.000	0.0%	Great_Sand_Dunes	512	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	25	0.000	0.0%	Eagles_Nest	512	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	25	0.002	0.0%	Mesa_Verde	512	0.015	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	25	0.001	0.0%	Flat_Tops	512	0.001	0.0%	Colorado
P	Total Royal Gorge Field Office	25	0.001	0.0%	Rocky_Mountain	512	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	25	0.004	0.0%	West_Elk	512	0.008	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	25	1.262	5.0%	Dinosaur_CO	512	1.262	0.2%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	25	1.435	5.7%	Dinosaur_CO	512	1.435	0.3%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	25	1.435	5.7%	Dinosaur_CO	512	1.435	0.3%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	25	1.495	6.0%	Dinosaur_CO	512	1.495	0.3%	Dinosaur_all
V	Natural Emissions	25	95.970	383.9%	Bandelier	512	64.686	12.6%	Dome
W	2021 All Emissions	25	96.160	384.6%	Bandelier	512	65.144	12.7%	Dome
X	2008 All Emissions	25	96.190	384.8%	Bandelier	512	65.161	12.7%	Dome

Table 5-4b. Maximum 3-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	SO2, 3-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	25	0.001	0.0%	Dinosaur_CO	512	0.001	0.0%	Dinosaur_all
B	White River FO	25	0.189	0.8%	Dinosaur_CO	512	0.189	0.0%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	25	0.000	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	25	0.000	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
E	Grand Junction FO	25	0.000	0.0%	Arches	512	0.000	0.0%	Colorado
F	Uncompahgre FO	25	0.001	0.0%	Maroon_Bells	512	0.001	0.0%	Raggeds
G	Tres Rios FO	25	0.001	0.0%	Mesa_Verde	512	0.001	0.0%	South_San_Juan
H	Kremmling FO	25	0.000	0.0%	Rawah	512	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	25	0.000	0.0%	Pecos	512	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	25	0.000	0.0%	Great_Sand_Dunes	512	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	25	0.000	0.0%	Eagles_Nest	512	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	25	0.002	0.0%	Mesa_Verde	512	0.015	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	25	0.001	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
P	Total Royal Gorge Field Office	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	25	0.004	0.0%	West_Elk	512	0.008	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	25	0.189	0.8%	Dinosaur_CO	512	0.189	0.0%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	25	0.240	1.0%	Dinosaur_CO	512	0.240	0.0%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	25	0.240	1.0%	Dinosaur_CO	512	0.240	0.0%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	25	0.497	2.0%	Mesa_Verde	512	1.328	0.3%	Aztec_Ruins
V	Natural Emissions	25	95.970	383.9%	Bandelier	512	64.688	12.6%	Dome
W	2021 All Emissions	25	96.160	384.6%	Bandelier	512	65.140	12.7%	Dome
X	2008 All Emissions	25	96.190	384.8%	Bandelier	512	65.161	12.7%	Dome

Table 5-4c. Maximum 3-hour SO_2 concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	SO2, 3-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	25	0.005	0.0%	Dinosaur_CO	512	0.005	0.0%	Dinosaur_all
B	White River FO	25	1.262	5.0%	Dinosaur_CO	512	1.262	0.2%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	25	0.001	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
D	Roan Plateau Planning area portion of CRVFO	25	0.001	0.0%	Flat_Tops	512	0.000	0.0%	Colorado
E	Grand Junction FO	25	0.003	0.0%	Arches	512	0.006	0.0%	Colorado
F	Uncompahgre FO	25	0.002	0.0%	Maroon_Bells	512	0.002	0.0%	Raggeds
G	Tres Rios FO	25	0.006	0.0%	Mesa_Verde	512	0.005	0.0%	South_San_Juan
H	Kremmling FO	25	0.000	0.0%	Rawah	512	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	25	0.000	0.0%	Pecos	512	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	25	0.000	0.0%	Great_Sand_Dunes	512	0.000	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	25	0.000	0.0%	Eagles_Nest	512	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	25	0.001	0.0%	Mesa_Verde	512	0.012	0.0%	Aztec_Ruins
O	Total Colorado River Field Office	25	0.001	0.0%	Flat_Tops	512	0.001	0.0%	Colorado
P	Total Royal Gorge Field Office	25	0.000	0.0%	Rocky_Mountain	512	0.000	0.0%	Lost_Creek
Q	Mining from 13 Colorado BLM Planning Areas	25	0.004	0.0%	West_Elk	512	0.008	0.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	25	1.262	5.0%	Dinosaur_CO	512	1.262	0.2%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	25	1.435	5.7%	Dinosaur_CO	512	1.435	0.3%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	25	1.435	5.7%	Dinosaur_CO	512	1.435	0.3%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	25	1.495	6.0%	Dinosaur_CO	512	1.495	0.3%	Dinosaur_all
V	Natural Emissions	25	95.970	383.9%	Bandelier	512	64.686	12.6%	Dome
W	2021 All Emissions	25	96.160	384.6%	Bandelier	512	65.144	12.7%	Dome
X	2008 All Emissions	25	96.190	384.8%	Bandelier	512	65.161	12.7%	Dome

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5.1.1.3 $PM_{2.5}$ PSD Concentrations

Tables 5-5 and 5-6 displays the, respectively, maximum annual and 24-hour $PM_{2.5}$ concentrations due the Source Groups at any Class I and II area and compares them with the PSD $PM_{2.5}$ Increments for the 2021 High, Low and Medium Development Scenarios. $PM_{2.5}$ concentrations due to emissions from Federal O&G within any of the 14 BLM Planning Areas do not come close to exceeding any of the PSD $PM_{2.5}$ Increments. The BLM Planning Area with the largest Federal O&G $PM_{2.5}$ contribution at any Class I area is the TRFO Planning Area that contributes $PM_{2.5}$ concentrations of 9 and 15 percent for the High, 5 and 9 percent for the Medium and 1 and 2 percent for the Low Development Scenarios to the, respectively, annual and 24-hour $PM_{2.5}$ Class I PSD Increments at the Mesa Verde Class I area. Mining on Federal land within all of the 13 Colorado BLM Planning Areas (Source Group Q) contributes a maximum of 0.16 $\mu g/m^3$ for annual $PM_{2.5}$ at Mount Zirkel and 0.79 $\mu g/m^3$ for 24-hour $PM_{2.5}$ at Flat Tops that represents 16% and 39% of the PSD Class I Increments, respectively, for all three of the 2021 Scenarios (BLM mining emissions were not altered in the three 2021 scenarios).

The maximum contribution at any Class I area to annual $PM_{2.5}$ due to all Federal O&G and mining in the 13 Colorado BLM Planning Areas (Source Group R), the Cumulative Emissions scenario of all Federal O&G and mining and non-Federal O&G in the 14 CO/NM Planning Areas (Source Group T) and all O&G emissions throughout the 4 km CARMMS domain are, respectively, 0.18 to 0.22 $\mu g/m^3$ that represents 18 to 22 percent of the Class I area increment for the High Development Scenario with similar results seen for the Medium and slightly lower values seen for the Low Development Scenarios. Similar results are seen for 24-hour $PM_{2.5}$ with the Source Groups R, S, T and U contributing 42 to 58 percent of the 24-hour $PM_{2.5}$ Class I Increment for the High and Medium and 40 to 43 percent of the Increment for the Low Development Scenario at Rocky Mountain National Park.

Extremely high maximum annual and 24-hour $PM_{2.5}$ contributions are seen due to natural emissions (Source Group V) that are also reflected in the total 2021 (W) and 2008 (X) Source Groups that are due to wildfires that occurred in 2008 for which the PSD Increments are not applicable.

Note that PSD increments are not applicable to natural emissions or existing sources, thus results from Source Groups U, V, W and X are not appropriate for comparison with PSD increments.

Table 5-5a. Maximum Annual $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	PM2.5, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	1	0.003	0.3%	Mount_Zirkel	4	0.003	0.1%	Dinosaur_all
B	White River FO	1	0.021	2.1%	Flat_Tops	4	0.046	1.2%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	1	0.003	0.3%	Flat_Tops	4	0.002	0.1%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	1	0.003	0.3%	Flat_Tops	4	0.002	0.0%	Holy_Cross
E	Grand Junction FO	1	0.011	1.1%	Maroon_Bells	4	0.023	0.6%	Colorado
F	Uncompahgre FO	1	0.012	1.2%	Maroon_Bells	4	0.017	0.4%	Raggeds
G	Tres Rios FO	1	0.087	8.7%	Mesa_Verde	4	0.084	2.1%	South_San_Juan
H	Kremmling FO	1	0.004	0.4%	Rawah	4	0.002	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	1	0.000	0.0%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	1	0.001	0.1%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	1	0.000	0.0%	Pecos	4	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	1	0.000	0.0%	Great_Sand_Dunes	4	0.003	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	1	0.000	0.0%	Eagles_Nest	4	0.003	0.1%	Lost_Creek
N	New Mexico Farmington District	1	0.007	0.7%	Weminuche	4	0.205	5.1%	Aztec_Ruins
O	Total Colorado River Field Office	1	0.006	0.6%	Flat_Tops	4	0.004	0.1%	Holy_Cross
P	Total Royal Gorge Field Office	1	0.001	0.1%	Rocky_Mountain	4	0.003	0.1%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1	0.164	16.4%	Mount_Zirkel	4	0.168	4.2%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	1	0.182	18.2%	Mount_Zirkel	4	0.195	4.9%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	1	0.216	21.6%	Mesa_Verde	4	0.224	5.6%	Raggeds
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	1	0.220	22.0%	Mesa_Verde	4	0.319	8.0%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	1	0.252	25.2%	Mesa_Verde	4	0.699	17.5%	Aztec_Ruins
V	Natural Emissions	1	9.730	973.0%	Bandelier	4	4.249	106.2%	Dome
W	2021 All Emissions	1	14.610	1461.0%	Bandelier	4	14.412	360.3%	Valle_De_Oro_NWR
X	2008 All Emissions	1	14.217	1421.7%	Bandelier	4	12.072	301.8%	Petroglyph

Table 5-5b. Maximum Annual $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	PM2.5, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	1	0.000	0.0%	Mount_Zirkel	4	0.000	0.0%	Dinosaur_all
B	White River FO	1	0.004	0.4%	Flat_Tops	4	0.008	0.2%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	1	0.002	0.2%	Flat_Tops	4	0.001	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	1	0.002	0.2%	Flat_Tops	4	0.001	0.0%	Holy_Cross
E	Grand Junction FO	1	0.001	0.1%	Maroon_Bells	4	0.001	0.0%	Colorado
F	Uncompahgre FO	1	0.004	0.4%	Maroon_Bells	4	0.005	0.1%	Raggeds
G	Tres Rios FO	1	0.011	1.1%	Mesa_Verde	4	0.011	0.3%	South_San_Juan
H	Kremmling FO	1	0.000	0.0%	Rawah	4	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	1	0.000	0.0%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	1	0.000	0.0%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	1	0.000	0.0%	Pecos	4	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	1	0.000	0.0%	Great_Sand_Dunes	4	0.002	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	1	0.000	0.0%	Eagles_Nest	4	0.000	0.0%	Lost_Creek
N	New Mexico Farmington District	1	0.007	0.7%	Weminuche	4	0.205	5.1%	Aztec_Ruins
O	Total Colorado River Field Office	1	0.004	0.4%	Flat_Tops	4	0.002	0.1%	Holy_Cross
P	Total Royal Gorge Field Office	1	0.000	0.0%	Rocky_Mountain	4	0.002	0.1%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1	0.164	16.4%	Mount_Zirkel	4	0.168	4.2%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	1	0.167	16.7%	Mount_Zirkel	4	0.175	4.4%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	1	0.173	17.3%	Mount_Zirkel	4	0.185	4.6%	Raggeds
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	1	0.173	17.3%	Mount_Zirkel	4	0.311	7.8%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	1	0.199	19.9%	Mount_Zirkel	4	0.692	17.3%	Aztec_Ruins
V	Natural Emissions	1	9.730	973.0%	Bandelier	4	4.249	106.2%	Dome
W	2021 All Emissions	1	14.608	1460.8%	Bandelier	4	14.409	360.2%	Valle_De_Oro_NWR
X	2008 All Emissions	1	14.217	1421.7%	Bandelier	4	12.072	301.8%	Petroglyph

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Table 5-5c. Maximum Annual $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	PM2.5, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	1	0.002	0.2%	Mount_Zirkel	4	0.002	0.1%	Dinosaur_all
B	White River FO	1	0.018	1.8%	Flat_Tops	4	0.044	1.1%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	1	0.002	0.2%	Flat_Tops	4	0.002	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	1	0.002	0.2%	Flat_Tops	4	0.001	0.0%	Holy_Cross
E	Grand Junction FO	1	0.008	0.8%	Arches	4	0.020	0.5%	Colorado
F	Uncompahgre FO	1	0.008	0.8%	Maroon_Bells	4	0.011	0.3%	Raggeds
G	Tres Rios FO	1	0.048	4.8%	Mesa_Verde	4	0.045	1.1%	South_San_Juan
H	Kremmling FO	1	0.002	0.2%	Rawah	4	0.001	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	1	0.000	0.0%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	1	0.000	0.0%	Rocky_Mountain	4	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	1	0.000	0.0%	Pecos	4	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	1	0.000	0.0%	Great_Sand_Dunes	4	0.002	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	1	0.000	0.0%	Eagles_Nest	4	0.001	0.0%	Lost_Creek
N	New Mexico Farmington District	1	0.005	0.5%	Weminuche	4	0.122	3.1%	Aztec_Ruins
O	Total Colorado River Field Office	1	0.004	0.4%	Flat_Tops	4	0.003	0.1%	Holy_Cross
P	Total Royal Gorge Field Office	1	0.000	0.0%	Rocky_Mountain	4	0.002	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1	0.164	16.4%	Mount_Zirkel	4	0.168	4.2%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	1	0.179	17.9%	Mount_Zirkel	4	0.188	4.7%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	1	0.191	19.1%	Mount_Zirkel	4	0.216	5.4%	Raggeds
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	1	0.191	19.1%	Mount_Zirkel	4	0.230	5.7%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	1	0.216	21.6%	Mount_Zirkel	4	0.611	15.3%	Aztec_Ruins
V	Natural Emissions	1	9.730	973.0%	Bandelier	4	4.249	106.2%	Dome
W	2021 All Emissions	1	14.609	1460.9%	Bandelier	4	14.411	360.3%	Valle_De_Oro_NWR
X	2008 All Emissions	1	14.217	1421.7%	Bandelier	4	12.072	301.8%	Petroglyph

Table 5-6a. Maximum 24-Hour $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	PM2.5, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.031	1.6%	Mount_Zirkel	9	0.030	0.3%	Dinosaur_all
B	White River FO	2	0.133	6.6%	Flat_Tops	9	0.293	3.3%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.015	0.7%	Flat_Tops	9	0.026	0.3%	Colorado
D	Roan Plateau Planning area portion of CRVFO	2	0.012	0.6%	Flat_Tops	9	0.025	0.3%	Colorado
E	Grand Junction FO	2	0.094	4.7%	Arches	9	0.242	2.7%	Colorado
F	Uncompahgre FO	2	0.060	3.0%	Maroon_Bells	9	0.062	0.7%	Raggeds
G	Tres Rios FO	2	0.302	15.1%	Mesa_Verde	9	0.260	2.9%	Hovenweep
H	Kremmling FO	2	0.011	0.5%	Mount_Zirkel	9	0.008	0.1%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.004	0.2%	Rocky_Mountain	9	0.002	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.018	0.9%	Rocky_Mountain	9	0.007	0.1%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.003	0.1%	Pecos	9	0.005	0.1%	Greenhorn_Mounta
L	RGFO#3 – South	2	0.003	0.1%	Great_Sand_Dunes	9	0.023	0.3%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.002	0.1%	Eagles_Nest	9	0.011	0.1%	Lost_Creek
N	New Mexico Farmington District	2	0.053	2.6%	Mesa_Verde	9	0.799	8.9%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.027	1.3%	Flat_Tops	9	0.050	0.6%	Colorado
P	Total Royal Gorge Field Office	2	0.023	1.1%	Rocky_Mountain	9	0.023	0.3%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.787	39.3%	Flat_Tops	9	1.075	11.9%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.842	42.1%	Flat_Tops	9	1.191	13.2%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.884	44.2%	Rocky_Mountain	9	1.248	13.9%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.886	44.3%	Rocky_Mountain	9	1.249	13.9%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	2	1.164	58.2%	Rocky_Mountain	9	3.535	39.3%	Dinosaur_all
V	Natural Emissions	2	1224.900	61245.0%	Bandelier	9	481.211	5346.8%	Dome
W	2021 All Emissions	2	1228.190	61409.5%	Bandelier	9	486.073	5400.8%	Dome
X	2008 All Emissions	2	1227.070	61353.5%	Bandelier	9	485.583	5395.4%	Dome

Table 5-6b. Maximum 24-Hour $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	PM2.5, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.004	0.2%	Mount_Zirkel	9	0.005	0.1%	Dinosaur_all
B	White River FO	2	0.026	1.3%	Flat_Tops	9	0.056	0.6%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.011	0.6%	Flat_Tops	9	0.018	0.2%	Colorado
D	Roan Plateau Planning area portion of CRVFO	2	0.008	0.4%	Flat_Tops	9	0.013	0.1%	Colorado
E	Grand Junction FO	2	0.006	0.3%	Black_Canyon	9	0.014	0.2%	Colorado
F	Uncompahgre FO	2	0.021	1.0%	Maroon_Bells	9	0.020	0.2%	Raggeds
G	Tres Rios FO	2	0.041	2.0%	Mesa_Verde	9	0.034	0.4%	Hovenweep
H	Kremmling FO	2	0.001	0.1%	Mount_Zirkel	9	0.001	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.001	0.0%	Rocky_Mountain	9	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.004	0.2%	Rocky_Mountain	9	0.001	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.000	0.0%	Pecos	9	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	2	0.002	0.1%	Great_Sand_Dunes	9	0.015	0.2%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.000	0.0%	Eagles_Nest	9	0.002	0.0%	Lost_Creek
N	New Mexico Farmington District	2	0.053	2.6%	Mesa_Verde	9	0.800	8.9%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.019	1.0%	Flat_Tops	9	0.031	0.3%	Colorado
P	Total Royal Gorge Field Office	2	0.005	0.2%	Rocky_Mountain	9	0.015	0.2%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.787	39.4%	Flat_Tops	9	1.081	12.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.804	40.2%	Flat_Tops	9	1.094	12.2%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.830	41.5%	Flat_Tops	9	1.110	12.3%	Raggeds
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.835	41.7%	Flat_Tops	9	1.181	13.1%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	2	0.852	42.6%	Flat_Tops	9	3.524	39.2%	Dinosaur_all
V	Natural Emissions	2	1224.890	61244.5%	Bandelier	9	481.209	5346.8%	Dome
W	2021 All Emissions	2	1228.160	61408.0%	Bandelier	9	486.060	5400.7%	Dome
X	2008 All Emissions	2	1227.070	61353.5%	Bandelier	9	485.583	5395.4%	Dome

Table 5-6c. Maximum 24-Hour $PM_{2.5}$ concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	PM2.5, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	2	0.027	1.4%	Mount_Zirkel	9	0.024	0.3%	Dinosaur_all
B	White River FO	2	0.132	6.6%	Flat_Tops	9	0.272	3.0%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	2	0.012	0.6%	Maroon_Bells	9	0.021	0.2%	Colorado
D	Roan Plateau Planning area portion of CRVFO	2	0.010	0.5%	Flat_Tops	9	0.020	0.2%	Colorado
E	Grand Junction FO	2	0.092	4.6%	Arches	9	0.207	2.3%	Colorado
F	Uncompahgre FO	2	0.039	1.9%	Maroon_Bells	9	0.041	0.5%	Raggeds
G	Tres Rios FO	2	0.186	9.3%	Mesa_Verde	9	0.188	2.1%	Hovenweep
H	Kremmling FO	2	0.007	0.3%	Eagles_Nest	9	0.005	0.1%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	2	0.002	0.1%	Rocky_Mountain	9	0.001	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	2	0.010	0.5%	Rocky_Mountain	9	0.004	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	2	0.002	0.1%	Pecos	9	0.004	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	2	0.002	0.1%	Great_Sand_Dunes	9	0.015	0.2%	Greenhorn_Mounta
M	RGFO#4 – East-Central	2	0.001	0.0%	Eagles_Nest	9	0.004	0.0%	Lost_Creek
N	New Mexico Farmington District	2	0.033	1.7%	Mesa_Verde	9	0.494	5.5%	Aztec_Ruins
O	Total Colorado River Field Office	2	0.022	1.1%	Eagles_Nest	9	0.042	0.5%	Colorado
P	Total Royal Gorge Field Office	2	0.013	0.6%	Rocky_Mountain	9	0.015	0.2%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	2	0.787	39.3%	Flat_Tops	9	1.076	12.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2	0.841	42.1%	Flat_Tops	9	1.175	13.1%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2	0.878	43.9%	Rocky_Mountain	9	1.231	13.7%	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2	0.879	43.9%	Rocky_Mountain	9	1.232	13.7%	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	2	1.152	57.6%	Rocky_Mountain	9	3.533	39.3%	Dinosaur_all
V	Natural Emissions	2	1224.900	61245.0%	Bandelier	9	481.211	5346.8%	Dome
W	2021 All Emissions	2	1228.190	61409.5%	Bandelier	9	486.069	5400.8%	Dome
X	2008 All Emissions	2	1227.070	61353.5%	Bandelier	9	485.583	5395.4%	Dome

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5.1.1.4 PM_{10} PSD Concentrations

The results of the comparisons against the PM_{10} PSD increments is very similar to $PM_{2.5}$ with none of the Source Groups, except Natural Emissions (Source Group V) that are also included in the total 2021 and 2008 Source Groups, showing any exceedances of the annual or 24-hour PM_{10} PSD increment (Tables 5-7 and 5-8). Wildfires within the Natural Emissions Source Group can produce very high PM concentrations.

Of the BLM Planning Areas, Federal O&G from the TRFO has the largest annual and 24-hour PM_{10} concentrations at any Class I area with maximum values that of 12 and 16 percent for the High, 5 and 7 percent for the Medium and 1 and 2 percent for the Low Development Scenarios of the PSD PM_{10} increment. The combined Source Groups R, S, T and U PM_{10} impacts at any Class I area are 36% or less of the PM_{10} PSD increments.

Table 5-7a. Maximum Annual PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	PM10, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	4	0.004	0.1%	Mount_Zirkel	17	0.004	0.0%	Dinosaur_all
B	White River FO	4	0.034	0.8%	Flat_Tops	17	0.054	0.3%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	4	0.007	0.2%	Flat_Tops	17	0.003	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	4	0.004	0.1%	Flat_Tops	17	0.002	0.0%	Holy_Cross
E	Grand Junction FO	4	0.025	0.6%	Maroon_Bells	17	0.036	0.2%	Colorado
F	Uncompahgre FO	4	0.034	0.9%	Maroon_Bells	17	0.054	0.3%	Raggeds
G	Tres Rios FO	4	0.473	11.8%	Mesa_Verde	17	0.522	3.1%	South_San_Juan
H	Kremmling FO	4	0.015	0.4%	Rawah	17	0.005	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	4	0.000	0.0%	Rocky_Mountain	17	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	4	0.001	0.0%	Rocky_Mountain	17	0.001	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	4	0.000	0.0%	Pecos	17	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	4	0.000	0.0%	Great_Sand_Dunes	17	0.009	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	4	0.000	0.0%	Eagles_Nest	17	0.013	0.1%	Lost_Creek
N	New Mexico Farmington District	4	0.024	0.6%	Weminuche	17	0.900	5.3%	Aztec_Ruins
O	Total Colorado River Field Office	4	0.011	0.3%	Flat_Tops	17	0.005	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	4	0.002	0.0%	Rocky_Mountain	17	0.014	0.1%	Lost_Creek
Q	Mining from 13 Colorado BLM Planning Areas	4	0.164	4.1%	Mount_Zirkel	17	0.168	1.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	4	0.492	12.3%	Mesa_Verde	17	0.530	3.1%	South_San_Juan
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	4	1.058	26.4%	Mesa_Verde	17	1.077	6.3%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	4	1.071	26.8%	Mesa_Verde	17	1.330	7.8%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	4	1.108	27.7%	Mesa_Verde	17	1.796	10.6%	Aztec_Ruins
V	Natural Emissions	4	10.653	266.3%	Bandelier	17	5.251	30.9%	Sevilleta_NWR
W	2021 All Emissions	4	21.754	543.8%	Wheeler_Peak	17	65.725	386.6%	Valle_De_Oro_NWR
X	2008 All Emissions	4	17.449	436.2%	Bandelier	17	51.874	305.1%	Petroglyph

Table 5-7b. Maximum Annual PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	PM10, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	4	0.001	0.0%	Mount_Zirkel	17	0.001	0.0%	Dinosaur_all
B	White River FO	4	0.006	0.1%	Flat_Tops	17	0.010	0.1%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	4	0.004	0.1%	Flat_Tops	17	0.002	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	4	0.002	0.1%	Flat_Tops	17	0.001	0.0%	Holy_Cross
E	Grand Junction FO	4	0.001	0.0%	Maroon_Bells	17	0.002	0.0%	Colorado
F	Uncompahgre FO	4	0.011	0.3%	Maroon_Bells	17	0.019	0.1%	Raggeds
G	Tres Rios FO	4	0.049	1.2%	Mesa_Verde	17	0.055	0.3%	South_San_Juan
H	Kremmling FO	4	0.002	0.0%	Rawah	17	0.000	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	4	0.000	0.0%	Rocky_Mountain	17	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	4	0.000	0.0%	Rocky_Mountain	17	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	4	0.000	0.0%	Pecos	17	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	4	0.000	0.0%	Great_Sand_Dunes	17	0.006	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	4	0.000–	0.0%	Eagles_Nest	17	0.002	0.0%	Lost_Creek
N	New Mexico Farmington District	4	0.024	0.6%	Weminuche	17	0.900	5.3%	Aztec_Ruins
O	Total Colorado River Field Office	4	0.007	0.2%	Flat_Tops	17	0.003	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	4	0.000	0.0%	Rocky_Mountain	17	0.007	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	4	0.164	4.1%	Mount_Zirkel	17	0.168	1.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	4	0.169	4.2%	Mount_Zirkel	17	0.183	1.1%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	4	0.688	17.2%	Mesa_Verde	17	0.672	4.0%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	4	0.701	17.5%	Mesa_Verde	17	1.315	7.7%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	4	0.738	18.5%	Mesa_Verde	17	1.781	10.5%	Aztec_Ruins
V	Natural Emissions	4	10.653	266.3%	Bandelier	17	5.251	30.9%	Sevilleta_NWR
W	2021 All Emissions	4	21.747	543.7%	Wheeler_Peak	17	65.719	386.6%	Valle_De_Oro_NWR
X	2008 All Emissions	4	17.449	436.2%	Bandelier	17	51.874	305.1%	Petroglyph

Table 5-7c. Maximum Annual PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	PM10, Annual	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	4	0.003	0.1%	Mount_Zirkel	17	0.003	0.0%	Dinosaur_all
B	White River FO	4	0.023	0.6%	Flat_Tops	17	0.047	0.3%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	4	0.004	0.1%	Flat_Tops	17	0.002	0.0%	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	4	0.003	0.1%	Flat_Tops	17	0.002	0.0%	Holy_Cross
E	Grand Junction FO	4	0.014	0.3%	Maroon_Bells	17	0.025	0.1%	Colorado
F	Uncompahgre FO	4	0.017	0.4%	Maroon_Bells	17	0.027	0.2%	Raggeds
G	Tres Rios FO	4	0.203	5.1%	Mesa_Verde	17	0.222	1.3%	South_San_Juan
H	Kremmling FO	4	0.007	0.2%	Rawah	17	0.002	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	4	0.000	0.0%	Rocky_Mountain	17	0.000	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	4	0.000	0.0%	Rocky_Mountain	17	0.000	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	4	0.000	0.0%	Pecos	17	0.000	0.0%	Maxwell_NWR
L	RGFO#3 – South	4	0.000	0.0%	Great_Sand_Dunes	17	0.004	0.0%	Greenhorn_Mounta
M	RGFO#4 – East-Central	4	0.000	0.0%	Eagles_Nest	17	0.003	0.0%	Lost_Creek
N	New Mexico Farmington District	4	0.011	0.3%	Weminuche	17	0.380	2.2%	Aztec_Ruins
O	Total Colorado River Field Office	4	0.007	0.2%	Flat_Tops	17	0.004	0.0%	Holy_Cross
P	Total Royal Gorge Field Office	4	0.001	0.0%	Rocky_Mountain	17	0.004	0.0%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	4	0.164	4.1%	Mount_Zirkel	17	0.168	1.0%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	4	0.219	5.5%	Mesa_Verde	17	0.229	1.3%	South_San_Juan
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	4	0.776	19.4%	Mesa_Verde	17	0.772	4.5%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	4	0.782	19.6%	Mesa_Verde	17	0.786	4.6%	South_San_Juan
U	Combined O&G and Mining in 4 km domain	4	0.819	20.5%	Mesa_Verde	17	1.241	7.3%	Aztec_Ruins
V	Natural Emissions	4	10.653	266.3%	Bandelier	17	5.251	30.9%	Sevilleta_NWR
W	2021 All Emissions	4	21.748	543.7%	Wheeler_Peak	17	65.722	386.6%	Valle_De_Oro_NWR
X	2008 All Emissions	4	17.449	436.2%	Bandelier	17	51.874	305.1%	Petroglyph

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Table 5-8a. Maximum 24-Hour PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 High Development Scenario.

Choose	PM10, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	8	0.036	0.4%	Mount_Zirkel	30	0.042	0.1%	Dinosaur_all
B	White River FO	8	0.161	2.0%	Flat_Tops	30	0.327	1.1%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	8	0.029	0.4%	Flat_Tops	30	0.031	0.1%	Colorado
D	Roan Plateau Planning area portion of CRVFO	8	0.019	0.2%	Flat_Tops	30	0.027	0.1%	Colorado
E	Grand Junction FO	8	0.130	1.6%	Arches	30	0.295	1.0%	Colorado
F	Uncompahgre FO	8	0.160	2.0%	Maroon_Bells	30	0.168	0.6%	Raggeds
G	Tres Rios FO	8	1.249	15.6%	Mesa_Verde	30	1.160	3.9%	South_San_Juan
H	Kremmling FO	8	0.038	0.5%	Rawah	30	0.020	0.1%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	8	0.009	0.1%	Rocky_Mountain	30	0.003	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	8	0.035	0.4%	Rocky_Mountain	30	0.012	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	8	0.003	0.0%	Pecos	30	0.005	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	8	0.004	0.1%	Great_Sand_Dunes	30	0.035	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	8	0.006	0.1%	Eagles_Nest	30	0.053	0.2%	Lost_Creek
N	New Mexico Farmington District	8	0.176	2.2%	Mesa_Verde	30	2.778	9.3%	Aztec_Ruins
O	Total Colorado River Field Office	8	0.049	0.6%	Flat_Tops	30	0.058	0.2%	Colorado
P	Total Royal Gorge Field Office	8	0.044	0.6%	Rocky_Mountain	30	0.053	0.2%	Lost_Creek
Q	Mining from 13 Colorado BLM Planning Areas	8	0.787	9.8%	Flat_Tops	30	1.075	3.6%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	8	1.284	16.1%	Mesa_Verde	30	1.234	4.1%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	8	2.746	34.3%	Mesa_Verde	30	2.372	7.9%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	8	2.773	34.7%	Mesa_Verde	30	4.063	13.5%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	8	2.880	36.0%	Mesa_Verde	30	6.475	21.6%	Aztec_Ruins
V	Natural Emissions	8	1310.760	16384.5%	Bandelier	30	512.681	1708.9%	Dome
W	2021 All Emissions	8	1318.400	16480.0%	Bandelier	30	522.924	1743.1%	Dome
X	2008 All Emissions	8	1314.400	16430.0%	Bandelier	30	520.280	1734.3%	Dome

Table 5-8b. Maximum 24-Hour PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Low Development Scenario.

Choose	PM10, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	8	0.005	0.1%	Mount_Zirkel	30	0.006	0.0%	Dinosaur_all
B	White River FO	8	0.029	0.4%	Flat_Tops	30	0.062	0.2%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	8	0.020	0.3%	Flat_Tops	30	0.022	0.1%	Colorado
D	Roan Plateau Planning area portion of CRVFO	8	0.011	0.1%	Flat_Tops	30	0.015	0.1%	Colorado
E	Grand Junction FO	8	0.007	0.1%	Black_Canyon	30	0.017	0.1%	Colorado
F	Uncompahgre FO	8	0.056	0.7%	Maroon_Bells	30	0.054	0.2%	Raggeds
G	Tres Rios FO	8	0.133	1.7%	Mesa_Verde	30	0.121	0.4%	South_San_Juan
H	Kremmling FO	8	0.004	0.0%	Rawah	30	0.002	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	8	0.002	0.0%	Rocky_Mountain	30	0.001	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	8	0.007	0.1%	Rocky_Mountain	30	0.002	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	8	0.000	0.0%	Pecos	30	0.000	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	8	0.003	0.0%	Great_Sand_Dunes	30	0.023	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	8	0.001	0.0%	Eagles_Nest	30	0.008	0.0%	Lost_Creek
N	New Mexico Farmington District	8	0.176	2.2%	Mesa_Verde	30	2.778	9.3%	Aztec_Ruins
O	Total Colorado River Field Office	8	0.031	0.4%	Flat_Tops	30	0.038	0.1%	Colorado
P	Total Royal Gorge Field Office	8	0.009	0.1%	Rocky_Mountain	30	0.023	0.1%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	8	0.787	9.8%	Flat_Tops	30	1.081	3.6%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	8	0.808	10.1%	Flat_Tops	30	1.114	3.7%	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	8	1.788	22.3%	Mesa_Verde	30	1.483	4.9%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	8	1.815	22.7%	Mesa_Verde	30	4.038	13.5%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	8	1.925	24.1%	Mesa_Verde	30	6.458	21.5%	Aztec_Ruins
V	Natural Emissions	8	1310.760	16384.5%	Bandelier	30	512.679	1708.9%	Dome
W	2021 All Emissions	8	1318.360	16479.5%	Bandelier	30	522.909	1743.0%	Dome
X	2008 All Emissions	8	1314.400	16430.0%	Bandelier	30	520.280	1734.3%	Dome

Table 5-8c. Maximum 24-Hour PM_{10} concentration at any Class I or sensitive Class II area due to the different Source Groups for the 2021 Medium Development Scenario.

Choose	PM10, 24-hour	µg/m3							
Across grid cells	Maximum								
Group	Group Name	PSD Class I Increment	Max @ any Class I area	Percent of PSD Class I Increment	Class I Area where Max occurred	PSD Class II Increment	Max @ any Class II area	Percent of PSD Class II Increment	Class II Area where Max occurred
A	Little Snake FO	8	0.029	0.4%	Mount_Zirkel	30	0.029	0.1%	Dinosaur_all
B	White River FO	8	0.132	1.7%	Flat_Tops	30	0.286	1.0%	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	8	0.017	0.2%	Flat_Tops	30	0.023	0.1%	Colorado
D	Roan Plateau Planning area portion of CRVFO	8	0.012	0.2%	Flat_Tops	30	0.022	0.1%	Colorado
E	Grand Junction FO	8	0.096	1.2%	Arches	30	0.223	0.7%	Colorado
F	Uncompahgre FO	8	0.079	1.0%	Maroon_Bells	30	0.081	0.3%	Raggeds
G	Tres Rios FO	8	0.561	7.0%	Mesa_Verde	30	0.492	1.6%	South_San_Juan
H	Kremmling FO	8	0.017	0.2%	Rawah	30	0.010	0.0%	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	8	0.003	0.0%	Rocky_Mountain	30	0.001	0.0%	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	8	0.014	0.2%	Rocky_Mountain	30	0.005	0.0%	Mount_Evans
K	RGFO#2 – West-Central/South	8	0.002	0.0%	Pecos	30	0.004	0.0%	Greenhorn_Mounta
L	RGFO#3 – South	8	0.002	0.0%	Great_Sand_Dunes	30	0.018	0.1%	Greenhorn_Mounta
M	RGFO#4 – East-Central	8	0.001	0.0%	Eagles_Nest	30	0.012	0.0%	Lost_Creek
N	New Mexico Farmington District	8	0.077	1.0%	Mesa_Verde	30	1.234	4.1%	Aztec_Ruins
O	Total Colorado River Field Office	8	0.028	0.4%	Flat_Tops	30	0.045	0.2%	Colorado
P	Total Royal Gorge Field Office	8	0.017	0.2%	Rocky_Mountain	30	0.019	0.1%	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	8	0.787	9.8%	Flat_Tops	30	1.076	3.6%	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	8	0.842	10.5%	Flat_Tops	30	1.192	4.0%	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	8	2.028	25.3%	Mesa_Verde	30	1.706	5.7%	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	8	2.042	25.5%	Mesa_Verde	30	2.405	8.0%	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	8	2.150	26.9%	Mesa_Verde	30	4.742	15.8%	Aztec_Ruins
V	Natural Emissions	8	1310.760	16384.5%	Bandelier	30	512.681	1708.9%	Dome
W	2021 All Emissions	8	1318.390	16479.9%	Bandelier	30	522.916	1743.1%	Dome
X	2008 All Emissions	8	1314.400	16430.0%	Bandelier	30	520.280	1734.3%	Dome

5.1.2 PSD Concentration across All Class I and Sensitive Class II Areas

In this section we present examples of the contributions of PSD pollutant concentrations across all PSD Class I and sensitive Class II areas for the BLM GJFO Planning Areas as well as several of the combined Planning Area Source Groups. The tables below were obtained from the "Summary" sheet of Attachments A-1, A-2 and A-3 Excel spreadsheet that contains results for all of the Source Groups.

5.1.2.1 Individual BLM Planning Area PSD Contributions

Table 5-9 displays the contributions of new oil and gas emissions on Federal lands to PSD pollutant concentrations at all Class I and sensitive Class II areas in the CARMMS 4 km domain for the BLM Grand Junction Field Office (GJFO) Planning Area. All of the PSD pollutant concentrations at Class I areas due to new O&G on Federal lands within the BLM GJFO Planning Area (as well as the other 14 BLM other Planning Areas) are well below the Class I and II PSD concentration increments. Similar Tables of concentrations contributions at all of the Class I and sensitive Class II areas from each of the 24 Source Groups and the High and Low Development Scenarios can be found in Attachments A-1, A-2 and A-3.

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Table 5-9a. Contributions of new oil and gas emissions on Federal lands within the BLM Grand Junction Field Office Planning Area to PSD pollutant concentrations at Class I and sensitive Class II areas for the 2021 High Development Scenario.

Group	G_E	Grand Junction FO							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		SO_2 (µg/m³)		
	Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.079	0.130	0.014	0.094	0.010	0.003	0.002	0.000
Bandelier NM	NM	NPS	0.001	0.014	0.001	0.010	0.001	0.000	0.000	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.029	0.129	0.013	0.093	0.008	0.001	0.001	0.000
Bosque del Apache Wilderness	NM	FWS	0.000	0.008	0.000	0.005	0.000	0.000	0.000	0.000
Canyonlands NP	UT	NPS	0.012	0.073	0.004	0.043	0.002	0.001	0.001	0.000
Capitol Reef NP	UT	NPS	0.001	0.016	0.001	0.011	0.000	0.000	0.000	0.000
Eagles Nest Wilderness	CO	FS	0.038	0.086	0.016	0.051	0.008	0.001	0.001	0.000
Flat Tops Wilderness	CO	FS	0.062	0.081	0.019	0.045	0.009	0.003	0.001	0.000
Galiuro Wilderness	AZ	FS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Gila Wilderness	NM	FS	0.000	0.005	0.000	0.003	0.000	0.000	0.000	0.000
Great Sand Dunes NM	CO	NPS	0.004	0.042	0.005	0.034	0.003	0.000	0.000	0.000
La Garita Wilderness	CO	FS	0.007	0.043	0.005	0.030	0.003	0.000	0.000	0.000
Maroon Bells-Snowmass Wilderness	CO	FS	0.067	0.121	0.025	0.065	0.011	0.002	0.001	0.000
Mesa Verde NP	CO	NPS	0.004	0.035	0.003	0.023	0.001	0.001	0.000	0.000
Mount Baldy Wilderness	AZ	FS	0.000	0.005	0.000	0.005	0.000	0.000	0.000	0.000
Mount Zirkel Wilderness	CO	FS	0.014	0.036	0.006	0.023	0.003	0.001	0.000	0.000
Pecos Wilderness	NM	FS	0.001	0.017	0.001	0.012	0.001	0.000	0.000	0.000
Petrified Forest NP	AZ	NPS	0.000	0.008	0.000	0.005	0.000	0.000	0.000	0.000
Rawah Wilderness	CO	FS	0.009	0.032	0.005	0.022	0.003	0.001	0.000	0.000
Rocky Mountain NP	CO	NPS	0.016	0.056	0.008	0.037	0.005	0.001	0.000	0.000
Salt Creek Wilderness	NM	FWS	0.000	0.008	0.000	0.005	0.000	0.000	0.000	0.000
San Pedro Parks Wilderness	NM	FS	0.001	0.014	0.001	0.010	0.001	0.000	0.000	0.000
Weminuche Wilderness	CO	FS	0.005	0.031	0.003	0.021	0.002	0.001	0.000	0.000
West Elk Wilderness	CO	FS	0.031	0.084	0.013	0.059	0.007	0.001	0.001	0.000
Wheeler Peak Wilderness	NM	FS	0.002	0.021	0.002	0.017	0.001	0.000	0.000	0.000
White Mountain Wilderness	NM	FS	0.000	0.005	0.000	0.003	0.000	0.000	0.000	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	0.003	0.001	0.000
Class II	State	Owner	PSD Class II Increment[1]							
			25	90	17	9	4	512	91	20
Alamosa NWR	CO	FWS	0.003	0.041	0.004	0.033	0.003	0.000	0.000	0.000
Aldo Leopold Wilderness	NM	USFS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Apache Kid Wilderness	NM	USFS	0.000	0.007	0.000	0.005	0.000	0.000	0.000	0.000
Aztec Ruins NM	NM	NPS	0.002	0.017	0.002	0.012	0.001	0.000	0.000	0.000
Baca NWR	CO	FWS	0.005	0.045	0.005	0.039	0.004	0.000	0.000	0.000
Bear Wallow Wilderness	AZ	USFS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Bitter Lake NWR	NM	FWS	0.000	0.008	0.000	0.005	0.000	0.000	0.000	0.000
Blue Range Wilderness	NM	USFS	0.000	0.004	0.000	0.003	0.000	0.000	0.000	0.000
Bosque Del Apache NWR	NM	FWS	0.000	0.008	0.000	0.005	0.000	0.000	0.000	0.000
Browns Park NWR	CO	FWS	0.002	0.014	0.001	0.009	0.001	0.001	0.000	0.000
Canyon de Chelly NM	AZ	NPS	0.001	0.014	0.001	0.009	0.000	0.000	0.000	0.000
Capitan Mountains Wilderness	NM	USFS	0.000	0.005	0.000	0.003	0.000	0.000	0.000	0.000
Chaco Culture NHP	NM	NPS	0.001	0.010	0.001	0.006	0.000	0.000	0.000	0.000
Chama River Canyon Wilderness	NM	USFS	0.001	0.014	0.001	0.011	0.001	0.000	0.000	0.000
Chimney Rock NM	CO	USFS	0.003	0.016	0.002	0.013	0.001	0.000	0.000	0.000
Colorado NM	CO	NPS	0.149	0.295	0.036	0.242	0.023	0.006	0.003	0.001
Cruces Basin Wilderness	NM	USFS	0.002	0.018	0.002	0.013	0.001	0.000	0.000	0.000
Curecanti NRA	CO	NPS	0.018	0.081	0.010	0.058	0.006	0.001	0.001	0.000
Dark Canyon Wilderness	UT	USFS	0.002	0.020	0.001	0.014	0.001	0.001	0.000	0.000
Dinosaur NM	CO	NPS	0.021	0.054	0.004	0.031	0.002	0.003	0.001	0.000
Dome Wilderness	NM	USFS	0.001	0.014	0.001	0.009	0.001	0.000	0.000	0.000
El Malpais NM	NM	NPS	0.001	0.011	0.001	0.006	0.000	0.000	0.000	0.000
Escudilla Wilderness	AZ	USFS	0.000	0.005	0.000	0.003	0.000	0.000	0.000	0.000
Flaming Gorge	UT	USFS	0.001	0.010	0.000	0.008	0.000	0.000	0.000	0.000
Florissant Fossil Beds NM	CO	NPS	0.006	0.037	0.004	0.025	0.003	0.001	0.000	0.000
Fossil Ridge Wilderness	CO	USFS	0.015	0.051	0.008	0.036	0.004	0.001	0.000	0.000
Glen Canyon NRA	UT	NPS	0.009	0.051	0.002	0.035	0.002	0.001	0.001	0.000
Great Sand Dunes National Park	CO	NPS	0.004	0.043	0.005	0.035	0.003	0.000	0.000	0.000
Great Sand Dunes National Preserve	CO	NPS	0.004	0.034	0.004	0.027	0.002	0.000	0.000	0.000
Greenhorn Mountain Wilderness	CO	USFS	0.003	0.021	0.002	0.016	0.001	0.000	0.000	0.000
High Uintas Wilderness	UT	USFS	0.000	0.006	0.000	0.003	0.000	0.000	0.000	0.000
Holy Cross Wilderness	CO	USFS	0.038	0.089	0.016	0.053	0.008	0.001	0.001	0.000
Hovenweep NM	CO	NPS	0.004	0.025	0.003	0.016	0.002	0.001	0.000	0.000
Hunter-Fryingpan Wilderness	CO	USFS	0.033	0.081	0.014	0.050	0.007	0.001	0.000	0.000
Las Vegas NWR	NM	FWS	0.001	0.015	0.001	0.012	0.001	0.000	0.000	0.000
Latir Peak Wilderness	NM	USFS	0.002	0.027	0.002	0.021	0.001	0.000	0.000	0.000
Lizard Head Wilderness	CO	USFS	0.006	0.042	0.004	0.023	0.002	0.001	0.000	0.000
Lost Creek Wilderness	CO	USFS	0.013	0.039	0.006	0.026	0.003	0.001	0.000	0.000
Manzano Mountain Wilderness	NM	USFS	0.001	0.011	0.001	0.007	0.000	0.000	0.000	0.000
Maxwell NWR	NM	FWS	0.001	0.017	0.001	0.012	0.001	0.000	0.000	0.000
Monte Vista NWR	CO	FWS	0.003	0.036	0.004	0.029	0.003	0.000	0.000	0.000
Mount Evans Wilderness	CO	USFS	0.014	0.042	0.007	0.027	0.004	0.001	0.000	0.000
Mount Sneffels Wilderness	CO	USFS	0.009	0.054	0.006	0.041	0.003	0.001	0.000	0.000
Natural Bridges NM	UT	NPS	0.001	0.016	0.001	0.010	0.001	0.000	0.000	0.000
Navajo NM	AZ	NPS	0.001	0.017	0.001	0.010	0.000	0.000	0.000	0.000
Petroglyph NM	NM	NPS	0.001	0.012	0.001	0.006	0.000	0.000	0.000	0.000
Powderhorn Wilderness	CO	USFS	0.008	0.044	0.005	0.030	0.003	0.001	0.000	0.000
Raggeds Wilderness	CO	USFS	0.046	0.097	0.017	0.054	0.008	0.001	0.001	0.000
Rio Mora NWR and CA	NM	FWS	0.001	0.014	0.001	0.010	0.001	0.000	0.000	0.000
Sandia Mountain Wilderness	NM	USFS	0.001	0.013	0.001	0.008	0.000	0.000	0.000	0.000
Sangre de Cristo Wilderness	CO	USFS	0.007	0.040	0.005	0.030	0.003	0.000	0.000	0.000
Savage Run Wilderness	WY	USFS	0.006	0.025	0.003	0.015	0.002	0.001	0.000	0.000
Sevilleta NWR	NM	FWS	0.000	0.015	0.001	0.011	0.000	0.000	0.000	0.000
South San Juan Wilderness	CO	USFS	0.003	0.024	0.002	0.016	0.001	0.000	0.000	0.000
Spanish Peaks Wilderness	CO	USFS	0.003	0.024	0.002	0.018	0.001	0.000	0.000	0.000
Uncompahgre Wilderness	CO	USFS	0.009	0.059	0.006	0.039	0.004	0.001	0.000	0.000
Valle De Oro NWR	NM	FWS	0.001	0.014	0.001	0.010	0.001	0.000	0.000	0.000
Withington Wilderness	NM	USFS	0.000	0.007	0.000	0.005	0.000	0.000	0.000	0.000

Table 5-9b. Contributions of new oil and gas emissions on Federal lands within the BLM Grand Junction Field Office Planning Area to PSD pollutant concentrations at Class I and sensitive Class II areas for the 2021 Low Development Scenario.

Group	G_E	Grand Junction FO							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		SO_2 (µg/m³)		
	Averaging Time	Annual[1]	24-hour[2]	Annual[1]	24-hour[2]	Annual[1]	3-hour[2]	24-hour[2]	Annual[1]
Class I	State	Owner	PSD Class I Increment[3]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.004	0.007	0.001	0.006	0.001	0.000	0.000	0.000
Bandelier NM	NM	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.002	0.007	0.001	0.006	0.000	0.000	0.000	0.000
Bosque del Apache Wilderness	NM	FWS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Canyonlands NP	UT	NPS	0.001	0.004	0.000	0.003	0.000	0.000	0.000	0.000
Capitol Reef NP	UT	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Eagles Nest Wilderness	CO	FS	0.002	0.005	0.001	0.004	0.001	0.000	0.000	0.000
Flat Tops Wilderness	CO	FS	0.004	0.004	0.001	0.003	0.001	0.000	0.000	0.000
Galiuro Wilderness	AZ	FS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gila Wilderness	NM	FS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Great Sand Dunes NM	CO	NPS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
La Garita Wilderness	CO	FS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Maroon Bells-Snowmass Wilderness	CO	FS	0.004	0.007	0.001	0.005	0.001	0.000	0.000	0.000
Mesa Verde NP	CO	NPS	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000
Mount Baldy Wilderness	AZ	FS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mount Zirkel Wilderness	CO	FS	0.001	0.002	0.000	0.001	0.000	0.000	0.000	0.000
Pecos Wilderness	NM	FS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Petrified Forest NP	AZ	NPS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rawah Wilderness	CO	FS	0.001	0.002	0.000	0.001	0.000	0.000	0.000	0.000
Rocky Mountain NP	CO	NPS	0.001	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Salt Creek Wilderness	NM	FWS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
San Pedro Parks Wilderness	NM	FS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Weminuche Wilderness	CO	FS	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000
West Elk Wilderness	CO	FS	0.002	0.005	0.001	0.004	0.000	0.000	0.000	0.000
Wheeler Peak Wilderness	NM	FS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
White Mountain Wilderness	NM	FS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	0.000	0.000	0.000
Class II	State	Owner	PSD Class II Increment[3]							
			25	30	17	9	4	512	91	25
Alamosa NWR	CO	FWS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Aldo Leopold Wilderness	NM	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Apache Kid Wilderness	NM	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aztec Ruins NM	NM	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Baca NWR	CO	FWS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Bear Wallow Wilderness	AZ	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bitter Lake NWR	NM	FWS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Blue Range Wilderness	NM	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bosque Del Apache NWR	NM	FWS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Browns Park NWR	CO	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Canyon de Chelly NM	AZ	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Capitan Mountains Wilderness	NM	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chaco Culture NHP	NM	NPS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Chama River Canyon Wilderness	NM	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Chimney Rock NM	CO	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Colorado NM	CO	NPS	0.008	0.017	0.002	0.014	0.001	0.000	0.000	0.000
Cruces Basin Wilderness	NM	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Curecanti NRA	CO	NPS	0.001	0.005	0.001	0.004	0.000	0.000	0.000	0.000
Dark Canyon Wilderness	UT	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Dinosaur NM	CO	NPS	0.001	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Dome Wilderness	NM	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
El Malpais NM	NM	NPS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Escudilla Wilderness	AZ	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Flaming Gorge	UT	USFS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Florissant Fossil Beds NM	CO	NPS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Fossil Ridge Wilderness	CO	USFS	0.001	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Glen Canyon NRA	UT	NPS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Great Sand Dunes National Park	CO	NPS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Great Sand Dunes National Preserve	CO	NPS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Greenhorn Mountain Wilderness	CO	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
High Uintas Wilderness	UT	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Holy Cross Wilderness	CO	USFS	0.002	0.005	0.001	0.004	0.001	0.000	0.000	0.000
Hovenweep NM	CO	NPS	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000
Hunter-Fryingpan Wilderness	CO	USFS	0.002	0.005	0.001	0.004	0.000	0.000	0.000	0.000
Las Vegas NWR	NM	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Latir Peak Wilderness	NM	USFS	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000
Lizard Head Wilderness	CO	USFS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Lost Creek Wilderness	CO	USFS	0.001	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Manzano Mountain Wilderness	NM	USFS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Maxwell NWR	NM	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Monte Vista NWR	CO	FWS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Mount Evans Wilderness	CO	USFS	0.001	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Mount Sneffels Wilderness	CO	USFS	0.001	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Natural Bridges NM	UT	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Navajo NM	AZ	NPS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Petroglyph NM	NM	NPS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Powderhorn Wilderness	CO	USFS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Raggeds Wilderness	CO	USFS	0.003	0.006	0.001	0.004	0.001	0.000	0.000	0.000
Rio Mora NWR and CA	NM	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Sandia Mountain Wilderness	NM	USFS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Sangre de Cristo Wilderness	CO	USFS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Savage Run Wilderness	WY	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Sevilleta NWR	NM	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
South San Juan Wilderness	CO	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Spanish Peaks Wilderness	CO	USFS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Uncompahgre Wilderness	CO	USFS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Valle De Oro NWR	NM	FWS	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Withington Wilderness	NM	USFS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Table 5-9c. Contributions of new oil and gas emissions on Federal lands within the BLM Grand Junction Field Office Planning Area to PSD pollutant concentrations at Class I and sensitive Class II areas for the 2021 Medium Development Scenario.

Group	G_E	Grand Junction FO							
Across grid cells	Maximum	Max							
		Pollutant	NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)	
		Averaging Time	Annual[1]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[5]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.075	0.096	0.010	0.092	0.008	0.003	0.002	0.000
Bandelier NM	NM	NPS	0.001	0.010	0.001	0.008	0.001	0.000	0.000	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.026	0.092	0.009	0.078	0.007	0.001	0.001	0.000
Bosque del Apache Wilderness	NM	FWS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Canyonlands NP	UT	NPS	0.011	0.051	0.003	0.033	0.002	0.001	0.001	0.000
Capitol Reef NP	UT	NPS	0.001	0.011	0.000	0.009	0.000	0.000	0.000	0.000
Eagles Nest Wilderness	CO	FS	0.031	0.054	0.009	0.041	0.006	0.001	0.001	0.000
Flat Tops Wilderness	CO	FS	0.050	0.044	0.011	0.036	0.007	0.003	0.001	0.000
Galiuro Wilderness	AZ	FS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Gila Wilderness	NM	FS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Great Sand Dunes NM	CO	NPS	0.003	0.031	0.003	0.028	0.003	0.000	0.000	0.000
La Garita Wilderness	CO	FS	0.006	0.032	0.003	0.025	0.002	0.000	0.000	0.000
Maroon Bells-Snowmass Wilderness	CO	FS	0.054	0.073	0.014	0.050	0.008	0.002	0.001	0.000
Mesa Verde NP	CO	NPS	0.004	0.023	0.002	0.019	0.001	0.001	0.000	0.000
Mount Baldy Wilderness	AZ	FS	0.000	0.004	0.000	0.004	0.000	0.000	0.000	0.000
Mount Zirkel Wilderness	CO	FS	0.012	0.022	0.004	0.019	0.002	0.001	0.000	0.000
Pecos Wilderness	NM	FS	0.001	0.012	0.001	0.010	0.001	0.000	0.000	0.000
Petrified Forest NP	AZ	NPS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Rawah Wilderness	CO	FS	0.008	0.023	0.003	0.018	0.002	0.001	0.000	0.000
Rocky Mountain NP	CO	NPS	0.013	0.035	0.005	0.029	0.004	0.001	0.000	0.000
Salt Creek Wilderness	NM	FWS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
San Pedro Parks Wilderness	NM	FS	0.001	0.010	0.001	0.009	0.000	0.000	0.000	0.000
Weminuche Wilderness	CO	FS	0.004	0.021	0.002	0.017	0.002	0.001	0.000	0.000
West Elk Wilderness	CO	FS	0.025	0.059	0.008	0.049	0.005	0.001	0.001	0.000
Wheeler Peak Wilderness	NM	FS	0.001	0.015	0.001	0.014	0.001	0.000	0.000	0.000
White Mountain Wilderness	NM	FS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	0.003	0.001	0.000
Class II	State	Owner	PSD Class II Increment[5]							
			25	30	17	9	4	512	91	20
Alamosa NWR	CO	FWS	0.003	0.030	0.003	0.028	0.002	0.000	0.000	0.000
Aldo Leopold Wilderness	NM	USFS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Apache Kid Wilderness	NM	USFS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Aztec Ruins NM	NM	NPS	0.002	0.011	0.001	0.009	0.001	0.000	0.000	0.000
Baca NWR	CO	FWS	0.004	0.034	0.004	0.032	0.003	0.000	0.000	0.000
Bear Wallow Wilderness	AZ	USFS	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Bitter Lake NWR	NM	FWS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Blue Range Wilderness	NM	USFS	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000
Bosque Del Apache NWR	NM	FWS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000
Browns Park NWR	CO	FWS	0.002	0.009	0.001	0.008	0.000	0.001	0.000	0.000
Canyon de Chelly NM	AZ	NPS	0.001	0.009	0.000	0.007	0.000	0.000	0.000	0.000
Capitan Mountains Wilderness	NM	USFS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Chaco Culture NHP	NM	NPS	0.001	0.006	0.000	0.005	0.000	0.000	0.000	0.000
Chama River Canyon Wilderness	NM	USFS	0.001	0.010	0.001	0.009	0.000	0.000	0.000	0.000
Chimney Rock NM	CO	USFS	0.002	0.012	0.001	0.010	0.001	0.000	0.000	0.000
Colorado NM	CO	NPS	0.137	0.223	0.025	0.207	0.020	0.006	0.003	0.001
Cruces Basin Wilderness	NM	USFS	0.002	0.013	0.001	0.011	0.001	0.000	0.000	0.000
Curecanti NRA	CO	NPS	0.016	0.057	0.007	0.048	0.005	0.001	0.001	0.000
Dark Canyon Wilderness	UT	USFS	0.002	0.014	0.001	0.012	0.001	0.001	0.000	0.000
Dinosaur NM	CO	NPS	0.018	0.035	0.002	0.022	0.002	0.003	0.001	0.000
Dome Wilderness	NM	USFS	0.001	0.009	0.001	0.008	0.000	0.000	0.000	0.000
El Malpais NM	NM	NPS	0.001	0.006	0.000	0.005	0.000	0.000	0.000	0.000
Escudilla Wilderness	AZ	USFS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Flaming Gorge	UT	USFS	0.001	0.007	0.000	0.007	0.000	0.000	0.000	0.000
Florissant Fossil Beds NM	CO	NPS	0.005	0.024	0.003	0.020	0.002	0.001	0.000	0.000
Fossil Ridge Wilderness	CO	USFS	0.012	0.034	0.005	0.030	0.003	0.001	0.000	0.000
Glen Canyon NRA	UT	NPS	0.008	0.035	0.002	0.028	0.002	0.001	0.001	0.000
Great Sand Dunes National Park	CO	NPS	0.003	0.032	0.003	0.029	0.003	0.000	0.000	0.000
Great Sand Dunes National Preserve	CO	NPS	0.003	0.025	0.003	0.022	0.002	0.000	0.000	0.000
Greenhorn Mountain Wilderness	CO	USFS	0.003	0.015	0.001	0.013	0.001	0.000	0.000	0.000
High Uintas Wilderness	UT	USFS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Holy Cross Wilderness	CO	USFS	0.030	0.053	0.009	0.042	0.006	0.001	0.001	0.000
Hovenweep NM	CO	NPS	0.004	0.017	0.002	0.012	0.001	0.001	0.000	0.000
Hunter-Fryingpan Wilderness	CO	USFS	0.026	0.050	0.008	0.040	0.005	0.001	0.000	0.000
Las Vegas NWR	NM	FWS	0.001	0.011	0.001	0.010	0.001	0.000	0.000	0.000
Latir Peak Wilderness	NM	USFS	0.002	0.020	0.001	0.017	0.001	0.000	0.000	0.000
Lizard Head Wilderness	CO	USFS	0.005	0.026	0.002	0.018	0.002	0.001	0.000	0.000
Lost Creek Wilderness	CO	USFS	0.011	0.026	0.004	0.021	0.003	0.001	0.000	0.000
Manzano Mountain Wilderness	NM	USFS	0.001	0.007	0.000	0.005	0.000	0.000	0.000	0.000
Maxwell NWR	NM	FWS	0.001	0.011	0.001	0.009	0.001	0.000	0.000	0.000
Monte Vista NWR	CO	FWS	0.003	0.026	0.003	0.024	0.003	0.000	0.000	0.000
Mount Evans Wilderness	CO	USFS	0.011	0.027	0.004	0.021	0.003	0.001	0.000	0.000
Mount Sneffels Wilderness	CO	USFS	0.008	0.040	0.004	0.035	0.003	0.001	0.000	0.000
Natural Bridges NM	UT	NPS	0.001	0.010	0.001	0.008	0.000	0.000	0.000	0.000
Navajo NM	AZ	NPS	0.001	0.010	0.000	0.008	0.000	0.000	0.000	0.000
Petroglyph NM	NM	NPS	0.001	0.007	0.001	0.004	0.000	0.000	0.000	0.000
Powderhorn Wilderness	CO	USFS	0.007	0.030	0.003	0.025	0.002	0.001	0.000	0.000
Raggeds Wilderness	CO	USFS	0.038	0.060	0.010	0.044	0.006	0.001	0.001	0.000
Rio Mora NWR and CA	NM	FWS	0.001	0.010	0.001	0.009	0.001	0.000	0.000	0.000
Sandia Mountain Wilderness	NM	USFS	0.001	0.008	0.000	0.006	0.000	0.000	0.000	0.000
Sangre de Cristo Wilderness	CO	USFS	0.006	0.028	0.003	0.024	0.003	0.000	0.000	0.000
Savage Run Wilderness	WY	USFS	0.005	0.016	0.002	0.012	0.001	0.000	0.000	0.000
Sevilleta NWR	NM	FWS	0.000	0.010	0.000	0.009	0.000	0.000	0.000	0.000
South San Juan Wilderness	CO	USFS	0.003	0.017	0.002	0.013	0.001	0.000	0.000	0.000
Spanish Peaks Wilderness	CO	USFS	0.002	0.017	0.002	0.015	0.001	0.000	0.000	0.000
Uncompahgre Wilderness	CO	USFS	0.007	0.040	0.004	0.033	0.003	0.001	0.000	0.000
Valle De Oro NWR	NM	FWS	0.000	0.010	0.001	0.008	0.000	0.000	0.000	0.000
Withington Wilderness	NM	USFS	0.000	0.005	0.000	0.004	0.000	0.000	0.000	0.000

5.1.2.2 Combined BLM Planning Area PSD Contributions

Below we examine the contributions of emissions to concentrations at Class I areas for three of the combination Source Groups: (R) Federal O&G and mining within the 13 Colorado BLM Planning Areas; (T) the Cumulative Emissions Scenario that includes new O&G and mining on Federal lands and new O&G on non-Federal lands within the 14 NM BLM Planning Areas; and (U) all O&G (new Federal and non-Federal and existing) throughout the 4 km CARMMS domain plus Federal mining. Results for the other Source Groups as well as results for the sensitive Class II areas are contained in Attachments A-1, A-2 and A-3.

Source Group R represents mining and new O&G development on Federal lands within the 13 Colorado BLM Planning Areas so represents potential new emissions that may be mitigated by the BLM COSO. The PSD contributions of Source Group R are below the Class I and Class II PSD increments at all Class I and sensitive Class II areas, respectively, for all PSD pollutants and averaging times and the 2021 High, Low and Medium Scenarios (Table 5-10). As a percentage of a PSD increment, the largest contribution at any Class I area due to Source Group R is 79% (1.979 $\mu g/m^3$), 10% (0.239 $\mu g/m^3$) and 67% (1.669 $\mu g/m^3$) of the 2.5 $\mu g/m^3$ annual NO_2 PSD Class I increment for the, respectively, High, Low and Medium Development Scenarios and occurs at the Mesa Verde National Park. These NO_2 impacts are primarily (99%) due to new Federal O&G emissions from the TRFO Planning Area.

Source Group T is the Cumulative Emissions Scenario that includes new Federal and non-Federal oil and gas and Federal mining within the 14 BLM Colorado and Northern New Mexico Planning Areas whose PSD pollutant concentrations for the 2021 High and Low Development Scenarios are shown in Table 5-11. With one exception, the contribution of the Cumulative Emissions Scenario to PSD concentrations at all Class I and sensitive Class II areas are below the PSD Class I and II concentrations increments. The exception is for annual NO_2 at the Mesa Verde Class I area where the 2021 High, Low and Medium Development Scenario estimate an annual NO_2 contributions of, respectively, 4.50, 4.11 and 2.87 $\mu g/m^3$ that exceed the 2.5 $\mu g/m^3$ annual NO_2 PSD Class I area increment. Note that new Federal O&G emissions from the TRFO Planning Area contributed 1.97 $\mu g/m^3$ (High Scenario), 0.24 $\mu g/m^3$ (Low Scenario) and 1.66 $\mu g/m^3$ (Medium Scenario) to the maximum annual NO_2 at Mesa Verde and the split between new Federal and non-Federal O&G in the TRFO planning Area is 40% and 60%, respectively (see Table 3-2). Thus, the Cumulative Emissions Source Group T annual NO_2 contribution at Mesa Verde is mainly due to new Federal and non-Federal O&G development within the TRFO Planning Area.

The contributions of all O&G within the 4 km CARMMS domain plus Federal mining in Colorado (Source Group U) to PSD pollutants at Class I areas for the two 2021 emission scenarios are shown in Table 5-12. Again, with one exception, the contributions of all O&G emissions throughout the 4 km CARMMS domain produce PSD pollutant concentrations at all Class I and sensitive Class II areas that are below the PSD Class I and II area increments, respectively. The exception is the annual NO_2 at Mesa Verde Class I area where Source Group U contributes 4.78, 3.15 and 4.38 $\mu g/m^3$ for the High, Low and Medium Development Scenarios, respectively.

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Table 5-10a. Contributions of new oil and gas and mining on Federal lands within the 13 Colorado BLM Planning Areas to PSD pollutant concentrations at Class I areas (Source Group R) for the 2021 High Development Scenario.

Group	G_R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas							
Across grid cells	Maximum	Max							
		Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		PM_{25} (µg/m³)		SO_2 (µg/m³)	
		Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.117	0.248	0.040	0.213	0.033	0.087	0.037	0.003
Bandelier NM	NM	NPS	0.006	0.080	0.009	0.069	0.006	0.011	0.005	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.064	0.380	0.057	0.327	0.046	0.071	0.043	0.004
Bosque del Apache Wilderness	NM	FWS	0.002	0.047	0.003	0.036	0.002	0.010	0.004	0.000
Canyonlands NP	UT	NPS	0.037	0.177	0.019	0.138	0.014	0.062	0.026	0.002
Capitol Reef NP	UT	NPS	0.003	0.060	0.003	0.047	0.003	0.021	0.007	0.000
Eagles Nest Wilderness	CO	FS	0.091	0.244	0.072	0.202	0.057	0.076	0.022	0.003
Flat Tops Wilderness	CO	FS	0.225	0.844	0.160	0.842	0.133	0.356	0.132	0.013
Galiuro Wilderness	AZ	FS	0.000	0.006	0.000	0.005	0.000	0.002	0.000	0.000
Gila Wilderness	NM	FS	0.001	0.025	0.001	0.020	0.001	0.009	0.003	0.000
Great Sand Dunes NM	CO	NPS	0.015	0.128	0.023	0.111	0.019	0.023	0.009	0.001
La Garita Wilderness	CO	FS	0.019	0.147	0.022	0.116	0.017	0.045	0.014	0.001
Maroon Bells-Snowmass Wilderness	CO	FS	0.202	0.534	0.157	0.442	0.118	0.096	0.030	0.005
Mesa Verde NP	CO	NPS	1.979	1.284	0.492	0.339	0.104	0.047	0.018	0.002
Mount Baldy Wilderness	AZ	FS	0.000	0.030	0.001	0.026	0.001	0.005	0.002	0.000
Mount Zirkel Wilderness	CO	FS	0.092	0.753	0.190	0.741	0.182	0.150	0.054	0.008
Pecos Wilderness	NM	FS	0.005	0.064	0.008	0.054	0.006	0.014	0.005	0.000
Petrified Forest NP	AZ	NPS	0.001	0.039	0.002	0.034	0.002	0.007	0.003	0.000
Rawah Wilderness	CO	FS	0.076	0.344	0.084	0.314	0.068	0.080	0.024	0.004
Rocky Mountain NP	CO	NPS	0.053	0.297	0.075	0.282	0.066	0.072	0.017	0.003
Salt Creek Wilderness	NM	FWS	0.001	0.038	0.002	0.032	0.002	0.005	0.002	0.000
San Pedro Parks Wilderness	NM	FS	0.008	0.077	0.009	0.057	0.006	0.019	0.007	0.000
Weminuche Wilderness	CO	FS	0.019	0.111	0.017	0.088	0.013	0.051	0.014	0.001
West Elk Wilderness	CO	FS	0.121	0.678	0.172	0.659	0.151	0.079	0.031	0.003
Wheeler Peak Wilderness	NM	FS	0.006	0.077	0.011	0.065	0.008	0.019	0.006	0.001
White Mountain Wilderness	NM	FS	0.001	0.028	0.002	0.022	0.002	0.008	0.003	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	1.262	0.412	0.090

Table 5-10b. Contributions of new oil and gas and mining on Federal lands within the 13 Colorado BLM Planning Areas to PSD pollutant concentrations at Class I areas (Source Group R) for the 2021 Low Development Scenario.

Group	G_R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas							
Across grid cells	Maximum	Max							
		Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		PM_{25} (µg/m³)		SO_2 (µg/m³)	
		Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.017	0.141	0.020	0.131	0.019	0.014	0.005	0.001
Bandelier NM	NM	NPS	0.001	0.038	0.004	0.037	0.004	0.002	0.001	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.010	0.211	0.031	0.204	0.030	0.011	0.006	0.001
Bosque del Apache Wilderness	NM	FWS	0.000	0.028	0.002	0.027	0.001	0.002	0.001	0.000
Canyonlands NP	UT	NPS	0.006	0.107	0.009	0.102	0.009	0.009	0.004	0.000
Capitol Reef NP	UT	NPS	0.000	0.039	0.002	0.037	0.002	0.004	0.001	0.000
Eagles Nest Wilderness	CO	FS	0.020	0.149	0.043	0.148	0.041	0.011	0.003	0.001
Flat Tops Wilderness	CO	FS	0.051	0.808	0.110	0.804	0.105	0.053	0.021	0.002
Galiuro Wilderness	AZ	FS	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Gila Wilderness	NM	FS	0.000	0.016	0.001	0.015	0.001	0.001	0.001	0.000
Great Sand Dunes NM	CO	NPS	0.004	0.066	0.011	0.063	0.011	0.004	0.002	0.000
La Garita Wilderness	CO	FS	0.004	0.110	0.011	0.108	0.011	0.007	0.002	0.000
Maroon Bells-Snowmass Wilderness	CO	FS	0.054	0.380	0.105	0.356	0.095	0.014	0.005	0.001
Mesa Verde NP	CO	NPS	0.239	0.160	0.063	0.130	0.031	0.007	0.003	0.000
Mount Baldy Wilderness	AZ	FS	0.000	0.012	0.001	0.012	0.000	0.001	0.000	0.000
Mount Zirkel Wilderness	CO	FS	0.022	0.714	0.169	0.712	0.167	0.022	0.008	0.001
Pecos Wilderness	NM	FS	0.001	0.035	0.004	0.034	0.004	0.002	0.001	0.000
Petrified Forest NP	AZ	NPS	0.000	0.022	0.001	0.022	0.001	0.001	0.001	0.000
Rawah Wilderness	CO	FS	0.013	0.303	0.057	0.300	0.056	0.013	0.004	0.001
Rocky Mountain NP	CO	NPS	0.011	0.257	0.054	0.256	0.053	0.012	0.003	0.001
Salt Creek Wilderness	NM	FWS	0.000	0.020	0.001	0.020	0.001	0.001	0.000	0.000
San Pedro Parks Wilderness	NM	FS	0.001	0.040	0.004	0.037	0.004	0.003	0.001	0.000
Weminuche Wilderness	CO	FS	0.003	0.080	0.008	0.076	0.008	0.007	0.002	0.000
West Elk Wilderness	CO	FS	0.034	0.646	0.139	0.642	0.134	0.011	0.005	0.001
Wheeler Peak Wilderness	NM	FS	0.001	0.046	0.006	0.044	0.005	0.003	0.001	0.000
White Mountain Wilderness	NM	FS	0.000	0.020	0.001	0.019	0.001	0.001	0.000	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	0.189	0.067	0.014

Table 5-10c. Contributions of new oil and gas and mining on Federal lands within the 13 Colorado BLM Planning Areas to PSD pollutant concentrations at Class I areas (Source Group R) for the 2021 Medium Development Scenario.

Group	G_R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		
	Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State / Owner	PSD Class I Increment[1]							
		2.5	8	4	2	1	25	5	2
Arches NP	UT / NPS	0.111	0.212	0.034	0.197	0.031	0.087	0.037	0.003
Bandelier NM	NM / NPS	0.005	0.066	0.007	0.062	0.006	0.011	0.005	0.000
Black Canyon of the Gunnison NM	CO / NPS	0.056	0.321	0.047	0.300	0.042	0.071	0.043	0.004
Bosque del Apache Wilderness	NM / FWS	0.001	0.036	0.002	0.032	0.002	0.010	0.004	0.000
Canyonlands NP	UT / NPS	0.033	0.143	0.015	0.128	0.013	0.062	0.026	0.002
Capitol Reef NP	UT / NPS	0.002	0.049	0.003	0.044	0.002	0.021	0.007	0.000
Eagles Nest Wilderness	CO / FS	0.078	0.194	0.059	0.183	0.053	0.076	0.022	0.003
Flat Tops Wilderness	CO / FS	0.176	0.842	0.137	0.841	0.126	0.356	0.132	0.013
Galiuro Wilderness	AZ / FS	0.000	0.005	0.000	0.004	0.000	0.002	0.000	0.000
Gila Wilderness	NM / FS	0.001	0.021	0.001	0.018	0.001	0.009	0.003	0.000
Great Sand Dunes NM	CO / NPS	0.012	0.103	0.018	0.097	0.017	0.023	0.009	0.001
La Garita Wilderness	CO / FS	0.016	0.117	0.018	0.113	0.016	0.045	0.014	0.001
Maroon Bells-Snowmass Wilderness	CO / FS	0.150	0.454	0.126	0.414	0.110	0.096	0.030	0.005
Mesa Verde NP	CO / NPS	1.669	0.597	0.219	0.221	0.064	0.047	0.018	0.002
Mount Baldy Wilderness	AZ / FS	0.000	0.025	0.001	0.024	0.001	0.005	0.002	0.000
Mount Zirkel Wilderness	CO / FS	0.079	0.743	0.182	0.739	0.179	0.150	0.053	0.008
Pecos Wilderness	NM / FS	0.005	0.052	0.006	0.048	0.005	0.014	0.005	0.000
Petrified Forest NP	AZ / NPS	0.001	0.034	0.002	0.032	0.002	0.007	0.003	0.000
Rawah Wilderness	CO / FS	0.056	0.318	0.071	0.310	0.065	0.080	0.024	0.004
Rocky Mountain NP	CO / NPS	0.043	0.279	0.066	0.272	0.063	0.072	0.017	0.003
Salt Creek Wilderness	NM / FWS	0.001	0.031	0.002	0.029	0.002	0.005	0.002	0.000
San Pedro Parks Wilderness	NM / FS	0.007	0.058	0.007	0.050	0.005	0.019	0.007	0.000
Weminuche Wilderness	CO / FS	0.017	0.093	0.013	0.084	0.011	0.051	0.014	0.001
West Elk Wilderness	CO / FS	0.094	0.662	0.154	0.654	0.146	0.079	0.031	0.003
Wheeler Peak Wilderness	NM / FS	0.005	0.064	0.008	0.060	0.007	0.019	0.006	0.001
White Mountain Wilderness	NM / FS	0.001	0.023	0.002	0.021	0.002	0.007	0.003	0.000
Dinosaur NM[5]	CO / NPS	NA	NA	NA	NA	NA	1.262	0.412	0.090

Table 5-11a. Contributions of new oil and gas and mining on Federal lands and new oil and gas on non-Federal lands within the 14 BLM Planning Areas to PSD pollutant concentrations at Class I and sensitive Class II areas (Source Group T) for the 2021 High Development Scenario.

Group	G_T	Cumulative Emissions Scenario -- New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Are							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		
	Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State / Owner	PSD Class I Increment[1]							
		2.5	8	4	2	1	25	5	2
Arches NP	UT / NPS	0.233	0.443	0.063	0.345	0.049	0.103	0.044	0.004
Bandelier NM	NM / NPS	0.028	0.200	0.027	0.138	0.014	0.013	0.006	0.000
Black Canyon of the Gunnison NM	CO / NPS	0.424	0.691	0.171	0.511	0.078	0.083	0.050	0.004
Bosque del Apache Wilderness	NM / FWS	0.004	0.083	0.007	0.051	0.004	0.012	0.004	0.000
Canyonlands NP	UT / NPS	0.069	0.249	0.032	0.178	0.021	0.072	0.031	0.002
Capitol Reef NP	UT / NPS	0.011	0.090	0.009	0.069	0.005	0.025	0.009	0.000
Eagles Nest Wilderness	CO / FS	0.185	0.391	0.105	0.312	0.077	0.088	0.026	0.004
Flat Tops Wilderness	CO / FS	0.387	0.974	0.201	0.856	0.156	0.405	0.150	0.015
Galiuro Wilderness	AZ / FS	0.000	0.022	0.000	0.010	0.000	0.002	0.001	0.000
Gila Wilderness	NM / FS	0.001	0.039	0.002	0.031	0.002	0.011	0.004	0.000
Great Sand Dunes NM	CO / NPS	0.037	0.218	0.047	0.187	0.033	0.027	0.011	0.001
La Garita Wilderness	CO / FS	0.044	0.240	0.038	0.179	0.026	0.052	0.016	0.002
Maroon Bells-Snowmass Wilderness	CO / FS	0.377	0.709	0.214	0.528	0.144	0.110	0.034	0.006
Mesa Verde NP	CO / NPS	4.498	2.773	1.071	0.726	0.220	0.054	0.021	0.004
Mount Baldy Wilderness	AZ / FS	0.001	0.045	0.002	0.039	0.001	0.006	0.002	0.000
Mount Zirkel Wilderness	CO / FS	0.154	0.800	0.212	0.758	0.194	0.173	0.061	0.009
Pecos Wilderness	NM / FS	0.025	0.144	0.024	0.102	0.012	0.017	0.006	0.001
Petrified Forest NP	AZ / NPS	0.004	0.076	0.005	0.048	0.003	0.009	0.004	0.000
Rawah Wilderness	CO / FS	0.141	0.410	0.117	0.328	0.082	0.091	0.028	0.004
Rocky Mountain NP	CO / NPS	0.187	1.612	0.183	0.886	0.094	0.083	0.020	0.004
Salt Creek Wilderness	NM / FWS	0.004	0.068	0.007	0.048	0.004	0.005	0.003	0.000
San Pedro Parks Wilderness	NM / FS	0.038	0.201	0.029	0.095	0.013	0.023	0.009	0.001
Weminuche Wilderness	CO / FS	0.081	0.199	0.056	0.128	0.025	0.059	0.017	0.001
West Elk Wilderness	CO / FS	0.234	0.736	0.214	0.684	0.172	0.091	0.036	0.004
Wheeler Peak Wilderness	NM / FS	0.025	0.127	0.028	0.095	0.016	0.022	0.007	0.001
White Mountain Wilderness	NM / FS	0.003	0.059	0.005	0.036	0.003	0.009	0.003	0.000
Dinosaur NM[5]	CO / NPS	NA	NA	NA	NA	NA	1.435	0.469	0.102

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Table 5-11b. Contributions of new oil and gas and mining on Federal lands and new oil and gas on non-Federal lands within the 14 BLM Planning Areas to PSD pollutant concentrations at Class I and sensitive Class II areas (Source Group T) for the 2021 Low Development Scenario.

Group	G_T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Are							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		SO_2 (µg/m³)		
	Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.071	0.198	0.033	0.171	0.028	0.019	0.008	0.001
Bandelier NM	NM	NPS	0.021	0.157	0.021	0.095	0.010	0.003	0.001	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.070	0.297	0.051	0.261	0.040	0.015	0.009	0.001
Bosque del Apache Wilderness	NM	FWS	0.002	0.057	0.004	0.035	0.003	0.002	0.001	0.000
Canyonlands NP	UT	NPS	0.028	0.148	0.019	0.119	0.013	0.012	0.006	0.000
Capitol Reef NP	UT	NPS	0.008	0.072	0.007	0.046	0.004	0.005	0.002	0.000
Eagles Nest Wilderness	CO	FS	0.064	0.191	0.062	0.174	0.052	0.015	0.005	0.001
Flat Tops Wilderness	CO	FS	0.142	0.837	0.134	0.835	0.118	0.068	0.027	0.003
Galiuro Wilderness	AZ	FS	0.000	0.013	0.000	0.007	0.000	0.000	0.000	0.000
Gila Wilderness	NM	FS	0.001	0.023	0.001	0.018	0.001	0.002	0.001	0.000
Great Sand Dunes NM	CO	NPS	0.018	0.096	0.027	0.083	0.019	0.005	0.002	0.000
La Garita Wilderness	CO	FS	0.021	0.118	0.023	0.113	0.017	0.009	0.003	0.000
Maroon Bells-Snowmass Wilderness	CO	FS	0.111	0.444	0.127	0.396	0.106	0.018	0.006	0.001
Mesa Verde NP	CO	NPS	2.870	1.815	0.701	0.512	0.148	0.010	0.005	0.002
Mount Baldy Wilderness	AZ	FS	0.000	0.028	0.001	0.018	0.001	0.001	0.000	0.000
Mount Zirkel Wilderness	CO	FS	0.046	0.728	0.179	0.719	0.173	0.029	0.011	0.002
Pecos Wilderness	NM	FS	0.019	0.112	0.018	0.063	0.009	0.003	0.001	0.000
Petrified Forest NP	AZ	NPS	0.002	0.045	0.003	0.035	0.002	0.002	0.001	0.000
Rawah Wilderness	CO	FS	0.038	0.314	0.072	0.306	0.062	0.016	0.005	0.001
Rocky Mountain NP	CO	NPS	0.068	0.679	0.090	0.397	0.062	0.016	0.004	0.001
Salt Creek Wilderness	NM	FWS	0.002	0.042	0.004	0.029	0.002	0.001	0.001	0.000
San Pedro Parks Wilderness	NM	FS	0.029	0.169	0.023	0.066	0.010	0.004	0.002	0.000
Weminuche Wilderness	CO	FS	0.066	0.177	0.047	0.091	0.020	0.010	0.003	0.000
West Elk Wilderness	CO	FS	0.072	0.661	0.157	0.650	0.144	0.015	0.007	0.001
Wheeler Peak Wilderness	NM	FS	0.016	0.097	0.020	0.058	0.011	0.004	0.001	0.000
White Mountain Wilderness	NM	FS	0.002	0.040	0.003	0.023	0.002	0.002	0.001	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	0.240	0.085	0.018

Table 5-11c. Contributions of new oil and gas and mining on Federal lands and new oil and gas on non-Federal lands within the 14 BLM Planning Areas to PSD pollutant concentrations at Class I and sensitive Class II areas (Source Group T) for the 2021 Medium Development Scenario.

Group	G_T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Are							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		SO_2 (µg/m³)		
	Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.226	0.388	0.056	0.321	0.046	0.103	0.044	0.004
Bandelier NM	NM	NPS	0.024	0.158	0.020	0.120	0.012	0.013	0.006	0.000
Black Canyon of the Gunnison NM	CO	NPS	0.384	0.636	0.160	0.469	0.074	0.083	0.050	0.004
Bosque del Apache Wilderness	NM	FWS	0.003	0.066	0.005	0.047	0.004	0.012	0.004	0.000
Canyonlands NP	UT	NPS	0.064	0.207	0.026	0.168	0.019	0.072	0.031	0.002
Capitol Reef NP	UT	NPS	0.009	0.075	0.006	0.060	0.004	0.025	0.009	0.000
Eagles Nest Wilderness	CO	FS	0.171	0.331	0.090	0.283	0.072	0.088	0.026	0.004
Flat Tops Wilderness	CO	FS	0.330	0.868	0.177	0.852	0.148	0.405	0.150	0.015
Galiuro Wilderness	AZ	FS	0.000	0.018	0.000	0.008	0.000	0.002	0.001	0.000
Gila Wilderness	NM	FS	0.001	0.034	0.002	0.028	0.002	0.011	0.004	0.000
Great Sand Dunes NM	CO	NPS	0.032	0.189	0.039	0.168	0.029	0.027	0.011	0.001
La Garita Wilderness	CO	FS	0.039	0.205	0.032	0.163	0.024	0.052	0.016	0.002
Maroon Bells-Snowmass Wilderness	CO	FS	0.314	0.627	0.182	0.494	0.135	0.110	0.035	0.006
Mesa Verde NP	CO	NPS	4.103	2.042	0.782	0.600	0.176	0.054	0.021	0.004
Mount Baldy Wilderness	AZ	FS	0.001	0.039	0.002	0.035	0.001	0.006	0.002	0.000
Mount Zirkel Wilderness	CO	FS	0.138	0.777	0.203	0.755	0.191	0.172	0.061	0.009
Pecos Wilderness	NM	FS	0.022	0.112	0.018	0.090	0.011	0.016	0.006	0.001
Petrified Forest NP	AZ	NPS	0.003	0.067	0.004	0.045	0.003	0.009	0.004	0.000
Rawah Wilderness	CO	FS	0.116	0.368	0.103	0.324	0.078	0.091	0.028	0.004
Rocky Mountain NP	CO	NPS	0.180	1.594	0.178	0.879	0.092	0.083	0.020	0.004
Salt Creek Wilderness	NM	FWS	0.003	0.055	0.006	0.044	0.003	0.005	0.003	0.000
San Pedro Parks Wilderness	NM	FS	0.033	0.137	0.021	0.085	0.011	0.022	0.009	0.001
Weminuche Wilderness	CO	FS	0.069	0.141	0.039	0.117	0.021	0.059	0.017	0.001
West Elk Wilderness	CO	FS	0.200	0.712	0.195	0.679	0.166	0.091	0.036	0.004
Wheeler Peak Wilderness	NM	FS	0.022	0.106	0.022	0.087	0.014	0.022	0.007	0.001
White Mountain Wilderness	NM	FS	0.003	0.054	0.004	0.033	0.003	0.009	0.003	0.000
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	1.435	0.468	0.102

Table 5-12a. Contributions of new Federal and non-Federal and existing oil and gas throughout the CARMMS 4 km domain and mining on Federal lands in Colorado to PSD pollutant concentrations at Class I areas (Source Group U) for the 2021 High Development Scenario.

Group	G_U	Combined O&G and Mining in 4 km domain
Across grid cells	Maximum	Max

			Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		PM_{25} (µg/m³)		SO_2 (µg/m³)		
			Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner		PSD Class I Increment[1]							
				2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS		0.357	0.577	0.096	0.430	0.080	0.107	0.046	0.006
Bandelier NM	NM	NPS		0.348	0.611	0.063	0.561	0.048	0.106	0.039	0.005
Black Canyon of the Gunnison NM	CO	NPS		0.481	0.763	0.199	0.617	0.104	0.086	0.052	0.006
Bosque del Apache Wilderness	NM	FWS		0.022	0.152	0.013	0.126	0.010	0.047	0.019	0.001
Canyonlands NP	UT	NPS		0.160	0.356	0.052	0.288	0.041	0.176	0.070	0.006
Capitol Reef NP	UT	NPS		0.083	0.171	0.019	0.166	0.014	0.162	0.054	0.004
Eagles Nest Wilderness	CO	FS		0.246	0.566	0.131	0.485	0.099	0.093	0.029	0.005
Flat Tops Wilderness	CO	FS		0.515	1.093	0.241	0.882	0.189	0.422	0.157	0.017
Galiuro Wilderness	AZ	FS		0.001	0.038	0.001	0.027	0.001	0.008	0.002	0.000
Gila Wilderness	NM	FS		0.004	0.072	0.004	0.064	0.004	0.016	0.006	0.000
Great Sand Dunes NM	CO	NPS		0.117	0.331	0.078	0.297	0.063	0.057	0.016	0.003
La Garita Wilderness	CO	FS		0.135	0.341	0.059	0.293	0.045	0.074	0.024	0.004
Maroon Bells-Snowmass Wilderness	CO	FS		0.447	0.824	0.241	0.587	0.167	0.114	0.036	0.007
Mesa Verde NP	CO	NPS		4.779	2.880	1.108	0.833	0.252	0.497	0.130	0.016
Mount Baldy Wilderness	AZ	FS		0.003	0.080	0.004	0.066	0.003	0.017	0.006	0.000
Mount Zirkel Wilderness	CO	FS		0.228	0.893	0.240	0.822	0.219	0.179	0.065	0.010
Pecos Wilderness	NM	FS		0.195	0.337	0.046	0.272	0.033	0.096	0.040	0.005
Petrified Forest NP	AZ	NPS		0.028	0.112	0.008	0.089	0.007	0.137	0.018	0.001
Rawah Wilderness	CO	FS		0.210	0.492	0.148	0.379	0.103	0.095	0.029	0.005
Rocky Mountain NP	CO	NPS		0.240	1.882	0.207	1.164	0.116	0.087	0.021	0.005
Salt Creek Wilderness	NM	FWS		0.027	0.120	0.012	0.097	0.009	0.176	0.038	0.002
San Pedro Parks Wilderness	NM	FS		0.433	0.329	0.058	0.230	0.041	0.175	0.066	0.011
Weminuche Wilderness	CO	FS		0.446	0.494	0.097	0.459	0.062	0.171	0.046	0.006
West Elk Wilderness	CO	FS		0.289	0.790	0.238	0.706	0.193	0.095	0.037	0.005
Wheeler Peak Wilderness	NM	FS		0.145	0.251	0.052	0.207	0.038	0.072	0.021	0.004
White Mountain Wilderness	NM	FS		0.015	0.116	0.010	0.095	0.008	0.025	0.010	0.001
Dinosaur NM[5]	CO	NPS		NA	NA	NA	NA	NA	1.495	0.487	0.108

Table 5-12b. Contributions of new Federal and non-Federal and existing oil and gas throughout the CARMMS 4 km domain and mining on Federal lands in Colorado to PSD pollutant concentrations at Class I areas (Source Group U) for the 2021 Low Development Scenario.

Group	G_U	Combined O&G and Mining in 4 km domain
Across grid cells	Maximum	Max

			Pollutant	NO_2 (µg/m³)	PM_{10} (µg/m³)		PM_{25} (µg/m³)		SO_2 (µg/m³)		
			Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner		PSD Class I Increment[1]							
				2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS		0.192	0.372	0.068	0.311	0.060	0.066	0.032	0.003
Bandelier NM	NM	NPS		0.342	0.531	0.057	0.495	0.045	0.105	0.038	0.005
Black Canyon of the Gunnison NM	CO	NPS		0.124	0.431	0.080	0.382	0.068	0.040	0.014	0.003
Bosque del Apache Wilderness	NM	FWS		0.021	0.129	0.011	0.112	0.009	0.047	0.019	0.001
Canyonlands NP	UT	NPS		0.138	0.320	0.040	0.249	0.033	0.175	0.070	0.006
Capitol Reef NP	UT	NPS		0.080	0.168	0.017	0.163	0.013	0.160	0.054	0.003
Eagles Nest Wilderness	CO	FS		0.128	0.401	0.090	0.360	0.076	0.020	0.014	0.002
Flat Tops Wilderness	CO	FS		0.269	0.856	0.176	0.852	0.154	0.082	0.033	0.005
Galiuro Wilderness	AZ	FS		0.000	0.029	0.001	0.023	0.000	0.008	0.002	0.000
Gila Wilderness	NM	FS		0.003	0.058	0.003	0.052	0.003	0.015	0.005	0.000
Great Sand Dunes NM	CO	NPS		0.099	0.298	0.059	0.263	0.049	0.057	0.016	0.002
La Garita Wilderness	CO	FS		0.118	0.283	0.044	0.260	0.036	0.074	0.024	0.003
Maroon Bells-Snowmass Wilderness	CO	FS		0.193	0.518	0.156	0.449	0.130	0.029	0.012	0.003
Mesa Verde NP	CO	NPS		3.146	1.925	0.738	0.621	0.181	0.497	0.125	0.015
Mount Baldy Wilderness	AZ	FS		0.002	0.066	0.003	0.051	0.003	0.017	0.006	0.000
Mount Zirkel Wilderness	CO	FS		0.119	0.797	0.209	0.781	0.199	0.035	0.015	0.003
Pecos Wilderness	NM	FS		0.189	0.235	0.040	0.203	0.030	0.096	0.039	0.004
Petrified Forest NP	AZ	NPS		0.026	0.102	0.007	0.084	0.006	0.136	0.017	0.001
Rawah Wilderness	CO	FS		0.106	0.391	0.103	0.337	0.083	0.020	0.007	0.002
Rocky Mountain NP	CO	NPS		0.119	0.998	0.115	0.715	0.082	0.020	0.009	0.002
Salt Creek Wilderness	NM	FWS		0.025	0.103	0.010	0.085	0.008	0.176	0.038	0.002
San Pedro Parks Wilderness	NM	FS		0.425	0.299	0.052	0.229	0.038	0.174	0.064	0.010
Weminuche Wilderness	CO	FS		0.431	0.494	0.088	0.459	0.057	0.171	0.046	0.006
West Elk Wilderness	CO	FS		0.126	0.680	0.183	0.667	0.167	0.034	0.011	0.003
Wheeler Peak Wilderness	NM	FS		0.137	0.223	0.044	0.193	0.033	0.072	0.021	0.003
White Mountain Wilderness	NM	FS		0.014	0.105	0.008	0.090	0.007	0.022	0.008	0.001
Dinosaur NM[5]	CO	NPS		NA	NA	NA	NA	NA	0.294	0.103	0.024

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Table 5-12c. Contributions of new Federal and non-Federal and existing oil and gas throughout the CARMMS 4 km domain and mining on Federal lands in Colorado to PSD pollutant concentrations at Class I areas (Source Group U) for the 2021 Medium Development Scenario.

Group	G_U	Combined O&G and Mining in 4 km domain							
Across grid cells	Maximum	Max							
	Pollutant	NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		
	Averaging Time	Annual[1]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Arches NP	UT	NPS	0.349	0.505	0.089	0.414	0.077	0.107	0.046	0.006
Bandelier NM	NM	NPS	0.344	0.579	0.056	0.545	0.046	0.106	0.039	0.005
Black Canyon of the Gunnison NM	CO	NPS	0.440	0.710	0.189	0.571	0.100	0.086	0.052	0.006
Bosque del Apache Wilderness	NM	FWS	0.022	0.140	0.012	0.123	0.010	0.047	0.019	0.001
Canyonlands NP	UT	NPS	0.155	0.314	0.047	0.278	0.039	0.176	0.070	0.006
Capitol Reef NP	UT	NPS	0.082	0.166	0.016	0.163	0.014	0.162	0.054	0.004
Eagles Nest Wilderness	CO	FS	0.222	0.512	0.117	0.463	0.094	0.093	0.028	0.005
Flat Tops Wilderness	CO	FS	0.458	0.959	0.218	0.878	0.182	0.421	0.157	0.017
Galiuro Wilderness	AZ	FS	0.001	0.034	0.001	0.026	0.001	0.008	0.002	0.000
Gila Wilderness	NM	FS	0.003	0.067	0.004	0.061	0.003	0.016	0.006	0.000
Great Sand Dunes NM	CO	NPS	0.113	0.303	0.071	0.279	0.060	0.057	0.016	0.003
La Garita Wilderness	CO	FS	0.130	0.316	0.052	0.282	0.043	0.074	0.024	0.004
Maroon Bells-Snowmass Wilderness	CO	FS	0.392	0.701	0.209	0.560	0.158	0.115	0.036	0.007
Mesa Verde NP	CO	NPS	4.383	2.150	0.819	0.709	0.208	0.497	0.130	0.015
Mount Baldy Wilderness	AZ	FS	0.003	0.072	0.004	0.063	0.003	0.017	0.006	0.000
Mount Zirkel Wilderness	CO	FS	0.212	0.858	0.232	0.821	0.216	0.179	0.065	0.010
Pecos Wilderness	NM	FS	0.192	0.324	0.040	0.266	0.032	0.096	0.040	0.005
Petrified Forest NP	AZ	NPS	0.027	0.097	0.008	0.084	0.006	0.137	0.018	0.001
Rawah Wilderness	CO	FS	0.185	0.447	0.134	0.367	0.099	0.095	0.029	0.005
Rocky Mountain NP	CO	NPS	0.234	1.850	0.201	1.152	0.114	0.087	0.021	0.005
Salt Creek Wilderness	NM	FWS	0.026	0.108	0.011	0.092	0.009	0.176	0.038	0.002
San Pedro Parks Wilderness	NM	FS	0.429	0.266	0.050	0.225	0.039	0.175	0.066	0.010
Weminuche Wilderness	CO	FS	0.434	0.470	0.080	0.449	0.058	0.171	0.046	0.006
West Elk Wilderness	CO	FS	0.255	0.746	0.219	0.695	0.188	0.095	0.037	0.005
Wheeler Peak Wilderness	NM	FS	0.142	0.234	0.046	0.201	0.036	0.072	0.021	0.004
White Mountain Wilderness	NM	FS	0.015	0.105	0.009	0.093	0.007	0.025	0.010	0.001
Dinosaur NM[5]	CO	NPS	NA	NA	NA	NA	NA	1.495	0.487	0.108

5.2 Visibility Impacts at Class I/II Areas using FLAG (2010)

Attachments B-1, B-2 and B-3 are interactive Excel spreadsheets that contain the visibility impacts at Class I and sensitive Class II areas due to emissions from the 24 Source Groups using the FLAG (2010) procedures as described in Section 4.6. There are four interactive sheets in Attachment B:

"Table1" shows maximum change in (delta) visibility (Δdv), the day of maximum Δdv and number of days that Δdv exceed the 0.5 and 1.0 dv thresholds for all Class I/II areas and a user selected Source Group that is controlled in cell B1.

"Table2" shows the temporal distribution (i.e., maximum and minimum and 98th, 80th and 20th percentiles) of Δdv by user selected Source Group (controlled by cell B1) for all Class I and II areas.

"Table3" shows maximum (or 98th, 80th, 20th or minimum controlled by cell B1) impact of Δdv from all Source Groups across all Class I, all Class II and combined all Class I and II areas.

"Table4" shows the maximum number of days that Δdv is greater than the 0.5 and 1.0 dv thresholds at any Class I or II area for all 24 Source Groups.

"Table 5" shows the number of days that Δdv is greater than the 0.5 and 1.0 dv thresholds and the maximum Δdv at each Class I and sensitive Class II area for a user-selected Source Group controlled by cell B1.

Addition information describing the Attachment B-1 and B-2 spreadsheets are contained in sheets "Readme" and "Ref."

5.2.1 Maximum Visibility Impacts at any Class I Area for all Source Groups

Table 5-13 displays the Class I and II areas where the maximum number of days Δdv exceeds the 0.5 and 1.0 thresholds occurred for each of the 24 Source Groups and the 2021 High Development Scenario. Tables 5-14 and 5-15 show the same information only for the 2021 Low and Medium Development Scenarios, respectively. These Tables were obtained from "Table4" in Attachments B-1, B-2 and B-3. The maximum Δdv impact at any Class I and II area due to each the 24 Source Groups for the 2021 High, Low and Medium Development Scenarios are shown in Table 5-16.

Of the 14 BLM Colorado and New Mexico Planning Areas (Source Groups A through N) plus the total CRFO (Source Group O) and RGFO (Source Group P) Planning Areas, only three have Federal O&G with Δdv visibility impacts at any Class I area that exceed the 0.5 dv threshold for the 2021 High Development Scenario as follows (Table 5-13a):

- WRFO with 6 days of Δdv > 0.5 and no days with Δdv > 1.0 (Table 5-13a) and max Δdv of 0.789 at Flats Tops Wilderness Area (Table 5-16a).
- GRFO with 2 days of Δdv > 0.5 and no days with Δdv > 1.0 and max Δdv of 0.900 at Arches National Park.
- TRFO with 35 days of Δdv > 0.5 and 4 days with Δdv > 1.0 and max Δdv of 1.42 at Mesa Verde National Park.

The individual Source Groups A through P of Federal O&G emissions in BLM Planning have no days with Δdv > 0.5 at any Class I area for the 2021 Low Development Scenario (Table 5-14a). The maximum Δdv at any Class I area for Federal O&G within an individual BLM Planning Area and the 2021 Low Development Scenario is 0.31 from the Farmington Field Office (Mancos Shale Development) (Table 5-16b).

Results for the 2021 Medium Development Scenario are similar but lower than the High Development Scenario with WRFO, GRFO and TRFO having 4, 2 and 5 days with Δdv > 0.5 at any Class I area with TRFO having 1 day with Δdv > 1.0 at any Class I area (Table 5-15a).

When looking at the 2021 High Development Scenario visibility impacts at Class II areas, there are four of the 18 BLM Planning Areas (Source Groups A through P) that have maximum Δdv that exceeds the 0.5 threshold, WRFO, GJFO and TRFO, as seen for Class I areas, but also NMFFO for the Class II areas (Tables 5-13b and 5-16a).

- WRFO with 40 days of Δdv > 0.5 and 5 days with Δdv > 1.0 and max Δdv of 1.43 at Dinosaur National Monument.

- GRFO with 23 days of Δdv > 0.5 and 3 days with Δdv > 1.0 and max Δdv of 1.46 at Colorado National Monument.
- TRFO with 16 days of Δdv > 0.5 and 3 days with Δdv > 1.0 and max Δdv of 2.46 at Hovenweep National Monument.
- NMFFO with 210 days of Δdv > 0.5 and 50 days with Δdv > 1.0 and max Δdv of 2.46 at Aztec Ruins National Monument.

For the 2021 Low Development Scenario, there is only one individual BLM Planning Area that has visibility impacts greater than 0.5 dv at any Class II area and that is for the NMFFO that has the exact same impacts as listed in the above bullet for the 2021 High Development Scenario (Table 5-14b). This is because the same high O&G development emissions were used for the Mancos Shale Development area in the 2021 High and Low Development Scenario because the contract from the BLM NMSO for developing emissions for the Mancos Shale Development area came in after the CARMMS 2021 Low Development Scenario source apportionment simulation was performed.

New O&G development on Federal lands result in exceedances of the 0.5 dv visibility threshold at Class II areas for the 2021 Medium Development Scenario for the same four BLM Planning Areas as seen for the 2021 High Development Scenarios only with lower number of days (Tables 5-15b and 5-16c).

- WRFO with 38 days of Δdv > 0.5 and 5 days with Δdv > 1.0 and max Δdv of 1.34 at Dinosaur National Monument.
- GRFO with 19 days of Δdv > 0.5 and 3 days with Δdv > 1.0 and max Δdv of 1.28 at Colorado National Monument.
- TRFO with 5 days of Δdv > 0.5 and 1 day with Δdv > 1.0 and max Δdv of 1.18 at Hovenweep National Monument.
- NMFFO with 77 days of Δdv > 0.5 and 3 days with Δdv > 1.0 and max Δdv of 1.60 at Aztec Ruins National Monument.

Not surprisingly, when looking at visibility impacts using the FLAG (2010) approach at Class I/II areas due to O&G emissions across combined BLM Planning Areas there are greater visibility impacts than for any individual BLM Planning Area. The FLMs have developed a Cumulative Visibility approach using the regional haze Worst 20 percent days (W20%) and Best 20 percent days (B20%) regional haze rule metric that is used to assess the visibility impacts for these combined Source Groups that is discussed in Section 5.3. The combined Source Group visibility impacts at Class I/II areas using the FLAG (2010) method in Figures 5-13 through 5-15 are provided for information only.

Table 5-13a. Class I area where each of the 24 Source Groups have the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the High Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class I	Class I (Max Occurs)	Max # of Day @ Class I	Class I (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	6	CI_Flat_Tops	0	NA
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	2	CI_Arches	0	NA
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	35	CI_Mesa_Verde	4	CI_Mesa_Verde
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 – West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	0	NA	0	NA
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	48	CI_Mount_Zirkel	5	CI_Flat_Tops
R	Combined new Federal O&G and Mining from the 13 Colo	72	CI_Mount_Zirkel	12	CI_Mount_Zirkel
S	Combined new Federal and non-Federal O&G and Mining	281	CI_Mesa_Verde	55	CI_Mesa_Verde
T	Cumulative Emissions Scenario – New Federal and non-Fe	285	CI_Mesa_Verde	62	CI_Mesa_Verde
U	Combined O&G and Mining in 4 km domain	312	CI_Mesa_Verde	105	CI_Mesa_Verde
V	Natural Emissions	192	CI_Bosque	139	CI_Bosque
W	2021 All Emissions	365	CI_Arches	365	CI_Arches
X	2008 All Emissions	365	CI_Arches	365	CI_Arches

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Table 5-13b. Sensitive Class II area where each of the 24 Source Groups has the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the High Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class II	Class II (Max Occurs)	Max # of Day @ Class II	Class II (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	40	CII_Dinosaur_all	5	CII_Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	23	CII_Colorado	3	CII_Colorado
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	16	CII_South_San_Juan	3	CII_Hovenweep
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 -- West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	210	CII_Aztec_Ruins	50	CII_Aztec_Ruins
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	39	CII_Raggeds	8	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colo	110	CII_Dinosaur_all	27	CII_Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining	288	Cli_South_San_Juan	43	CII_Colorado
T	Cumulative Emissions Scenario – New Federal and non-Fe	299	CII_South_San_Juan	133	CII_Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	350	CII_Aztec_Ruins	278	CII_Aztec_Ruins
V	Natural Emissions	246	CII_Sevilleta_NWR	202	CII_Sevilleta_NWR
W	2021 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR
X	2008 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR

Table 5-14a. Class I area where each of the 24 Source Groups have the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the Low Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class I	Class I (Max Occurs)	Max # of Day @ Class I	Class I (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	0	NA	0	NA
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	0	NA	0	NA
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	0	NA	0	NA
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 – West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	0	NA	0	NA
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	48	CI_Mount_Zirkel	5	CI_Flat_Tops
R	Combined new Federal O&G and Mining from the 13 Colo	51	CI_Mount_Zirkel	6	CI_Flat_Tops
S	Combined new Federal and non-Federal O&G and Mining	135	CI_Mesa_Verde	10	CI_Mesa_Verde
T	Cumulative Emissions Scenario – New Federal and non-Fe	143	CI_Mesa_Verde	11	CI_Mesa_Verde
U	Combined O&G and Mining in 4 km domain	201	CI_Mesa_Verde	44	CI_Mesa_Verde
V	Natural Emissions	192	CI_Bosque	139	CI_Bosque
W	2021 All Emissions	365	CI_Arches	365	CI_Arches
X	2008 All Emissions	365	CI_Arches	365	CI_Arches

Table 5-14b. Sensitive Class II area where each of the 24 Source Groups has the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the Low Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class II	Class II (Max Occurs)	Max # of Day @ Class II	Class II (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	0	NA	0	NA
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	0	NA	0	NA
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	0	NA	0	NA
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 – West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	210	CII_Aztec_Ruins	50	CII_Aztec_Ruins
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	39	CII_Raggeds	8	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colo	46	CII_Raggeds	9	CII_Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining	91	CII_South_San_Juan	16	CII_Hovenweep
T	Cumulative Emissions Scenario – New Federal and non-Fe	278	CII_Aztec_Ruins	127	CII_Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	349	CII_Aztec_Ruins	275	CII_Aztec_Ruins
V	Natural Emissions	246	CII_Sevilleta_NWR	202	CII_Sevilleta_NWR
W	2021 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR
X	2008 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR

Table 5-15a. Class I area where each of the 24 Source Groups have the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the Medium Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class I	Class I (Max Occurs)	Max # of Day @ Class I	Class I (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	4	CI_Flat_Tops	0	NA
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	2	CI_Arches	0	NA
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	5	CI_Mesa_Verde	1	CI_Mesa_Verde
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 – West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	0	NA	0	NA
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	48	CI_Mount_Zirkel	5	CI_Flat_Tops
R	Combined new Federal O&G and Mining from the 13 Colo	69	CI_Mount_Zirkel	12	CI_Mount_Zirkel
S	Combined new Federal and non-Federal O&G and Mining	209	CI_Mesa_Verde	28	CI_Rocky_Mountain
T	Cumulative Emissions Scenario – New Federal and non-Fe	213	CI_Mesa_Verde	28	CI_Rocky_Mountain
U	Combined O&G and Mining in 4 km domain	265	CI_Mesa_Verde	64	CI_Mesa_Verde
V	Natural Emissions	192	CI_Bosque	139	CI_Bosque
W	2021 All Emissions	365	CI_Arches	365	CI_Arches
X	2008 All Emissions	365	CI_Arches	365	CI_Arches

Table 5-15b. Sensitive Class II area where each of the 24 Source Groups has the maximum number of days that Δdv exceeds the 0.5 and 1.0 dv thresholds for the Medium Development Scenario.

Source Group	Group Name	>0.5		>1.0	
		Max # of Day @ Class II	Class II (Max Occurs)	Max # of Day @ Class II	Class II (Max Occurs)
A	Little Snake FO	0	NA	0	NA
B	White River FO	38	CII_Dinosaur_all	5	CII_Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0	NA	0	NA
D	Roan Plateau Planning area portion of CRVFO	0	NA	0	NA
E	Grand Junction FO	19	CII_Colorado	3	CII_Colorado
F	Uncompahgre FO	0	NA	0	NA
G	Tres Rios FO	5	CII_Hovenweep	1	CII_Hovenweep
H	Kremmling FO	0	NA	0	NA
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0	NA	0	NA
J	Pawnee Grasslands portion of RGFO#1	0	NA	0	NA
K	RGFO#2 – West-Central/South	0	NA	0	NA
L	RGFO#3 – South	0	NA	0	NA
M	RGFO#4 – East-Central	0	NA	0	NA
N	New Mexico Farmington District	77	CII_Aztec_Ruins	3	CII_Aztec_Ruins
O	Total Colorado River Field Office	0	NA	0	NA
P	Total Royal Gorge Field Office	0	NA	0	NA
Q	Mining from 13 Colorado BLM Planning Areas	39	CII_Raggeds	8	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colo	102	CII_Dinosaur_all	26	CII_Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining	163	CII_South_San_Juan	38	CII_Colorado
T	Cumulative Emissions Scenario – New Federal and non-Fe	226	CII_Aztec_Ruins	57	CII_Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	342	CII_Aztec_Ruins	240	CII_Aztec_Ruins
V	Natural Emissions	246	CII_Sevilleta_NWR	202	CII_Sevilleta_NWR
W	2021 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR
X	2008 All Emissions	365	CII_Alamosa_NWR	365	CII_Alamosa_NWR

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Table 5-16a. Maximum Δdv impact at any Class I and sensitive Class II area due to each of the 24 Source Groups for the 2021 High Development Scenario.

Source Group	Group Name	Max dv @ Class I	Class I (Max Occurs)	Max dv @ Class II	Class II (Max Occurs)
A	Little Snake FO	0.21939	CI_Mount_Zirkel	0.22310	CII_Dinosaur_all
B	White River FO	0.78870	CI_Flat_Tops	1.43427	CII_Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.10714	CI_Eagles_Nest	0.15269	CII_Colorado
D	Roan Plateau Planning area portion of CRVFO	0.09446	CI_Maroon_Bells	0.14267	CII_Colorado
E	Grand Junction FO	0.90007	CI_Arches	1.46046	CII_Colorado
F	Uncompahgre FO	0.21822	CI_Maroon_Bells	0.26247	CII_Raggeds
G	Tres Rios FO	1.41540	CI_Mesa_Verde	1.46604	CII_Hovenweep
H	Kremmling FO	0.07991	CI_Eagles_Nest	0.05406	CII_Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.02253	CI_Rocky_Mountain	0.01337	CII_Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.12545	CI_Rocky_Mountain	0.05321	CII_Mount_Evans
K	RGFO#2 – West-Central/South	0.02275	CI_Pecos	0.03937	CII_Greenhorn_Mounta
L	RGFO#3 – South	0.01940	CI_Great_Sand_Dunes	0.11458	CII_Greenhorn_Mounta
M	RGFO#4 – East-Central	0.00772	CI_Eagles_Nest	0.04298	CII_Lost_Creek
N	New Mexico Farmington District	0.30608	CI_Weminuche	2.45884	CII_Aztec_Ruins
O	Total Colorado River Field Office	0.19924	CI_Eagles_Nest	0.29345	CII_Colorado
P	Total Royal Gorge Field Office	0.14801	CI_Rocky_Mountain	0.11458	CII_Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1.27398	CI_Flat_Tops	1.90579	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	1.63971	CI_Flat_Tops	2.63206	CII_Colorado
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	4.19030	CI_Rocky_Mountain	4.59771	CII_Colorado
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	4.19144	CI_Rocky_Mountain	4.60319	CII_Colorado
U	Combined O&G and Mining in 4 km domain	5.53454	CI_Rocky_Mountain	11.71349	CII_Dinosaur_all
V	Natural Emissions	61.82309	CI_Bandelier	57.86500	CII_Dome
W	2021 All Emissions	81.23828	CI_Pecos	57.91427	CII_Dome
X	2008 All Emissions	123.70431	CI_Bandelier	115.81325	CII_Dome

Table 5-16b. Maximum Δdv impact at any Class I and sensitive Class II area due to each of the 24 Source Groups for the 2021 Low Development Scenario.

Source Group	Group Name	Max dv @ Class I	Class I (Max Occurs)	Max dv @ Class II	Class II (Max Occurs)
A	Little Snake FO	0.03379	CI_Mount_Zirkel	0.03217	CII_Dinosaur_all
B	White River FO	0.17342	CI_Flat_Tops	0.35529	CII_Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.08399	CI_Eagles_Nest	0.10547	CII_Colorado
D	Roan Plateau Planning area portion of CRVFO	0.06573	CI_Maroon_Bells	0.08541	CII_Colorado
E	Grand Junction FO	0.06394	CI_Arches	0.10458	CII_Colorado
F	Uncompahgre FO	0.09830	CI_Maroon_Bells	0.08642	CII_Raggeds
G	Tres Rios FO	0.21039	CI_Mesa_Verde	0.20104	CII_Hovenweep
H	Kremmling FO	0.00866	CI_Eagles_Nest	0.00657	CII_Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.00538	CI_Rocky_Mountain	0.00288	CII_Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.02803	CI_Rocky_Mountain	0.01093	CII_Mount_Evans
K	RGFO#2 – West-Central/South	0.00197	CI_Pecos	0.00361	CII_Greenhorn_Mounta
L	RGFO#3 – South	0.01214	CI_Great_Sand_Dunes	0.07568	CII_Greenhorn_Mounta
M	RGFO#4 – East-Central	0.00116	CI_Eagles_Nest	0.00677	CII_Lost_Creek
N	New Mexico Farmington District	0.30611	CI_Weminuche	2.45923	CII_Aztec_Ruins
O	Total Colorado River Field Office	0.14638	CI_Maroon_Bells	0.19010	CII_Colorado
P	Total Royal Gorge Field Office	0.03345	CI_Rocky_Mountain	0.07568	CII_Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1.27455	CI_Flat_Tops	1.90811	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colo	1.32779	CI_Flat_Tops	1.92664	CII_Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining	2.33257	CI_Mesa_Verde	2.89740	CII_Hovenweep
T	Cumulative Emissions Scenario – New Federal and non-Fe	2.34277	CI_Mesa_Verde	3.43746	CII_Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	3.86495	CI_Rocky_Mountain	11.69008	CII_Dinosaur_all
V	Natural Emissions	61.82309	CI_Bandelier	57.86496	CII_Dome
W	2021 All Emissions	81.23822	CI_Pecos	57.91372	CII_Dome
X	2008 All Emissions	123.70431	CI_Bandelier	115.81325	CII_Dome

Table 5-16c. Maximum Δdv impact at any Class I and sensitive Class II area due to each of the 24 Source Groups for the 2021 Medium Development Scenario.

Source Group	Group Name	Max dv @ Class I	Class I (Max Occurs)	Max dv @ Class II	Class II (Max Occurs)
A	Little Snake FO	0.18773	CI_Mount_Zirkel	0.18619	CII_Dinosaur_all
B	White River FO	0.78275	CI_Flat_Tops	1.33901	CII_Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.08876	CI_Eagles_Nest	0.12445	CII_Colorado
D	Roan Plateau Planning area portion of CRVFO	0.08081	CI_Maroon_Bells	0.12163	CII_Colorado
E	Grand Junction FO	0.83689	CI_Arches	1.28333	CII_Colorado
F	Uncompahgre FO	0.14666	CI_Maroon_Bells	0.17131	CII_Raggeds
G	Tres Rios FO	1.02858	CI_Mesa_Verde	1.18014	CII_Hovenweep
H	Kremmling FO	0.07964	CI_Eagles_Nest	0.03373	CII_Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.01231	CI_Rocky_Mountain	0.00764	CII_Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.07521	CI_Rocky_Mountain	0.03252	CII_Mount_Evans
K	RGFO#2 – West-Central/South	0.01639	CI_Pecos	0.02875	CII_Greenhorn_Mounta
L	RGFO#3 – South	0.01298	CI_Great_Sand_Dunes	0.07842	CII_Greenhorn_Mounta
M	RGFO#4 – East-Central	0.00366	CI_Eagles_Nest	0.01837	CII_Lost_Creek
N	New Mexico Farmington District	0.22871	CI_Weminuche	1.60245	CII_Aztec_Ruins
O	Total Colorado River Field Office	0.16619	CI_Eagles_Nest	0.24274	CII_Colorado
P	Total Royal Gorge Field Office	0.08758	CI_Rocky_Mountain	0.07842	CII_Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	1.27401	CI_Flat_Tops	1.90580	CII_Dinosaur_all
R	Combined new Federal O&G and Mining from the 13 Colo	1.60208	CI_Flat_Tops	2.32929	CII_Colorado
S	Combined new Federal and non-Federal O&G and Mining	4.14160	CI_Rocky_Mountain	4.32611	CII_Colorado
T	Cumulative Emissions Scenario – New Federal and non-Fe	4.14242	CI_Rocky_Mountain	4.33038	CII_Colorado
U	Combined O&G and Mining in 4 km domain	5.49465	CI_Rocky_Mountain	11.71799	CII_Dinosaur_all
V	Natural Emissions	61.82309	CI_Bandelier	57.86499	CII_Dome
W	2021 All Emissions	81.23827	CI_Pecos	57.91420	CII_Dome
X	2008 All Emissions	123.70431	CI_Bandelier	115.81325	CII_Dome

5.2.2 Individual Planning Area Contributions to Visibility Impairment at Class I and II Areas using FLAG (2010)

Below we present the visibility impacts at Class I areas due to Federal O&G in five BLM Planning Areas: WRFO, GJFO, TRFO, NMFFO and USFS-PG and the 2021 High, Low and Medium Development Scenarios. The first four BLM Planning Areas were selected because they were the ones that had Δdv impacts of greater than 0.5 at any Class I or II area (see Table 5-15), whereas USFS-PG was selected as it is one of our example Planning Areas. Tables 5-17 through 5-21 displays the maximum Δdv and number of days Δdv exceeds the 0.5 and 1.0 thresholds for all Class I areas due to emissions from Federal O&G development within the WRFO, GJFO, TRFO, NMFFO and USFS-PG Planning Areas, respectively. These Tables were obtained from sheet "Table1" in Attachments B-1, B-2 and B-3. The visibility results for the 2021 High, Low and Medium Development Scenario and these five BLM Planning Areas are summarized as follows, results for the other Source Groups and for sensitive Class II areas can be found in Attachments B-1, B-2 and B-3:

- Federal O&G from the WRFO Planning Area and the 2021 High Development Scenario results in 6 days at Flat Tops, 1 day at Eagles Nest and 2 days at Maroon Bells-Snowmass Class I areas with Δdv > 0.5 and no days > 1.0 and maximum Δdv of 0.789, 0.538 and 0.559 at these three Class I areas, respectively (Table 5-17a). The mitigation in the 2021 Medium Development Scenario reduces these values to 4, 0 and 0 days with Δdv > 0.5 and 0.782, 0.439 and 0.479 maximum Δdv at Flat Tops, Eagles Nest and Maroon-Bells Class I areas, respectively (Table 5-17c). For the 2021 Low Development Scenario new Federal O&G from the WRFO Planning Are have no days with Δdv > 0.5 with maximum

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Δdv at Flat Tops, Eagles Nest and Maroon Bells-Snowmass of 0.173, 0.107 and 0.122, respectively (Table 5-16b).

- For the 2021 High and Medium Development Scenarios, the GJFO Planning Area has two Class I areas where new Federal O&G emissions result in Δdv greater than 0.5 with 2 days at Arches and 1 day at Black Canyon of the Gunnison that have maximum Δdv of 0.900/0.837 (High/Medium) and 0.580/0.500 (High/Medium), respective (Table 5-18a,c). There are no days with Δdv > 0.5 at any Class I area due to new Federal O&G emissions within the GJFO Planning area for the 2021 Low Development Scenario (Table 5-18b).
- For new Federal O&G within the TRFO Planning Area the 2021 High Development Scenario has 35 days with Δdv > 0.5 and 4 days with Δdv > 1.0 at just the Mesa Verde Class I area (Table 5-19a). These values are reduced to 5 days with Δdv > 0.5 and 1 day with Δdv > 1.0 at the Mesa Verde Class I area due to the mitigation in the 2021 Medium Development Scenario (Table 5-19c). There are no days greater than these thresholds for the 2021 Low Development Scenario (Table 5-19b). The maximum Δdv due to the TRFO at Mesa Verde are 1.412, 0.210 and 1.029 for the 2021 High, Low and Medium Development Scenario, respectively.
- There are no days with Δdv > 0.5 at any Class I area due to Federal O&G emissions from the NMFFO Mancos Shale Development area for all three 2021 emission scenarios (Table 5-20). However, as shown in Attachments B-1, B-2 and B-3, there are 210, 210 and 77 days with Δdv > 0.5 and 50, 50 and 3 days with Δdv > 1.0 at the Aztec Ruins sensitive Class II area for the 2021 High, Low and Medium Development Scenarios. Note that the CARMMS 2021 High and Low Development Scenarios both ran with the same High Development Scenario emissions for the NMFFO Mancos Shale O&G emissions since the Low Scenario emissions were not available at the time of the CARMMS 2021 Low Development Scenario CAMx source apportionment simulation.
- New Federal O&G from the USFS-PG Planning Area has no days with Δdv > 0.5 at any Class I or sensitive Class II area for all three 2021 emissions scenarios (Table 5-21). The maximum Δdv impact due to new Federal O&G development in the USGS-PG Planning Area is 0.125, 0.028 and 0.075 at Rocky Mountain National Park for the, respectively, 2021 High, Low and Medium Development Scenarios (Table 5-21).

Table 5-17a. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the WRFO Planning Area (2021 High Development Scenario).

White River FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.43533	1/14/2008	0	0
CI_Bandelier	Bandelier NM	0.11148	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.47587	2/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.03747	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.26536	1/14/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.07285	2/15/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.53773	1/12/2008	0	1
CI_Flat_Tops	Flat Tops Wilderness	0.78870	1/22/2008	0	6
CI_Galiuro	Galiuro Wilderness	0.00336	5/14/2008	0	0
CI_Gila	Gila Wilderness	0.02166	1/17/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.20730	2/17/2008	0	0
CI_La_Garita	La Garita Wilderness	0.14817	3/6/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.55850	1/12/2008	0	2
CI_Mesa_Verde	Mesa Verde NP	0.17805	3/6/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.04517	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.32817	1/12/2008	0	0
CI_Pecos	Pecos Wilderness	0.08404	4/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.04465	3/23/2008	0	0
CI_Rawah	Rawah Wilderness	0.22532	12/17/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.20118	3/27/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.03710	5/19/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.07923	3/7/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.12011	5/14/2008	0	0
CI_West_Elk	West Elk Wilderness	0.32166	1/12/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.09681	5/20/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.02573	1/14/2008	0	0

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Table 5-17b. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the WRFO Planning Area (2021 Low Development Scenario).

White River FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.09570	1/14/2008	0	0
CI_Bandelier	Bandelier NM	0.01819	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.08959	2/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00606	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.05029	1/14/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.01199	2/15/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.10731	1/12/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.17342	1/22/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00057	5/14/2008	0	0
CI_Gila	Gila Wilderness	0.00357	1/14/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.03269	1/12/2008	0	0
CI_La_Garita	La Garita Wilderness	0.02915	3/6/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.12272	1/12/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.02813	3/6/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00755	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.06246	1/12/2008	0	0
CI_Pecos	Pecos Wilderness	0.01509	4/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00758	3/23/2008	0	0
CI_Rawah	Rawah Wilderness	0.03847	3/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.03799	3/27/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00666	5/19/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.01379	3/7/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.02257	3/6/2008	0	0
CI_West_Elk	West Elk Wilderness	0.06922	1/12/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.01743	5/20/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00433	1/14/2008	0	0

Table 5-17c. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the WRFO Planning Area (2021 Medium Development Scenario).

White River FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.38770	1/14/2008	0	0
CI_Bandelier	Bandelier NM	0.09901	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.46855	2/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.03146	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.23310	1/14/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.06555	2/15/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.43903	1/12/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.78275	1/12/2008	0	4
CI_Galiuro	Galiuro Wilderness	0.00308	5/14/2008	0	0
CI_Gila	Gila Wilderness	0.01893	1/17/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.18367	2/17/2008	0	0
CI_La_Garita	La Garita Wilderness	0.12817	3/6/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.47918	11/11/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.15716	3/6/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.03930	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.32707	1/12/2008	0	0
CI_Pecos	Pecos Wilderness	0.07481	4/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.04403	3/23/2008	0	0
CI_Rawah	Rawah Wilderness	0.18687	12/17/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.19646	3/27/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.03306	5/19/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.06799	3/7/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.10672	5/14/2008	0	0
CI_West_Elk	West Elk Wilderness	0.30428	2/17/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.08643	5/20/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.02139	1/14/2008	0	0

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Table 5-18a. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the GJFO Planning Area (2021 High Development Scenario).

Grand Junction FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.90007	1/13/2008	0	2
CI_Bandelier	Bandelier NM	0.07374	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.58026	2/16/2008	0	1
CI_Bosque	Bosque del Apache Wilderness	0.02721	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.34965	1/13/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.13423	1/2/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.29818	1/22/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.34568	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00199	5/18/2008	0	0
CI_Gila	Gila Wilderness	0.01637	1/14/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.18116	1/12/2008	0	0
CI_La_Garita	La Garita Wilderness	0.15510	1/12/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.43962	1/12/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.14631	1/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.02719	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.28359	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.07952	1/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.02661	3/9/2008	0	0
CI_Rawah	Rawah Wilderness	0.14821	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.16054	3/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.02422	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.05123	3/6/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.09183	3/5/2008	0	0
CI_West_Elk	West Elk Wilderness	0.40600	1/12/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.10652	1/12/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.01722	1/14/2008	0	0

Table 5-18b. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the GJFO Planning Area (2021 Low Development Scenario).

Grand Junction FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.06394	1/13/2008	0	0
CI_Bandelier	Bandelier NM	0.00426	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.03463	2/16/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00157	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.02204	1/13/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.00678	1/2/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.02113	1/22/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.01884	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00012	5/18/2008	0	0
CI_Gila	Gila Wilderness	0.00099	1/14/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.01113	1/13/2008	0	0
CI_La_Garita	La Garita Wilderness	0.01015	3/22/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.03801	1/12/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.00879	1/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00165	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.01705	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.00503	1/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00157	3/9/2008	0	0
CI_Rawah	Rawah Wilderness	0.00923	4/22/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.01079	3/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00146	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.00328	3/6/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.00642	3/5/2008	0	0
CI_West_Elk	West Elk Wilderness	0.03084	1/12/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.00653	1/13/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00101	1/14/2008	0	0

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Table 5-18c. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the GJFO Planning Area (2021 Medium Development Scenario).

Grand Junction FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.83689	1/13/2008	0	2
CI_Bandelier	Bandelier NM	0.06171	1/17/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.50011	2/16/2008	0	1
CI_Bosque	Bosque del Apache Wilderness	0.02177	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.32464	1/13/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.11614	1/2/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.24399	1/22/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.27841	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00155	5/18/2008	0	0
CI_Gila	Gila Wilderness	0.01337	1/14/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.15145	1/12/2008	0	0
CI_La_Garita	La Garita Wilderness	0.13364	1/12/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.36723	1/12/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.12182	1/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.02259	1/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.23447	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.06703	1/13/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.02307	3/9/2008	0	0
CI_Rawah	Rawah Wilderness	0.11926	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.13008	3/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.02030	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.04261	3/6/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.07837	3/5/2008	0	0
CI_West_Elk	West Elk Wilderness	0.34239	1/12/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.08939	1/12/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.01405	1/14/2008	0	0

Table 5-19a. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the TRFO Planning Area (2021 High Development Scenario).

Tres Rios FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.08112	2/10/2008	0	0
CI_Bandelier	Bandelier NM	0.08282	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.15138	2/11/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.03171	1/13/2008	0	0
CI_Canyonlands	Canyonlands NP	0.14171	12/21/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.02766	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.06000	5/24/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.08493	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00177	3/23/2008	0	0
CI_Gila	Gila Wilderness	0.01053	4/13/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.03540	11/19/2008	0	0
CI_La_Garita	La Garita Wilderness	0.05190	3/21/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.08297	5/24/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	1.41540	2/10/2008	4	35
CI_Mount_Baldy	Mount Baldy Wilderness	0.01073	3/23/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.07637	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.03618	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.03174	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.05117	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.03678	5/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.01197	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.06324	1/12/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.06845	3/21/2008	0	0
CI_West_Elk	West Elk Wilderness	0.07588	12/20/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.02479	2/8/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.01629	1/13/2008	0	0

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Table 5-19b. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the TRFO Planning Area (2021 Low Development Scenario).

Tres Rios FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.01083	2/10/2008	0	0
CI_Bandelier	Bandelier NM	0.00987	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.01743	2/11/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00383	1/13/2008	0	0
CI_Canyonlands	Canyonlands NP	0.01906	12/21/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.00330	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.00728	5/24/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.01074	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00021	3/23/2008	0	0
CI_Gila	Gila Wilderness	0.00133	4/13/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.00413	11/19/2008	0	0
CI_La_Garita	La Garita Wilderness	0.00642	3/21/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.00984	5/24/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.21039	2/10/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00130	3/23/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.00984	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.00427	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00384	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.00634	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.00465	5/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00149	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.00768	1/12/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.00834	3/21/2008	0	0
CI_West_Elk	West Elk Wilderness	0.00900	12/20/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.00302	2/8/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00201	1/13/2008	0	0

Table 5-19c. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the TRFO Planning Area (2021 Medium Development Scenario).

Tres Rios FO					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	>1.0	>0.5
Class I					
CI_Arches	Arches NP	0.06784	2/10/2008	0	0
CI_Bandelier	Bandelier NM	0.06815	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.12458	2/11/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.02502	1/13/2008	0	0
CI_Canyonlands	Canyonlands NP	0.11730	12/21/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.02288	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.04997	5/24/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.07172	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00146	3/23/2008	0	0
CI_Gila	Gila Wilderness	0.00855	4/13/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.02765	3/21/2008	0	0
CI_La_Garita	La Garita Wilderness	0.04270	3/21/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.06869	5/24/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	1.02858	2/10/2008	1	5
CI_Mount_Baldy	Mount Baldy Wilderness	0.00885	3/23/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.06459	5/25/2008	0	0
CI_Pecos	Pecos Wilderness	0.02941	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.02271	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.04288	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.03083	5/24/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00975	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.05047	1/12/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.05626	3/21/2008	0	0
CI_West_Elk	West Elk Wilderness	0.06237	12/20/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.02032	2/8/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.01354	1/13/2008	0	0

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Table 5-20a. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the NMFFO Planning Area (2021 High Development Scenario).

New Mexico Farmington District					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.05561	11/25/2008	0	0
CI_Bandelier	Bandelier NM	0.15626	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.12266	5/25/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.02491	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.08824	12/30/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.08109	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.07141	5/25/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.07557	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00596	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.01445	5/18/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.12535	12/8/2008	0	0
CI_La_Garita	La Garita Wilderness	0.15074	5/24/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.09903	5/25/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.19519	1/1/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.01094	5/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.04961	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.08594	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.07565	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.03416	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.03444	5/25/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.02992	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.13503	3/18/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.30608	5/24/2008	0	0
CI_West_Elk	West Elk Wilderness	0.11344	5/25/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.07107	3/24/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.02660	1/13/2008	0	0

Table 5-20b. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the NMFFO Planning Area (2021 Low Development Scenario).

New Mexico Farmington District					
Short Name	Class I&II Name	Δdv	Date	Number of Day > 1.0	Number of Day > 0.5
Class I					
CI_Arches	Arches NP	0.05560	11/25/2008	0	0
CI_Bandelier	Bandelier NM	0.15753	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.12277	5/25/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.02532	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.08843	12/30/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.08074	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.07157	5/25/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.07693	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00600	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.01454	5/18/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.12514	12/8/2008	0	0
CI_La_Garita	La Garita Wilderness	0.15069	5/24/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.09914	5/25/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.19566	1/1/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.01103	5/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.05047	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.08613	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.07619	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.03453	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.03407	5/25/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.03084	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.13617	3/18/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.30611	5/24/2008	0	0
CI_West_Elk	West Elk Wilderness	0.11343	5/25/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.07176	3/24/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.02696	1/13/2008	0	0

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Table 5-20c. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the NMFFO Planning Area (2021 Medium Development Scenario).

New Mexico Farmington District					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.03949	11/25/2008	0	0
CI_Bandelier	Bandelier NM	0.11621	1/18/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.09211	5/25/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.01757	3/7/2008	0	0
CI_Canyonlands	Canyonlands NP	0.06564	12/30/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.06059	1/3/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.05397	5/25/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.05739	5/25/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00370	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.00984	5/18/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.09241	12/8/2008	0	0
CI_La_Garita	La Garita Wilderness	0.11350	5/24/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.07456	5/25/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.14509	12/30/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00702	5/17/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.03725	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.06296	3/11/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.04816	1/14/2008	0	0
CI_Rawah	Rawah Wilderness	0.02590	5/25/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.02598	5/25/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.02222	1/13/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.08660	3/18/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.22871	5/24/2008	0	0
CI_West_Elk	West Elk Wilderness	0.08529	5/25/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.04916	2/8/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.01987	1/13/2008	0	0

Table 5-21a. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the USFS-PG Planning Area (2021 High Development Scenario).

Pawnee Grasslands portion of RGFO#1					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.00006	9/30/2008	0	0
CI_Bandelier	Bandelier NM	0.00242	12/9/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.00137	3/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00144	11/15/2008	0	0
CI_Canyonlands	Canyonlands NP	0.00007	7/10/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.00004	7/10/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.00630	3/9/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.00154	3/17/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00008	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.00096	5/17/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.00676	11/27/2008	0	0
CI_La_Garita	La Garita Wilderness	0.00159	4/17/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.00261	3/17/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.00030	3/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00039	5/16/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.00255	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.00395	11/24/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00056	5/16/2008	0	0
CI_Rawah	Rawah Wilderness	0.02765	5/26/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.12545	11/20/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00225	5/18/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.00120	5/16/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.00183	4/17/2008	0	0
CI_West_Elk	West Elk Wilderness	0.00204	3/17/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.00246	5/15/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00268	5/18/2008	0	0

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Table 5-21b. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the USFS-PG Planning Area (2021 Low Development Scenario).

Pawnee Grasslands portion of RGFO#1					
				Number of Day	
Short Name	Class I&II Name	Δdv	Date	> 1.0	> 0.5
Class I					
CI_Arches	Arches NP	0.00001	12/30/2008	0	0
CI_Bandelier	Bandelier NM	0.00048	12/9/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.00032	3/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00028	11/15/2008	0	0
CI_Canyonlands	Canyonlands NP	0.00008	12/30/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.00001	7/10/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.00130	3/9/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.00031	3/17/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00002	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.00019	5/17/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.00139	11/27/2008	0	0
CI_La_Garita	La Garita Wilderness	0.00035	3/17/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.00055	3/17/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.00007	3/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00008	5/16/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.00054	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.00074	11/24/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00011	5/16/2008	0	0
CI_Rawah	Rawah Wilderness	0.00556	5/26/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.02803	11/20/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00047	5/18/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.00023	5/16/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.00038	4/17/2008	0	0
CI_West_Elk	West Elk Wilderness	0.00046	3/17/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.00049	5/15/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00056	5/18/2008	0	0

Table 5-21c. Maximum Δdv and number of days Δdv exceeds 0.5 and 1.0 for each Class I area due to emissions from Federal O&G within the USFS-PG Planning Area (2021 Medium Development Scenario).

Pawnee Grasslands portion of RGFO#1					
Short Name	Class I&II Name	Δdv	Date	Number of Day > 1.0	Number of Day > 0.5
Class I					
CI_Arches	Arches NP	0.00002	9/30/2008	0	0
CI_Bandelier	Bandelier NM	0.00146	12/9/2008	0	0
CI_Black_Canyon	Black Canyon of the Gunnison NM	0.00086	3/17/2008	0	0
CI_Bosque	Bosque del Apache Wilderness	0.00079	11/15/2008	0	0
CI_Canyonlands	Canyonlands NP	0.00003	7/10/2008	0	0
CI_Capitol_Reef	Capitol Reef NP	0.00002	7/10/2008	0	0
CI_Eagles_Nest	Eagles Nest Wilderness	0.00369	3/9/2008	0	0
CI_Flat_Tops	Flat Tops Wilderness	0.00091	3/17/2008	0	0
CI_Galiuro	Galiuro Wilderness	0.00003	5/17/2008	0	0
CI_Gila	Gila Wilderness	0.00047	5/17/2008	0	0
CI_Great_Sand_Dunes	Great Sand Dunes NM	0.00371	11/27/2008	0	0
CI_La_Garita	La Garita Wilderness	0.00099	3/17/2008	0	0
CI_Maroon_Bells	Maroon Bells-Snowmass Wilderness	0.00158	3/17/2008	0	0
CI_Mesa_Verde	Mesa Verde NP	0.00018	3/17/2008	0	0
CI_Mount_Baldy	Mount Baldy Wilderness	0.00019	5/16/2008	0	0
CI_Mount_Zirkel	Mount Zirkel Wilderness	0.00155	5/26/2008	0	0
CI_Pecos	Pecos Wilderness	0.00234	11/24/2008	0	0
CI_Petrified_Forest	Petrified Forest NP	0.00024	5/16/2008	0	0
CI_Rawah	Rawah Wilderness	0.01687	5/26/2008	0	0
CI_Rocky_Mountain	Rocky Mountain NP	0.07521	11/20/2008	0	0
CI_Salt_Creek	Salt Creek Wilderness	0.00124	2/18/2008	0	0
CI_San_Pedro	San Pedro Parks Wilderness	0.00066	11/24/2008	0	0
CI_Weminuche	Weminuche Wilderness	0.00106	4/17/2008	0	0
CI_West_Elk	West Elk Wilderness	0.00126	3/17/2008	0	0
CI_Wheeler_Peak	Wheeler Peak Wilderness	0.00135	5/15/2008	0	0
CI_White_Mountain	White Mountain Wilderness	0.00146	5/18/2008	0	0

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5.3 Cumulative Visibility Impacts at Class I Areas

The visibility impacts due to new oil and gas emissions from combined BLM Planning Areas were examined following the procedures provided by the FWS and NPS (FWS and NPS, 2012) and described in Section 4.6.2. These procedures use EPA's Modeled Attainment Test Software (MATS) to project current year observed visibility impairment for the observed best 20 percent (B20%) and worst 20 percent (W20%) visibility days to the future year using the CAMx 2008 Base Case and 2021 High, Low and Medium Development Scenarios modeling results with and without emissions from each of the combined emission Source Groups. The cumulative visibility analysis was conducted for the following four combined Source Groups:

- Source Group R: New oil and gas and mining on Federal lands within the 13 Colorado BLM Planning Areas;
- Source Group S: New oil and gas on Federal and non-Federal lands and mining on Federal lands within the 13 Colorado BLM Planning Areas;

- Source Group T: Cumulative Emissions Scenario of new oil and gas on Federal and non-Federal lands and mining on Federal lands within the 14 Colorado and northern New Mexico BLM Planning Areas;
- Source Group U: Existing and New Federal and non-Federal oil and gas throughout the 4 km CARMMS domain plus mining on Federal land within the 13 Colorado BLM Planning Areas.

Attachments C-1, C-2 and C-3 contain the 2008 observed and 2021 projected visibility for the W20% and B20% days at Class I and sensitive Class II areas for the, respectively, High, Low and Medium Development Scenarios with and without each of the combined Source Groups. Tables 5-22 through 5-27 from Attachments C-1, C-2 and C-3 displays the cumulative visibility results at Class I areas for the 2021 High, Low and Medium Development Scenarios, the four combined emission Source Groups listed above and the W20% and B20% days. MATS uses observed PM species concentrations and monthly average relative humidity from IMPROVE monitoring sites to calculate daily visibility impairment from which the W20% and B20% visibility days metrics are determined. Not all Class I areas have a co-located IMPROVE monitoring site. Thus, IMPROVE observations were mapped to nearby Class I areas that did not include an IMPROVE monitor. In Tables 5-22 through 5-27, the Class I area of interest is shown in the first column and the IMPROVE site used to represent observed visibility at the Class I area is shown in the third column. For example, the IMPROVE data from Canyonlands National Park was used to represent observed visibility for both the Canyonlands and Arches National Parks. The MATS includes the IMPROVE site to Class I area mappings. However, MATS does not include mappings between IMPROVE sites and sensitive Class II areas. Thus, we assigned an IMPROVE monitoring site to each sensitive Class II area based mainly on proximity so that MATS could calculate cumulative visibility impacts for the W20%/B20% days at sensitive Class II areas. Tables 5-22 through 5-26 include cumulative visibility impacts for just the Class I areas, the results for the sensitive Class II areas are included in Attachments C-1, C-2 and C-3.

Table 5-22a displays the observed W20% visibility metric for the current year (2008) and the projected W20% metric for the 2021 High Development Scenario with and without each of the four combined Source Groups with differences in the W20% visibility metric shown in Table 5-22b. From the 2008 current year to the 2021 High Development Scenario future year, the W20% visibility metric is estimated to improve at 24 and degrade at 2 of the 26 Class I areas. The biggest improvement in W20% visibility between 2008 and 2021 High Scenario is a reduction of 0.89 dv that occurs at Rocky Mountain National Park that goes from 12.04 dv in 2008 to 11.15 dv in the 2021 High Development Scenario. The two Class I areas with degradation are Salt Creek (0.22 dv increase) and White Mountain (0.23 dv increase).

There are even more improvements in the W20% visibility between 2008 and 2021 for the Low Development Scenario (Table 5-23). Again the Class I area with the biggest improvement between 2008 and 2021 Low Scenario is a reduction of 0.92 dv at Rocky Mountain National Park. Again 24 of the 26 Class I areas see W20% visibility improvements between 2008 and 2021 Low Scenario with the same two Class I areas showing W20% visibility degradation in the High and Low Development Scenarios. The results for the 2021 Medium Development Scenario are similar with 24 of 26 Class I areas showing improvements in the W20% visibility metric with

the largest improvement (0.89 dv decrease) occurring at Rocky Mountain National Park (Table 5-24).

The Source Group R (new Federal O&G and mining in Colorado) contribution to 2021 W20% visibility ranges from a minimum of zero to maximums of 0.12 (High), 0.10 (Low) and 0.12 (Medium) dv (Tables 5-22b, 5-23b and 5-24b). Whereas, the contributions of all O&G emissions in the 4 km CARMMS domain (Source Group U) to the W20% days is always positive with maximum values of 0.50, 0.40 and 0.45 dv for the High, Low and Medium Development Scenarios, respectively.

The results for the B20% visibility days and High, Low and Medium Development Scenarios are shown in Tables 5-25 through 5-27. Between 2008 and 2021 the B20% visibility improves for approximately half and degrades for the other half of the Class I areas for all three 2021 emission scenarios. The largest improvement in B20% visibility for the High, Low and Medium Development Scenarios are 0.16, 0.20 and 0.17 dv and the largest degradation in B20% visibility is 0.61, 0.57 and 0.61 dv, respectively. The Source Groups' R, S, T and U contributions to the B20% visibility range from zero to 0.16, 0.33, 0.40 and 0.80 dv for the High and zero to 0.13, 0.16, 0.23 and 0.75 dv for the Low Development Scenarios with the 2021 Medium Development scenario results falling between the High and Low Development Scenarios.

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Table 5-22a. Cumulative visibility results for W20% visibility days at Class I areas for current year (2008) and 2021 High Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name	State	IMPROVE Site	2008 Base	2021 High	2021 High w/o R	2021 High w/o S	2021 High w/o T	2021 High w/o U
Arches NP	UT	CANY1	11.02	10.37	10.34	10.26	10.26	10.19
Mount Baldy Wilderness	AZ	BALD1	11.10	10.56	10.56	10.55	10.55	10.54
Bandelier NM	NM	BAND1	11.33	10.88	10.83	10.80	10.79	10.44
Black Canyon of the Gunnison NM	CO	WEMI1	9.95	9.31	9.30	9.11	9.11	9.05
Bosque del Apache	NM	BOAP1	12.72	12.31	12.30	12.30	12.30	12.27
Canyonlands NP	UT	CANY1	12.49	11.98	11.96	11.91	11.91	11.86
Capitol Reef NP	UT	CAPI1	12.92	12.72	12.71	12.65	12.65	12.61
Eagles Nest Wilderness	CO	WHRI1	8.68	7.87	7.85	7.78	7.78	7.70
Flat Tops Wilderness	CO	WHRI1	8.68	8.07	8.06	7.89	7.89	7.85
Galiuro Wilderness[1]	AZ	CHIR1	11.58	11.19	11.19	11.19	11.19	11.18
Gila Wilderness	NM	GICL1	11.58	11.54	11.54	11.54	11.54	11.54
Great Sand Dunes NM	CO	GRSA1	10.90	10.78	10.73	10.70	10.70	10.66
La Garita Wilderness	CO	WEMI1	9.95	9.36	9.35	9.34	9.33	9.31
Maroon Bells-Snowmass Wilderness	CO	WHRI1	8.68	7.91	7.89	7.84	7.84	7.80
Mesa Verde NP	CO	MEVE1	11.20	10.82	10.79	10.77	10.76	10.71
Mount Zirkel Wilderness	CO	MOZI1	9.36	8.54	8.53	8.45	8.45	8.42
Pecos Wilderness[2]	NM	BAND1	11.33	10.86	10.80	10.76	10.75	10.51
Petrified Forest NP	AZ	PEFO1	12.49	12.06	12.04	12.02	12.02	11.89
Rawah Wilderness	CO	MOZI1	9.36	8.53	8.52	8.44	8.44	8.39
Rocky Mountain NP	CO	ROMO1	12.04	11.15	11.14	11.09	11.09	11.03
Salt Creek	NM	SACR1	16.87	17.09	17.08	17.08	17.08	17.06
San Pedro Parks Wilderness	NM	SAPE1	9.43	8.72	8.60	8.58	8.58	8.54
West Elk Wilderness	CO	WHRi1	8.68	8.08	8.06	8.01	8.01	7.97
Weminuche Wilderness	CO	WEMI1	9.95	9.49	9.46	9.45	9.45	9.42
Wheeler Peak Wilderness[2]	NM	BAND1	11.33	10.86	10.75	10.59	10.52	10.36
White Mountain Wilderness	NM	WHIT1	12.92	13.15	13.15	13.15	13.15	13.13

Table 5-22b. Differences in cumulative visibility results for W20% visibility days at Class I areas between current year (2008) and 2021 High Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name	State	IMPROVE Site	2021 High Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.65	0.03	0.11	0.11	0.18
Mount Baldy Wilderness	AZ	BALD1	0.54	0.00	0.01	0.01	0.02
Bandelier NM	NM	BAND1	0.45	0.05	0.08	0.09	0.44
Black Canyon of the Gunnison NM	CO	WEMI1	0.64	0.01	0.20	0.20	0.26
Bosque del Apache	NM	BOAP1	0.41	0.01	0.01	0.01	0.04
Canyonlands NP	UT	CANY1	0.51	0.02	0.07	0.07	0.12
Capitol Reef NP	UT	CAPI1	0.20	0.01	0.07	0.07	0.11
Eagles Nest Wilderness	CO	WHRI1	0.81	0.02	0.09	0.09	0.17
Flat Tops Wilderness	CO	WHRI1	0.61	0.01	0.18	0.18	0.22
Galiuro Wilderness[1]	AZ	CHIR1	0.39	0.00	0.00	0.00	0.01
Gila Wilderness	NM	GICL1	0.04	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	0.12	0.05	0.08	0.08	0.12
La Garita Wilderness	CO	WEMI1	0.59	0.01	0.02	0.03	0.05
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.77	0.02	0.07	0.07	0.11
Mesa Verde NP	CO	MEVE1	0.38	0.03	0.05	0.06	0.11
Mount Zirkel Wilderness	CO	MOZI1	0.82	0.01	0.09	0.09	0.12
Pecos Wilderness[2]	NM	BAND1	0.47	0.06	0.10	0.11	0.35
Petrified Forest NP	AZ	PEFO1	0.43	0.02	0.04	0.04	0.17
Rawah Wilderness	CO	MOZI1	0.83	0.01	0.09	0.09	0.14
Rocky Mountain NP	CO	ROMO1	0.89	0.01	0.06	0.06	0.12
Salt Creek	NM	SACR1	-0.22	0.01	0.01	0.01	0.03
San Pedro Parks Wilderness	NM	SAPE1	0.71	0.12	0.14	0.14	0.18
West Elk Wilderness	CO	WHRI1	0.60	0.02	0.07	0.07	0.11
Weminuche Wilderness	CO	WEMI1	0.46	0.03	0.04	0.04	0.07
Wheeler Peak Wilderness[2]	NM	BAND1	0.47	0.11	0.27	0.34	0.50
White Mountain Wilderness	NM	WHIT1	-0.23	0.00	0.00	0.00	0.02

Table 5-23a. Cumulative visibility results for W20% visibility days at Class I areas for current year (2008) and 2021 Low Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name	State	IMPROVE Site	2008 Base	2021 Low	2021 Low w/o R	2021 Low w/o S	2021 Low w/o T	2021 Low w/o U
Arches NP	UT	CANY1	11.02	10.33	10.32	10.28	10.28	10.21
Mount Baldy Wilderness	AZ	BALD1	11.10	10.56	10.56	10.55	10.55	10.54
Bandelier NM	NM	BAND1	11.33	10.85	10.83	10.81	10.81	10.45
Black Canyon of the Gunnison NM	CO	WEMI1	9.95	9.21	9.20	9.12	9.12	9.06
Bosque del Apache	NM	BOAP1	12.72	12.31	12.31	12.30	12.30	12.27
Canyonlands NP	UT	CANY1	12.49	11.95	11.94	11.92	11.91	11.87
Capitol Reef NP	UT	CAPI1	12.92	12.69	12.69	12.66	12.66	12.62
Eagles Nest Wilderness	CO	WHRI1	8.68	7.83	7.82	7.79	7.79	7.71
Flat Tops Wilderness	CO	WHRI1	8.68	8.00	7.99	7.91	7.91	7.86
Galiuro Wilderness[1]	AZ	CHIR1	11.58	11.19	11.19	11.19	11.19	11.18
Gila Wilderness	NM	GICL1	11.58	11.54	11.54	11.54	11.54	11.54
Great Sand Dunes NM	CO	GRSA1	10.90	10.76	10.73	10.72	10.71	10.67
La Garita Wilderness	CO	WEMI1	9.95	9.35	9.35	9.34	9.34	9.31
Maroon Bells-Snowmass Wilderness	CO	WHRI1	8.68	7.88	7.87	7.85	7.85	7.81
Mesa Verde NP	CO	MEVE1	11.20	10.81	10.79	10.78	10.78	10.72
Mount Zirkel Wilderness	CO	MOZI1	9.36	8.49	8.49	8.45	8.45	8.42
Pecos Wilderness[2]	NM	BAND1	11.33	10.82	10.80	10.78	10.77	10.52
Petrified Forest NP	AZ	PEFO1	12.49	12.04	12.04	12.02	12.02	11.89
Rawah Wilderness	CO	MOZI1	9.36	8.48	8.47	8.44	8.44	8.39
Rocky Mountain NP	CO	ROMO1	12.04	11.12	11.12	11.09	11.09	11.03
Salt Creek	NM	SACR1	16.87	17.09	17.08	17.08	17.08	17.06
San Pedro Parks Wilderness	NM	SAPE1	9.43	8.70	8.60	8.59	8.59	8.55
West Elk Wilderness	CO	WHRI1	8.68	8.05	8.04	8.02	8.01	7.98
Weminuche Wilderness	CO	WEMI1	9.95	9.48	9.46	9.46	9.45	9.43
Wheeler Peak Wilderness[2]	NM	BAND1	11.33	10.75	10.70	10.61	10.55	10.38
White Mountain Wilderness	NM	WHIT1	12.92	13.15	13.15	13.15	13.15	13.13

Table 5-23b. Differences in cumulative visibility results for W20% visibility days at Class I areas between current year (2008) and 2021 Low Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name	State	IMPROVE Site	2021 Low Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.69	0.01	0.05	0.05	0.12
Mount Baldy Wilderness	AZ	BALD1	0.54	0.00	0.01	0.01	0.02
Bandelier NM	NM	BAND1	0.48	0.02	0.04	0.04	0.40
Black Canyon of the Gunnison NM	CO	WEMI1	0.74	0.01	0.09	0.09	0.15
Bosque del Apache	NM	BOAP1	0.41	0.00	0.01	0.01	0.04
Canyonlands NP	UT	CANY1	0.54	0.01	0.03	0.04	0.08
Capitol Reef NP	UT	CAPI1	0.23	0.00	0.03	0.03	0.07
Eagles Nest Wilderness	CO	WHRI1	0.85	0.01	0.04	0.04	0.12
Flat Tops Wilderness	CO	WHRI1	0.68	0.01	0.09	0.09	0.14
Galiuro Wilderness[1]	AZ	CHIR1	0.39	0.00	0.00	0.00	0.01
Gila Wilderness	NM	GICL1	0.04	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	0.14	0.03	0.04	0.05	0.09
La Garita Wilderness	CO	WEMI1	0.60	0.00	0.01	0.01	0.04
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.80	0.01	0.03	0.03	0.07
Mesa Verde NP	CO	MEVE1	0.39	0.02	0.03	0.03	0.09
Mount Zirkel Wilderness	CO	MOZI1	0.87	0.00	0.04	0.04	0.07
Pecos Wilderness[2]	NM	BAND1	0.51	0.02	0.04	0.05	0.30
Petrified Forest NP	AZ	PEFO1	0.45	0.00	0.02	0.02	0.15
Rawah Wilderness	CO	MOZI1	0.88	0.01	0.04	0.04	0.09
Rocky Mountain NP	CO	ROMO1	0.92	0.00	0.03	0.03	0.09
Salt Creek	NM	SACR1	-0.22	0.01	0.01	0.01	0.03
San Pedro Parks Wilderness	NM	SAPE1	0.73	0.10	0.11	0.11	0.15
West Elk Wilderness	CO	WHRI1	0.63	0.01	0.03	0.04	0.07
Weminuche Wilderness	CO	WEMI1	0.47	0.02	0.02	0.03	0.05
Wheeler Peak Wilderness[2]	NM	BAND1	0.58	0.05	0.14	0.20	0.37
White Mountain Wilderness	NM	WHIT1	-0.23	0.00	0.00	0.00	0.02

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Table 5-24a. Cumulative visibility results for W20% visibility days at Class I areas for current year (2008) and 2021 Medium Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name	State	IMPROVE Site	2008 Base	2021 Medium	2021 Med w/o R	2021 Med w/o S	2021 Med w/o T	2021 Med w/o U
Arches NP	UT	CANY1	11.02	10.36	10.35	10.26	10.26	10.19
Mount Baldy Wilderness	AZ	BALD1	11.10	10.56	10.56	10.55	10.55	10.54
Bandelier NM	NM	BAND1	11.33	10.87	10.83	10.80	10.79	10.44
Black Canyon of the Gunnison NM	CO	WEMI1	9.95	9.31	9.30	9.11	9.11	9.05
Bosque del Apache	NM	BOAP1	12.72	12.31	12.30	12.30	12.30	12.27
Canyonlands NP	UT	CANY1	12.49	11.98	11.96	11.91	11.91	11.86
Capitol Reef NP	UT	CAPI1	12.92	12.72	12.71	12.65	12.65	12.61
Eagles Nest Wilderness	CO	WHRI1	8.68	7.86	7.85	7.78	7.78	7.70
Flat Tops Wilderness	CO	WHRI1	8.68	8.07	8.06	7.89	7.89	7.85
Galiuro Wilderness[1]	AZ	CHIR1	11.58	11.19	11.19	11.19	11.19	11.18
Gila Wilderness	NM	GICL1	11.58	11.54	11.54	11.54	11.54	11.54
Great Sand Dunes NM	CO	GRSA1	10.90	10.77	10.73	10.71	10.70	10.66
La Garita Wilderness	CO	WEMI1	9.95	9.36	9.35	9.33	9.33	9.31
Maroon Bells-Snowmass Wilderness	CO	WHRI1	8.68	7.90	7.89	7.85	7.84	7.80
Mesa Verde NP	CO	MEVE1	11.20	10.82	10.79	10.77	10.77	10.71
Mount Zirkel Wilderness	CO	MOZI1	9.36	8.54	8.53	8.45	8.45	8.42
Pecos Wilderness[2]	NM	BAND1	11.33	10.84	10.80	10.76	10.75	10.51
Petrified Forest NP	AZ	PEFO1	12.49	12.06	12.04	12.02	12.02	11.89
Rawah Wilderness	CO	MOZI1	9.36	8.53	8.52	8.44	8.44	8.39
Rocky Mountain NP	CO	ROMO1	12.04	11.15	11.14	11.09	11.09	11.03
Salt Creek	NM	SACR1	16.87	17.09	17.08	17.08	17.08	17.06
San Pedro Parks Wilderness	NM	SAPE1	9.43	8.72	8.60	8.58	8.58	8.54
West Elk Wilderness	CO	WHRI1	8.68	8.08	8.06	8.01	8.01	7.97
Weminuche Wilderness	CO	WEMI1	9.95	9.48	9.46	9.45	9.45	9.42
Wheeler Peak Wilderness[2]	NM	BAND1	11.33	10.81	10.72	10.56	10.53	10.36
White Mountain Wilderness	NM	WHIT1	12.92	13.15	13.15	13.15	13.15	13.13

Table 5-24b. Differences in cumulative visibility results for W20% visibility days at Class I areas between current year (2008) and 2021 Medium Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name	State	IMPROVE Site	2021 Med Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.66	0.01	0.10	0.10	0.17
Mount Baldy Wilderness	AZ	BALD1	0.54	0.00	0.01	0.01	0.02
Bandelier NM	NM	BAND1	0.46	0.04	0.07	0.08	0.43
Black Canyon of the Gunnison NM	CO	WEMI1	0.64	0.01	0.20	0.20	0.26
Bosque del Apache	NM	BOAP1	0.41	0.01	0.01	0.01	0.04
Canyonlands NP	UT	CANY1	0.51	0.02	0.07	0.07	0.12
Capitol Reef NP	UT	CAPI1	0.20	0.01	0.07	0.07	0.11
Eagles Nest Wilderness	CO	WHRI1	0.82	0.01	0.08	0.08	0.16
Flat Tops Wilderness	CO	WHRI1	0.61	0.01	0.18	0.18	0.22
Galiuro Wilderness[1]	AZ	CHIR1	0.39	0.00	0.00	0.00	0.01
Gila Wilderness	NM	GICL1	0.04	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	0.13	0.04	0.06	0.07	0.11
La Garita Wilderness	CO	WEMI1	0.59	0.01	0.03	0.03	0.05
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.78	0.01	0.05	0.06	0.10
Mesa Verde NP	CO	MEVE1	0.38	0.03	0.05	0.05	0.11
Mount Zirkel Wilderness	CO	MOZI1	0.82	0.01	0.09	0.09	0.12
Pecos Wilderness[2]	NM	BAND1	0.49	0.04	0.08	0.09	0.33
Petrified Forest NP	AZ	PEFO1	0.43	0.02	0.04	0.04	0.17
Rawah Wilderness	CO	MOZI1	0.83	0.01	0.09	0.09	0.14
Rocky Mountain NP	CO	ROMO1	0.89	0.01	0.06	0.06	0.12
Salt Creek	NM	SACR1	-0.22	0.01	0.01	0.01	0.03
San Pedro Parks Wilderness	NM	SAPE1	0.71	0.12	0.14	0.14	0.18
West Elk Wilderness	CO	WHRI1	0.60	0.02	0.07	0.07	0.11
Weminuche Wilderness	CO	WEMI1	0.47	0.02	0.03	0.03	0.06
Wheeler Peak Wilderness[2]	NM	BAND1	0.52	0.09	0.25	0.28	0.45
White Mountain Wilderness	NM	WHIT1	-0.23	0.00	0.00	0.00	0.02

Table 5-25a. Cumulative visibility results for B20% visibility days at Class I areas for current year (2008) and 2021 High Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name		IMPROVE Site	2008 Base	2021 High	2021 High w/o R	2021 High w/o S	2021 High w/o T	2021 High w/o U
Arches NP	UT	CANY1	2.86	2.86	2.85	2.81	2.81	2.78
Mount Baldy Wilderness	AZ	BALD1	2.86	2.84	2.83	2.83	2.83	2.80
Bandelier NM	NM	BAND1	4.01	4.62	4.57	4.53	4.51	3.82
Black Canyon of the Gunnison NM	CO	WEMI1	2.25	2.18	2.17	2.07	2.07	2.04
Bosque del Apache	NM	BOAP1	5.50	5.42	5.42	5.42	5.42	5.41
Canyonlands NP	UT	CANY1	4.54	4.72	4.69	4.62	4.62	4.57
Capitol Reef NP	UT	CAPI1	3.33	3.43	3.41	3.37	3.36	3.33
Eagles Nest Wilderness	CO	WHRI1	0.69	0.55	0.54	0.50	0.50	0.48
Flat Tops Wilderness	CO	WHRI1	0.69	0.55	0.53	0.41	0.41	0.38
Galiuro Wilderness[1]	AZ	GICL1	2.58	2.87	2.86	2.86	2.86	2.86
Gila Wilderness	NM	CHIR1	2.58	2.89	2.89	2.89	2.89	2.89
Great Sand Dunes NM	CO	GRSA1	3.58	3.82	3.77	3.75	3.74	3.70
La Garita Wilderness	CO	WEMI1	2.25	2.29	2.27	2.26	2.26	2.22
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.69	0.53	0.51	0.49	0.49	0.47
Mesa Verde NP	CO	MEVE1	3.12	3.28	3.24	3.21	3.21	3.14
Mount Zirkel Wilderness	CO	MOZI1	0.95	0.84	0.83	0.72	0.72	0.68
Pecos Wilderness[2]	NM	PEFO1	4.54	4.65	4.60	4.57	4.56	4.21
Petrified Forest NP	AZ	BAND1	4.01	4.51	4.45	4.40	4.39	3.94
Rawah Wilderness	CO	MOZI1	0.95	0.87	0.86	0.75	0.75	0.71
Rocky Mountain NP	CO	ROMO1	1.91	1.87	1.86	1.82	1.82	1.80
Salt Creek	NM	SACR1	6.81	7.00	7.00	7.00	7.00	6.99
San Pedro Parks Wilderness	NM	SAPE1	1.28	1.32	1.18	1.16	1.16	1.11
West Elk Wilderness	CO	WHRI1	0.69	0.57	0.56	0.54	0.54	0.52
Weminuche Wilderness	CO	WEMI1	2.25	2.43	2.40	2.38	2.38	2.35
Wheeler Peak Wilderness[2]	NM	BAND1	4.01	4.37	4.21	4.04	3.97	3.75
White Mountain Wilderness	NM	WHIT1	3.33	3.32	3.32	3.32	3.32	3.29

Table 5-25b. Differences in cumulative visibility results for B20% visibility days at Class I areas between current year (2008) and 2021 High Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name		IMPROVE Site	2021 High Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.00	0.01	0.05	0.05	0.08
Mount Baldy Wilderness	AZ	BALD1	0.02	0.01	0.01	0.01	0.04
Bandelier NM	NM	BAND1	-0.61	0.05	0.09	0.11	0.80
Black Canyon of the Gunnison NM	CO	WEMI1	0.07	0.01	0.11	0.11	0.14
Bosque del Apache	NM	BOAP1	0.08	0.00	0.00	0.00	0.01
Canyonlands NP	UT	CANY1	-0.18	0.03	0.10	0.10	0.15
Capitol Reef NP	UT	CAPI1	-0.10	0.02	0.06	0.07	0.10
Eagles Nest Wilderness	CO	WHRI1	0.14	0.01	0.05	0.05	0.07
Flat Tops Wilderness	CO	WHRI1	0.14	0.02	0.14	0.14	0.17
Galiuro Wilderness[1]	AZ	GICL1	-0.29	0.01	0.01	0.01	0.01
Gila Wilderness	NM	CHIR1	-0.31	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	-0.24	0.05	0.07	0.08	0.12
La Garita Wilderness	CO	WEMI1	-0.04	0.02	0.03	0.03	0.07
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.16	0.02	0.04	0.04	0.06
Mesa Verde NP	CO	MEVE1	-0.16	0.04	0.07	0.07	0.14
Mount Zirkel Wilderness	CO	MOZI1	0.11	0.01	0.12	0.12	0.16
Pecos Wilderness[2]	NM	PEFO1	-0.11	0.05	0.08	0.09	0.44
Petrified Forest NP	AZ	BAND1	-0.50	0.06	0.11	0.12	0.57
Rawah Wilderness	CO	MOZI1	0.08	0.01	0.12	0.12	0.16
Rocky Mountain NP	CO	ROMO1	0.04	0.01	0.05	0.05	0.07
Salt Creek	NM	SACR1	-0.19	0.00	0.00	0.00	0.01
San Pedro Parks Wilderness	NM	SAPE1	-0.04	0.14	0.16	0.16	0.21
West Elk Wilderness	CO	WHRI1	0.12	0.01	0.03	0.03	0.05
Weminuche Wilderness	CO	WEMI1	-0.18	0.03	0.05	0.05	0.08
Wheeler Peak Wilderness[2]	NM	BAND1	-0.36	0.16	0.33	0.40	0.62
White Mountain Wilderness	NM	WHIT1	0.01	0.00	0.00	0.00	0.03

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Table 5-26a. Cumulative visibility results for B20% visibility days at Class I areas for current year (2008) and 2021 Low Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name		IMPROVE Site	2008 Base	2021 Low	2021 Low w/o R	2021 Low w/o S	2021 Low w/o T	2021 Low w/o U
Arches NP	UT	CANY1	2.86	2.84	2.84	2.82	2.82	2.79
Mount Baldy Wilderness	AZ	BALD1	2.86	2.83	2.83	2.83	2.83	2.80
Bandelier NM	NM	BAND1	4.01	4.58	4.56	4.54	4.53	3.83
Black Canyon of the Gunnison NM	CO	WEMI1	2.25	2.13	2.12	2.08	2.08	2.05
Bosque del Apache	NM	BOAP1	5.50	5.42	5.42	5.42	5.42	5.41
Canyonlands NP	UT	CANY1	4.54	4.69	4.67	4.64	4.64	4.59
Capitol Reef NP	UT	CAPI1	3.33	3.41	3.40	3.37	3.37	3.34
Eagles Nest Wilderness	CO	WHRI1	0.69	0.53	0.53	0.51	0.51	0.48
Flat Tops Wilderness	CO	WHRI1	0.69	0.49	0.49	0.42	0.42	0.39
Galiuro Wilderness[1]	AZ	GICL1	2.58	2.86	2.86	2.86	2.86	2.86
Gila Wilderness	NM	CHIR1	2.58	2.89	2.89	2.89	2.89	2.89
Great Sand Dunes NM	CO	GRSA1	3.58	3.80	3.77	3.76	3.75	3.70
La Garita Wilderness	CO	WEMI1	2.25	2.28	2.27	2.26	2.26	2.22
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.69	0.51	0.51	0.50	0.50	0.48
Mesa Verde NP	CO	MEVE1	3.12	3.25	3.24	3.22	3.22	3.14
Mount Zirkel Wilderness	CO	MOZI1	0.95	0.79	0.78	0.73	0.73	0.69
Pecos Wilderness[2]	NM	PEFO1	4.54	4.61	4.60	4.58	4.57	4.21
Petrified Forest NP	AZ	BAND1	4.01	4.46	4.44	4.41	4.40	3.95
Rawah Wilderness	CO	MOZI1	0.95	0.82	0.82	0.77	0.77	0.72
Rocky Mountain NP	CO	ROMO1	1.91	1.85	1.84	1.82	1.82	1.80
Salt Creek	NM	SACR1	6.81	7.00	7.00	7.00	7.00	6.99
San Pedro Parks Wilderness	NM	SAPE1	1.28	1.30	1.17	1.17	1.17	1.12
West Elk Wilderness	CO	WHRI1	0.69	0.56	0.55	0.54	0.54	0.52
Weminuche Wilderness	CO	WEMI1	2.25	2.41	2.40	2.39	2.39	2.35
Wheeler Peak Wilderness[2]	NM	BAND1	4.01	4.22	4.16	4.06	3.99	3.76
White Mountain Wilderness	NM	WHIT1	3.33	3.32	3.32	3.32	3.32	3.29

Table 5-26b. Differences in cumulative visibility results for B20% visibility days at Class I areas between current year (2008) and 2021 Low Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name		IMPROVE Site	2021 Low Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.02	0.00	0.02	0.02	0.05
Mount Baldy Wilderness	AZ	BALD1	0.03	0.00	0.00	0.00	0.03
Bandelier NM	NM	BAND1	-0.57	0.02	0.04	0.05	0.75
Black Canyon of the Gunnison NM	CO	WEMI1	0.12	0.01	0.05	0.05	0.08
Bosque del Apache	NM	BOAP1	0.08	0.00	0.00	0.00	0.01
Canyonlands NP	UT	CANY1	-0.15	0.02	0.05	0.05	0.10
Capitol Reef NP	UT	CAPI1	-0.08	0.01	0.04	0.04	0.07
Eagles Nest Wilderness	CO	WHRI1	0.16	0.00	0.02	0.02	0.05
Flat Tops Wilderness	CO	WHRI1	0.20	0.00	0.07	0.07	0.10
Galiuro Wilderness[1]	AZ	GICL1	-0.28	0.00	0.00	0.00	0.00
Gila Wilderness	NM	CHIR1	-0.31	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	-0.22	0.03	0.04	0.05	0.10
La Garita Wilderness	CO	WEMI1	-0.03	0.01	0.02	0.02	0.06
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.18	0.00	0.01	0.01	0.03
Mesa Verde NP	CO	MEVE1	-0.13	0.01	0.03	0.03	0.11
Mount Zirkel Wilderness	CO	MOZI1	0.16	0.01	0.06	0.06	0.10
Pecos Wilderness[2]	NM	PEFO1	-0.07	0.01	0.03	0.04	0.40
Petrified Forest NP	AZ	BAND1	-0.45	0.02	0.05	0.06	0.51
Rawah Wilderness	CO	MOZI1	0.13	0.00	0.05	0.05	0.10
Rocky Mountain NP	CO	ROMO1	0.06	0.01	0.03	0.03	0.05
Salt Creek	NM	SACR1	-0.19	0.00	0.00	0.00	0.01
San Pedro Parks Wilderness	NM	SAPE1	-0.02	0.13	0.13	0.13	0.18
West Elk Wilderness	CO	WHRI1	0.13	0.01	0.02	0.02	0.04
Weminuche Wilderness	CO	WEMI1	-0.16	0.01	0.02	0.02	0.06
Wheeler Peak Wilderness[2]	NM	BAND1	-0.21	0.06	0.16	0.23	0.46
White Mountain Wilderness	NM	WHIT1	0.01	0.00	0.00	0.00	0.03

Table 5-27a. Cumulative visibility results for B20% visibility days at Class I areas for current year (2008) and 2021 Medium Development Scenario using all emissions and without Source Groups R, S, T and U.

Class I Name		IMPROVE Site	2008 Base	2021 Medium	2021 Med w/o R	2021 Med w/o S	2021 Med w/o T	2021 Med w/o U
Arches NP	UT	CANY1	2.86	2.86	2.85	2.81	2.81	2.78
Mount Baldy Wilderness	AZ	BALD1	2.86	2.83	2.83	2.83	2.83	2.80
Bandelier NM	NM	BAND1	4.01	4.62	4.57	4.52	4.52	3.82
Black Canyon of the Gunnison NM	CO	WEMI1	2.25	2.18	2.17	2.07	2.07	2.04
Bosque del Apache	NM	BOAP1	5.50	5.42	5.42	5.42	5.42	5.41
Canyonlands NP	UT	CANY1	4.54	4.72	4.69	4.62	4.62	4.58
Capitol Reef NP	UT	CAPI1	3.33	3.43	3.41	3.37	3.36	3.33
Eagles Nest Wilderness	CO	WHRI1	0.69	0.55	0.54	0.50	0.50	0.48
Flat Tops Wilderness	CO	WHRI1	0.69	0.54	0.53	0.41	0.41	0.38
Galiuro Wilderness[1]	AZ	GICL1	2.58	2.87	2.86	2.86	2.86	2.86
Gila Wilderness	NM	CHIR1	2.58	2.89	2.89	2.89	2.89	2.89
Great Sand Dunes NM	CO	GRSA1	3.58	3.81	3.77	3.75	3.75	3.70
La Garita Wilderness	CO	WEMI1	2.25	2.29	2.27	2.26	2.26	2.22
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.69	0.52	0.51	0.49	0.49	0.47
Mesa Verde NP	CO	MEVE1	3.12	3.27	3.24	3.21	3.21	3.14
Mount Zirkel Wilderness	CO	MOZI1	0.95	0.83	0.83	0.72	0.72	0.68
Pecos Wilderness[2]	NM	PEFO1	4.54	4.64	4.60	4.57	4.56	4.21
Petrified Forest NP	AZ	BAND1	4.01	4.50	4.44	4.40	4.39	3.94
Rawah Wilderness	CO	MOZI1	0.95	0.87	0.86	0.75	0.75	0.71
Rocky Mountain NP	CO	ROMO1	1.91	1.87	1.86	1.82	1.82	1.80
Salt Creek	NM	SACR1	6.81	7.00	7.00	7.00	7.00	6.99
San Pedro Parks Wilderness	NM	SAPE1	1.28	1.32	1.18	1.16	1.16	1.11
West Elk Wilderness	CO	WHRI1	0.69	0.57	0.56	0.54	0.54	0.52
Weminuche Wilderness	CO	WEMI1	2.25	2.43	2.40	2.38	2.38	2.35
Wheeler Peak Wilderness[2]	NM	BAND1	4.01	4.32	4.19	4.02	3.97	3.75
White Mountain Wilderness	NM	WHIT1	3.33	3.32	3.32	3.32	3.32	3.29

Table 5-27b. Differences in cumulative visibility results for B20% visibility days at Class I areas between current year (2008) and 2021 Medium Development Scenario (2008-2021) and contributions of Source Groups R, S, T and U to 2021 W20% day's visibility.

Class I Name		IMPROVE Site	2021 Med Improvement from 2008	Contribution from R	Contribution from S	Contribution from T	Contribution from U
Arches NP	UT	CANY1	0.00	0.01	0.05	0.05	0.08
Mount Baldy Wilderness	AZ	BALD1	0.03	0.00	0.00	0.00	0.03
Bandelier NM	NM	BAND1	-0.61	0.05	0.10	0.10	0.80
Black Canyon of the Gunnison NM	CO	WEMI1	0.07	0.01	0.11	0.11	0.14
Bosque del Apache	NM	BOAP1	0.08	0.00	0.00	0.00	0.01
Canyonlands NP	UT	CANY1	-0.18	0.03	0.10	0.10	0.14
Capitol Reef NP	UT	CAPI1	-0.10	0.02	0.06	0.07	0.10
Eagles Nest Wilderness	CO	WHRI1	0.14	0.01	0.05	0.05	0.07
Flat Tops Wilderness	CO	WHRI1	0.15	0.01	0.13	0.13	0.16
Galiuro Wilderness[1]	AZ	GICL1	-0.29	0.01	0.01	0.01	0.01
Gila Wilderness	NM	CHIR1	-0.31	0.00	0.00	0.00	0.00
Great Sand Dunes NM	CO	GRSA1	-0.23	0.04	0.06	0.06	0.11
La Garita Wilderness	CO	WEMI1	-0.04	0.02	0.03	0.03	0.07
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.17	0.01	0.03	0.03	0.05
Mesa Verde NP	CO	MEVE1	-0.15	0.03	0.06	0.06	0.13
Mount Zirkel Wilderness	CO	MOZI1	0.12	0.00	0.11	0.11	0.15
Pecos Wilderness[2]	NM	PEFO1	-0.10	0.04	0.07	0.08	0.43
Petrified Forest NP	AZ	BAND1	-0.49	0.06	0.10	0.11	0.56
Rawah Wilderness	CO	MOZI1	0.08	0.01	0.12	0.12	0.16
Rocky Mountain NP	CO	ROMO1	0.04	0.01	0.05	0.05	0.07
Salt Creek	NM	SACR1	-0.19	0.00	0.00	0.00	0.01
San Pedro Parks Wilderness	NM	SAPE1	-0.04	0.14	0.16	0.16	0.21
West Elk Wilderness	CO	WHRI1	0.12	0.01	0.03	0.03	0.05
Weminuche Wilderness	CO	WEMI1	-0.18	0.03	0.05	0.05	0.08
Wheeler Peak Wilderness[2]	NM	BAND1	-0.31	0.13	0.30	0.35	0.57
White Mountain Wilderness	NM	WHIT1	0.01	0.00	0.00	0.00	0.03

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5.4 Sulfur and Nitrogen Deposition at Class I and Sensitive Class II Areas

Attachments D-1, D-2 and D-3 are interactive Excel spreadsheets that display Maximum and Average sulfur and nitrogen deposition due to emissions from each of the 24 Source Groups shown in Table 4-2. As for the PSD concentrations Attachment A spreadsheet, there is a "Summary" sheet that displays the sulfur and nitrogen deposition across all Class I and sensitive Class II areas for a user selected Source Group that is controlled by a drop down menu in cell B5. And a "MaxImpact" sheet that gives the highest sulfur or nitrogen deposition that occurred at any Class I area or sensitive Class II area that is controlled by cell B3 to select Sulfur or Nitrogen and cell B4 to select either Maximum or Average. Here Maximum represents the maximum deposition in any grid cell covering the Class I/II area, whereas Average provides the average of deposition across all grid cells covering a Class I/II area. Although the convention in the past has been to report the Maximum deposition in any receptor in a Class I/II area, since deposition relates to the total amount deposited across an entire watershed, the Average metric is probably a more relevant parameter for evaluating potential environment effects. Both Maximum and Average deposition metrics are reported.

For the deposition impacts associated with Federal O&G within each of the individual BLM Planning Areas (i.e., Source Groups A through P), the sulfur and nitrogen deposition amounts are compared against the 0.005 kg/ha/yr Deposition Analysis Threshold (DAT) for the western U.S.. The DAT is a screening threshold where if a Project's deposition amount is below the DAT then its deposition impacts is considered insignificant. The deposition due to the total emission scenarios, that is Source Groups W (2021) and X (2008), are compared against the Critical Load Values, which for nitrogen is 2.2 kg/ha/yr in Wyoming and 2.3 kg/ha/yr in Colorado except for 3.0 kg/ha/yr for Dinosaur NM and for sulfur is 5.0 kg/ha/yr everywhere.

5.4.1 Highest Deposition Impacts at Class I/II Areas

Tables 5-29 through 5-31 display the highest Maximum and Average nitrogen and sulfur deposition in any Class I or sensitive Class II area due to emissions from each of the 24 Source Groups for the, respectively 2021 High, Low and Medium Development Scenarios. The results for the GJFO, UFO and USFS-PG Planning Areas are summarized in Table 5-28.

5.4.1.1 Individual BLM Planning Area Comparison to DATs

Individual BLM Planning Area (i.e., Source Groups A through P) annual nitrogen and sulfur deposition are compared against the 0.005 kg/ha/yr western U.S. Deposition Analysis Threshold (DAT). The two BLM Planning Area with Federal O&G having the highest annual nitrogen deposition impact are the TRFO and WRFO with Maximum values of 0.126 and 0.108 and Average values of 0.043 and 0.068 for the High, Maximum values of 0.106 and 0.134 and Average values of 0.036 and 0.056 for the Medium, and Maximum values of 0.015 and 0.017 and Average values of 0.005 and 0.011 for the Low Development Scenarios all of which are above the DAT (Tables 5-29 through 5-31).

Table 5-28 summarizes the Average and Maximum nitrogen and sulfur deposition results for new Federal O&G emissions from the Grand Junction Field Office (GJFO), Uncompahgre Field Office (UFO) and Pawnee Grassland (USFS-PG) Planning Areas and the 2021 High, Low and Medium Development Scenarios. For the 2021 High Development Scenario, the highest

Maximum and Average nitrogen deposition at any Class I area due to GJFO (0.0679 and 0.0416 kg/ha/yr) and UFO (0.0240 and 0.0104 kg/ha/yr) that are above the DAT. However, for USFS-PG Planning Area, its highest Maximum and Average nitrogen deposition at any Class I area is below the DAT (0.0017 and 0.0006 kg/ha/yr) for the 2021 High Development Scenario. For the 2021 Low Development Scenario, the Maximum and Average nitrogen deposition for GJFO (0.0037 and 0.0023 kg/ha/yr) are below the DAT. And for UFO the Maximum value (0.0065 kg/ha/yr) is above but the Average value (0.0027 kg/ha/yr) is below the DAT. The nitrogen deposition results for the Medium Scenario falls between the High and Low Scenarios.

The annual sulfur deposition from new Federal O&G in the BLM Planning Areas tends to be much lower than seen for the nitrogen deposition so results for just the 2021 High Development Scenario and Maximum sulfur deposition metric are presented in Table 5-32 with the other results provided in Attachments D-1, D-2 and D-3. The only individual BLM Planning Area whose new Federal O&G emissions results in its sulfur deposition exceeding the DAT is the WRFO and that is just for the Maximum (0.011 kg/ha/yr) and Average (0.008 kg/ha/yr) 2021 High Development Scenario. The Maximum (0.021 kg/ha/yr) and Average (0.008 kg/ha/yr) sulfur deposition due to WRFO for the 2021 Medium Development Scenario are also above the DAT. However, the highest WRFO sulfur deposition for the Maximum (0.002 kg/ha/yr) and Average (0.001 kg/ha/yr) metrics and the 2021 Low Development Scenario are below the DAT. The sulfur deposition results for all the other individual BLM Planning areas are below the DAT. For example, Table 5-28b displays the highest Maximum and Average sulfur deposition results at any Class I or II area due to new Federal O&G emissions from the GJFO, UFO and USFS-PG Planning Areas and all values are approximately a factor of 10 or more below the DAT.

Table 5-28a. Highest maximum and average nitrogen deposition (kg/ha/yr) at any Class I or sensitive Class II area due to new Federal oil and gas emissions from the BLM Grand Junction Field Office and Uncompahgre Field Office and the USFS Pawnee Grassland Planning Areas for the 2021 High, Low and Medium Development Scenarios.

Source Group	Class I Areas			Sensitive Class II Areas		
	Max	Avg	Area	Max	Avg	Area
2021 High Development Scenario						
GJFO	0.0679	0.0416	Maroon-B	0.0679	0.0543	Colorado NM
UFO	0.0240	0.0104	Maroon-B	0.0347	0.0151	Raggeds
USFS-PG	0.0017	0.006	Rocky Mtn	0.0013	0.0007	Mt. Evans
2021 Low Development Scenario						
GJFO	0.0037	0.0023	Maroon-B	0.0037	0.0029	Colorado NM
UFO	0.0065	0.0027	Maroon-B	0.0100	0.0400	Raggeds Gun
USFS-PG	0.0004	0.0001	Rocky Mtn	0.0003	0.0002	Mt. Evans
2021 Medium Development Scenario						
GJFO	0.0558	0.0344	Maroon-B	0.06071	0.0483	Colorado NM
UFO	0.0167	0.0076	Maroon-B	0.0241	0.0109	Raggeds Gun
USFS-PG	0.0011	0.0004	Rocky Mtn	0.0008	0.0005	Mt. Evans

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Table 5-28b. Highest maximum and average sulfur deposition (kg/ha/yr) at any Class I or sensitive Class II area due to new Federal oil and gas emissions from the BLM Grand Junction Field Office and Uncompahgre Field Office and the USFS Pawnee Grassland Planning Areas for the 2021 High, Low and Medium Development Scenarios.

Source Group	Class I Areas			Sensitive Class II Areas		
	Max	Avg	Area	Max	Avg	Area
2021 High Development Scenario						
GJFO	0.0006	0.0004	Maroon-B	0.0005	0.0003	Raggeds
UFO	0.0004	0.0002	Maroon-B	0.0008	0.0003	Raggeds
USFS-PG	0.0000	0.0000	Rocky Mtn	0.0000	0.0000	Lost Creek
2021 Low Development Scenario						
GJFO	0.0001	0.0000	Maroon-B	0.0000	0.0000	Raggeds
UFO	0.0001	0.0001	Maroon-B	0.0002	0.0001	Raggeds
USFS-PG	0.0000	0.0000	Rocky Mtn	0.0000	0.0000	Lost Creek
2021 Medium Development Scenario						
GJFO	0.0005	0.0003	Maroon-B	0.0004	0.0002	Raggeds
UFO	0.0003	0.0001	Maroon-B	0.0006	0.0002	Raggeds
USFS-PG	0.0000	0.0000	Rocky Mtn	0.0000	0.0000	Lost Creek

Table 5-29a. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 High Development Scenario using the Maximum deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Maximum				
Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0169	Mount_Zirkel	0.0136	Dinosaur_all
B	White River FO	0.1083	Flat_Tops	0.1418	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0198	Flat_Tops	0.0118	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0200	Flat_Tops	0.0107	Holy_Cross
E	Grand Junction FO	0.0679	Maroon_Bells	0.0679	Colorado
F	Uncompahgre FO	0.0240	Maroon_Bells	0.0347	Raggeds
G	Tres Rios FO	0.1256	Mesa_Verde	0.1448	South_San_Juan
H	Kremmling FO	0.0065	Rawah	0.0022	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0004	Rocky_Mountain	0.0003	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.0017	Rocky_Mountain	0.0013	Mount_Evans
K	RGFO#2 – West-Central/South	0.0005	Pecos	0.0008	Las_Vegas_NWR
L	RGFO#3 – South	0.0017	Great_Sand_Dunes	0.0272	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0002	Eagles_Nest	0.0028	Lost_Creek
N	New Mexico Farmington District	0.0371	Weminuche	0.1607	Aztec_Ruins
O	Total Colorado River Field Office	0.0398	Flat_Tops	0.0225	Holy_Cross
P	Total Royal Gorge Field Office	0.0024	Rocky_Mountain	0.0279	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0086	Mount_Zirkel	0.0062	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.2120	Flat_Tops	0.1762	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.3660	Flat_Tops	0.3388	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.3680	Flat_Tops	0.3746	South_San_Juan
U	Combined O&G and Mining in 4 km domain	0.5946	Mesa_Verde	1.9374	Aztec_Ruins
V	Natural Emissions	6.6543	Bandelier	1.4498	Chama_River_Cany
W	All 2021 Emissions	8.4676	Bandelier	11.2607	Valle_De_Oro_NWR
X	All 2008 Emissions	9.0012	Bandelier	12.6927	Bitter_Lake_NWR

Table 5-29b. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 High Development Scenario using the Average deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Average				
Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0133	Mount_Zirkel	0.0079	Savage_Run
B	White River FO	0.0680	Flat_Tops	0.0390	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0120	Flat_Tops	0.0082	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0120	Flat_Tops	0.0075	Holy_Cross
E	Grand Junction FO	0.0416	Maroon_Bells	0.0543	Colorado
F	Uncompahgre FO	0.0104	Maroon_Bells	0.0151	Raggeds
G	Tres Rios FO	0.0428	Mesa_Verde	0.0466	Hovenweep
H	Kremmling FO	0.0031	Rawah	0.0015	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0001	Rocky_Mountain	0.0002	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	0.0006	Rocky_Mountain	0.0007	Lost_Creek
K	RGFO#2 – West-Central/South	0.0003	Salt_Creek	0.0006	Maxwell_NWR
L	RGFO#3 – South	0.0011	Great_Sand_Dunes	0.0133	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0001	Eagles_Nest	0.0017	Lost_Creek
N	New Mexico Farmington District	0.0242	Mesa_Verde	0.1501	Aztec_Ruins
O	Total Colorado River Field Office	0.0241	Flat_Tops	0.0157	Holy_Cross
P	Total Royal Gorge Field Office	0.0014	Great_Sand_Dunes	0.0147	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0051	Mount_Zirkel	0.0050	Colorado
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.1454	Flat_Tops	0.1160	Colorado
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.2550	Flat_Tops	0.2191	Colorado
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.2566	Flat_Tops	0.2552	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	0.4902	Mesa_Verde	1.9175	Aztec_Ruins
V	Natural Emissions	0.7876	Bandelier	0.4469	Dome
W	All 2021 Emissions	3.1160	Mount_Zirkel	8.8528	Valle_De_Oro_NWR
X	All 2008 Emissions	5.3938	Salt_Creek	10.0402	Valle_De_Oro_NWR

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Table 5-30a. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 Low Development Scenario using the Maximum deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Maximum				
Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0023	Mount_Zirkel	0.0018	Dinosaur_all
B	White River FO	0.0169	Flat_Tops	0.0228	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0122	Flat_Tops	0.0072	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0101	Flat_Tops	0.0053	Holy_Cross
E	Grand Junction FO	0.0037	Maroon_Bells	0.0037	Colorado
F	Uncompahgre FO	0.0065	Maroon_Bells	0.0100	Raggeds
G	Tres Rios FO	0.0153	Mesa_Verde	0.0182	South_San_Juan
H	Kremmling FO	0.0007	Rawah	0.0002	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0001	Rocky_Mountain	0.0001	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.0004	Rocky_Mountain	0.0003	Mount_Evans
K	RGFO#2 – West-Central/South	0.0000	Pecos	0.0001	Las_Vegas_NWR
L	RGFO#3 – South	0.0011	Great_Sand_Dunes	0.0169	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0000	Eagles_Nest	0.0004	Lost_Creek
N	New Mexico Farmington District	0.0371	Weminuche	0.1605	Aztec_Ruins
O	Total Colorado River Field Office	0.0223	Flat_Tops	0.0125	Holy_Cross
P	Total Royal Gorge Field Office	0.0011	Great_Sand_Dunes	0.0170	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0085	Mount_Zirkel	0.0061	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.0434	Flat_Tops	0.0315	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.2000	Mesa_Verde	0.2128	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.2156	Mesa_Verde	0.2487	South_San_Juan
U	Combined O&G and Mining in 4 km domain	0.5434	Mesa_Verde	1.9167	Aztec_Ruins
V	Natural Emissions	6.6543	Bandelier	1.4498	Chama_River_Cany
W	All 2021 Emissions	8.4513	Bandelier	11.2549	Valle_De_Oro_NWR
X	All 2008 Emissions	9.0012	Bandelier	12.6927	Bitter_Lake_NWR

Table 5-30b. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 Low Development Scenario using the Average deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Average				

Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0018	Mount_Zirkel	0.0011	Savage_Run
B	White River FO	0.0107	Flat_Tops	0.0061	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0074	Flat_Tops	0.0050	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0060	Flat_Tops	0.0037	Holy_Cross
E	Grand Junction FO	0.0023	Flat_Tops	0.0029	Colorado
F	Uncompahgre FO	0.0027	Maroon_Bells	0.0040	Raggeds
G	Tres Rios FO	0.0052	Mesa_Verde	0.0056	Hovenweep
H	Kremmling FO	0.0003	Rawah	0.0002	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0000	Rocky_Mountain	0.0000	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	0.0001	Rocky_Mountain	0.0002	Lost_Creek
K	RGFO#2 – West-Central/South	0.0000	Salt_Creek	0.0001	Maxwell_NWR
L	RGFO#3 – South	0.0007	Great_Sand_Dunes	0.0083	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0000	Eagles_Nest	0.0002	Lost_Creek
N	New Mexico Farmington District	0.0242	Mesa_Verde	0.1499	Aztec_Ruins
O	Total Colorado River Field Office	0.0134	Flat_Tops	0.0087	Holy_Cross
P	Total Royal Gorge Field Office	0.0007	Great_Sand_Dunes	0.0085	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0051	Mount_Zirkel	0.0049	Colorado
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.0303	Flat_Tops	0.0216	Raggeds
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.0841	Flat_Tops	0.0973	Hovenweep
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.1058	Mesa_Verde	0.2348	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	0.4345	Mesa_Verde	1.8948	Aztec_Ruins
V	Natural Emissions	0.7876	Bandelier	0.4469	Dome
W	All 2021 Emissions	2.9682	Mount_Zirkel	8.8463	Valle_De_Oro_NWR
X	All 2008 Emissions	5.3938	Salt_Creek	10.0402	Valle_De_Oro_NWR

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Table 5-31a. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 Medium Development Scenario using the Maximum deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Maximum				

Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0153	Mount_Zirkel	0.0118	Dinosaur_all
B	White River FO	0.1343	Dinosaur_CO	0.1343	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0156	Flat_Tops	0.0097	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0163	Flat_Tops	0.0089	Holy_Cross
E	Grand Junction FO	0.0558	Maroon_Bells	0.0607	Colorado
F	Uncompahgre FO	0.0167	Maroon_Bells	0.0241	Raggeds
G	Tres Rios FO	0.1062	Mesa_Verde	0.1230	South_San_Juan
H	Kremmling FO	0.0040	Rawah	0.0015	Mount_Evans
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0003	Rocky_Mountain	0.0002	Mount_Evans
J	Pawnee Grasslands portion of RGFO#1	0.0011	Rocky_Mountain	0.0008	Mount_Evans
K	RGFO#2 – West-Central/South	0.0004	Pecos	0.0006	Las_Vegas_NWR
L	RGFO#3 – South	0.0012	Great_Sand_Dunes	0.0190	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0001	Eagles_Nest	0.0016	Lost_Creek
N	New Mexico Farmington District	0.0285	Weminuche	0.1236	Aztec_Ruins
O	Total Colorado River Field Office	0.0320	Flat_Tops	0.0186	Holy_Cross
P	Total Royal Gorge Field Office	0.0015	Rocky_Mountain	0.0195	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0086	Mount_Zirkel	0.0062	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.1739	Flat_Tops	0.1639	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.3200	Flat_Tops	0.3105	South_San_Juan
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.3216	Flat_Tops	0.3380	South_San_Juan
U	Combined O&G and Mining in 4 km domain	0.6433	Dinosaur_CO	1.8955	Aztec_Ruins
V	Natural Emissions	6.6543	Bandelier	1.4498	Chama_River_Cany
W	All 2021 Emissions	8.4636	Bandelier	11.2595	Valle_De_Oro_NWR
X	All 2008 Emissions	9.0012	Bandelier	12.6927	Bitter_Lake_NWR

Table 5-31b. Highest nitrogen deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 Medium Development Scenario using the Average deposition in any receptor in the Class I/II area.

Choose	Nitrogen				
Across grid cells	Average				

Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0120	Mount_Zirkel	0.0070	Savage_Run
B	White River FO	0.0559	Flat_Tops	0.0374	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0095	Flat_Tops	0.0068	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0098	Flat_Tops	0.0062	Holy_Cross
E	Grand Junction FO	0.0344	Maroon_Bells	0.0483	Colorado
F	Uncompahgre FO	0.0076	Maroon_Bells	0.0109	Raggeds
G	Tres Rios FO	0.0363	Mesa_Verde	0.0396	Hovenweep
H	Kremmling FO	0.0020	Rawah	0.0010	Mount_Evans
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0001	Rocky_Mountain	0.0001	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	0.0004	Rocky_Mountain	0.0005	Lost_Creek
K	RGFO#2 – West-Central/South	0.0003	Salt_Creek	0.0004	Maxwell_NWR
L	RGFO#3 – South	0.0008	Great_Sand_Dunes	0.0093	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0000	Eagles_Nest	0.0009	Lost_Creek
N	New Mexico Farmington District	0.0185	Mesa_Verde	0.1154	Aztec_Ruins
O	Total Colorado River Field Office	0.0193	Flat_Tops	0.0129	Holy_Cross
P	Total Royal Gorge Field Office	0.0010	Great_Sand_Dunes	0.0102	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0051	Mount_Zirkel	0.0050	Colorado
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.1199	Flat_Tops	0.1027	Colorado
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.2240	Flat_Tops	0.2027	Colorado
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.2253	Flat_Tops	0.2145	Aztec_Ruins
U	Combined O&G and Mining in 4 km domain	0.4729	Mesa_Verde	1.8770	Aztec_Ruins
V	Natural Emissions	0.7876	Bandelier	0.4469	Dome
W	All 2021 Emissions	3.0955	Mount_Zirkel	8.8515	Valle_De_Oro_NWR
X	All 2008 Emissions	5.3938	Salt_Creek	10.0402	Valle_De_Oro_NWR

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Table 5-32. Highest sulfur deposition at any Class I area or sensitive Class II area for each of the 24 Source Groups and the 2021 High Development Scenario using the Maximum deposition in any receptor in the Class I/II area.

Choose	Sulfur				
Across grid cells	Maximum				
Group	Group Name	Max @ any Class I area	Class I Area where Max occurred	Max @ any Class II area	Class II Area where Max occurred
A	Little Snake FO	0.0003	Mount_Zirkel	0.0001	Savage_Run
B	White River FO	0.0111	Flat_Tops	0.0212	Dinosaur_all
C	Colorado River Valley FO (CRVFO)	0.0003	Flat_Tops	0.0001	Holy_Cross
D	Roan Plateau Planning area portion of CRVFO	0.0002	Flat_Tops	0.0001	Holy_Cross
E	Grand Junction FO	0.0006	Maroon_Bells	0.0005	Raggeds
F	Uncompahgre FO	0.0004	Maroon_Bells	0.0008	Raggeds
G	Tres Rios FO	0.0006	Mesa_Verde	0.0012	South_San_Juan
H	Kremmling FO	0.0001	Rawah	0.0000	Savage_Run
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0000	Rocky_Mountain	0.0000	Lost_Creek
J	Pawnee Grasslands portion of RGFO#1	0.0000	Rocky_Mountain	0.0000	Lost_Creek
K	RGFO#2 – West-Central/South	0.0000	Pecos	0.0000	Greenhorn_Mounta
L	RGFO#3 – South	0.0000	Great_Sand_Dunes	0.0001	Greenhorn_Mounta
M	RGFO#4 – East-Central	0.0000	Eagles_Nest	0.0000	Lost_Creek
N	New Mexico Farmington District	0.0009	Weminuche	0.0019	Aztec_Ruins
O	Total Colorado River Field Office	0.0004	Flat_Tops	0.0002	Holy_Cross
P	Total Royal Gorge Field Office	0.0000	Rocky_Mountain	0.0001	Greenhorn_Mounta
Q	Mining from 13 Colorado BLM Planning Areas	0.0235	Mount_Zirkel	0.0078	Raggeds
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.0323	Mount_Zirkel	0.0229	Dinosaur_all
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	0.0345	Mount_Zirkel	0.0259	Dinosaur_all
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	0.0345	Mount_Zirkel	0.0260	Dinosaur_all
U	Combined O&G and Mining in 4 km domain	0.0411	Mount_Zirkel	0.0300	Dinosaur_all
V	Natural Emissions	0.1642	Bandelier	0.0497	Dome
W	All 2021 Emissions	1.7369	Mount_Baldy	1.4079	South_San_Juan
X	All 2008 Emissions	2.3428	Mount_Zirkel	2.1000	South_San_Juan

5.4.1.2 Comparisons Against Critical Loads

In this section we compare the total sulfur and nitrogen deposition from all sources in the 2008 Base Case and 2021 High, Low and Medium Development Scenarios with Critical Load values. It is unclear what the sulfur and nitrogen for the combined Source Groups Q through U should be compared against given that the DAT and Critical Load LOCs were designed for single Projects and total emissions, respectively. The total nitrogen and sulfur deposition amounts for the combined Source Groups Q through U are much lower than the Critical Load values (Attachments D-1, D-2 and D-3).

Tables 5-33 and 5-34 display the total nitrogen and sulfur deposition, respectively, at Class I areas for the 2021 High, Low and Medium Development Scenarios, the 2008 Base Case, the differences between the three2021 scenarios and the 2008 Base Case (2021 minus 2008) and the difference between the three 2021 scenarios and the natural emissions (Source Group V). As seen in Table 5-29a the Class I area with the highest Maximum nitrogen deposition in the 2021 High Development Scenario is 8.47 kg/ha/yr at the Bandelier Class I area in New Mexico that is over 3 times the nitrogen Critical Load value (2.3 kg/ha/yr). However, most of this (6.65 kg/ha/yr) is due to natural emissions (Source Group V in Table 5-29a) and when natural emission contributions are removed the value at Bandelier for the 2021 scenarios (1.80-1.81

kg/ha/yr) is reduced to below the nitrogen Critical Load value (2.3 kg/ha/yr) (Table 5-33). When removing natural emission contributions the Maximum nitrogen deposition exceeds the 2.3 kg/ha/yr Critical Load value at approximately half (14) of the 26 Class I areas for all three 2021 emission scenarios with the highest value of 4.23, 4.04 and 4.20 kg/ha/yr at the Mount Zirkel Wilderness Area and the 2021 High, Low and Medium Development Scenarios, respectively. When examining the Average annual nitrogen deposition across Class I areas, approximately a quarter of the Class I areas exceed the 2.3 kg/ha/yr nitrogen Critical Load value for the 2021 emission scenarios..

With one exception, all 26 Class I areas exhibit a reduction in annual nitrogen deposition from 2008 to 2021 with the largest reduction occurring at Salt Creek (-5.5 kg/ha/yr) and the second largest reduction occurring at Bosque del Apache (-2.6 kg/ha/yr). The exception is the Great Sand Dunes NM that saw essentially no change in nitrogen deposition between 2008 and 2021 for the three 2021 emissions scenarios (changes of -0.02 to +0.07 kg/ha/yr).

The total sulfur deposition at all of the Class I areas for the 2008 and three 2021 emission scenarios are all well below the sulfur Critical Load of 5 kg/ha/yr (Table 5-34). Sulfur deposition is reduced by 5% to 50% across the Class I areas between the 2008 and 2021 emissions scenarios. The highest sulfur deposition at any Class I area for the three 2021 emission scenarios is 1.7 kg/ha/yr at Mt. Baldy that is approximately a factor of three below the sulfur deposition Critical Load (5.0 kg/ha/yr) (Table 5-34).

Additional results, including those for sensitive Class II areas and all Source Groups, are found in Attachments D-1, D-2 and D-3.

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Table 5-33a. Total annual nitrogen deposition at Class I areas for the 2021 High Development Scenario, 2008 Base Case, their differences (2021 High minus 2008) and 2021 High Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 High		2008 Base		2021 High - 2008		2021 Hi - Natural	
Class I Area	N-Max (kg/ha)	N-Avg (kg/ha)	N-Max (kg/ha)	N-Avg (kg/ha)	N-Max (kg/ha)	N-Avg (kg/ha)	N-Max (kg/ha)	N-Avg (kg/ha)
Arches NP	1.67	1.56	2.20	1.81	-0.53	-0.25	1.64	1.52
Bandelier NM	8.47	2.51	9.00	2.96	-0.53	-0.45	1.81	1.72
Black Canyon NP	2.85	2.30	2.99	2.57	-0.14	-0.27	2.79	2.25
Bosque del Apache WA	2.49	1.64	5.08	2.46	-2.60	-0.82	2.26	1.51
Canyonlands NP	1.89	1.43	2.31	1.77	-0.42	-0.34	1.84	1.39
Capitol Reef NP	3.22	1.54	3.37	1.90	-0.15	-0.36	3.20	1.52
Eagles Nest WA	2.79	2.08	3.59	2.94	-0.79	-0.85	2.73	2.03
Flat Tops WA	3.00	2.39	3.71	3.09	-0.71	-0.70	2.90	2.34
Galiuro WA	2.39	2.29	2.97	2.83	-0.57	-0.54	2.38	2.28
Gila WA	2.07	1.36	2.69	1.68	-0.63	-0.31	1.98	1.31
Great Sand Dunes NM	2.77	1.97	2.70	1.95	0.07	0.02	2.66	1.89
La Garita WA	1.97	1.55	2.75	2.11	-0.78	-0.56	1.88	1.48
Maroon Bells-Snowmass	3.01	2.18	3.81	2.94	-0.80	-0.77	2.93	2.12
Mesa Verde NP	2.92	2.53	3.14	2.76	-0.21	-0.22	2.86	2.47
Mount Baldy WA	2.38	1.94	3.24	2.69	-0.86	-0.75	2.05	1.70
Mount Zirkel WA	4.29	3.12	5.13	3.95	-0.84	-0.84	4.23	3.07
Pecos WA	2.98	2.27	3.95	2.99	-0.97	-0.72	2.19	2.09
Petrified Forest NP	2.04	1.72	2.66	2.16	-0.62	-0.44	1.99	1.68
Rawah WA	3.23	2.51	4.07	3.27	-0.84	-0.76	3.14	2.45
Rocky Mountain NP	3.41	2.58	4.49	3.50	-1.08	-0.92	3.31	2.51
Salt Creek WA	2.70	2.43	8.21	5.39	-5.51	-2.96	2.64	2.38
San Pedro Parks WA	2.70	2.33	3.36	2.93	-0.67	-0.60	2.25	2.15
Weminuche WA	3.03	2.14	3.80	2.84	-0.78	-0.70	2.89	2.06
West Elk WA	2.58	1.98	3.34	2.63	-0.76	-0.66	2.27	1.91
Wheeler Peak WA	3.10	2.55	4.11	3.44	-1.02	-0.88	2.90	2.41
White Mountain WA	3.09	2.42	3.73	2.85	-0.65	-0.42	2.57	2.14

Table 5-33b. Total annual nitrogen deposition at Class I areas for the 2021 Low Development Scenario, 2008 Base Case, their differences (2021 Low minus 2008) and 2021 Low Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 Low		2008 Base		2021 Low - 2008		2021 Low - Natural	
	N-Max	N-Avg	N-Max	N-Avg	N-Max	N-Avg	N-Max	N-Avg
Class I Area	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)
Arches NP	1.59	1.48	2.20	1.81	-0.62	-0.33	1.55	1.44
Bandelier NM	8.45	2.49	9.00	2.96	-0.55	-0.47	1.80	1.70
Black Canyon NP	2.72	2.19	2.99	2.57	-0.26	-0.38	2.67	2.14
Bosque del Apache WA	2.48	1.63	5.08	2.46	-2.60	-0.83	2.26	1.51
Canyonlands NP	1.86	1.40	2.31	1.77	-0.45	-0.37	1.81	1.37
Capitol Reef NP	3.22	1.54	3.37	1.90	-0.15	-0.37	3.19	1.52
Eagles Nest WA	2.61	1.95	3.59	2.94	-0.98	-0.99	2.54	1.90
Flat Tops WA	2.75	2.20	3.71	3.09	-0.96	-0.89	2.66	2.15
Galiuro WA	2.39	2.29	2.97	2.83	-0.58	-0.55	2.38	2.28
Gila WA	2.06	1.36	2.69	1.68	-0.63	-0.31	1.98	1.31
Great Sand Dunes NM	2.72	1.93	2.70	1.95	0.02	-0.02	2.62	1.86
La Garita WA	1.91	1.51	2.75	2.11	-0.83	-0.60	1.82	1.44
Maroon Bells-Snowmass	2.82	2.02	3.81	2.94	-0.99	-0.92	2.73	1.97
Mesa Verde NP	2.86	2.47	3.14	2.76	-0.27	-0.28	2.80	2.41
Mount Baldy WA	2.37	1.94	3.24	2.69	-0.86	-0.75	2.05	1.69
Mount Zirkel WA	4.10	2.97	5.13	3.95	-1.03	-0.98	4.04	2.92
Pecos WA	2.96	2.25	3.95	2.99	-0.99	-0.74	2.17	2.07
Petrified Forest NP	2.03	1.72	2.66	2.16	-0.63	-0.44	1.98	1.67
Rawah WA	3.09	2.39	4.07	3.27	-0.98	-0.88	3.00	2.33
Rocky Mountain NP	3.22	2.44	4.49	3.50	-1.26	-1.06	3.12	2.37
Salt Creek WA	2.69	2.42	8.21	5.39	-5.52	-2.97	2.63	2.37
San Pedro Parks WA	2.68	2.31	3.36	2.93	-0.69	-0.62	2.23	2.13
Weminuche WA	3.00	2.11	3.80	2.84	-0.81	-0.73	2.86	2.03
West Elk WA	2.44	1.87	3.34	2.63	-0.90	-0.76	2.13	1.80
Wheeler Peak WA	3.06	2.52	4.11	3.44	-1.05	-0.91	2.87	2.38
White Mountain WA	3.08	2.42	3.73	2.85	-0.65	-0.43	2.56	2.14

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Table 5-33c. Total annual nitrogen deposition at Class I areas for the 2021 Medium Development Scenario, 2008 Base Case, their differences (2021 Medium minus 2008) and 2021 Medium Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 High		2008 Base		2021 High - 2008		2021 Hi - Natural	
	N-Max	N-Avg	N-Max	N-Avg	N-Max	N-Avg	N-Max	N-Avg
Class I Area	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)
Arches NP	1.67	1.55	2.20	1.81	-0.54	-0.26	1.63	1.52
Bandelier NM	8.46	2.50	9.00	2.96	-0.54	-0.46	1.81	1.72
Black Canyon NP	2.83	2.29	2.99	2.57	-0.16	-0.29	2.78	2.23
Bosque del Apache WA	2.49	1.64	5.08	2.46	-2.60	-0.83	2.26	1.51
Canyonlands NP	1.89	1.43	2.31	1.77	-0.42	-0.35	1.83	1.39
Capitol Reef NP	3.22	1.54	3.37	1.90	-0.15	-0.36	3.20	1.52
Eagles Nest WA	2.76	2.06	3.59	2.94	-0.83	-0.88	2.70	2.01
Flat Tops WA	2.95	2.35	3.71	3.09	-0.75	-0.73	2.86	2.31
Galiuro WA	2.39	2.29	2.97	2.83	-0.57	-0.54	2.38	2.28
Gila WA	2.07	1.36	2.69	1.68	-0.63	-0.31	1.98	1.31
Great Sand Dunes NM	2.76	1.96	2.70	1.95	0.06	0.01	2.66	1.89
La Garita WA	1.96	1.54	2.75	2.11	-0.79	-0.57	1.87	1.47
Maroon Bells-Snowmass	2.98	2.15	3.81	2.94	-0.84	-0.79	2.89	2.09
Mesa Verde NP	2.90	2.51	3.14	2.76	-0.23	-0.24	2.84	2.46
Mount Baldy WA	2.38	1.94	3.24	2.69	-0.86	-0.75	2.05	1.69
Mount Zirkel WA	4.27	3.10	5.13	3.95	-0.86	-0.86	4.20	3.05
Pecos WA	2.98	2.27	3.95	2.99	-0.97	-0.72	2.19	2.08
Petrified Forest NP	2.04	1.72	2.66	2.16	-0.62	-0.44	1.98	1.68
Rawah WA	3.21	2.49	4.07	3.27	-0.86	-0.78	3.12	2.43
Rocky Mountain NP	3.39	2.56	4.49	3.50	-1.10	-0.93	3.29	2.49
Salt Creek WA	2.69	2.43	8.21	5.39	-5.52	-2.97	2.64	2.38
San Pedro Parks WA	2.69	2.33	3.36	2.93	-0.67	-0.61	2.24	2.14
Weminuche WA	3.01	2.13	3.80	2.84	-0.79	-0.71	2.88	2.05
West Elk WA	2.56	1.96	3.34	2.63	-0.78	-0.67	2.25	1.89
Wheeler Peak WA	3.09	2.55	4.11	3.44	-1.03	-0.89	2.89	2.40
White Mountain WA	3.09	2.42	3.73	2.85	-0.65	-0.42	2.57	2.14

Table 5-34a. Total annual sulfur deposition at Class I areas for the 2021 High Development Scenario, 2008 Base Case, their differences (2021 High minus 2008) and 2021 High Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 High		2008 Base		2021 High - 2008		2021 Hi - Natural	
Class I Area	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)
Arches NP	0.22	0.20	0.36	0.33	-0.14	-0.13	0.22	0.22
Bandelier NM	0.77	0.47	1.12	0.71	-0.34	-0.24	0.61	0.77
Black Canyon NP	0.36	0.31	0.62	0.53	-0.26	-0.22	0.36	0.36
Bosque del Apache WA	0.38	0.35	0.41	0.36	-0.03	-0.02	0.38	0.38
Canyonlands NP	0.35	0.22	0.60	0.35	-0.25	-0.13	0.35	0.35
Capitol Reef NP	0.40	0.22	0.55	0.33	-0.15	-0.11	0.40	0.40
Eagles Nest WA	0.92	0.56	1.56	1.10	-0.64	-0.54	0.92	0.92
Flat Tops WA	1.04	0.71	1.72	1.33	-0.69	-0.61	1.04	1.04
Galiuro WA	1.31	1.17	1.12	1.02	0.19	0.15	1.31	1.31
Gila WA	1.32	0.58	1.61	0.72	-0.29	-0.13	1.32	1.32
Great Sand Dunes NM	0.57	0.33	0.94	0.56	-0.38	-0.23	0.57	0.57
La Garita WA	0.67	0.43	1.25	0.88	-0.58	-0.45	0.67	0.67
Maroon Bells-Snowmass	1.14	0.70	1.86	1.33	-0.71	-0.64	1.14	1.14
Mesa Verde NP	0.58	0.49	0.91	0.80	-0.33	-0.32	0.58	0.58
Mount Baldy WA	1.74	1.13	2.06	1.52	-0.33	-0.38	1.72	1.74
Mount Zirkel WA	1.48	0.93	2.34	1.73	-0.86	-0.80	1.48	1.48
Pecos WA	1.42	0.83	1.95	1.30	-0.53	-0.46	1.40	1.42
Petrified Forest NP	0.58	0.47	0.80	0.68	-0.22	-0.21	0.58	0.58
Rawah WA	1.01	0.65	1.77	1.29	-0.77	-0.64	1.00	1.01
Rocky Mountain NP	1.11	0.68	1.91	1.35	-0.80	-0.66	1.11	1.11
Salt Creek WA	0.69	0.61	0.73	0.66	-0.04	-0.05	0.69	0.69
San Pedro Parks WA	1.11	0.77	1.61	1.24	-0.51	-0.47	1.10	1.11
Weminuche WA	1.50	0.80	2.06	1.36	-0.56	-0.56	1.50	1.50
West Elk WA	0.90	0.53	1.48	1.01	-0.58	-0.48	0.89	0.90
Wheeler Peak WA	1.54	1.07	2.23	1.66	-0.69	-0.59	1.53	1.54
White Mountain WA	1.61	0.97	1.85	1.11	-0.24	-0.14	1.59	1.61

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Table 5-34b. Total annual sulfur deposition at Class I areas for the 2021 Low Development Scenario, 2008 Base Case, their differences (2021 Low minus 2008) and 2021 Low Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 Low		2008 Base		2021 Low - 2008		2021 Low - Natural	
	S-Max	S-Avg	S-Max	S-Avg	S-Max	S-Avg	S-Max	S-Avg
Class I Area	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)
Arches NP	0.22	0.20	0.36	0.33	-0.15	-0.13	0.22	0.20
Bandelier NM	0.77	0.47	1.12	0.71	-0.34	-0.24	0.61	0.45
Black Canyon NP	0.36	0.31	0.62	0.53	-0.26	-0.22	0.36	0.31
Bosque del Apache WA	0.38	0.35	0.41	0.36	-0.03	-0.02	0.38	0.35
Canyonlands NP	0.35	0.22	0.60	0.35	-0.25	-0.13	0.35	0.22
Capitol Reef NP	0.40	0.22	0.55	0.33	-0.15	-0.11	0.40	0.22
Eagles Nest WA	0.92	0.56	1.56	1.10	-0.64	-0.54	0.92	0.56
Flat Tops WA	1.03	0.71	1.72	1.33	-0.69	-0.62	1.03	0.71
Galiuro WA	1.31	1.17	1.12	1.02	0.19	0.15	1.31	1.17
Gila WA	1.32	0.58	1.61	0.72	-0.29	-0.13	1.32	0.58
Great Sand Dunes NM	0.57	0.33	0.94	0.56	-0.38	-0.23	0.57	0.33
La Garita WA	0.67	0.43	1.25	0.88	-0.58	-0.45	0.67	0.43
Maroon Bells-Snowmass	1.14	0.69	1.86	1.33	-0.72	-0.64	1.14	0.69
Mesa Verde NP	0.58	0.49	0.91	0.80	-0.33	-0.32	0.58	0.49
Mount Baldy WA	1.74	1.13	2.06	1.52	-0.33	-0.38	1.72	1.13
Mount Zirkel WA	1.47	0.93	2.34	1.73	-0.87	-0.80	1.47	0.93
Pecos WA	1.42	0.83	1.95	1.30	-0.53	-0.47	1.40	0.83
Petrified Forest NP	0.58	0.47	0.80	0.68	-0.22	-0.21	0.58	0.47
Rawah WA	1.00	0.65	1.77	1.29	-0.77	-0.64	1.00	0.65
Rocky Mountain NP	1.11	0.68	1.91	1.35	-0.80	-0.67	1.10	0.68
Salt Creek WA	0.69	0.61	0.73	0.66	-0.04	-0.05	0.69	0.61
San Pedro Parks WA	1.11	0.76	1.61	1.24	-0.51	-0.47	1.10	0.76
Weminuche WA	1.50	0.80	2.06	1.36	-0.56	-0.56	1.50	0.80
West Elk WA	0.90	0.53	1.48	1.01	-0.58	-0.48	0.89	0.53
Wheeler Peak WA	1.54	1.07	2.23	1.66	-0.69	-0.59	1.53	1.07
White Mountain WA	1.61	0.97	1.85	1.11	-0.24	-0.14	1.59	0.96

Table 5-34c. Total annual sulfur deposition at Class I areas for the 2021 Medium Development Scenario, 2008 Base Case, their differences (2021 Medium minus 2008) and 2021 Medium Development Scenario without the contributions of natural emissions (e.g., wildfires).

	2021 High		2008 Base		2021 High - 2008		2021 Hi - Natural	
Class I Area	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)	S-Max (kg/ha)	S-Avg (kg/ha)
Arches NP	0.22	0.20	0.36	0.33	-0.14	-0.13	0.22	0.20
Bandelier NM	0.77	0.47	1.12	0.71	-0.34	-0.24	0.61	0.45
Black Canyon NP	0.36	0.31	0.62	0.53	-0.26	-0.22	0.36	0.31
Bosque del Apache WA	0.38	0.35	0.41	0.36	-0.03	-0.02	0.38	0.35
Canyonlands NP	0.35	0.22	0.60	0.35	-0.25	-0.13	0.35	0.22
Capitol Reef NP	0.40	0.22	0.55	0.33	-0.15	-0.11	0.40	0.22
Eagles Nest WA	0.92	0.56	1.56	1.10	-0.64	-0.54	0.92	0.56
Flat Tops WA	1.04	0.71	1.72	1.33	-0.69	-0.61	1.04	0.71
Galiuro WA	1.31	1.17	1.12	1.02	0.19	0.15	1.31	1.17
Gila WA	1.32	0.58	1.61	0.72	-0.29	-0.13	1.32	0.58
Great Sand Dunes NM	0.57	0.33	0.94	0.56	-0.38	-0.23	0.57	0.33
La Garita WA	0.67	0.43	1.25	0.88	-0.58	-0.45	0.67	0.43
Maroon Bells-Snowmass	1.14	0.70	1.86	1.33	-0.71	-0.64	1.14	0.70
Mesa Verde NP	0.58	0.49	0.91	0.80	-0.33	-0.32	0.58	0.49
Mount Baldy WA	1.74	1.13	2.06	1.52	-0.33	-0.38	1.72	1.13
Mount Zirkel WA	1.48	0.93	2.34	1.73	-0.86	-0.80	1.48	0.93
Pecos WA	1.42	0.83	1.95	1.30	-0.53	-0.46	1.40	0.83
Petrified Forest NP	0.58	0.47	0.80	0.68	-0.22	-0.21	0.58	0.47
Rawah WA	1.01	0.65	1.77	1.29	-0.77	-0.64	1.00	0.65
Rocky Mountain NP	1.11	0.68	1.91	1.35	-0.80	-0.66	1.11	0.68
Salt Creek WA	0.69	0.61	0.73	0.66	-0.04	-0.05	0.69	0.61
San Pedro Parks WA	1.11	0.77	1.61	1.24	-0.51	-0.47	1.10	0.76
Weminuche WA	1.50	0.80	2.06	1.36	-0.56	-0.56	1.50	0.80
West Elk WA	0.90	0.53	1.48	1.01	-0.58	-0.48	0.89	0.53
Wheeler Peak WA	1.54	1.07	2.23	1.66	-0.69	-0.59	1.53	1.07
White Mountain WA	1.61	0.97	1.85	1.11	-0.24	-0.14	1.59	0.96

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5.5 Acid Neutralizing Capacity (ANC) at Sensitive Lakes

Acid Neutralizing Capacity (ANC) at sensitive lakes was calculated for each Source Group following the procedures given in Section 4.8. For a Project, the USFS ANC Level of Acceptable Change (LAC) threshold is no change greater than 10% for lakes with base ANC > 25 μeq/l and no change greater than 1 μeq/l for lakes with base ANC values < 25 μeq/l. Attachments E-1, E-2 and E-3 are interactive Excel spreadsheet that displays the change in ANC at the sensitive lakes due to emissions from each of the 24 Source Groups and the, respectively, High, Low and Medium Development Scenarios. The Source Group to be displayed is controlled by cell B3 with the resultant change in ANC (Delta ANC) shown as a percent in Column N and as μeq/l in Column O with an indication of whether it is below the USFS LAC value given in Column P. Although ANC is presented for each Source Group, the ANC results for the Source Groups with existing sources (U, V, W and X) are not meaningful since their effects are contained within both the 10 percentile baseline lake acidity as well as the incremental acidity added to the baseline.

5.5.1 ANC Calculations for Individual BLM Planning Areas

For new Federal O&G from each of the 14 BLM Planning Areas (Source Groups A through P) the change in ANC were below the USFS LAC significance thresholds at all of the sensitive lakes. For example, Table 5-35 displays ANC results from Attachment E-1 (2021 High Development Scenario) for the GJFO, UFO and USFS-PG Planning Areas (Source Groups E, F and J). For new Federal O&G from the GJFO Planning Area and the 2021 High Scenario, the maximum change in ANC at any sensitive lake is 3.22% at the White Dome Lake in the Weminuche National Forest. This change is below both of the USFS LAC values (Table 5-35a). Note that Attachment D contains more information on the sensitive lakes than presented in Table 5-35 including the lake chemistry parameters. For new Federal O&G within the UFO Planning Area and the 2021 High Scenario, the maximum change in ANC at any sensitive lake is 1.02% at Deep Creek Lake in the Raggeds Wilderness Area - Gunnison National Forest that is below the USFS LAC thresholds (Table 5-35b). New Federal O&G development within the USFS Pawnee Grassland Planning Area has almost no effect on acidification at the sensitive lakes with maximum change in ANC values of 0.02% (Table 5-35c). ANC results for the other BLM Planning Areas and the 2021 Low and Medium Development Scenario are contained in Attachments E-1, E-2 and E-3.

Table 5-35a. ANC calculations at sensitive lakes for new Federal oil and gas development within the BLM Grand Junction Field Office Planning Area (Source Group E) and the 2021 High Development Scenario.

Lake	10th Percentile Lowest ANC Value (µeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (µeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (µeq/L)
Brooklyn Lake	101.7	0.0003	0.0277	0.898	0.33%	0.3316	<10%	yes	101.3
Tabor Lake	112.4	0.0003	0.0289	0.860	0.32%	0.3617	<10%	yes	112.0
Booth Lake	86.8	0.0004	0.0442	0.844	0.65%	0.5621	<10%	yes	86.2
Upper Willow Lake	134.1	0.0002	0.0295	0.741	0.32%	0.4278	<10%	yes	133.7
Ned Wilson Lake	39.0	0.0004	0.0438	1.158	1.04%	0.4059	<10%	yes	38.6
Upper Ned Wilson Lake	12.9	0.0004	0.0438	1.158	3.15%	0.4059	<1(µeq/L)	yes	12.5
Lower NWL Packtrail Pothole	29.7	0.0004	0.0438	1.158	1.37%	0.4059	<10%	yes	29.2
Upper NWL Packtrail Pothole	48.7	0.0004	0.0438	1.158	0.83%	0.4059	<10%	yes	48.3
Walk Up Lake	55.2	0.0000	0.0008	0.878	0.02%	0.0101	<10%	yes	55.2
Bluebell Lake	55.5	0.0000	0.0005	0.883	0.01%	0.0066	<10%	yes	55.5
Dean Lake	48.9	0.0000	0.0005	1.061	0.01%	0.0050	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0000	0.0008	0.844	0.02%	0.0105	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0000	0.0006	0.960	0.01%	0.0070	<10%	yes	64.8
Fish Lake	105.8	0.0000	0.0008	0.869	0.01%	0.0101	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0004	0.0471	0.928	1.14%	0.5446	<10%	yes	47.1
Upper Turquoise Lake	104.0	0.0004	0.0475	0.809	0.61%	0.6316	<10%	yes	103.4
Upper West Tennessee Lake	114.2	0.0003	0.0374	0.904	0.39%	0.4440	<10%	yes	113.8
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0003	0.0360	1.128	1.78%	0.3424	<1(µeq/L)	yes	18.9
Crater Lake	53.1	0.0003	0.0314	1.071	0.59%	0.3144	<10%	yes	52.8
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0002	0.0331	0.959	0.71%	0.3699	<10%	yes	51.9
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0003	0.0370	1.126	1.38%	0.3531	<10%	yes	25.3
Upper Lake	69.0	0.0003	0.0340	1.139	0.46%	0.3204	<10%	yes	68.7
Small Lake Above U-Shaped Lake	59.9	0.0001	0.0100	0.927	0.19%	0.1153	<10%	yes	59.8
U-Shaped Lake	81.4	0.0001	0.0100	0.927	0.14%	0.1153	<10%	yes	81.2
Avalanche Lake	158.8	0.0006	0.0526	1.282	0.28%	0.4419	<10%	yes	158.4
Capitol Lake	154.4	0.0006	0.0519	1.110	0.33%	0.5030	<10%	yes	153.9
Moon Lake (Upper)	53.0	0.0006	0.0519	1.110	0.95%	0.5030	<10%	yes	52.5
Upper Middle Beartrack Lake	50.9	0.0002	0.0209	0.869	0.51%	0.2583	<10%	yes	50.6
Abyss Lake	81.1	0.0001	0.0218	0.896	0.32%	0.2613	<10%	yes	80.8
Frozen Lake	93.3	0.0001	0.0218	0.896	0.28%	0.2613	<10%	yes	93.0
North Lake	80.9	0.0001	0.0218	0.896	0.32%	0.2613	<10%	yes	80.7
South Lake	66.7	0.0001	0.0218	0.896	0.39%	0.2613	<10%	yes	66.5
Lake Elbert	56.6	0.0003	0.0299	1.726	0.33%	0.1859	<10%	yes	56.4
Seven Lakes (LG East)	36.2	0.0002	0.0246	1.546	0.47%	0.1713	<10%	yes	36.1
Summit Lake	48.0	0.0003	0.0290	1.449	0.45%	0.2153	<10%	yes	47.8
Deep Creek Lake	20.6	0.0003	0.0409	0.887	2.40%	0.4949	<1(µeq/L)	yes	20.1
Island Lake	71.0	0.0002	0.0222	1.079	0.31%	0.2215	<10%	yes	70.8
Kelly Lake	179.9	0.0002	0.0222	1.079	0.12%	0.2215	<10%	yes	179.6
Rawah Lake #4	41.3	0.0002	0.0225	1.098	0.53%	0.2206	<10%	yes	41.1
Crater Lake (Sangre de Cristo)	162.9	0.0001	0.0097	0.959	0.07%	0.1084	<10%	yes	162.8
Lower Stout Lake	145.2	0.0001	0.0123	0.671	0.14%	0.1975	<10%	yes	145.0
Upper Little Sand Creek Lake	129.5	0.0001	0.0092	1.064	0.07%	0.0926	<10%	yes	129.4
Upper Stout Lake	76.3	0.0001	0.0123	0.671	0.26%	0.1975	<10%	yes	76.1
Glacier Lake (Colorado)	63.4	0.0000	0.0042	1.145	0.06%	0.0398	<10%	yes	63.4
Lake South of Blue Lakes	16.9	0.0000	0.0050	1.312	0.24%	0.0406	<1(µeq/L)	yes	16.9
Big Eldorado Lake	19.6	0.0000	0.0070	1.128	0.34%	0.0664	<1(µeq/L)	yes	19.6
Four Mile Pothole	123.4	0.0001	0.0069	1.173	0.05%	0.0633	<10%	yes	123.3
Lake Due South of Ute Lake	13.2	0.0000	0.0059	1.067	0.45%	0.0597	<1(µeq/L)	yes	13.1
Little Eldorado	-3.3	0.0000	0.0070	1.128	2.01%	0.0664	<1(µeq/L)	yes	-3.4
Little Granite Lake	80.7	0.0000	0.0069	0.830	0.11%	0.0890	<10%	yes	80.6
Lower Sunlight Lake	80.9	0.0001	0.0073	1.177	0.08%	0.0670	<10%	yes	80.8
Middle Ute Lake	42.8	0.0000	0.0059	1.052	0.14%	0.0603	<10%	yes	42.7
Small Pond Above Trout Lake	25.5	0.0000	0.0069	1.087	0.27%	0.0682	<10%	yes	25.4
Upper Grizzly Lake	29.9	0.0001	0.0075	1.177	0.23%	0.0689	<10%	yes	29.8
Upper Sunlight Lake	28.0	0.0001	0.0075	1.177	0.25%	0.0689	<10%	yes	27.9
West Snowdon Lake	39.4	0.0000	0.0070	0.978	0.20%	0.0772	<10%	yes	39.3
White Dome Lake	2.1	0.0000	0.0070	1.128	3.22%	0.0664	<1(µeq/L)	yes	2.0
South Golden Lake	111.4	0.0002	0.0317	0.984	0.31%	0.3456	<10%	yes	111.1

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

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Table 5-35b. ANC calculations at sensitive lakes for new Federal oil and gas development within the BLM Uncompahgre Field Office Planning Area (Source Group F) and the 2021 High Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0001	0.0045	0.898	0.05%	0.0543	<10%	yes	101.6
Tabor Lake	112.4	0.0001	0.0044	0.860	0.05%	0.0559	<10%	yes	112.3
Booth Lake	86.8	0.0000	0.0030	0.844	0.04%	0.0389	<10%	yes	86.7
Upper Willow Lake	134.1	0.0000	0.0022	0.741	0.02%	0.0325	<10%	yes	134.1
Ned Wilson Lake	39.0	0.0000	0.0015	1.158	0.04%	0.0137	<10%	yes	39.0
Upper Ned Wilson Lake	12.9	0.0000	0.0015	1.158	0.11%	0.0137	<1(μeq/L)	yes	12.9
Lower NWL Packtrail Pothole	29.7	0.0000	0.0015	1.158	0.05%	0.0137	<10%	yes	29.6
Upper NWL Packtrail Pothole	48.7	0.0000	0.0015	1.158	0.03%	0.0137	<10%	yes	48.7
Walk Up Lake	55.2	0.0000	0.0000	0.878	0.00%	0.0003	<10%	yes	55.2
Bluebell Lake	55.5	0.0000	0.0000	0.883	0.00%	0.0002	<10%	yes	55.5
Dean Lake	48.9	0.0000	0.0000	1.061	0.00%	0.0001	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0000	0.0000	0.844	0.00%	0.0003	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0000	0.0000	0.960	0.00%	0.0002	<10%	yes	64.8
Fish Lake	105.8	0.0000	0.0000	0.869	0.00%	0.0003	<10%	yes	105.8
Blodgett Lake, Colorado	47.7	0.0001	0.0044	0.928	0.11%	0.0518	<10%	yes	47.6
Upper Turquoise Lake	104.0	0.0001	0.0038	0.809	0.05%	0.0506	<10%	yes	103.9
Upper West Tennessee Lake	114.2	0.0001	0.0041	0.904	0.04%	0.0492	<10%	yes	114.2
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0000	0.0025	1.128	0.12%	0.0235	<1(μeq/L)	yes	19.2
Crater Lake	53.1	0.0000	0.0021	1.071	0.04%	0.0211	<10%	yes	53.1
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0000	0.0021	0.959	0.05%	0.0236	<10%	yes	52.2
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0000	0.0025	1.126	0.09%	0.0240	<10%	yes	25.6
Upper Lake	69.0	0.0000	0.0024	1.139	0.03%	0.0230	<10%	yes	69.0
Small Lake Above U-Shaped Lake	59.9	0.0000	0.0013	0.927	0.03%	0.0154	<10%	yes	59.9
U-Shaped Lake	81.4	0.0000	0.0013	0.927	0.02%	0.0154	<10%	yes	81.3
Avalanche Lake	158.8	0.0004	0.0147	1.282	0.08%	0.1250	<10%	yes	158.7
Capitol Lake	154.4	0.0003	0.0132	1.110	0.08%	0.1299	<10%	yes	154.3
Moon Lake (Upper)	53.0	0.0003	0.0132	1.110	0.25%	0.1299	<10%	yes	52.9
Upper Middle Beartrack Lake	50.9	0.0000	0.0017	0.869	0.04%	0.0205	<10%	yes	50.9
Abyss Lake	81.1	0.0000	0.0018	0.896	0.03%	0.0211	<10%	yes	81.1
Frozen Lake	93.3	0.0000	0.0018	0.896	0.02%	0.0211	<10%	yes	93.2
North Lake	80.9	0.0000	0.0018	0.896	0.03%	0.0211	<10%	yes	80.9
South Lake	66.7	0.0000	0.0018	0.896	0.03%	0.0211	<10%	yes	66.7
Lake Elbert	56.6	0.0000	0.0011	1.726	0.01%	0.0066	<10%	yes	56.6
Seven Lakes (LG East)	36.2	0.0000	0.0007	1.546	0.01%	0.0052	<10%	yes	36.2
Summit Lake	48.0	0.0000	0.0011	1.449	0.02%	0.0084	<10%	yes	48.0
Deep Creek Lake	20.6	0.0003	0.0173	0.887	1.02%	0.2107	<1(μeq/L)	yes	20.4
Island Lake	71.0	0.0000	0.0014	1.079	0.02%	0.0141	<10%	yes	71.0
Kelly Lake	179.9	0.0000	0.0014	1.079	0.01%	0.0141	<10%	yes	179.8
Rawah Lake #4	41.3	0.0000	0.0014	1.098	0.03%	0.0137	<10%	yes	41.3
Crater Lake (Sangre de Cristo)	162.9	0.0000	0.0012	0.959	0.01%	0.0134	<10%	yes	162.9
Lower Stout Lake	145.2	0.0000	0.0019	0.671	0.02%	0.0308	<10%	yes	145.2
Upper Little Sand Creek Lake	129.5	0.0000	0.0012	1.064	0.01%	0.0118	<10%	yes	129.5
Upper Stout Lake	76.3	0.0000	0.0019	0.671	0.04%	0.0308	<10%	yes	76.3
Glacier Lake (Colorado)	63.4	0.0000	0.0005	1.145	0.01%	0.0044	<10%	yes	63.4
Lake South of Blue Lakes	16.9	0.0000	0.0005	1.312	0.02%	0.0042	<1(μeq/L)	yes	16.9
Big Eldorado Lake	19.6	0.0000	0.0007	1.128	0.03%	0.0065	<1(μeq/L)	yes	19.6
Four Mile Pothole	123.4	0.0000	0.0006	1.173	0.00%	0.0057	<10%	yes	123.4
Lake Due South of Ute Lake	13.2	0.0000	0.0006	1.067	0.04%	0.0057	<1(μeq/L)	yes	13.2
Little Eldorado	-3.3	0.0000	0.0007	1.128	0.20%	0.0065	<1(μeq/L)	yes	-3.3
Little Granite Lake	80.7	0.0000	0.0007	0.830	0.01%	0.0092	<10%	yes	80.7
Lower Sunlight Lake	80.9	0.0000	0.0007	1.177	0.01%	0.0063	<10%	yes	80.9
Middle Ute Lake	42.8	0.0000	0.0006	1.052	0.01%	0.0059	<10%	yes	42.8
Small Pond Above Trout Lake	25.5	0.0000	0.0007	1.087	0.03%	0.0071	<10%	yes	25.5
Upper Grizzly Lake	29.9	0.0000	0.0007	1.177	0.02%	0.0063	<10%	yes	29.9
Upper Sunlight Lake	28.0	0.0000	0.0007	1.177	0.02%	0.0063	<10%	yes	28.0
West Snowdon Lake	39.4	0.0000	0.0007	0.978	0.02%	0.0074	<10%	yes	39.3
White Dome Lake	2.1	0.0000	0.0007	1.128	0.32%	0.0065	<1(μeq/L)	yes	2.1
South Golden Lake	111.4	0.0001	0.0090	0.984	0.09%	0.0989	<10%	yes	111.3

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

Table 5-35c. ANC calculations at sensitive lakes for new Federal oil and gas development within the USFS Pawnee Grasslands Planning Area (Source Group J) and the 2021 High Development Scenario.

Lake	10th Percentile Lowest ANC Value (µeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (µeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (µeq/L)
Brooklyn Lake	101.7	0.0000	0.0000	0.898	0.00%	0.0005	<10%	yes	101.7
Tabor Lake	112.4	0.0000	0.0000	0.860	0.00%	0.0005	<10%	yes	112.4
Booth Lake	86.8	0.0000	0.0001	0.844	0.00%	0.0006	<10%	yes	86.8
Upper Willow Lake	134.1	0.0000	0.0001	0.741	0.00%	0.0015	<10%	yes	134.1
Ned Wilson Lake	39.0	0.0000	0.0000	1.158	0.00%	0.0001	<10%	yes	39.0
Upper Ned Wilson Lake	12.9	0.0000	0.0000	1.158	0.00%	0.0001	<1(µeq/L)	yes	12.9
Lower NWL Packtrail Pothole	29.7	0.0000	0.0000	1.158	0.00%	0.0001	<10%	yes	29.6
Upper NWL Packtrail Pothole	48.7	0.0000	0.0000	1.158	0.00%	0.0001	<10%	yes	48.7
Walk Up Lake	55.2	0.0000	0.0000	0.878	0.00%	0.0000	<10%	yes	55.2
Bluebell Lake	55.5	0.0000	0.0000	0.883	0.00%	0.0000	<10%	yes	55.5
Dean Lake	48.9	0.0000	0.0000	1.061	0.00%	0.0000	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0000	0.0000	0.844	0.00%	0.0000	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0000	0.0000	0.960	0.00%	0.0000	<10%	yes	64.8
Fish Lake	105.8	0.0000	0.0000	0.869	0.00%	0.0000	<10%	yes	105.8
Blodgett Lake, Colorado	47.7	0.0000	0.0000	0.928	0.00%	0.0003	<10%	yes	47.7
Upper Turquoise Lake	104.0	0.0000	0.0000	0.809	0.00%	0.0005	<10%	yes	104.0
Upper West Tennessee Lake	114.2	0.0000	0.0000	0.904	0.00%	0.0006	<10%	yes	114.2
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0000	0.0003	1.128	0.02%	0.0032	<1(µeq/L)	yes	19.2
Crater Lake	53.1	0.0000	0.0003	1.071	0.01%	0.0027	<10%	yes	53.1
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0000	0.0004	0.959	0.01%	0.0042	<10%	yes	52.3
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0000	0.0005	1.126	0.02%	0.0044	<10%	yes	25.6
Upper Lake	69.0	0.0000	0.0003	1.139	0.00%	0.0024	<10%	yes	69.0
Small Lake Above U-Shaped Lake	59.9	0.0000	0.0000	0.927	0.00%	0.0004	<10%	yes	59.9
U-Shaped Lake	81.4	0.0000	0.0000	0.927	0.00%	0.0004	<10%	yes	81.4
Avalanche Lake	158.8	0.0000	0.0000	1.282	0.00%	0.0001	<10%	yes	158.8
Capitol Lake	154.4	0.0000	0.0000	1.110	0.00%	0.0002	<10%	yes	154.4
Moon Lake (Upper)	53.0	0.0000	0.0000	1.110	0.00%	0.0002	<10%	yes	53.0
Upper Middle Beartrack Lake	50.9	0.0000	0.0005	0.869	0.01%	0.0064	<10%	yes	50.9
Abyss Lake	81.1	0.0000	0.0004	0.896	0.01%	0.0044	<10%	yes	81.1
Frozen Lake	93.3	0.0000	0.0004	0.896	0.00%	0.0044	<10%	yes	93.3
North Lake	80.9	0.0000	0.0004	0.896	0.01%	0.0044	<10%	yes	80.9
South Lake	66.7	0.0000	0.0004	0.896	0.01%	0.0044	<10%	yes	66.7
Lake Elbert	56.6	0.0000	0.0000	1.726	0.00%	0.0002	<10%	yes	56.6
Seven Lakes (LG East)	36.2	0.0000	0.0000	1.546	0.00%	0.0002	<10%	yes	36.2
Summit Lake	48.0	0.0000	0.0000	1.449	0.00%	0.0002	<10%	yes	48.0
Deep Creek Lake	20.6	0.0000	0.0000	0.887	0.00%	0.0002	<1(µeq/L)	yes	20.6
Island Lake	71.0	0.0000	0.0001	1.079	0.00%	0.0012	<10%	yes	71.0
Kelly Lake	179.9	0.0000	0.0001	1.079	0.00%	0.0012	<10%	yes	179.8
Rawah Lake #4	41.3	0.0000	0.0002	1.098	0.00%	0.0015	<10%	yes	41.3
Crater Lake (Sangre de Cristo)	162.9	0.0000	0.0002	0.959	0.00%	0.0024	<10%	yes	162.9
Lower Stout Lake	145.2	0.0000	0.0003	0.671	0.00%	0.0042	<10%	yes	145.2
Upper Little Sand Creek Lake	129.5	0.0000	0.0002	1.064	0.00%	0.0025	<10%	yes	129.5
Upper Stout Lake	76.3	0.0000	0.0003	0.671	0.01%	0.0042	<10%	yes	76.3
Glacier Lake (Colorado)	63.4	0.0000	0.0001	1.145	0.00%	0.0005	<10%	yes	63.4
Lake South of Blue Lakes	16.9	0.0000	0.0001	1.312	0.00%	0.0005	<1(µeq/L)	yes	16.9
Big Eldorado Lake	19.6	0.0000	0.0000	1.128	0.00%	0.0001	<1(µeq/L)	yes	19.6
Four Mile Pothole	123.4	0.0000	0.0000	1.173	0.00%	0.0003	<10%	yes	123.4
Lake Due South of Ute Lake	13.2	0.0000	0.0000	1.067	0.00%	0.0001	<1(µeq/L)	yes	13.2
Little Eldorado	-3.3	0.0000	0.0000	1.128	0.00%	0.0001	<1(µeq/L)	yes	-3.3
Little Granite Lake	80.7	0.0000	0.0000	0.830	0.00%	0.0003	<10%	yes	80.7
Lower Sunlight Lake	80.9	0.0000	0.0000	1.177	0.00%	0.0001	<10%	yes	80.9
Middle Ute Lake	42.8	0.0000	0.0000	1.052	0.00%	0.0001	<10%	yes	42.8
Small Pond Above Trout Lake	25.5	0.0000	0.0000	1.087	0.00%	0.0003	<10%	yes	25.5
Upper Grizzly Lake	29.9	0.0000	0.0000	1.177	0.00%	0.0001	<10%	yes	29.9
Upper Sunlight Lake	28.0	0.0000	0.0000	1.177	0.00%	0.0001	<10%	yes	28.0
West Snowdon Lake	39.4	0.0000	0.0000	0.978	0.00%	0.0001	<10%	yes	39.3
White Dome Lake	2.1	0.0000	0.0000	1.128	0.01%	0.0001	<1(µeq/L)	yes	2.1
South Golden Lake	111.4	0.0000	0.0000	0.984	0.00%	0.0002	<10%	yes	111.4

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

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5.5.2 ANC Calculations for Combined BLM Planning Areas

The Attachment E-1, E-2 and E-3 spreadsheets also contain ANC calculations for the combined BLM Planning Area Source Groups Q through T of new emission sources. Below we provide results for Source Group R (new Federal O&G and mining within 13 CO BLM Planning Areas) and the Cumulative Emissions Scenario (Source Group T) that also adds new O&G and O&G emissions from the Mancos Shale development in northern New Mexico.

Table 5-36 displays the ANC results at the 58 sensitive lakes for the combined new Federal O&G and mining within the 13 Colorado BLM Planning Areas (Source Group R) and the 2021 High, Low and Medium Development Scenarios. For the lakes that have base ANC values > 25 μeq/l the maximum percent change in ANC is always below the USFS LAC 10% threshold for all three 2021 emission scenarios. However, for the 8 lakes with base ANC < 25 μeq/l, three have changes in ANC greater than the 1 μeq/l USFS LAC threshold for the 2021 High Development Scenario (Table 5-36a): Upper Ned Wilson Lake (1.61 μeq/l); Blue Lake (1.11 μeq/l) and Deep Creek Lake (1.47 μeq/l). The mitigation in the 2021 Medium Development scenario is sufficient to reduce the change in ANC value at Blue Lake (0.94 μeq/l) to below the 1 μeq/l LAC threshold, but the change in ANC values at Upper Ned Wilson (1.36 μeq/l) and Deep Creek (1.21 μeq/l) lakes remain above the LAC threshold. For these same three lakes the change in ANC values are below the 1 μeq/l USFS LAC threshold for the 2021 Low Development Scenario (0.3887, 0.2611 and 0.3577 μeq/l).

The ANC results for the Cumulative Emissions Scenario (Source Group T) and the 2021 High and Low Emissions Scenario are shown in Table 5-37. Since this Source Group contains Source Group R then the same three sensitive lakes with ANC < 25 μeq/l have changes in ANC greater than the 1 μeq/l USFS LAC threshold for the 2021 High Development Scenario (Table 5-37a): Upper Ned Wilson Lake (2.7137 μeq/l); Blue Lake (2.4663 μeq/l) and Deep Creek Lake (2.6909 μeq/l). However, in addition there is one sensitive lake with base ANC > 25 μeq/l whose change in ANC exceeds the USFS 10% LAC threshold for the 2021 High Development Scenario and Source Group T: No Name Lake (10.50%). The mitigation in the 2021 Medium Development Scenario is sufficient to reduce the change in ANC at No Name Lake (9.67%) to below the 10% LAC threshold but not to reduce it at the other three lakes with base ANC < 25 μeq/l to below the 1 μeq/l LAC threshold (Table 5-37c). For the 2021 Low Development Scenario and Source Group T, all sensitive lakes have change in ANC below the LAC thresholds (Table 5-37b).

Note that the USFS ANC LAC thresholds were developed for evaluating potential lake acidification for individual Projects, not for quasi-cumulative emission source groups of new O&G development across an entire state as in Source Groups R and T. In addition, the USFS ANC LAC thresholds were developed for evaluating potential lake acidification for individual Projects (i.e. new emissions since baseline lake chemistry data was monitored), not for cumulative emissions scenarios that include all existing O&G since the baseline ANC values that are used in the ANC calculations would already account for impacts from existing emissions sources.

Table 5-36a. ANC calculations at sensitive lakes for new Federal oil and gas development and mining within the 13 Colorado BLM Planning Areas (Source Group R) and 2021 High Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0061	0.0783	0.898	0.98%	0.9924	<10%	yes	100.7
Tabor Lake	112.4	0.0060	0.0808	0.860	0.95%	1.0663	<10%	yes	111.3
Booth Lake	86.8	0.0076	0.1114	0.844	1.72%	1.4898	<10%	yes	85.3
Upper Willow Lake	134.1	0.0062	0.0783	0.741	0.90%	1.2051	<10%	yes	132.9
Ned Wilson Lake	39.0	0.0195	0.1577	1.158	4.13%	1.6089	<10%	yes	37.4
Upper Ned Wilson Lake	12.9	0.0195	0.1577	1.158	12.49%	1.6089	<1(μeq/L)	no	11.3
Lower NWL Packtrail Pothole	29.7	0.0195	0.1577	1.158	5.43%	1.6089	<10%	yes	28.0
Upper NWL Packtrail Pothole	48.7	0.0195	0.1577	1.158	3.30%	1.6089	<10%	yes	47.1
Walk Up Lake	55.2	0.0003	0.0035	0.878	0.08%	0.0453	<10%	yes	55.2
Bluebell Lake	55.5	0.0001	0.0020	0.883	0.05%	0.0259	<10%	yes	55.5
Dean Lake	48.9	0.0001	0.0018	1.061	0.04%	0.0188	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0003	0.0043	0.844	0.09%	0.0580	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0002	0.0024	0.960	0.04%	0.0284	<10%	yes	64.8
Fish Lake	105.8	0.0003	0.0034	0.869	0.04%	0.0443	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0081	0.1146	0.928	2.93%	1.3978	<10%	yes	46.3
Upper Turquoise Lake	104.0	0.0094	0.1221	0.809	1.65%	1.7194	<10%	yes	102.3
Upper West Tennessee Lake	114.2	0.0059	0.0912	0.904	0.99%	1.1363	<10%	yes	113.1
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0115	0.1069	1.128	5.75%	1.1064	<1(μeq/L)	no	18.1
Crater Lake	53.1	0.0122	0.0963	1.071	2.01%	1.0659	<10%	yes	52.1
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0120	0.1027	0.959	2.41%	1.2580	<10%	yes	51.0
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0124	0.1104	1.126	4.48%	1.1479	<10%	yes	24.5
Upper Lake	69.0	0.0128	0.1031	1.139	1.55%	1.0700	<10%	yes	67.9
Small Lake Above U-Shaped Lake	59.9	0.0018	0.0295	0.927	0.60%	0.3574	<10%	yes	59.5
U-Shaped Lake	81.4	0.0018	0.0295	0.927	0.44%	0.3574	<10%	yes	81.0
Avalanche Lake	158.8	0.0117	0.1349	1.282	0.76%	1.2069	<10%	yes	157.6
Capitol Lake	154.4	0.0116	0.1325	1.110	0.89%	1.3695	<10%	yes	153.0
Moon Lake (Upper)	53.0	0.0116	0.1325	1.110	2.58%	1.3695	<10%	yes	51.6
Upper Middle Beartrack Lake	50.9	0.0053	0.0593	0.869	1.54%	0.7841	<10%	yes	50.1
Abyss Lake	81.1	0.0050	0.0611	0.896	0.96%	0.7790	<10%	yes	80.3
Frozen Lake	93.3	0.0050	0.0611	0.896	0.84%	0.7790	<10%	yes	92.5
North Lake	80.9	0.0050	0.0611	0.896	0.96%	0.7790	<10%	yes	80.2
South Lake	66.7	0.0050	0.0611	0.896	1.17%	0.7790	<10%	yes	66.0
Lake Elbert	56.6	0.0290	0.1501	1.726	1.92%	1.0843	<10%	yes	55.5
Seven Lakes (LG East)	36.2	0.0205	0.1239	1.546	2.70%	0.9779	<10%	yes	35.3
Summit Lake	48.0	0.0323	0.1501	1.449	2.73%	1.3118	<10%	yes	46.7
Deep Creek Lake	20.6	0.0096	0.1135	0.887	7.11%	1.4652	<1(μeq/L)	no	19.1
Island Lake	71.0	0.0140	0.0931	1.079	1.47%	1.0406	<10%	yes	70.0
Kelly Lake	179.9	0.0140	0.0931	1.079	0.58%	1.0406	<10%	yes	178.8
Rawah Lake #4	41.3	0.0135	0.0951	1.098	2.51%	1.0384	<10%	yes	40.3
Crater Lake (Sangre de Cristo)	162.9	0.0025	0.0311	0.959	0.23%	0.3696	<10%	yes	162.6
Lower Stout Lake	145.2	0.0029	0.0388	0.671	0.45%	0.6568	<10%	yes	144.5
Upper Little Sand Creek Lake	129.5	0.0027	0.0311	1.064	0.26%	0.3347	<10%	yes	129.2
Upper Stout Lake	76.3	0.0029	0.0388	0.671	0.86%	0.6568	<10%	yes	75.7
Glacier Lake (Colorado)	63.4	0.0013	0.0186	1.145	0.29%	0.1835	<10%	yes	63.2
Lake South of Blue Lakes	16.9	0.0013	0.0236	1.312	1.19%	0.2011	<1(μeq/L)	yes	16.7
Big Eldorado Lake	19.6	0.0014	0.0246	1.128	1.24%	0.2442	<1(μeq/L)	yes	19.4
Four Mile Pothole	123.4	0.0015	0.0232	1.173	0.18%	0.2229	<10%	yes	123.2
Lake Due South of Ute Lake	13.2	0.0012	0.0206	1.067	1.65%	0.2170	<1(μeq/L)	yes	12.9
Little Eldorado	-3.3	0.0014	0.0246	1.128	7.40%	0.2442	<1(μeq/L)	yes	-3.5
Little Granite Lake	80.7	0.0011	0.0229	0.830	0.38%	0.3068	<10%	yes	80.4
Lower Sunlight Lake	80.9	0.0018	0.0267	1.177	0.32%	0.2561	<10%	yes	80.6
Middle Ute Lake	42.8	0.0012	0.0206	1.052	0.51%	0.2192	<10%	yes	42.6
Small Pond Above Trout Lake	25.5	0.0012	0.0231	1.087	0.93%	0.2369	<10%	yes	25.2
Upper Grizzly Lake	29.9	0.0020	0.0272	1.177	0.88%	0.2623	<10%	yes	29.6
Upper Sunlight Lake	28.0	0.0020	0.0272	1.177	0.94%	0.2623	<10%	yes	27.7
West Snowdon Lake	39.4	0.0010	0.0246	0.978	0.71%	0.2781	<10%	yes	39.1
White Dome Lake	2.1	0.0014	0.0246	1.128	11.85%	0.2442	<1(μeq/L)	yes	1.8
South Golden Lake	111.4	0.0045	0.0872	0.984	0.89%	0.9872	<10%	yes	110.4

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

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Table 5-36b. ANC calculations at sensitive lakes for new Federal oil and gas development and mining within the 13 Colorado BLM Planning Areas (Source Group R) and 2021 Low Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0033	0.0157	0.898	0.22%	0.2204	<10%	yes	101.5
Tabor Lake	112.4	0.0033	0.0161	0.860	0.21%	0.2353	<10%	yes	112.2
Booth Lake	86.8	0.0043	0.0223	0.844	0.38%	0.3290	<10%	yes	86.5
Upper Willow Lake	134.1	0.0037	0.0157	0.741	0.20%	0.2731	<10%	yes	133.8
Ned Wilson Lake	39.0	0.0113	0.0323	1.158	1.00%	0.3887	<10%	yes	38.6
Upper Ned Wilson Lake	12.9	0.0113	0.0323	1.158	3.02%	0.3887	<1(μeq/L)	yes	12.5
Lower NWL Packtrail Pothole	29.7	0.0113	0.0323	1.158	1.31%	0.3887	<10%	yes	29.3
Upper NWL Packtrail Pothole	48.7	0.0113	0.0323	1.158	0.80%	0.3887	<10%	yes	48.3
Walk Up Lake	55.2	0.0001	0.0007	0.878	0.02%	0.0091	<10%	yes	55.2
Bluebell Lake	55.5	0.0000	0.0004	0.883	0.01%	0.0052	<10%	yes	55.5
Dean Lake	48.9	0.0000	0.0003	1.061	0.01%	0.0037	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0001	0.0008	0.844	0.02%	0.0113	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0001	0.0005	0.960	0.01%	0.0058	<10%	yes	64.8
Fish Lake	105.8	0.0001	0.0006	0.869	0.01%	0.0090	<10%	yes	105.8
Blodgett Lake, Colorado	47.7	0.0045	0.0223	0.928	0.63%	0.3009	<10%	yes	47.4
Upper Turquoise Lake	104.0	0.0053	0.0244	0.809	0.37%	0.3831	<10%	yes	103.6
Upper West Tennessee Lake	114.2	0.0033	0.0175	0.904	0.21%	0.2404	<10%	yes	114.0
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0078	0.0208	1.128	1.36%	0.2611	<1(μeq/L)	yes	19.0
Crater Lake	53.1	0.0086	0.0188	1.071	0.49%	0.2626	<10%	yes	52.9
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0084	0.0202	0.959	0.59%	0.3066	<10%	yes	52.0
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0085	0.0216	1.126	1.07%	0.2746	<10%	yes	25.3
Upper Lake	69.0	0.0084	0.0200	1.139	0.37%	0.2562	<10%	yes	68.7
Small Lake Above U-Shaped Lake	59.9	0.0009	0.0056	0.927	0.12%	0.0743	<10%	yes	59.8
U-Shaped Lake	81.4	0.0009	0.0056	0.927	0.09%	0.0743	<10%	yes	81.3
Avalanche Lake	158.8	0.0074	0.0262	1.282	0.17%	0.2716	<10%	yes	158.5
Capitol Lake	154.4	0.0071	0.0258	1.110	0.20%	0.3079	<10%	yes	154.1
Moon Lake (Upper)	53.0	0.0071	0.0258	1.110	0.58%	0.3079	<10%	yes	52.7
Upper Middle Beartrack Lake	50.9	0.0031	0.0118	0.869	0.35%	0.1779	<10%	yes	50.7
Abyss Lake	81.1	0.0029	0.0121	0.896	0.22%	0.1744	<10%	yes	80.9
Frozen Lake	93.3	0.0029	0.0121	0.896	0.19%	0.1744	<10%	yes	93.1
North Lake	80.9	0.0029	0.0121	0.896	0.22%	0.1744	<10%	yes	80.8
South Lake	66.7	0.0029	0.0121	0.896	0.26%	0.1744	<10%	yes	66.6
Lake Elbert	56.6	0.0212	0.0320	1.726	0.55%	0.3124	<10%	yes	56.3
Seven Lakes (LG East)	36.2	0.0135	0.0250	1.546	0.70%	0.2535	<10%	yes	36.0
Summit Lake	48.0	0.0250	0.0329	1.449	0.84%	0.4029	<10%	yes	47.6
Deep Creek Lake	20.6	0.0066	0.0240	0.887	1.74%	0.3577	<1(μeq/L)	yes	20.2
Island Lake	71.0	0.0094	0.0191	1.079	0.38%	0.2698	<10%	yes	70.8
Kelly Lake	179.9	0.0094	0.0191	1.079	0.15%	0.2698	<10%	yes	179.6
Rawah Lake #4	41.3	0.0090	0.0194	1.098	0.64%	0.2653	<10%	yes	41.0
Crater Lake (Sangre de Cristo)	162.9	0.0013	0.0063	0.959	0.05%	0.0825	<10%	yes	162.8
Lower Stout Lake	145.2	0.0015	0.0077	0.671	0.10%	0.1427	<10%	yes	145.1
Upper Little Sand Creek Lake	129.5	0.0014	0.0067	1.064	0.06%	0.0794	<10%	yes	129.4
Upper Stout Lake	76.3	0.0015	0.0077	0.671	0.19%	0.1427	<10%	yes	76.2
Glacier Lake (Colorado)	63.4	0.0006	0.0034	1.145	0.06%	0.0368	<10%	yes	63.4
Lake South of Blue Lakes	16.9	0.0006	0.0041	1.312	0.22%	0.0379	<1(μeq/L)	yes	16.9
Big Eldorado Lake	19.6	0.0006	0.0045	1.128	0.24%	0.0479	<1(μeq/L)	yes	19.6
Four Mile Pothole	123.4	0.0007	0.0043	1.173	0.04%	0.0446	<10%	yes	123.3
Lake Due South of Ute Lake	13.2	0.0006	0.0039	1.067	0.33%	0.0435	<1(μeq/L)	yes	13.1
Little Eldorado	-3.3	0.0006	0.0045	1.128	1.45%	0.0479	<1(μeq/L)	yes	-3.3
Little Granite Lake	80.7	0.0005	0.0043	0.830	0.07%	0.0601	<10%	yes	80.7
Lower Sunlight Lake	80.9	0.0008	0.0049	1.177	0.06%	0.0510	<10%	yes	80.8
Middle Ute Lake	42.8	0.0005	0.0038	1.052	0.10%	0.0435	<10%	yes	42.7
Small Pond Above Trout Lake	25.5	0.0006	0.0043	1.087	0.18%	0.0469	<10%	yes	25.4
Upper Grizzly Lake	29.9	0.0010	0.0050	1.177	0.18%	0.0533	<10%	yes	29.8
Upper Sunlight Lake	28.0	0.0010	0.0050	1.177	0.19%	0.0533	<10%	yes	27.9
West Snowdon Lake	39.4	0.0004	0.0044	0.978	0.13%	0.0519	<10%	yes	39.3
White Dome Lake	2.1	0.0006	0.0045	1.128	2.33%	0.0479	<1(μeq/L)	yes	2.0
South Golden Lake	111.4	0.0028	0.0170	0.984	0.19%	0.2100	<10%	yes	111.2

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

Table 5-36c. ANC calculations at sensitive lakes for new Federal oil and gas development and mining within the 13 Colorado BLM Planning Areas (Source Group R) and 2021 Medium Development Scenario.

Lake	10th Percentile Lowest ANC Value (µeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (µeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Med Predicted 10th Percentile Lowest ANC Value (µeq/L)
Brooklyn Lake	101.7	0.0060	0.0641	0.898	0.81%	0.8229	<10%	yes	100.9
Tabor Lake	112.4	0.0059	0.0661	0.860	0.79%	0.8827	<10%	yes	111.5
Booth Lake	86.8	0.0074	0.0913	0.844	1.42%	1.2346	<10%	yes	85.5
Upper Willow Lake	134.1	0.0061	0.0645	0.741	0.75%	1.0042	<10%	yes	133.1
Ned Wilson Lake	39.0	0.0193	0.1306	1.158	3.48%	1.3575	<10%	yes	37.6
Upper Ned Wilson Lake	12.9	0.0193	0.1306	1.158	10.54%	1.3575	<1(µeq/L)	no	11.5
Lower NWL Packtrail Pothole	29.7	0.0193	0.1306	1.158	4.58%	1.3575	<10%	yes	28.3
Upper NWL Packtrail Pothole	48.7	0.0193	0.1306	1.158	2.79%	1.3575	<10%	yes	47.3
Walk Up Lake	55.2	0.0003	0.0032	0.878	0.08%	0.0420	<10%	yes	55.2
Bluebell Lake	55.5	0.0001	0.0019	0.883	0.04%	0.0239	<10%	yes	55.5
Dean Lake	48.9	0.0001	0.0016	1.061	0.04%	0.0173	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0003	0.0040	0.844	0.08%	0.0543	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0002	0.0022	0.960	0.04%	0.0263	<10%	yes	64.8
Fish Lake	105.8	0.0002	0.0031	0.869	0.04%	0.0411	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0079	0.0939	0.928	2.43%	1.1578	<10%	yes	46.5
Upper Turquoise Lake	104.0	0.0092	0.1000	0.809	1.37%	1.4249	<10%	yes	102.6
Upper West Tennessee Lake	114.2	0.0057	0.0746	0.904	0.82%	0.9392	<10%	yes	113.3
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0114	0.0898	1.128	4.90%	0.9429	<1(µeq/L)	yes	18.3
Crater Lake	53.1	0.0121	0.0811	1.071	1.72%	0.9128	<10%	yes	52.2
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0118	0.0865	0.959	2.06%	1.0769	<10%	yes	51.2
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0123	0.0928	1.126	3.83%	0.9801	<10%	yes	24.6
Upper Lake	69.0	0.0126	0.0869	1.139	1.33%	0.9175	<10%	yes	68.1
Small Lake Above U-Shaped Lake	59.9	0.0017	0.0250	0.927	0.51%	0.3049	<10%	yes	59.6
U-Shaped Lake	81.4	0.0017	0.0250	0.927	0.37%	0.3049	<10%	yes	81.1
Avalanche Lake	158.8	0.0114	0.1105	1.282	0.63%	1.0020	<10%	yes	157.8
Capitol Lake	154.4	0.0113	0.1087	1.110	0.74%	1.1389	<10%	yes	153.3
Moon Lake (Upper)	53.0	0.0113	0.1087	1.110	2.15%	1.1389	<10%	yes	51.8
Upper Middle Beartrack Lake	50.9	0.0052	0.0492	0.869	1.30%	0.6592	<10%	yes	50.2
Abyss Lake	81.1	0.0049	0.0507	0.896	0.81%	0.6542	<10%	yes	80.4
Frozen Lake	93.3	0.0049	0.0507	0.896	0.70%	0.6542	<10%	yes	92.6
North Lake	80.9	0.0049	0.0507	0.896	0.81%	0.6542	<10%	yes	80.3
South Lake	66.7	0.0049	0.0507	0.896	0.98%	0.6542	<10%	yes	66.1
Lake Elbert	56.6	0.0288	0.1301	1.726	1.70%	0.9594	<10%	yes	55.6
Seven Lakes (LG East)	36.2	0.0203	0.1071	1.546	2.38%	0.8618	<10%	yes	35.4
Summit Lake	48.0	0.0321	0.1301	1.449	2.42%	1.1640	<10%	yes	46.8
Deep Creek Lake	20.6	0.0094	0.0927	0.887	5.89%	1.2130	<1(µeq/L)	no	19.4
Island Lake	71.0	0.0138	0.0792	1.079	1.27%	0.9025	<10%	yes	70.1
Kelly Lake	179.9	0.0138	0.0792	1.079	0.50%	0.9025	<10%	yes	178.9
Rawah Lake #4	41.3	0.0134	0.0808	1.098	2.18%	0.8984	<10%	yes	40.4
Crater Lake (Sangre de Cristo)	162.9	0.0024	0.0258	0.959	0.19%	0.3108	<10%	yes	162.6
Lower Stout Lake	145.2	0.0028	0.0324	0.671	0.38%	0.5539	<10%	yes	144.6
Upper Little Sand Creek Lake	129.5	0.0026	0.0258	1.064	0.22%	0.2813	<10%	yes	129.2
Upper Stout Lake	76.3	0.0028	0.0324	0.671	0.73%	0.5539	<10%	yes	75.8
Glacier Lake (Colorado)	63.4	0.0013	0.0158	1.145	0.25%	0.1572	<10%	yes	63.2
Lake South of Blue Lakes	16.9	0.0013	0.0200	1.312	1.02%	0.1717	<1(µeq/L)	yes	16.7
Big Eldorado Lake	19.6	0.0014	0.0211	1.128	1.08%	0.2113	<1(µeq/L)	yes	19.4
Four Mile Pothole	123.4	0.0015	0.0198	1.173	0.16%	0.1916	<10%	yes	123.2
Lake Due South of Ute Lake	13.2	0.0012	0.0178	1.067	1.43%	0.1881	<1(µeq/L)	yes	13.0
Little Eldorado	-3.3	0.0014	0.0211	1.128	6.40%	0.2113	<1(µeq/L)	yes	-3.5
Little Granite Lake	80.7	0.0011	0.0196	0.830	0.33%	0.2645	<10%	yes	80.5
Lower Sunlight Lake	80.9	0.0018	0.0230	1.177	0.27%	0.2220	<10%	yes	80.6
Middle Ute Lake	42.8	0.0012	0.0177	1.052	0.44%	0.1900	<10%	yes	42.6
Small Pond Above Trout Lake	25.5	0.0012	0.0197	1.087	0.80%	0.2038	<10%	yes	25.3
Upper Grizzly Lake	29.9	0.0020	0.0234	1.177	0.76%	0.2277	<10%	yes	29.7
Upper Sunlight Lake	28.0	0.0020	0.0234	1.177	0.81%	0.2277	<10%	yes	27.8
West Snowdon Lake	39.4	0.0010	0.0212	0.978	0.61%	0.2404	<10%	yes	39.1
White Dome Lake	2.1	0.0014	0.0211	1.128	10.26%	0.2113	<1(µeq/L)	yes	1.8
South Golden Lake	111.4	0.0044	0.0719	0.984	0.74%	0.8204	<10%	yes	110.6

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Table 5-37a. ANC calculations at sensitive lakes for new Federal oil and gas development and mining and new non-Federal oil and gas within the 14 Colorado and northern New Mexico BLM Planning Areas (Source Group T) and the 2021 High Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0073	0.1527	0.898	1.86%	1.8877	<10%	yes	99.8
Tabor Lake	112.4	0.0071	0.1557	0.860	1.79%	2.0080	<10%	yes	110.4
Booth Lake	86.8	0.0090	0.2179	0.844	3.29%	2.8510	<10%	yes	83.9
Upper Willow Lake	134.1	0.0072	0.1589	0.741	1.77%	2.3766	<10%	yes	131.7
Ned Wilson Lake	39.0	0.0220	0.2756	1.158	6.96%	2.7137	<10%	yes	36.3
Upper Ned Wilson Lake	12.9	0.0220	0.2756	1.158	21.07%	2.7137	<1(μeq/L)	no	10.2
Lower NWL Packtrail Pothole	29.7	0.0220	0.2756	1.158	9.15%	2.7137	<10%	yes	26.9
Upper NWL Packtrail Pothole	48.7	0.0220	0.2756	1.158	5.57%	2.7137	<10%	yes	46.0
Walk Up Lake	55.2	0.0003	0.0061	0.878	0.14%	0.0780	<10%	yes	55.1
Bluebell Lake	55.5	0.0002	0.0039	0.883	0.09%	0.0484	<10%	yes	55.5
Dean Lake	48.9	0.0001	0.0034	1.061	0.07%	0.0347	<10%	yes	48.8
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0004	0.0075	0.844	0.15%	0.0989	<10%	yes	66.9
Upper Coffin Lake	64.9	0.0002	0.0044	0.960	0.08%	0.0503	<10%	yes	64.8
Fish Lake	105.8	0.0003	0.0059	0.869	0.07%	0.0758	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0097	0.2231	0.928	5.58%	2.6596	<10%	yes	45.0
Upper Turquoise Lake	104.0	0.0112	0.2361	0.809	3.12%	3.2422	<10%	yes	100.8
Upper West Tennessee Lake	114.2	0.0070	0.1798	0.904	1.92%	2.1922	<10%	yes	112.0
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0134	0.2491	1.128	12.81%	2.4663	<1(μeq/L)	no	16.8
Crater Lake	53.1	0.0139	0.2157	1.071	4.27%	2.2690	<10%	yes	50.9
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0136	0.2374	0.959	5.31%	2.7724	<10%	yes	49.5
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0148	0.2713	1.126	10.50%	2.6909	<10%	no	22.9
Upper Lake	69.0	0.0147	0.2274	1.139	3.26%	2.2504	<10%	yes	66.7
Small Lake Above U-Shaped Lake	59.9	0.0023	0.0717	0.927	1.41%	0.8472	<10%	yes	59.1
U-Shaped Lake	81.4	0.0023	0.0717	0.927	1.04%	0.8472	<10%	yes	80.5
Avalanche Lake	158.8	0.0138	0.2629	1.282	1.44%	2.2877	<10%	yes	156.5
Capitol Lake	154.4	0.0139	0.2581	1.110	1.68%	2.5949	<10%	yes	151.8
Moon Lake (Upper)	53.0	0.0139	0.2581	1.110	4.90%	2.5949	<10%	yes	50.4
Upper Middle Beartrack Lake	50.9	0.0070	0.1670	0.869	4.17%	2.1247	<10%	yes	48.8
Abyss Lake	81.1	0.0063	0.1566	0.896	2.38%	1.9289	<10%	yes	79.2
Frozen Lake	93.3	0.0063	0.1566	0.896	2.07%	1.9289	<10%	yes	91.3
North Lake	80.9	0.0063	0.1566	0.896	2.38%	1.9289	<10%	yes	79.0
South Lake	66.7	0.0063	0.1566	0.896	2.89%	1.9289	<10%	yes	64.8
Lake Elbert	56.6	0.0314	0.2514	1.726	3.04%	1.7227	<10%	yes	54.9
Seven Lakes (LG East)	36.2	0.0224	0.2067	1.546	4.31%	1.5610	<10%	yes	34.7
Summit Lake	48.0	0.0345	0.2513	1.449	4.31%	2.0711	<10%	yes	45.9
Deep Creek Lake	20.6	0.0111	0.2214	0.887	13.48%	2.7769	<1(μeq/L)	no	17.8
Island Lake	71.0	0.0155	0.1711	1.079	2.57%	1.8257	<10%	yes	69.2
Kelly Lake	179.9	0.0155	0.1711	1.079	1.02%	1.8257	<10%	yes	178.0
Rawah Lake #4	41.3	0.0151	0.1772	1.098	4.48%	1.8487	<10%	yes	39.4
Crater Lake (Sangre de Cristo)	162.9	0.0034	0.0932	0.959	0.66%	1.0691	<10%	yes	161.9
Lower Stout Lake	145.2	0.0038	0.1045	0.671	1.18%	1.7122	<10%	yes	143.5
Upper Little Sand Creek Lake	129.5	0.0035	0.0905	1.064	0.72%	0.9369	<10%	yes	128.6
Upper Stout Lake	76.3	0.0038	0.1045	0.671	2.24%	1.7122	<10%	yes	74.6
Glacier Lake (Colorado)	63.4	0.0023	0.0741	1.145	1.12%	0.7081	<10%	yes	62.7
Lake South of Blue Lakes	16.9	0.0025	0.0965	1.312	4.74%	0.8013	<1(μeq/L)	yes	16.1
Big Eldorado Lake	19.6	0.0021	0.0637	1.128	3.15%	0.6190	<1(μeq/L)	yes	19.0
Four Mile Pothole	123.4	0.0029	0.0926	1.173	0.70%	0.8647	<10%	yes	122.5
Lake Due South of Ute Lake	13.2	0.0020	0.0617	1.067	4.82%	0.6346	<1(μeq/L)	yes	12.5
Little Eldorado	-3.3	0.0021	0.0637	1.128	18.76%	0.6190	<1(μeq/L)	yes	-3.9
Little Granite Lake	80.7	0.0019	0.0729	0.830	1.19%	0.9583	<10%	yes	79.8
Lower Sunlight Lake	80.9	0.0027	0.0734	1.177	0.85%	0.6867	<10%	yes	80.2
Middle Ute Lake	42.8	0.0019	0.0589	1.052	1.43%	0.6132	<10%	yes	42.2
Small Pond Above Trout Lake	25.5	0.0021	0.0746	1.087	2.94%	0.7494	<10%	yes	24.7
Upper Grizzly Lake	29.9	0.0031	0.0766	1.177	2.40%	0.7182	<10%	yes	29.2
Upper Sunlight Lake	28.0	0.0031	0.0766	1.177	2.57%	0.7182	<10%	yes	27.3
West Snowdon Lake	39.4	0.0015	0.0616	0.978	1.74%	0.6863	<10%	yes	38.7
White Dome Lake	2.1	0.0021	0.0637	1.128	30.05%	0.6190	<1(μeq/L)	yes	1.4
South Golden Lake	111.4	0.0053	0.1712	0.984	1.71%	1.9060	<10%	yes	109.5

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

Table 5-37b. ANC calculations at sensitive lakes for new Federal oil and gas development and mining and new non-Federal oil and gas within the 14 Colorado and northern New Mexico BLM Planning Areas (Source Group T) and the 2021 Low Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Hi Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0039	0.0528	0.898	0.66%	0.6663	<10%	yes	101.0
Tabor Lake	112.4	0.0038	0.0529	0.860	0.62%	0.6973	<10%	yes	111.7
Booth Lake	86.8	0.0050	0.0745	0.844	1.15%	0.9959	<10%	yes	85.8
Upper Willow Lake	134.1	0.0042	0.0544	0.741	0.62%	0.8349	<10%	yes	133.3
Ned Wilson Lake	39.0	0.0123	0.0913	1.158	2.41%	0.9397	<10%	yes	38.1
Upper Ned Wilson Lake	12.9	0.0123	0.0913	1.158	7.30%	0.9397	<1(μeq/L)	yes	11.9
Lower NWL Packtrail Pothole	29.7	0.0123	0.0913	1.158	3.17%	0.9397	<10%	yes	28.7
Upper NWL Packtrail Pothole	48.7	0.0123	0.0913	1.158	1.93%	0.9397	<10%	yes	47.8
Walk Up Lake	55.2	0.0001	0.0023	0.878	0.05%	0.0293	<10%	yes	55.2
Bluebell Lake	55.5	0.0001	0.0016	0.883	0.04%	0.0203	<10%	yes	55.5
Dean Lake	48.9	0.0000	0.0013	1.061	0.03%	0.0139	<10%	yes	48.9
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0001	0.0029	0.844	0.06%	0.0383	<10%	yes	67.0
Upper Coffin Lake	64.9	0.0001	0.0017	0.960	0.03%	0.0197	<10%	yes	64.8
Fish Lake	105.8	0.0001	0.0022	0.869	0.03%	0.0283	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0052	0.0757	0.928	1.93%	0.9220	<10%	yes	46.7
Upper Turquoise Lake	104.0	0.0061	0.0804	0.809	1.09%	1.1299	<10%	yes	102.9
Upper West Tennessee Lake	114.2	0.0038	0.0606	0.904	0.66%	0.7537	<10%	yes	113.4
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0086	0.0832	1.128	4.45%	0.8574	<1(μeq/L)	yes	18.4
Crater Lake	53.1	0.0093	0.0713	1.071	1.49%	0.7904	<10%	yes	52.3
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0091	0.0791	0.959	1.85%	0.9676	<10%	yes	51.3
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0095	0.0922	1.126	3.71%	0.9507	<10%	yes	24.7
Upper Lake	69.0	0.0092	0.0751	1.139	1.13%	0.7789	<10%	yes	68.2
Small Lake Above U-Shaped Lake	59.9	0.0013	0.0341	0.927	0.68%	0.4050	<10%	yes	59.5
U-Shaped Lake	81.4	0.0013	0.0341	0.927	0.50%	0.4050	<10%	yes	81.0
Avalanche Lake	158.8	0.0083	0.0864	1.282	0.49%	0.7788	<10%	yes	158.0
Capitol Lake	154.4	0.0081	0.0855	1.110	0.58%	0.8892	<10%	yes	153.5
Moon Lake (Upper)	53.0	0.0081	0.0855	1.110	1.68%	0.8892	<10%	yes	52.1
Upper Middle Beartrack Lake	50.9	0.0038	0.0610	0.869	1.55%	0.7890	<10%	yes	50.1
Abyss Lake	81.1	0.0035	0.0561	0.896	0.87%	0.7037	<10%	yes	80.4
Frozen Lake	93.3	0.0035	0.0561	0.896	0.75%	0.7037	<10%	yes	92.6
North Lake	80.9	0.0035	0.0561	0.896	0.87%	0.7037	<10%	yes	80.2
South Lake	66.7	0.0035	0.0561	0.896	1.05%	0.7037	<10%	yes	66.0
Lake Elbert	56.6	0.0221	0.0776	1.726	1.06%	0.5989	<10%	yes	56.0
Seven Lakes (LG East)	36.2	0.0142	0.0627	1.546	1.43%	0.5180	<10%	yes	35.7
Summit Lake	48.0	0.0258	0.0770	1.449	1.53%	0.7325	<10%	yes	47.3
Deep Creek Lake	20.6	0.0072	0.0713	0.887	4.53%	0.9324	<1(μeq/L)	yes	19.7
Island Lake	71.0	0.0100	0.0541	1.079	0.87%	0.6214	<10%	yes	70.4
Kelly Lake	179.9	0.0100	0.0541	1.079	0.35%	0.6214	<10%	yes	179.2
Rawah Lake #4	41.3	0.0096	0.0563	1.098	1.52%	0.6284	<10%	yes	40.7
Crater Lake (Sangre de Cristo)	162.9	0.0019	0.0460	0.959	0.32%	0.5292	<10%	yes	162.4
Lower Stout Lake	145.2	0.0019	0.0459	0.671	0.52%	0.7565	<10%	yes	144.4
Upper Little Sand Creek Lake	129.5	0.0019	0.0437	1.064	0.35%	0.4542	<10%	yes	129.0
Upper Stout Lake	76.3	0.0019	0.0459	0.671	0.99%	0.7565	<10%	yes	75.6
Glacier Lake (Colorado)	63.4	0.0014	0.0524	1.145	0.79%	0.4991	<10%	yes	62.9
Lake South of Blue Lakes	16.9	0.0016	0.0695	1.312	3.41%	0.5762	<1(μeq/L)	yes	16.3
Big Eldorado Lake	19.6	0.0011	0.0348	1.128	1.72%	0.3385	<1(μeq/L)	yes	19.3
Four Mile Pothole	123.4	0.0019	0.0647	1.173	0.49%	0.6038	<10%	yes	122.8
Lake Due South of Ute Lake	13.2	0.0012	0.0375	1.067	2.93%	0.3854	<1(μeq/L)	yes	12.8
Little Eldorado	-3.3	0.0011	0.0348	1.128	10.26%	0.3385	<1(μeq/L)	yes	-3.6
Little Granite Lake	80.7	0.0012	0.0454	0.830	0.74%	0.5965	<10%	yes	80.1
Lower Sunlight Lake	80.9	0.0015	0.0424	1.177	0.49%	0.3963	<10%	yes	80.5
Middle Ute Lake	42.8	0.0010	0.0347	1.052	0.84%	0.3608	<10%	yes	42.4
Small Pond Above Trout Lake	25.5	0.0012	0.0465	1.087	1.83%	0.4667	<10%	yes	25.0
Upper Grizzly Lake	29.9	0.0018	0.0450	1.177	1.41%	0.4219	<10%	yes	29.5
Upper Sunlight Lake	28.0	0.0018	0.0450	1.177	1.51%	0.4219	<10%	yes	27.6
West Snowdon Lake	39.4	0.0007	0.0330	0.978	0.93%	0.3666	<10%	yes	39.0
White Dome Lake	2.1	0.0011	0.0348	1.128	16.43%	0.3385	<1(μeq/L)	yes	1.7
South Golden Lake	111.4	0.0031	0.0571	0.984	0.58%	0.6489	<10%	yes	110.8

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

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Table 5-37c. ANC calculations at sensitive lakes for new Federal oil and gas development and mining and new non-Federal oil and gas within the 14 Colorado and northern New Mexico BLM Planning Areas (Source Group T) and the 2021 Medium Development Scenario.

Lake	10th Percentile Lowest ANC Value (μeq/L)	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)*	Delta ANC (μeq/L)*	USFS LAC Threshold	Below Threshold?	2021 Med Predicted 10th Percentile Lowest ANC Value (μeq/L)
Brooklyn Lake	101.7	0.0071	0.1347	0.898	1.64%	1.6718	<10%	yes	100.0
Tabor Lake	112.4	0.0069	0.1372	0.860	1.58%	1.7763	<10%	yes	110.6
Booth Lake	86.8	0.0088	0.1928	0.844	2.92%	2.5307	<10%	yes	84.2
Upper Willow Lake	134.1	0.0070	0.1413	0.741	1.58%	2.1223	<10%	yes	132.0
Ned Wilson Lake	39.0	0.0217	0.2423	1.158	6.17%	2.4048	<10%	yes	36.6
Upper Ned Wilson Lake	12.9	0.0217	0.2423	1.158	18.67%	2.4048	<1(μeq/L)	no	10.5
Lower NWL Packtrail Pothole	29.7	0.0217	0.2423	1.158	8.11%	2.4048	<10%	yes	27.2
Upper NWL Packtrail Pothole	48.7	0.0217	0.2423	1.158	4.94%	2.4048	<10%	yes	46.3
Walk Up Lake	55.2	0.0003	0.0057	0.878	0.13%	0.0728	<10%	yes	55.2
Bluebell Lake	55.5	0.0001	0.0036	0.883	0.08%	0.0449	<10%	yes	55.5
Dean Lake	48.9	0.0001	0.0031	1.061	0.07%	0.0322	<10%	yes	48.8
No Name (Utah, Duchesne - 4D2-039)	67.0	0.0004	0.0070	0.844	0.14%	0.0924	<10%	yes	66.9
Upper Coffin Lake	64.9	0.0002	0.0041	0.960	0.07%	0.0469	<10%	yes	64.8
Fish Lake	105.8	0.0003	0.0055	0.869	0.07%	0.0708	<10%	yes	105.7
Blodgett Lake, Colorado	47.7	0.0094	0.1971	0.928	4.95%	2.3588	<10%	yes	45.3
Upper Turquoise Lake	104.0	0.0109	0.2084	0.809	2.76%	2.8736	<10%	yes	101.1
Upper West Tennessee Lake	114.2	0.0068	0.1588	0.904	1.70%	1.9433	<10%	yes	112.3
Blue Lake (Colorado; Boulder - 4E1-040)	19.3	0.0133	0.2273	1.128	11.73%	2.2589	<1(μeq/L)	no	17.0
Crater Lake	53.1	0.0137	0.1964	1.071	3.91%	2.0754	<10%	yes	51.1
King Lake (Colorado; Grand - 4E1-049)	52.3	0.0135	0.2170	0.959	4.87%	2.5434	<10%	yes	49.7
No Name Lake (Colorado; Boulder - 4E1-055)	25.6	0.0146	0.2490	1.126	9.67%	2.4781	<10%	yes	23.1
Upper Lake	69.0	0.0146	0.2069	1.139	2.98%	2.0569	<10%	yes	66.9
Small Lake Above U-Shaped Lake	59.9	0.0022	0.0636	0.927	1.26%	0.7533	<10%	yes	59.1
U-Shaped Lake	81.4	0.0022	0.0636	0.927	0.93%	0.7533	<10%	yes	80.6
Avalanche Lake	158.8	0.0135	0.2321	1.282	1.28%	2.0283	<10%	yes	156.8
Capitol Lake	154.4	0.0135	0.2281	1.110	1.49%	2.3031	<10%	yes	152.1
Moon Lake (Upper)	53.0	0.0135	0.2281	1.110	4.35%	2.3031	<10%	yes	50.7
Upper Middle Beartrack Lake	50.9	0.0068	0.1541	0.869	3.86%	1.9647	<10%	yes	48.9
Abyss Lake	81.1	0.0062	0.1432	0.896	2.18%	1.7692	<10%	yes	79.3
Frozen Lake	93.3	0.0062	0.1432	0.896	1.90%	1.7692	<10%	yes	91.5
North Lake	80.9	0.0062	0.1432	0.896	2.19%	1.7692	<10%	yes	79.2
South Lake	66.7	0.0062	0.1432	0.896	2.65%	1.7692	<10%	yes	65.0
Lake Elbert	56.6	0.0311	0.2264	1.726	2.77%	1.5664	<10%	yes	55.0
Seven Lakes (LG East)	36.2	0.0222	0.1859	1.546	3.91%	1.4167	<10%	yes	34.8
Summit Lake	48.0	0.0343	0.2262	1.449	3.93%	1.8847	<10%	yes	46.1
Deep Creek Lake	20.6	0.0109	0.1950	0.887	11.93%	2.4569	<1(μeq/L)	no	18.1
Island Lake	71.0	0.0153	0.1536	1.079	2.33%	1.6514	<10%	yes	69.4
Kelly Lake	179.9	0.0153	0.1536	1.079	0.92%	1.6514	<10%	yes	178.2
Rawah Lake #4	41.3	0.0149	0.1591	1.098	4.05%	1.6719	<10%	yes	39.6
Crater Lake (Sangre de Cristo)	162.9	0.0033	0.0837	0.959	0.59%	0.9634	<10%	yes	162.0
Lower Stout Lake	145.2	0.0037	0.0943	0.671	1.07%	1.5492	<10%	yes	143.7
Upper Little Sand Creek Lake	129.5	0.0034	0.0814	1.064	0.65%	0.8447	<10%	yes	128.7
Upper Stout Lake	76.3	0.0037	0.0943	0.671	2.03%	1.5492	<10%	yes	74.8
Glacier Lake (Colorado)	63.4	0.0021	0.0646	1.145	0.98%	0.6183	<10%	yes	62.8
Lake South of Blue Lakes	16.9	0.0023	0.0839	1.312	4.13%	0.6979	<1(μeq/L)	yes	16.2
Big Eldorado Lake	19.6	0.0020	0.0565	1.128	2.80%	0.5499	<1(μeq/L)	yes	19.1
Four Mile Pothole	123.4	0.0027	0.0802	1.173	0.61%	0.7502	<10%	yes	122.6
Lake Due South of Ute Lake	13.2	0.0019	0.0543	1.067	4.25%	0.5593	<1(μeq/L)	yes	12.6
Little Eldorado	-3.3	0.0020	0.0565	1.128	16.66%	0.5499	<1(μeq/L)	yes	-3.8
Little Granite Lake	80.7	0.0018	0.0639	0.830	1.04%	0.8408	<10%	yes	79.9
Lower Sunlight Lake	80.9	0.0026	0.0649	1.177	0.75%	0.6080	<10%	yes	80.3
Middle Ute Lake	42.8	0.0018	0.0519	1.052	1.27%	0.5419	<10%	yes	42.2
Small Pond Above Trout Lake	25.5	0.0020	0.0653	1.087	2.58%	0.6573	<10%	yes	24.8
Upper Grizzly Lake	29.9	0.0030	0.0675	1.177	2.13%	0.6352	<10%	yes	29.2
Upper Sunlight Lake	28.0	0.0030	0.0675	1.177	2.27%	0.6352	<10%	yes	27.4
West Snowdon Lake	39.4	0.0014	0.0548	0.978	1.55%	0.6107	<10%	yes	38.7
White Dome Lake	2.1	0.0020	0.0565	1.128	26.69%	0.5499	<1(μeq/L)	yes	1.5
South Golden Lake	111.4	0.0052	0.1515	0.984	1.52%	1.6909	<10%	yes	109.7

* USDA Forest Service methodology reports both Delta ANC calculations and LAC thresholds as positive quantities, however they reflect a decrease in lake ANC

5.6 2021 NAAQS Comparisons

In this section we compare the CAMx 2021 High. Low and Medium Development Scenario modeling results against the National Ambient Air Quality Standard (NAAQS). For the ozone NAAQS analysis, the results are analyzed using both the absolute CAMx 2021 modeling results as well as using the CAMx 2008 and 2021 modeling results in a relative fashion to scale the observed current year Design Values (DVC) to project future year 2021 Design Values (DVF) as recommended by EPA (2007) and described in Section 4.5.

5.6.1 Ozone NAAQS Analysis using Relative Modeling Results

EPA's Model Attainment Test Software (MATS) was used to make future year ozone Design Value (DV) projections using the CAMx 2008 Base Case and 2021 High and Low Development Scenario modeling results. MATS was also used to make future year 2021 ozone DV (DVF) projections for the 2021 High and Low Development Scenario removing the contributions of four of the combined Source Groups R, S, T and U. MATS was used to make 2021 ozone DVF projections at the monitoring sites as well as throughout the CARMMS modeling domain using the MATS Unmonitored Area Analysis (UAA) procedures.

5.6.1.1 Ozone Design Value Projections at Monitoring Sites

The results of the 2021 ozone DVF projections at the monitoring sites are given in Attachments F-1, F-2 and F-3 and shown in Table 5-39. The maximum current year DVC (DVC; based on 2006-2010 observations) is 82.0 ppb at the Rocky Flats North (CO_Jefferson_006) monitor that is projected to be reduced to 79.5, 78.1 and 79.5 ppb for the 2021 High, Low and Medium Development Scenarios, respectively. There are 8 monitoring sites in the CARMMS 4 km domain with current year DVCs above the ozone NAAQS that are reduced to two sites in the 2021 emission scenarios, Rocky Flats North and Fort Collins West (CO_Larimer_0011). Removing the contributions due to new O&G and mining on Federal lands within the 13 Colorado BLM Planning Areas (Source Group R) reduces the 2021 DVF at Rocky Flats North by 0.9 ppb to 78.6 ppb for the High, by 0.3 ppb to 77.8 ppb for the Low and by 0.8 ppb to 78.7 ppb for the Medium Development Scenarios, which are still above the ozone NAAQS (76.0 ppb or higher). However, when emissions from new non-Federal O&G within the 13 Colorado Planning Areas are also removed (Source Group S), the projected 2021 DVFs are 74.5, 75.8 and 74.5 ppb for the High, Low and Medium Development Scenarios. The maximum reduction in 2021 DVFs due to the removal of Source Group R at any monitor is 0.9 ppb at the Rocky Flats North and South Bolder Creek (CO_Boulder_0011) monitoring site for the High Development Scenario. Whereas maximum reduction from removing Source Group R for the Low and Medium Scenarios are 0.3 and 0.8 ppb at Rocky Flats North. The maximum reduction in 2021 DVF due to the removal of Source Group S, T and U in the High Development Scenario are, respectively, 7.2, 7.3 and 9.0 ppb at the Greely – Weld Tower (CO_Weld_009) monitoring site. Most of the O&G development in Weld County (Royal Gorge FO Area#1; Source Group I) is on non-Federal lands so the monitors in Weld County are less affected by the Federal O&G development (Source Group R).

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Table 5-39a. Current year ozone Design Values (DVC) and projected 2021 future year ozone Design Values (DVF) for the 2021 High Development Scenario and without Source Group R, S, T and U.

CID	Name	Lat	Long	State	County	DVC	DVF					Contribution from			
							2021 Hi	2021 Hi w/o R	2021 Hi w/o S	2021 Hi w/o T	2021 Hi w/o U	Group R	Group S	Group T	Group U
080013001	CO_Adams_3001	39.8381	-104.9498	Colorado	Adams	71.5	70.5	69.7	67.2	67.2	65.6	0.8	3.3	3.3	4.9
080130011	CO_Boulder_0011	39.9572	-105.2385	Colorado	Boulder	77.3	74.4	73.5	69.0	69.0	66.8	0.9	5.4	5.4	7.6
080310014	CO_Denver_0014	39.7518	-105.0307	Colorado	Denver	70.3	69.0	68.3	66.2	66.2	64.8	0.7	2.8	2.8	4.2
080350004	CO_Douglas_0004	39.5345	-105.0704	Colorado	Douglas	78.3	75.7	74.9	72.3	72.3	70.7	0.8	3.4	3.4	5.0
080410013	CO_El Paso_0013	38.9583	-104.8172	Colorado	El Paso	68.0	66.0	65.4	64.5	64.5	63.3	0.6	1.5	1.5	2.7
080410016	CO_El Paso_0016	38.8531	-104.9013	Colorado	El Paso	70.3	68.8	68.4	67.7	67.6	66.4	0.4	1.1	1.2	2.4
080590002	CO_Jefferson_0002	39.8003	-105.1000	Colorado	Jefferson	75.0	73.5	72.6	70.0	70.0	68.4	0.9	3.5	3.5	5.1
080590005	CO_Jefferson_0005	39.6388	-105.1395	Colorado	Jefferson	74.3	72.4	71.8	70.0	70.0	68.8	0.6	2.4	2.4	3.6
080590006	CO_Jefferson_0006	39.9128	-105.1886	Colorado	Jefferson	82.0	79.5	78.6	74.5	74.5	72.4	0.9	5.0	5.0	7.1
080590011	CO_Jefferson_0011	39.7437	-105.1780	Colorado	Jefferson	76.3	74.0	73.3	71.0	71.0	69.7	0.7	3.0	3.0	4.3
080671004	CO_La Plata_1004	37.3039	-107.4842	Colorado	La Plata	70.0	69.8	69.5	69.3	69.3	68.9	0.3	0.5	0.5	0.9
080677001	CO_La Plata_7001	37.1368	-107.6286	Colorado	La Plata	66.0	65.9	65.5	65.1	64.8	61.6	0.4	0.8	1.1	4.3
080677003	CO_La Plata_7003	37.1026	-107.8702	Colorado	La Plata	67.0	66.8	66.4	66.0	65.8	62.9	0.4	0.8	1.0	3.9
080690007	CO_Larimer_0007	40.2772	-105.5450	Colorado	Larimer	74.3	72.7	72.4	70.1	70.1	68.9	0.3	2.6	2.6	3.8
080690011	CO_Larimer_0011	40.5925	-105.1411	Colorado	Larimer	78.0	78.9	78.6	73.5	73.5	72.1	0.3	5.4	5.4	6.8
080691004	CO_Larimer_1004	40.5775	-105.0789	Colorado	Larimer	67.3	67.4	67.2	62.9	62.9	61.7	0.2	4.5	4.5	5.7
080830101	CO_Montezuma_0101	37.1983	-108.4903	Colorado	Montezuma	69.3	68.9	68.6	68.3	68.3	66.5	0.3	0.6	0.6	2.4
081230009	CO_Weld_0009	40.3864	-104.7374	Colorado	Weld	72.7	72.1	71.5	64.9	64.8	63.1	0.6	7.2	7.3	9.0
350010023	NM_Bernalillo_0023	35.1343	-106.5852	New Mexico	Bernalillo	66.0	63.8	63.6	63.5	63.4	62.4	0.2	0.3	0.4	1.4
350010024	NM_Bernalillo_0024	35.0631	-106.5788	New Mexico	Bernalillo	67.3	64.8	64.7	64.5	64.5	63.5	0.1	0.3	0.3	1.3
350010027	NM_Bernalillo_0027	35.1539	-106.6972	New Mexico	Bernalillo	68.3	64.7	64.6	64.5	64.5	63.7	0.1	0.2	0.2	1.0
350010029	NM_Bernalillo_0029	35.0171	-106.6574	New Mexico	Bernalillo	67.0	64.8	64.6	64.5	64.5	63.5	0.2	0.3	0.3	1.3
350011012	NM_Bernalillo_1012	35.1852	-106.5082	New Mexico	Bernalillo	69.0	66.7	66.5	66.3	66.3	65.2	0.2	0.4	0.4	1.5
350011013	NM_Bernalillo_1013	35.1932	-106.6138	New Mexico	Bernalillo	68.7	66.0	65.9	65.7	65.7	64.6	0.1	0.3	0.3	1.4
350431001	NM_Sandoval_1001	35.2994	-106.5483	New Mexico	Sandoval	60.3	58.3	58.1	58.0	57.9	56.9	0.2	0.3	0.4	1.4
350431003	NM_Sandoval_1003	35.2381	-106.6494	New Mexico	Sandoval	70.0	67.2	67.1	66.9	66.9	65.8	0.1	0.3	0.3	1.4
350439004	NM_Sandoval_9004	35.6153	-106.7244	New Mexico	Sandoval	68.0	67.8	67.5	67.2	67.1	65.4	0.3	0.6	0.7	2.4
350450009	NM_San Juan_0009	36.7422	-107.9769	New Mexico	San Juan	62.0	61.0	60.8	60.5	60.3	55.6	0.2	0.5	0.7	5.4
350451005	NM_San Juan_1005	36.7967	-108.4725	New Mexico	San Juan	67.0	65.9	65.5	65.0	64.8	61.2	0.4	0.9	1.1	4.7
490110004	UT_Davis_0004	40.9030	-111.8845	Utah	Davis	77.0	74.5	74.5	74.4	74.4	74.2	0.0	0.1	0.1	0.3
490350003	UT_Salt Lake_0003	40.6467	-111.8497	Utah	Salt Lake	78.0	75.8	75.8	75.8	75.8	75.6	0.0	0.0	0.0	0.2
490352004	UT_Salt Lake_2004	40.7364	-112.2103	Utah	Salt Lake	75.7	73.3	73.3	73.3	73.3	73.1	0.0	0.0	0.0	0.2
490353006	UT_Salt Lake_3006	40.7364	-111.8722	Utah	Salt Lake	77.0	74.3	74.3	74.3	74.3	74.1	0.0	0.0	0.0	0.2
490370101	UT_San Juan_0101	38.4500	-109.8167	Utah	San Juan	70.0	69.2	69.1	69.0	69.0	68.5	0.1	0.2	0.2	0.7
490490002	UT_Utah_0002	40.2536	-111.6631	Utah	Utah	72.0	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1
490495008	UT_Utah_5008	40.4303	-111.8039	Utah	Utah	72.3	70.4	70.4	70.4	70.4	70.3	0.0	0.0	0.0	0.1
490495010	UT_Utah_5010	40.1364	-111.6597	Utah	Utah	72.3	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1

Table 5-39b. Current year ozone Design Values (DVC) and projected 2021 future year ozone Design Values (DVF) for the 2021 Low Development Scenario and without Source Group R, S, T and U.

CID	Name	Lat	Long	State	County	DVC	DVF					Contribution from			
							2021 Low	2021 Low w/o R	2021 Low w/o S	2021 Low w/o T	2021 Low w/o U	Group R	Group S	Group T	Group U
080013001	CO_Adams_3001	39.8381	-104.9498	Colorado	Adams	71.5	69.6	69.4	68.1	68.1	66.3	0.2	1.5	1.5	3.3
080130011	CO_Boulder_0011	39.9572	-105.2385	Colorado	Boulder	77.3	72.8	72.6	70.3	70.2	67.9	0.2	2.5	2.6	4.9
080310014	CO_Denver_0014	39.7518	-105.0307	Colorado	Denver	70.3	68.2	68.0	67.0	66.9	65.5	0.2	1.2	1.3	2.7
080350004	CO_Douglas_0004	39.5345	-105.0704	Colorado	Douglas	78.3	74.7	74.5	73.2	73.2	71.5	0.2	1.5	1.5	3.2
080410013	CO_El Paso_0013	38.9583	-104.8172	Colorado	El Paso	68.0	65.6	65.5	65.0	64.9	63.7	0.1	0.6	0.7	1.9
080410016	CO_El Paso_0016	38.8531	-104.9013	Colorado	El Paso	70.3	68.6	68.5	68.1	68.0	66.8	0.1	0.5	0.6	1.8
080590002	CO_Jefferson_0002	39.8003	-105.1000	Colorado	Jefferson	75.0	72.5	72.3	70.9	70.9	69.2	0.2	1.6	1.6	3.3
080590005	CO_Jefferson_0005	39.6388	-105.1395	Colorado	Jefferson	74.3	71.7	71.5	70.6	70.6	69.3	0.2	1.1	1.1	2.4
080590006	CO_Jefferson_0006	39.9128	-105.1886	Colorado	Jefferson	82.0	78.1	77.8	75.8	75.8	73.4	0.3	2.3	2.3	4.7
080590011	CO_Jefferson_0011	39.7437	-105.1780	Colorado	Jefferson	76.3	73.2	73.1	71.9	71.8	70.4	0.1	1.3	1.4	2.8
080671004	CO_La Plata_1004	37.3039	-107.4842	Colorado	La Plata	70.0	69.7	69.6	69.4	69.4	69.0	0.1	0.3	0.3	0.7
080677001	CO_La Plata_7001	37.1368	-107.6286	Colorado	La Plata	66.0	65.7	65.7	65.3	65.0	61.8	0.0	0.4	0.7	3.9
080677003	CO_La Plata_7003	37.1026	-107.8702	Colorado	La Plata	67.0	66.7	66.6	66.2	66.0	63.1	0.1	0.5	0.7	3.6
080690007	CO_Larimer_0007	40.2772	-105.5450	Colorado	Larimer	74.3	71.9	71.9	70.7	70.7	69.3	0.0	1.2	1.2	2.6
080690011	CO_Larimer_0011	40.5925	-105.1411	Colorado	Larimer	78.0	77.2	77.2	73.9	73.9	72.0	0.0	3.3	3.3	5.2
080691004	CO_Larimer_1004	40.5775	-105.0789	Colorado	Larimer	67.3	66.0	65.9	63.2	63.2	61.7	0.1	2.8	2.8	4.3
080830101	CO_Montezuma_0101	37.1983	-108.4903	Colorado	Montezuma	69.3	68.8	68.7	68.5	68.4	66.6	0.1	0.3	0.4	2.2
081230009	CO_Weld_0009	40.3864	-104.7374	Colorado	Weld	72.7	70.3	70.1	66.0	66.0	63.5	0.2	4.3	4.3	6.8
350010023	NM_Bernalillo_0023	35.1343	-106.5852	New Mexico	Bernalillo	66.0	63.7	63.7	63.6	63.5	62.5	0.0	0.1	0.2	1.2
350010024	NM_Bernalillo_0024	35.0631	-106.5788	New Mexico	Bernalillo	67.3	64.8	64.7	64.6	64.6	63.5	0.1	0.2	0.2	1.3
350010027	NM_Bernalillo_0027	35.1539	-106.6972	New Mexico	Bernalillo	68.3	64.7	64.7	64.6	64.5	63.7	0.0	0.1	0.2	1.0
350010029	NM_Bernalillo_0029	35.0171	-106.6574	New Mexico	Bernalillo	67.0	64.7	64.7	64.6	64.6	63.6	0.0	0.1	0.1	1.1
350011012	NM_Bernalillo_1012	35.1852	-106.5082	New Mexico	Bernalillo	69.0	66.6	66.6	66.4	66.4	65.3	0.0	0.2	0.2	1.3
350011013	NM_Bernalillo_1013	35.1932	-106.6138	New Mexico	Bernalillo	68.7	66.0	65.9	65.8	65.8	64.7	0.1	0.2	0.2	1.3
350431001	NM_Sandoval_1001	35.2994	-106.5483	New Mexico	Sandoval	60.3	58.2	58.2	58.1	58.0	56.9	0.0	0.1	0.2	1.3
350431003	NM_Sandoval_1003	35.2381	-106.6494	New Mexico	Sandoval	70.0	67.2	67.2	67.0	67.0	65.9	0.0	0.2	0.2	1.3
350439004	NM_Sandoval_9004	35.6153	-106.7244	New Mexico	Sandoval	68.0	67.7	67.6	67.4	67.3	65.5	0.1	0.3	0.4	2.2
350450009	NM_San Juan_0009	36.7422	-107.9769	New Mexico	San Juan	62.0	60.9	60.9	60.6	60.4	55.7	0.0	0.3	0.5	5.2
350451005	NM_San Juan_1005	36.7967	-108.4725	New Mexico	San Juan	67.0	65.7	65.6	65.2	65.1	61.4	0.1	0.5	0.6	4.3
490110004	UT_Davis_0004	40.9030	-111.8845	Utah	Davis	77.0	74.5	74.5	74.5	74.5	74.3	0.0	0.0	0.0	0.2
490350003	UT_Salt Lake_0003	40.6467	-111.8497	Utah	Salt Lake	78.0	75.8	75.8	75.8	75.8	75.6	0.0	0.0	0.0	0.2
490352004	UT_Salt Lake_2004	40.7364	-112.2103	Utah	Salt Lake	75.7	73.3	73.3	73.3	73.3	73.1	0.0	0.0	0.0	0.2
490353006	UT_Salt Lake_3006	40.7364	-111.8722	Utah	Salt Lake	77.0	74.3	74.3	74.3	74.3	74.1	0.0	0.0	0.0	0.2
490370101	UT_San Juan_0101	38.4500	-109.8167	Utah	San Juan	70.0	69.2	69.1	69.1	69.1	68.5	0.1	0.1	0.1	0.7
490490002	UT_Utah_0002	40.2536	-111.6631	Utah	Utah	72.0	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1
490495008	UT_Utah_5008	40.4303	-111.8039	Utah	Utah	72.3	70.4	70.4	70.4	70.4	70.3	0.0	0.0	0.0	0.1
490495010	UT_Utah_5010	40.1364	-111.6597	Utah	Utah	72.3	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1

Table 5-39c. Current year ozone Design Values (DVC) and projected 2021 future year ozone Design Values (DVF) for the 2021 Medium Development Scenario and without Source Group R, S, T and U.

CID	Name	Lat	Long	State	County	DVC	DVF					Contribution from			
							2021 Med	2021 Med w/o R	2021 Med w/o S	2021 Med w/o T	2021 Med w/o U	Group R	Group S	Group T	Group U
080013001	CO_Adams_3001	39.8381	-104.9498	Colorado	Adams	71.5	70.5	69.8	67.3	67.2	65.6	0.7	3.2	3.3	4.9
080130011	CO_Boulder_0011	39.9572	-105.2385	Colorado	Boulder	77.3	74.4	73.6	69.1	69.1	66.9	0.8	5.3	5.3	7.5
080310014	CO_Denver_0014	39.7518	-105.0307	Colorado	Denver	70.3	69.0	68.3	66.2	66.2	64.9	0.7	2.8	2.8	4.1
080350004	CO_Douglas_0004	39.5345	-105.0704	Colorado	Douglas	78.3	75.6	75.0	72.3	72.3	70.8	0.6	3.3	3.3	4.8
080410013	CO_El Paso_0013	38.9583	-104.8172	Colorado	El Paso	68.0	66.0	65.5	64.5	64.5	63.3	0.5	1.5	1.5	2.7
080410016	CO_El Paso_0016	38.8531	-104.9013	Colorado	El Paso	70.3	68.8	68.4	67.7	67.7	66.5	0.4	1.1	1.1	2.3
080590002	CO_Jefferson_0002	39.8003	-105.1000	Colorado	Jefferson	75.0	73.4	72.6	70.0	70.0	68.5	0.8	3.4	3.4	4.9
080590005	CO_Jefferson_0005	39.6388	-105.1395	Colorado	Jefferson	74.3	72.4	71.8	70.0	70.0	68.8	0.6	2.4	2.4	3.6
080590006	CO_Jefferson_0006	39.9128	-105.1886	Colorado	Jefferson	82.0	79.5	78.7	74.5	74.5	72.4	0.8	5.0	5.0	7.1
080590011	CO_Jefferson_0011	39.7437	-105.1780	Colorado	Jefferson	76.3	74.0	73.4	71.1	71.0	69.7	0.6	2.9	3.0	4.3
080671004	CO_La Plata_1004	37.3039	-107.4842	Colorado	La Plata	70.0	69.8	69.5	69.3	69.3	68.9	0.3	0.5	0.5	0.9
080677001	CO_La Plata_7001	37.1368	-107.6286	Colorado	La Plata	66.0	65.8	65.5	65.1	64.9	61.6	0.3	0.7	0.9	4.2
080677003	CO_La Plata_7003	37.1026	-107.8702	Colorado	La Plata	67.0	66.8	66.4	66.0	65.9	62.9	0.4	0.8	0.9	3.9
080690007	CO_Larimer_0007	40.2772	-105.5450	Colorado	Larimer	74.3	72.7	72.5	70.2	70.1	69.0	0.2	2.5	2.6	3.7
080690011	CO_Larimer_0011	40.5925	-105.1411	Colorado	Larimer	78.0	78.9	78.7	73.5	73.5	72.1	0.2	5.4	5.4	6.8
080691004	CO_Larimer_1004	40.5775	-105.0789	Colorado	Larimer	67.3	67.4	67.2	62.9	62.9	61.7	0.2	4.5	4.5	5.7
080830101	CO_Montezuma_0101	37.1983	-108.4903	Colorado	Montezuma	69.3	68.9	68.6	68.3	68.3	66.5	0.3	0.6	0.6	2.4
081230009	CO_Weld_0009	40.3864	-104.7374	Colorado	Weld	72.7	72.0	71.5	64.9	64.9	63.1	0.5	7.1	7.1	8.9
350010023	NM_Bernalillo_0023	35.1343	-106.5852	New Mexico	Bernalillo	66.0	63.8	63.6	63.5	63.5	62.4	0.2	0.3	0.3	1.4
350010024	NM_Bernalillo_0024	35.0631	-106.5788	New Mexico	Bernalillo	67.3	64.8	64.7	64.5	64.5	63.5	0.1	0.3	0.3	1.3
350010027	NM_Bernalillo_0027	35.1539	-106.6972	New Mexico	Bernalillo	68.3	64.7	64.6	64.5	64.5	63.7	0.1	0.2	0.2	1.0
350010029	NM_Bernalillo_0029	35.0171	-106.6574	New Mexico	Bernalillo	67.0	64.8	64.6	64.5	64.5	63.6	0.2	0.3	0.3	1.2
350011012	NM_Bernalillo_1012	35.1852	-106.5082	New Mexico	Bernalillo	69.0	66.7	66.5	66.3	66.3	65.2	0.2	0.4	0.4	1.5
350011013	NM_Bernalillo_1013	35.1932	-106.6138	New Mexico	Bernalillo	68.7	66.0	65.9	65.7	65.7	64.7	0.1	0.3	0.3	1.3
350431001	NM_Sandoval_1001	35.2994	-106.5483	New Mexico	Sandoval	60.3	58.3	58.1	58.0	58.0	56.9	0.2	0.3	0.3	1.4
350431003	NM_Sandoval_1003	35.2381	-106.6494	New Mexico	Sandoval	70.0	67.2	67.1	67.0	66.9	65.8	0.1	0.2	0.3	1.4
350439004	NM_Sandoval_9004	35.6153	-106.7244	New Mexico	Sandoval	68.0	67.8	67.5	67.2	67.1	65.4	0.3	0.6	0.7	2.4
350450009	NM_San Juan_0009	36.7422	-107.9769	New Mexico	San Juan	62.0	61.0	60.8	60.5	60.3	55.7	0.2	0.5	0.7	5.3
350451005	NM_San Juan_1005	36.7967	-108.4725	New Mexico	San Juan	67.0	65.8	65.5	65.0	64.9	61.2	0.3	0.8	0.9	4.6
490110004	UT_Davis_0004	40.9030	-111.8845	Utah	Davis	77.0	74.5	74.5	74.4	74.4	74.2	0.0	0.1	0.1	0.3
490350003	UT_Salt Lake_0003	40.6467	-111.8497	Utah	Salt Lake	78.0	75.8	75.8	75.8	75.8	75.6	0.0	0.0	0.0	0.2
490352004	UT_Salt Lake_2004	40.7364	-112.2103	Utah	Salt Lake	75.7	73.3	73.3	73.3	73.3	73.1	0.0	0.0	0.0	0.2
490353006	UT_Salt Lake_3006	40.7364	-111.8722	Utah	Salt Lake	77.0	74.3	74.3	74.3	74.3	74.1	0.0	0.0	0.0	0.2
490370101	UT_San Juan_0101	38.4500	-109.8167	Utah	San Juan	70.0	69.2	69.1	69.0	69.0	68.5	0.1	0.2	0.2	0.7
490490002	UT_Utah_0002	40.2536	-111.6631	Utah	Utah	72.0	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1
490495008	UT_Utah_5008	40.4203	-111.8039	Utah	Utah	72.3	70.4	70.4	70.4	70.4	70.3	0.0	0.0	0.0	0.1
490495010	UT_Utah_5010	40.1364	-111.6597	Utah	Utah	72.3	70.3	70.3	70.3	70.3	70.2	0.0	0.0	0.0	0.1

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5.6.1.2 Ozone Design Value Projection Unmonitored Area Analysis

MATS was used to perform an unmonitored area analysis (UAA) of the 2021 ozone DVF projections for the 2021 High, Low and Medium Development Scenarios and the 2021 results without the contributions from the combined Source Groups R, S, T and U. The MATS UAA interpolates the current year observed ozone DVCs across the CARMMS 4 km domain and then makes 2021 ozone DVF projections throughout the domain using the relative change in the CAMx 2008 and 2021 modeling results in each 4 km grid cell. Figure 5-1 displays the spatial distribution of the MATS UAA derived 2008 ozone DVCs and 2021 ozone DVFs and their differences for the three 2021 emission scenarios. The color scheme for the spatial plots has a cut-point at 76.0 ppb so tiles that are yellow or warmer indicate exceedances of the 0.075 ppm ozone NAAQS. The current year DVCs indicate areas of ozone exceedances in Denver and Salt Lake City with a maximum DVC of 81.5 ppb just northwest of Denver (Figure 5-1, top left). For the 2021 High, Low and Medium Development Scenarios the areas of 2021 ozone DVF exceedances is reduced and limited to smaller areas in the Denver and SLC area and just east of SLC with a peak DVF of 79.3, 77.5 and 79.2 ppb for the 2021 High, Low and Medium Development Scenarios, respectively, just northwest of Denver near Rocky Flats North (top right in Figures 5-1a, 5-1b and 5-1c). The 2021 DVF – 2008 DVC difference plots (Figure 5-1, bottom) shows mainly ozone reductions with the largest reduction in the Denver and SLC areas but ozone increases in the Piceance Basin (Garfield County) for the 2021 High Scenario (Figure 5-1a) that is not scene for the Low Scenario (Figure 5-1b), but is seen in the Medium Development Scenario (Figure 5-1c). Although the largest ozone increase in both 2021

scenarios occurs near downtown Denver and is due to less fresh NO_X emissions that suppress urban ozone concentrations.

The 2021 High Development Scenario UAA ozone DVF without Source Group R (Federal O&G and mining in 13 CO BLM Planning Areas) results in reduction in the DVFs with the highest reduction of 6.4 ppb in the Piceance Basin and the peak DVF being reduced from 79.3 to 78.4 ppb that occurs just northwest of Denver (Figure 5-2a, top panels). In contrast, the removal of Source Group R from the 2021 Low Development Scenario results in smaller ozone reductions mainly in the Piceance Basin with a maximum reduction of 2.8 ppb (Figure 5-3a, top panels). The removal of Source Group R from the 2021 Medium Development Scenario reduces the maximum 2021 DFV from 79.2 to 78.5 ppb with a maximum DFV reduction of 5.6 ppb that occurs in the Piceance Basin (Figure 5-4a). There are still areas in Denver and SLC with 2021 DVFs exceeding the NAAQS with Source Group R removed.

Removing both Federal O&G and mining and non-Federal O&G (Source Group S) results in more reductions in the 2021 DVFs, especially in Weld County in the greater Denver area (Figures 5-2a, 5-3a and 5-4a, bottom panels). There are large reductions in 2021 DVFs in the Piceance and D-J Basins (Weld County) with the largest reduction being 12.8 ppb (High Scenario), 8.5 ppb (Low Scenario) and 12.2 ppb (Medium Scenario) in the Piceance Basin. There are no longer any ozone exceedances in the greater Denver area without emissions from Source Group S. The peak 2021 DVF is now ~77 ppb in the SLC area.

Source Group T adds the new O&G within the Mancos Shale development area to Source Group S (Figures 5-2b, 5-3b and 5-4b, top panels) and results in nearly identical 2021 DVFs as Source Group S in Colorado only with more ozone reductions in northwestern New Mexico.

When all O&G emissions are removed from the 2021 High and Low Development Scenarios in Source Group U, there are widespread reductions in the 2021 ozone DVFs throughout Colorado and spreading into Utah and New Mexico. Large ozone reductions occur in the D-J Basin (Weld County), Piceance Basin, Uinta Basin and South San Juan Basin; the single grid cell with the highest ozone reduction in the High (-18.8 ppb), Low (-16.1 ppb) and Medium (-18.4 ppb) occurs in the Piceance Basin (Figures 5-2b, 5-3b and 5-3c, bottom panels).

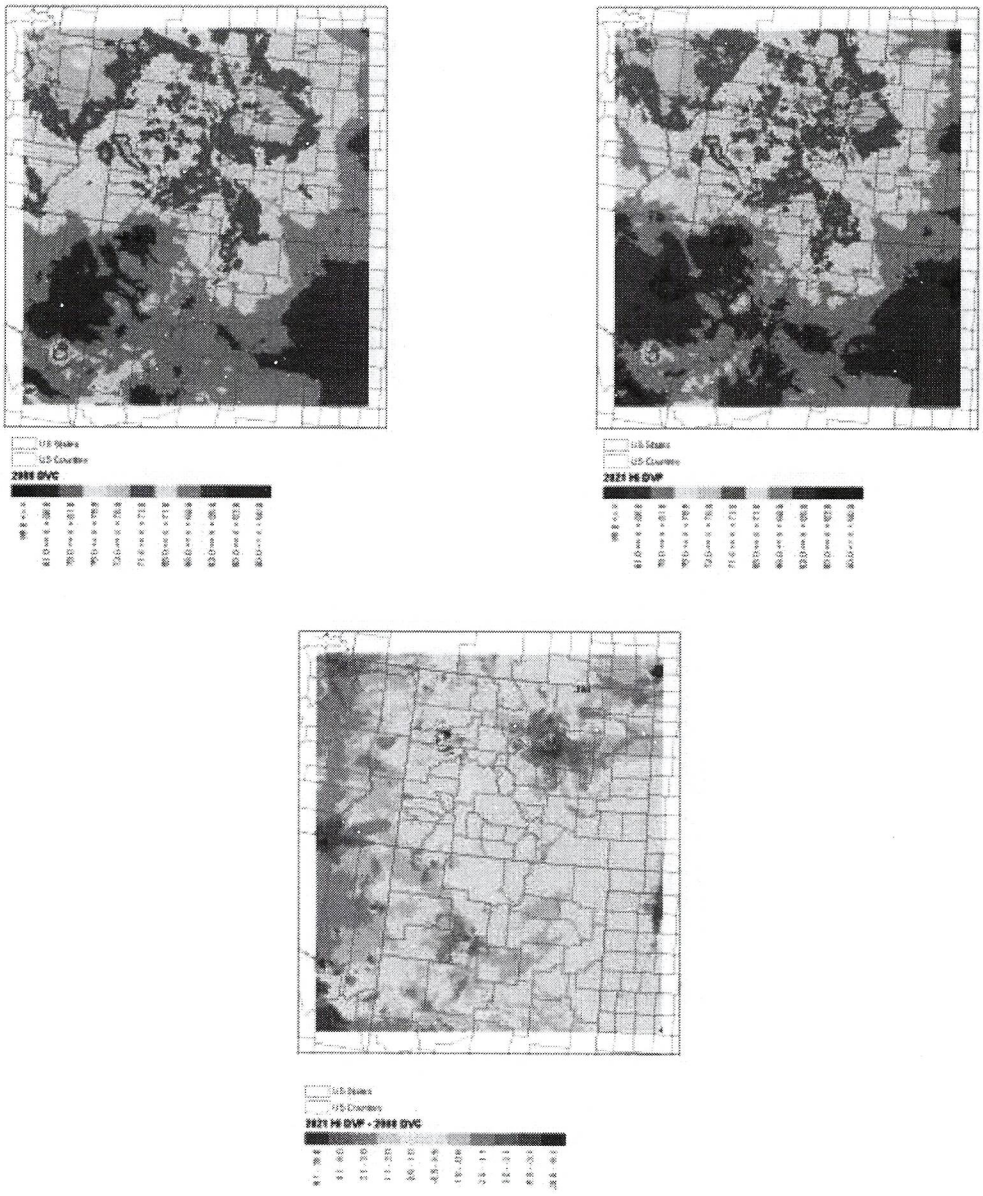

Figure 5-1a. 2008 ozone DVC (top left), 2021 High Development Scenario ozone DVF (top right) and their differences (2021 High – 2008) (bottom) calculated using MATS.

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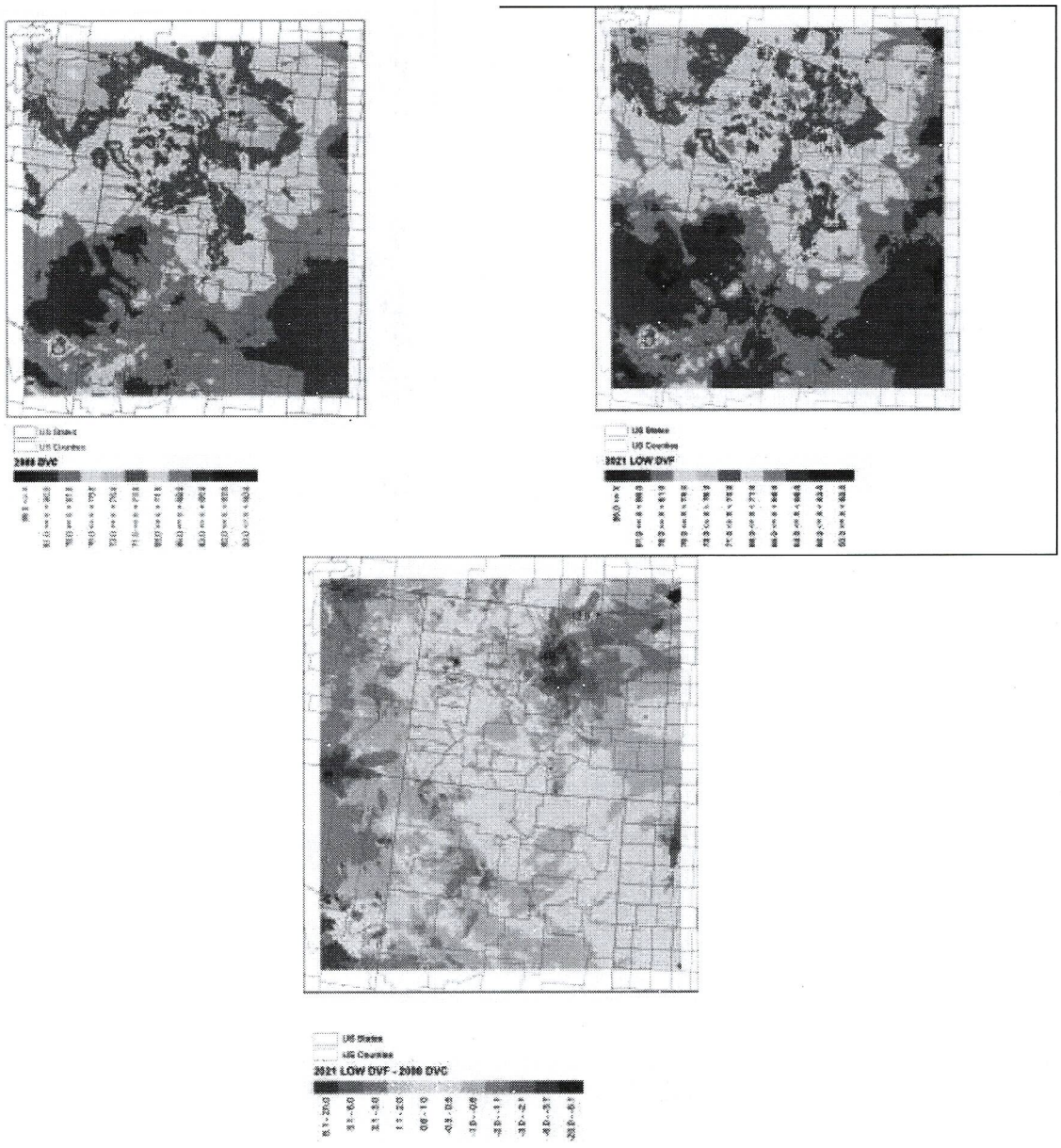

Figure 5-1b. 2008 ozone DVC (top left), 2021 Low Development Scenario ozone DVF (top right) and their differences (2021 Low – 2008) (bottom) calculated using MATS.

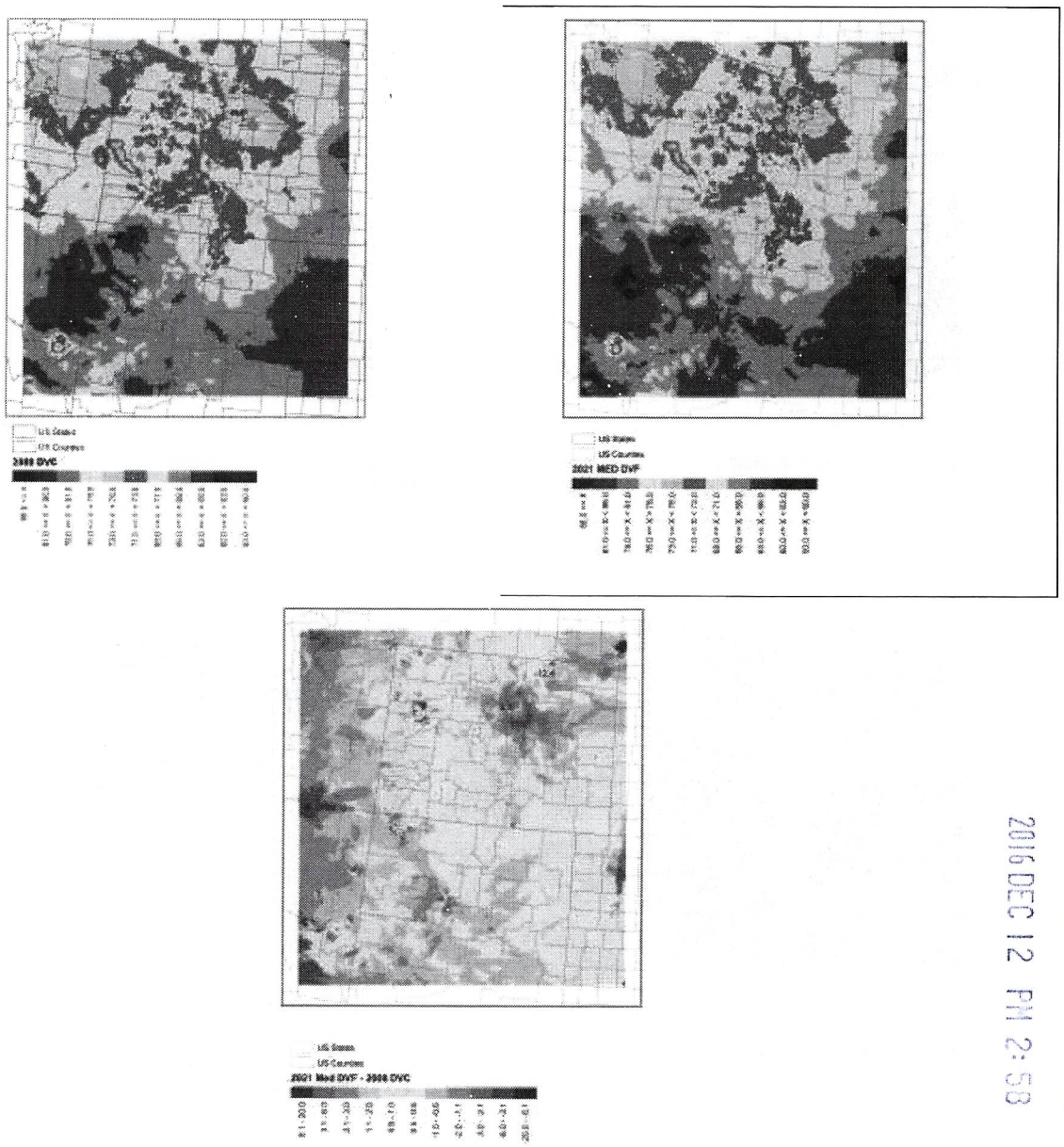

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Figure 5-1c. 2008 ozone DVC (top left), 2021 Medium Development Scenario ozone DVF (top right) and their differences (2021 Medium – 2008) (bottom) calculated using MATS.

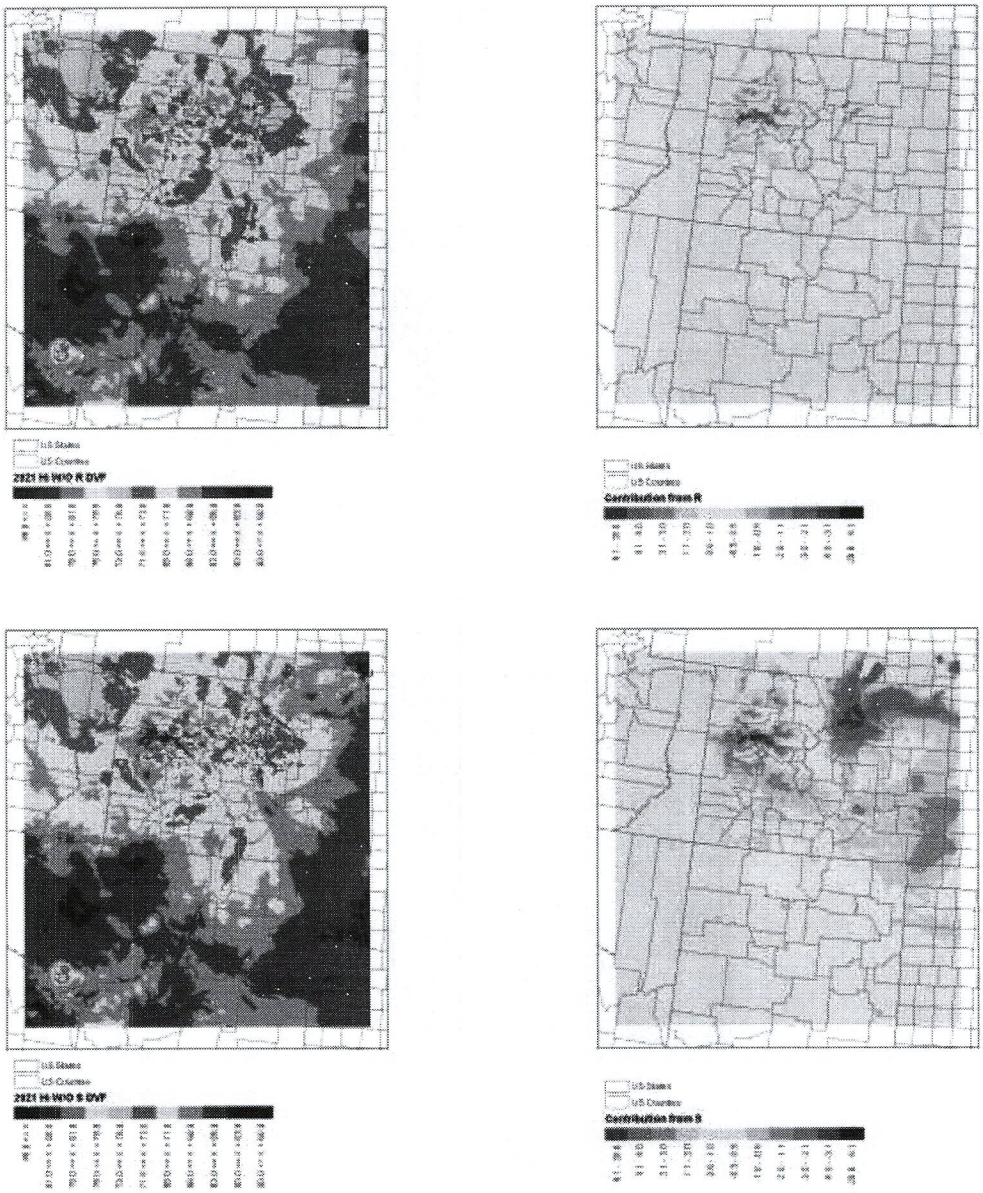

Figure 5-2a. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group R (top) and S (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 High Development Scenario (right).

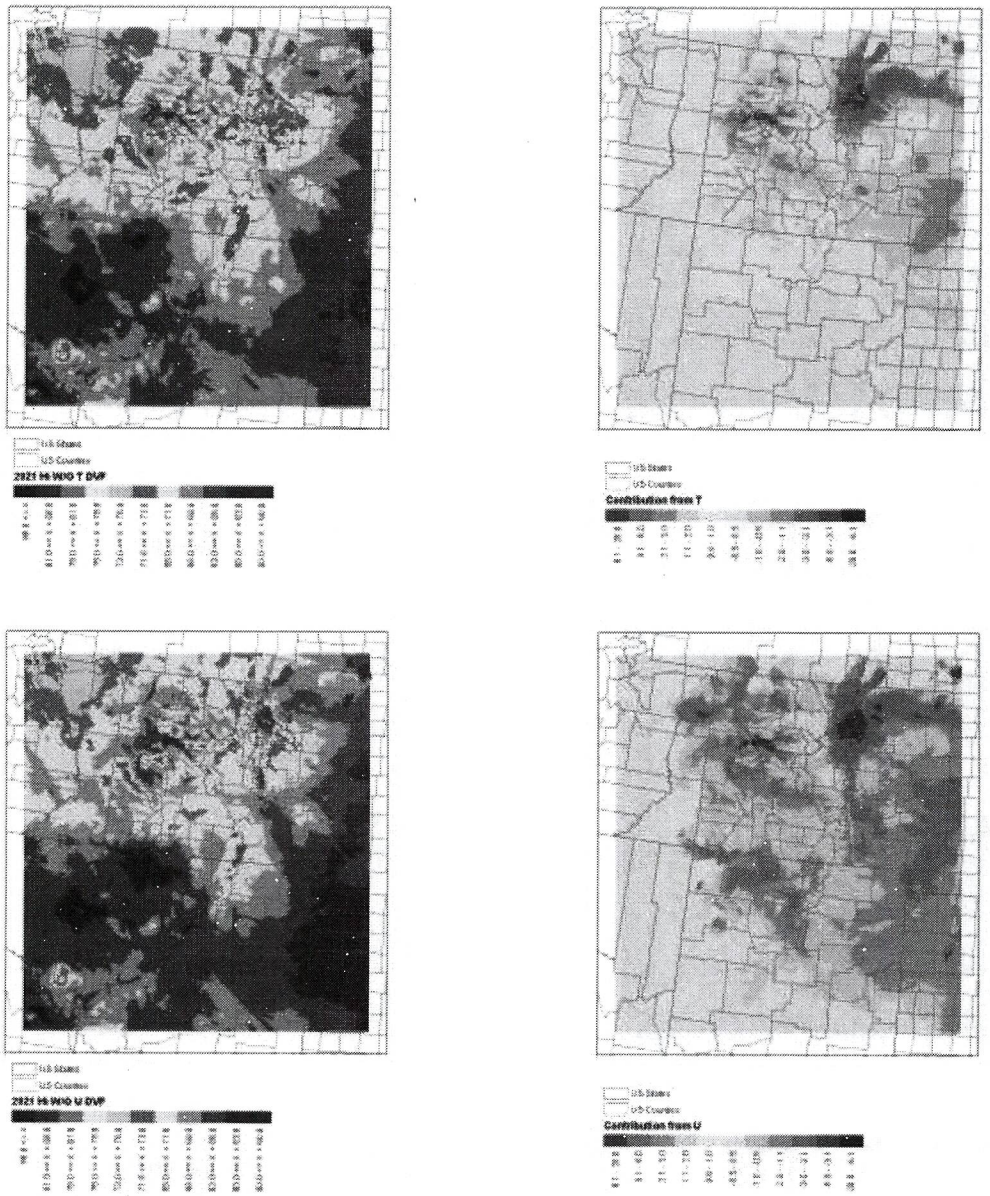

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Figure 5-2b. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group T (top) and U (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 High Development Scenario (right).

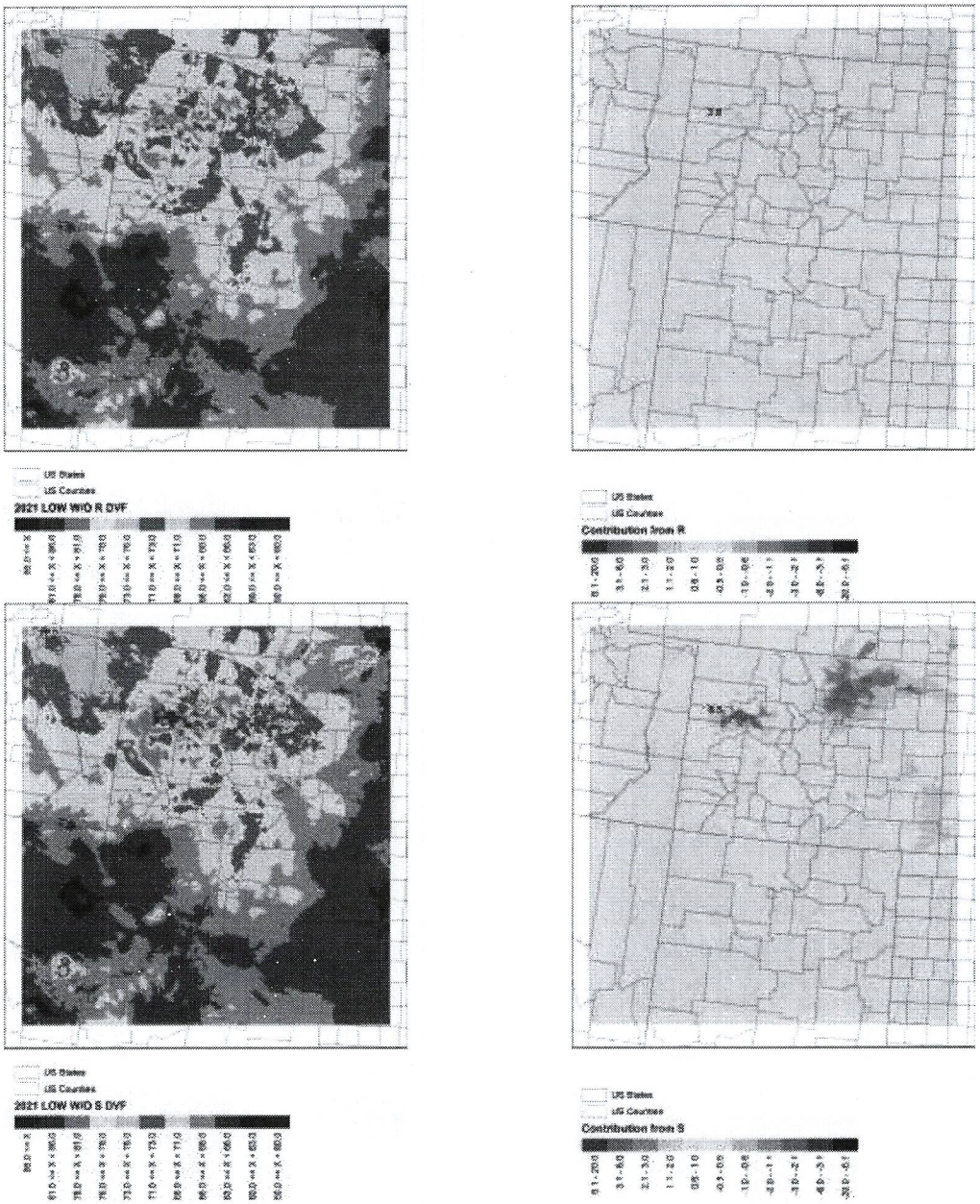

Figure 5-3a. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group R (top) and S (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 Low Development Scenario (right).

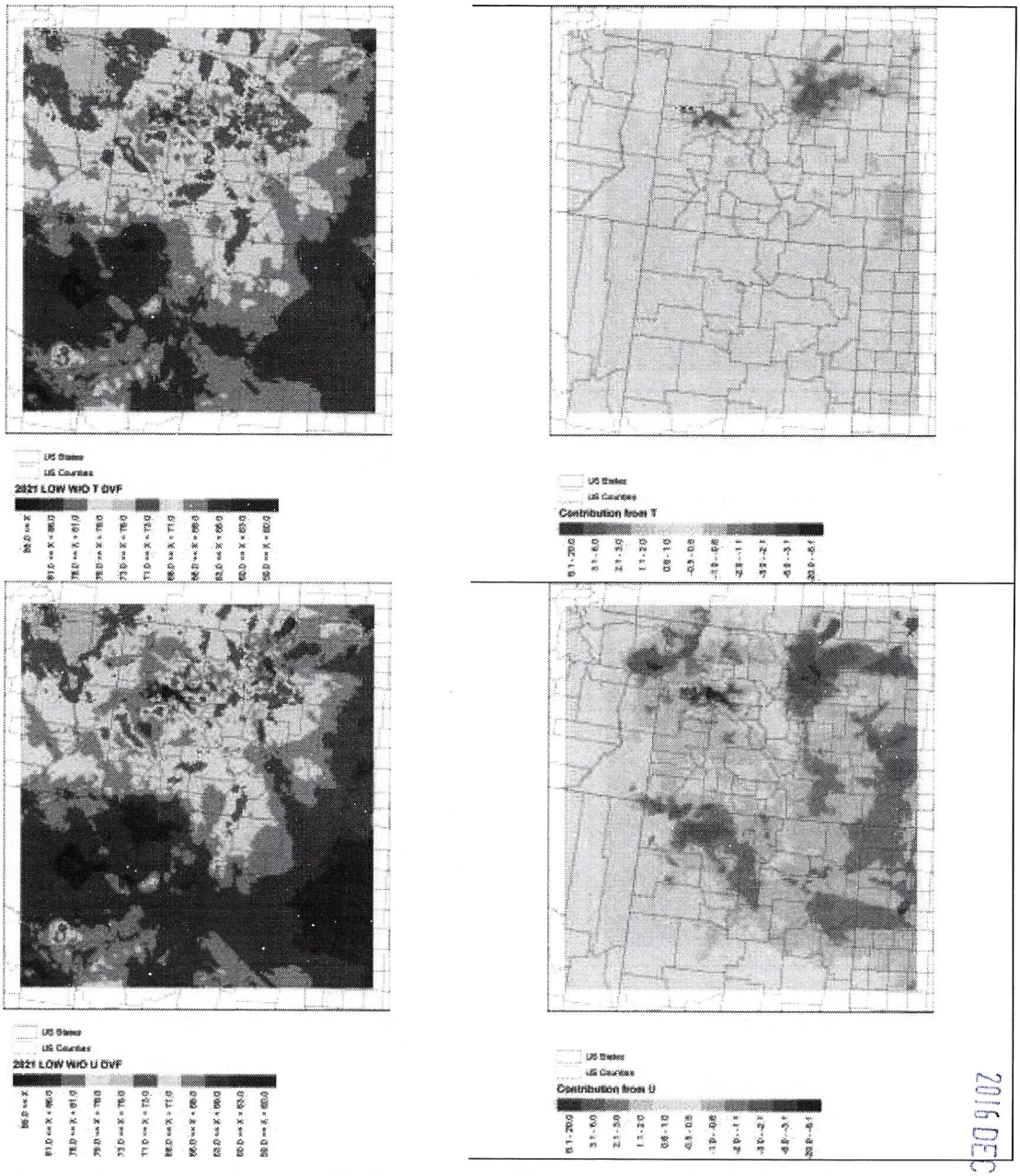

Figure 5-3b. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group T (top) and U (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 Low Development Scenario (right).

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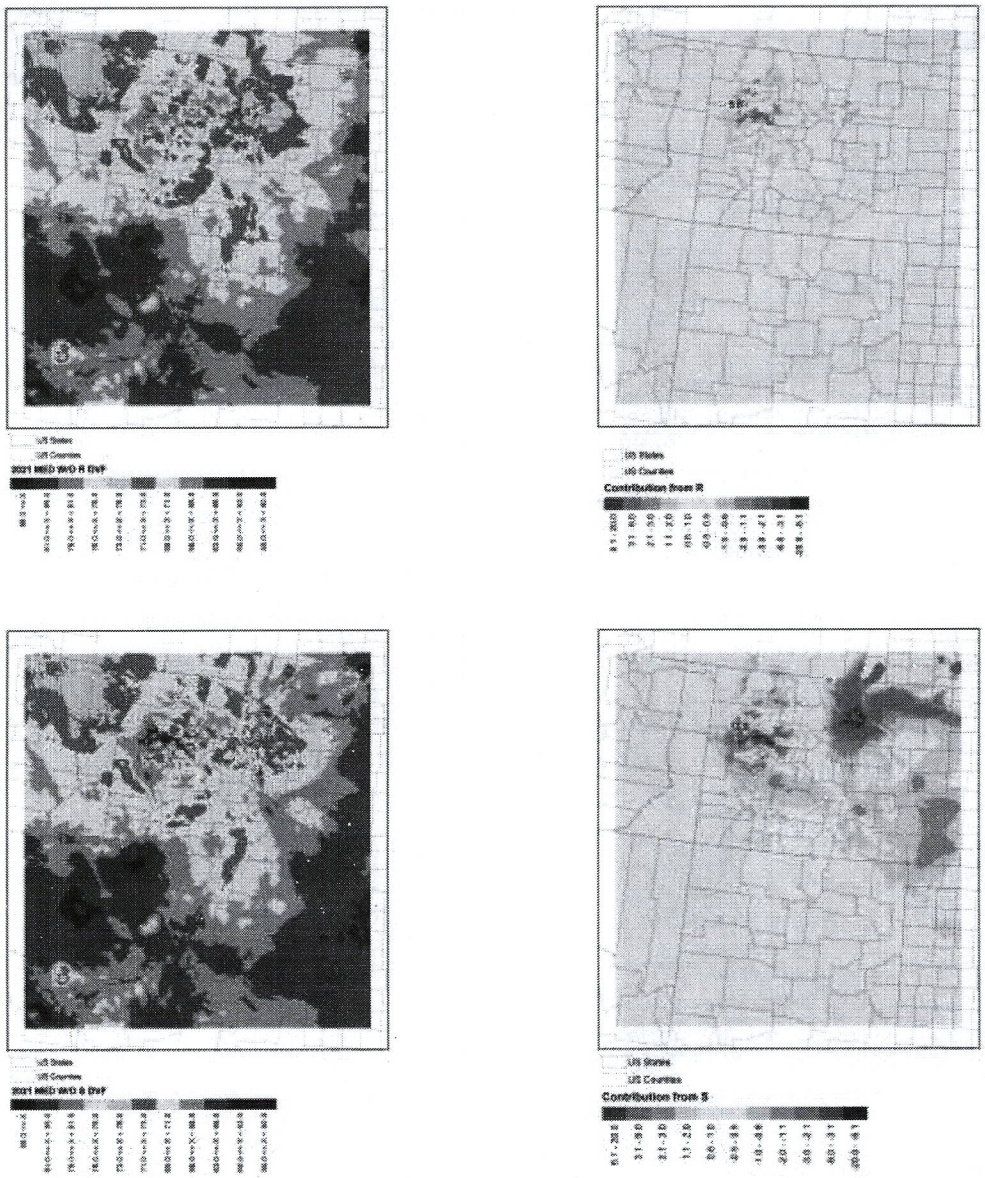

Figure 5-4a. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group R (top) and S (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 Medium Development Scenario (right).

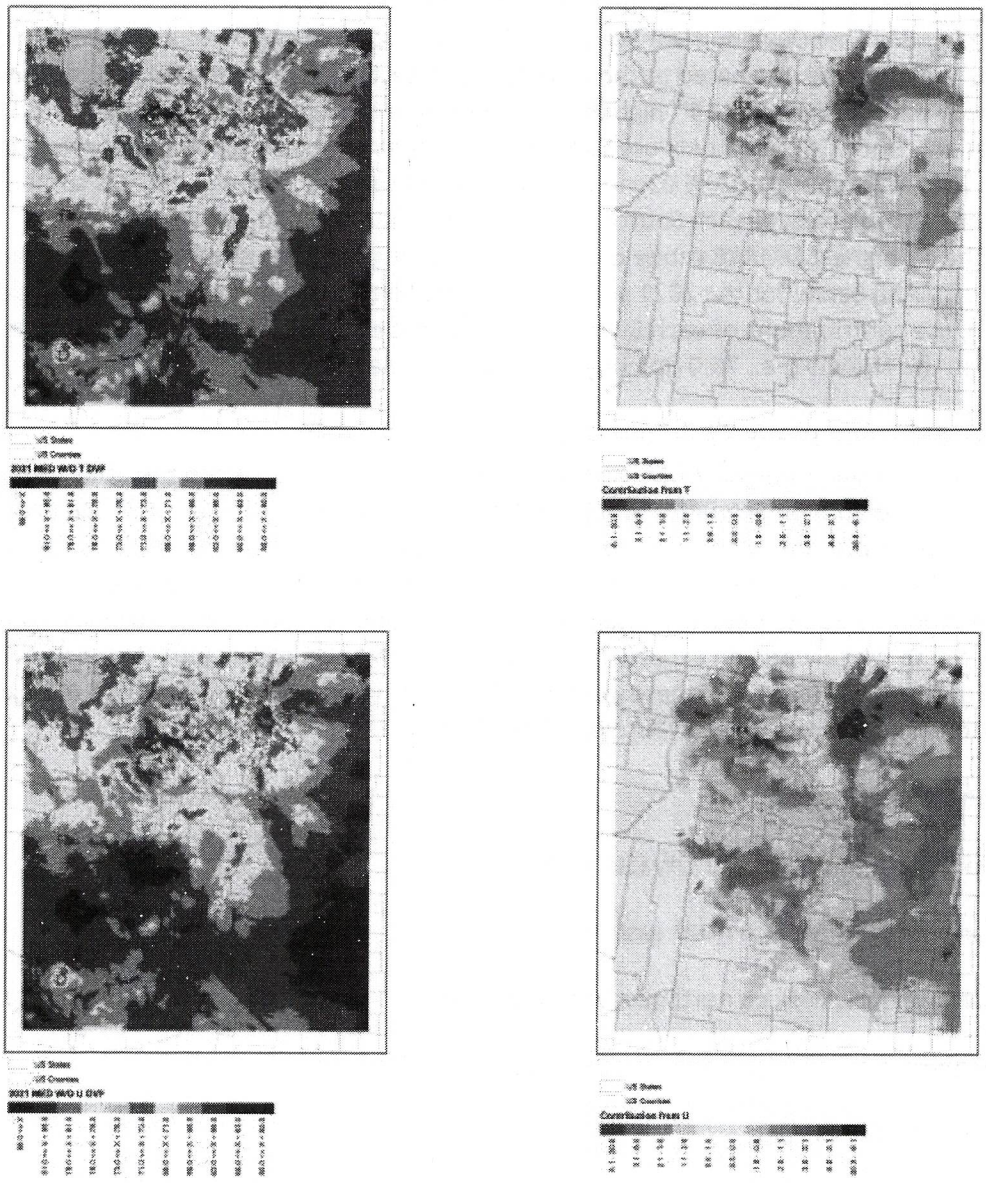

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Figure 5-4b. 2021 projected ozone DVF 2021 Unmonitored Area Analysis for Source Group T (top) and U (bottom) showing 2021 DVF without each Source Group (left) and difference in DVFs with 2021 Medium Development Scenario (right).

5.6.2 Ozone NAAQS Analysis using the Absolute Modeling Results

The 2021 High and Low Development Scenario CAMx source apportionment absolute modeling results are analyzed and compared to the NAAQS in this section. The ozone NAAQS is defined as the three-year average of the 4th highest daily maximum 8-hour (DMAX8) ozone concentration. Since CARMMS only uses one year of modeling results (2008 meteorological year), the 2021 4th highest DMAX8 ozone concentration is used as a pseudo-NAAQS comparison metric. The contributions of each Source Group to ozone is examined as the difference between the 4th highest DMAX8 ozone concentration for the 2021 emissions scenario minus the 4th highest DMAX8 ozone for the 2021 scenario with the Source Group contributions removed. In addition, the contributions of each Source Group to modeled 2021 4th high DMAX8 ozone greater than the NAAQS (i.e., 76.0 ppb or greater) is also analyzed.

5.6.2.1 Contributions of Source Groups to 4th High DMAX8 Ozone

Figure 5-5 displays the 4th highest DMAX8 ozone for the 2008 Base Case and the 2021 High, Low and Medium Development Scenarios and their differences and the 4th highest DMAX8 ozone for the 2021 scenario with the ozone contributions from natural emissions removed (Source Group V). This last display was generated to determine whether exceedances of the NAAQS could have been primarily due to natural emissions. The color scale in Figure 5-5 has a sharp contrast from dark red to white when an exceedances of the ozone NAAQS occurs (i.e., 76.0 ppb or higher). For the 2008 Base Case, there are several regions where the modeled 2021 4th high DMAX8 ozone exceeds the NAAQS (Figure 5-5, top left):

- The Denver area;
- Uinta Basin and Salt Lake City (SLC), Utah;
- Northern New Mexico northeast of Santa Fe;
- Northern New Mexico northeast of Los Alamos;
- Northern New Mexico north of Taos; and
- On the UT/AZ border.

In the 2021 High, Low and Medium Development Scenarios, the area of ozone exceedances in Denver is reduced and the ozone exceedances in the SLC and UT/AZ border area are gone. However, the modeled ozone exceedance area in northern New Mexico remains the same and there is a new ozone exceedance area in the Uinta Basin in the three 2021 scenarios (Figure 5-5, top right). The 2021 – 2008 ozone differences (Figure 5-5, bottom left) show more decreases than increases and the areas of ozone increases tend to occur in O&G development areas, such as the D-J, Piceance and Uinta Basins. The contribution of natural emissions to the modeled 4th highest daily maximum 8-hour ozone concentrations (Figure 5-5, bottom right) show that the ozone exceedance areas in northern New Mexico are due to natural emissions, most likely wildfires.

Attachment I is a zipped file that contains spatial maps of concentrations including total concentrations and the contributions of each of the Source Groups to the 4th highest DMAX8 ozone and other pollutants from the 2021 High, Low and Medium Development Scenarios CAMx source apportionment modeling. Figure 5-6 displays example spatial maps of contributions to the 4th highest DMAX8 ozone concentrations for Source Groups E (GJFO), F (UFO), J (USFS-PG), R (Federal O&G/mining in CO) T (Cumulative Emissions Scenario) and U (all O&G in 4 km CARMMS domain) and the 2021 High, Low and Medium Development Scenarios that were extracted out of Attachment I. The maximum ozone contributions to the 4th highest DMAX8 ozone for each of the Source Groups are given in Table 5-40. Note that these maximum Source Group contributions to the 4th highest DMAX8 ozone occur when the total ozone is less than the ozone NAAQS. Section 5.6.2.2 discusses the Source Group contributions when the total 4th high DMAX8 ozone exceeds the ozone NAAQS. Ozone contributions due to Federal O&G development in the GJFO Planning Area are centered on the GJFO area where a maximum ozone contribution of 4.4 ppb occurs for the 2021 High Development Scenario (Table 5-40 and Figure 5-6a, top left). The mitigation in the 2021 Medium Development Scenario reduces this maximum GJFO ozone contribution by -18% to 3.6 ppb. There is much lower 4th high DMAX8 ozone contributions due to GJFO for the 2021 Low Development Scenario (Figure 5-6a, top right) with a maximum contribution of only 0.8 ppb (Table 5-40).

Lower 4th high DMAX8 ozone contributions are seen for UFO new Federal O&G with highest ozone contributions of 0.8, 0.2 and 0.6 ppb for the, respectively, 2021 High, Low and Medium Development Scenarios occurring in the northeast corner of the UFO Planning Area (Figure 5-6b). Even smaller ozone contributions still are seen due to new Federal O&G within the USFS-PG area with a maximum values of 0.5, 0.1 and 0.3 ppb for the 2021 High, Low and Medium Development Scenarios, respectively (Figure 5-6c).

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The maximum ozone contribution due to Federal O&G and mining throughout the 13 CO Planning areas for the 2021 High, Low and Medium Development Scenarios are, respectively, 7.9, 2.8 and 6.1 ppb and occur in the Piceance Basin (Table 5-40 and Figure 5-6d). There are several areas with ozone contributions of 3 ppb or more for the 2021 High and Medium Development Scenarios and the Cumulative Emissions Source Group T (new Federal and non-Federal O&G and mining in the 14 BLM Planning Areas), including the Piceance and D-J Basins but also in southeastern Colorado (RGFO area No. 2) as shown in the top left and bottom panels of Figure 5-6e. Substantial ozone reductions are seen in the 2021 Low Development Scenario (Figure 5-6e, top right) with the highest ozone being reduced from 8.4 and 7.0 ppb in the High and Medium scenarios to 4.4 ppb in the Low Development Scenario.

Figure 5-6f displays the reduction in 4th highest DMAX8 ozone concentrations due to the elimination of all O&G in the 4 km CARMMS domain. All of the major O&G Basins exhibit reductions in ozone in excess of 3 ppb in the 2021 High and Medium Development Scenarios with the highest ozone reduction occurring in the Uinta Basin of 9.4 ppb for both the High and Medium Development scenarios and 9.2 ppb for the Low Development Scenario. Note that the same O&G emissions were used in the Uinta Basin for the three CARMMS 2021 Scenarios that came from the BLM UTSO ARMS study, which explains why there is little difference in the peak ozone contribution for the three scenarios.

Table 5-40. Maximum contribution to the 4th highest DMAX8 ozone (ppb) for each of the Source Groups and the 2021 High, Low and Medium Development Scenarios.

Source Group	High	Low	Medium
A. Little Snake FO	1.0	0.3	1.0
B. White River FO	3.9	1.2	3.6
C. Colorado River Valley FO (w/o Roan Plateau)	2.6	1.5	2.3
D. Roan Plateau	3.8	1.7	3.3
E. Grand Junction FO	4.4	0.8	3.6
F. Uncompahgre FO	0.8	0.2	0.6
G. Tres Rios FO	1.4	0.4	1.4
H. Kremmling FO	0.5	0.1	0.5
I. Royal Gorge FO No. 1 (North)	0.1	0.0	0.1
J. Pawnee Grasslands	0.5	0.1	0.3
K. Royal Gorge FO No. 2	0.9	0.1	0.7
L. Royal Gorge FO No. 3	0.2	0.1	0.2
M. Royal Gorge FO No. 4	0.1	0.0	0.1
N. New Mexico Farmington FO (Mancos)	1.1	0.8	0.8
O. Colorado River Valley FO (w/ Roan Plateau)	5.0	2.1	3.9
P. Royal Gorge FO (total)	0.9	0.1	0.7
Q. Federal Mining in Colorado	0.9	0.9	0.9
R. New Federal O&G and Mining In Colorado	7.9	2.8	6.1
S. New Federal/Non-Federal O&G/Mining in CO	8.4	4.4	7.0
T. New Federal/Non-Federal O&G/Mining in CO/NM	8.4	4.4	7.0
U. Existing and New Fed/Non-Fed O&G in 4 km Domain	9.4	9.2	9.4
V. Natural Emissions	5.6	5.7	5.6

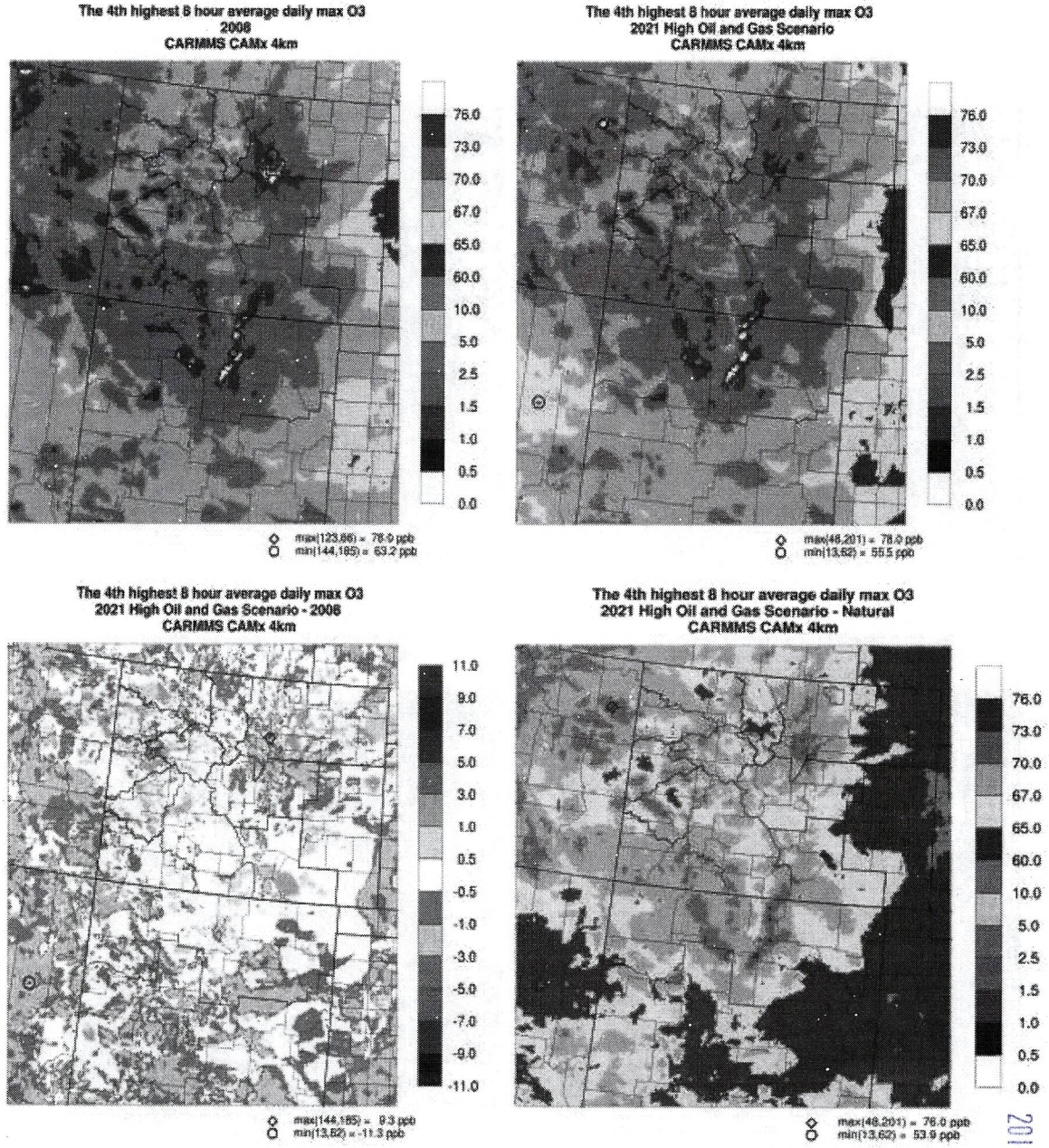

Figure 5-5a. Fourth highest daily maximum 8-hour ozone concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 High minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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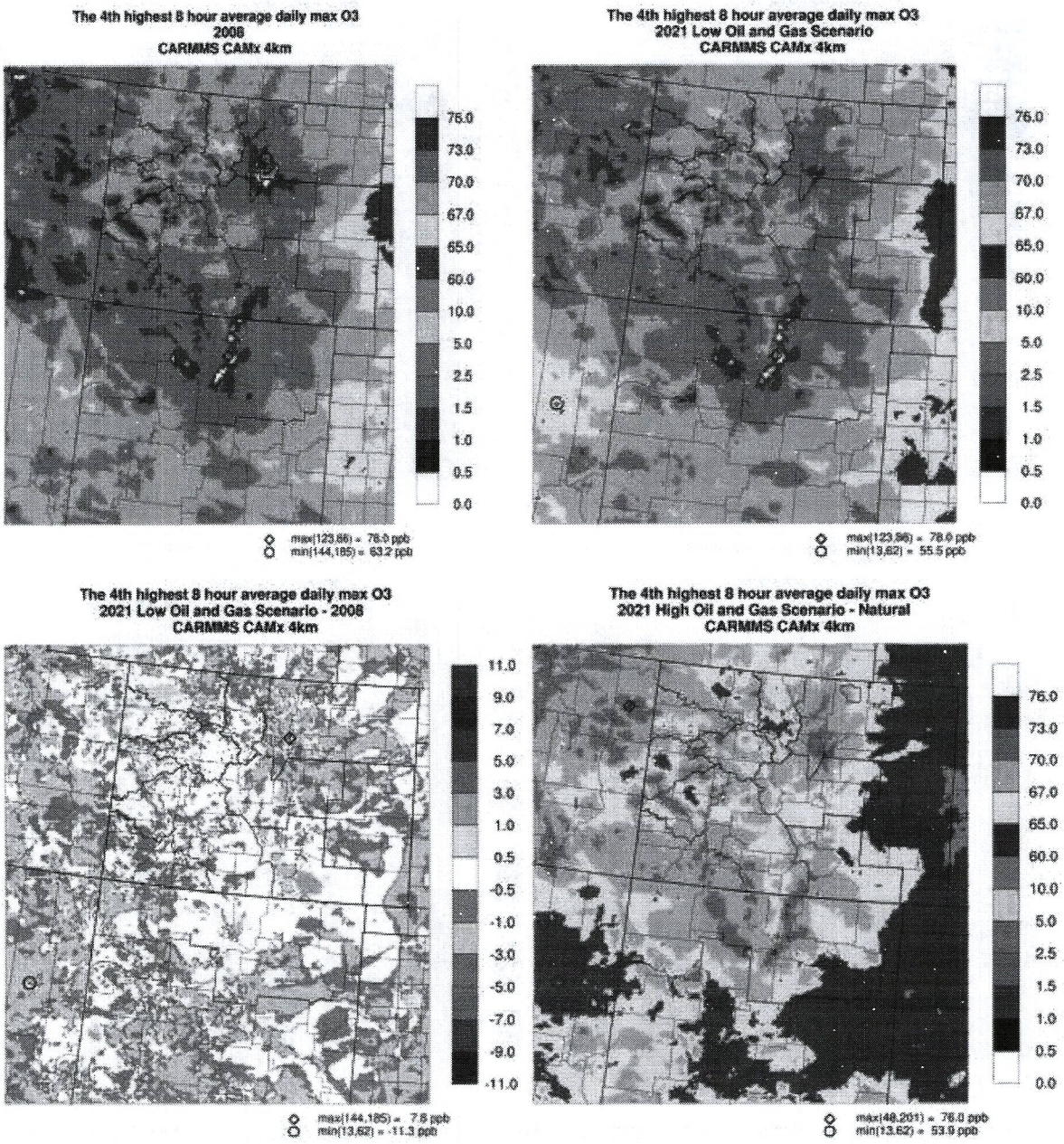

Figure 5-5b. Fourth highest daily maximum 8-hour ozone concentrations for the 2008 Base Case (top left), 2021 Low Development Scenario (top right), 2021 Low minus 2008 differences (bottom left) and Natural Emissions (bottom right).

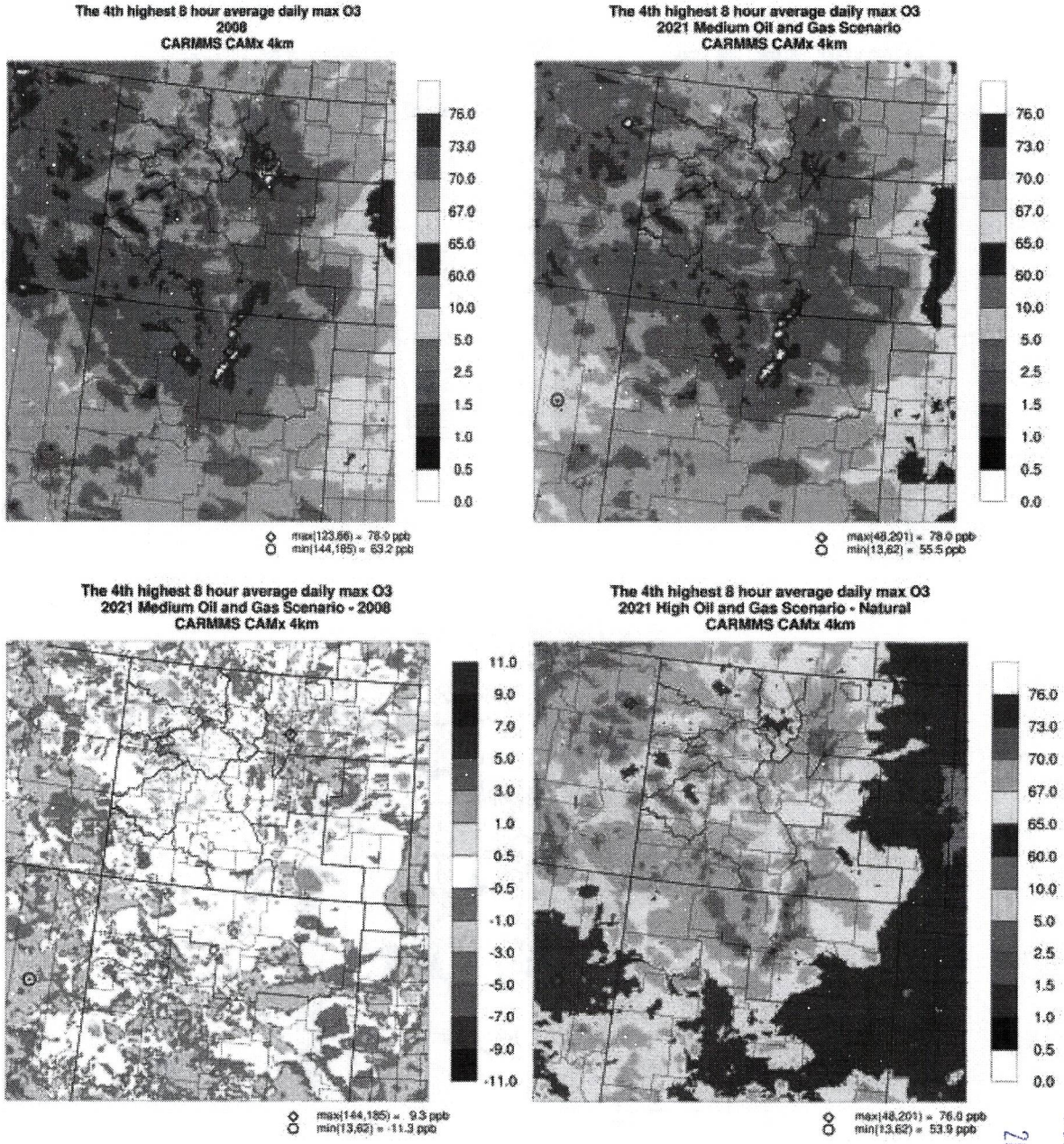

Figure 5-5c. Fourth highest daily maximum 8-hour ozone concentrations for the 2008 Base Case (top left), 2021 Medium Development Scenario (top right), 2021 Medium minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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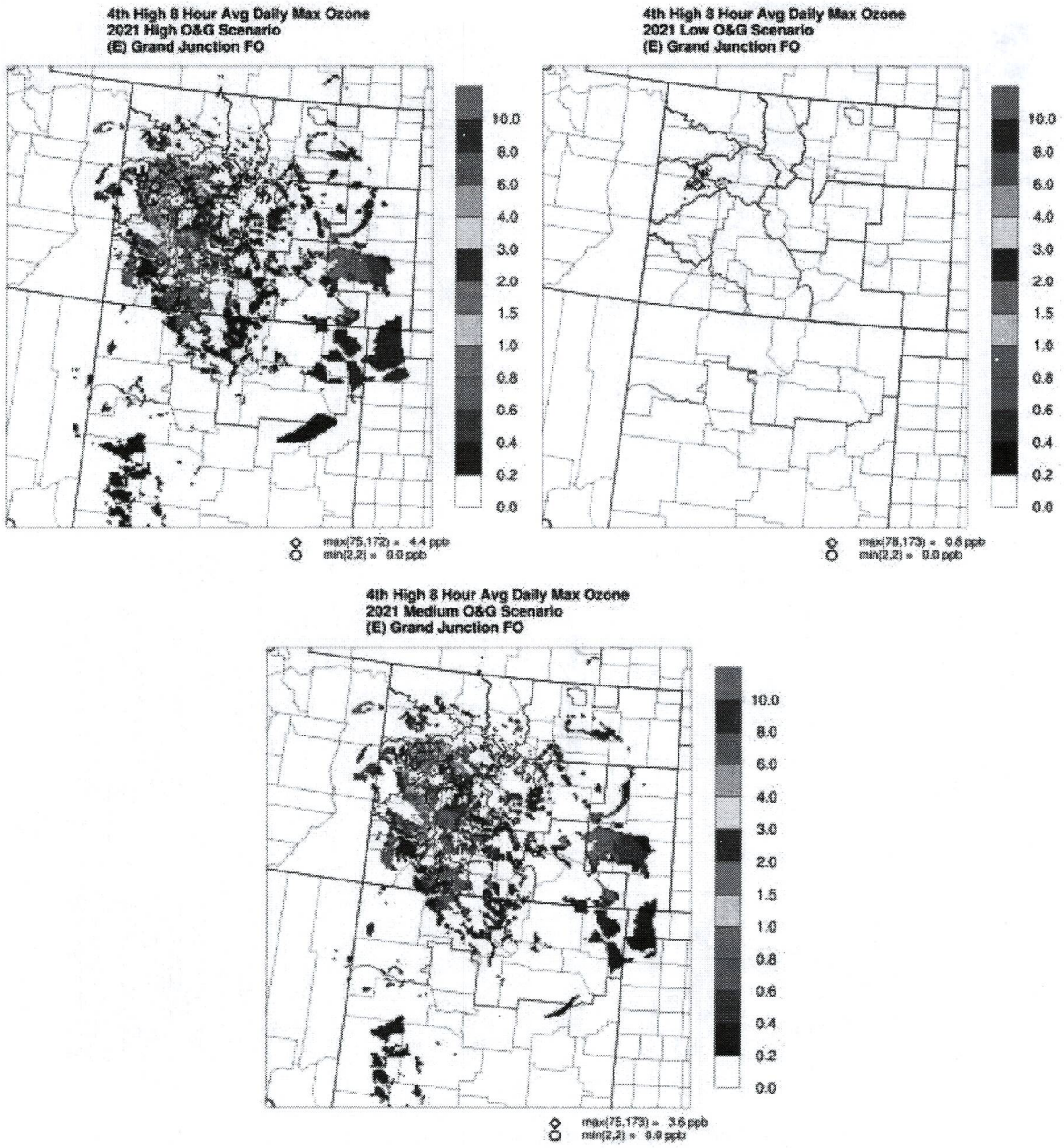

Figure 5-6a. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from new Federal O&G within the GJFO (Source Group E) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

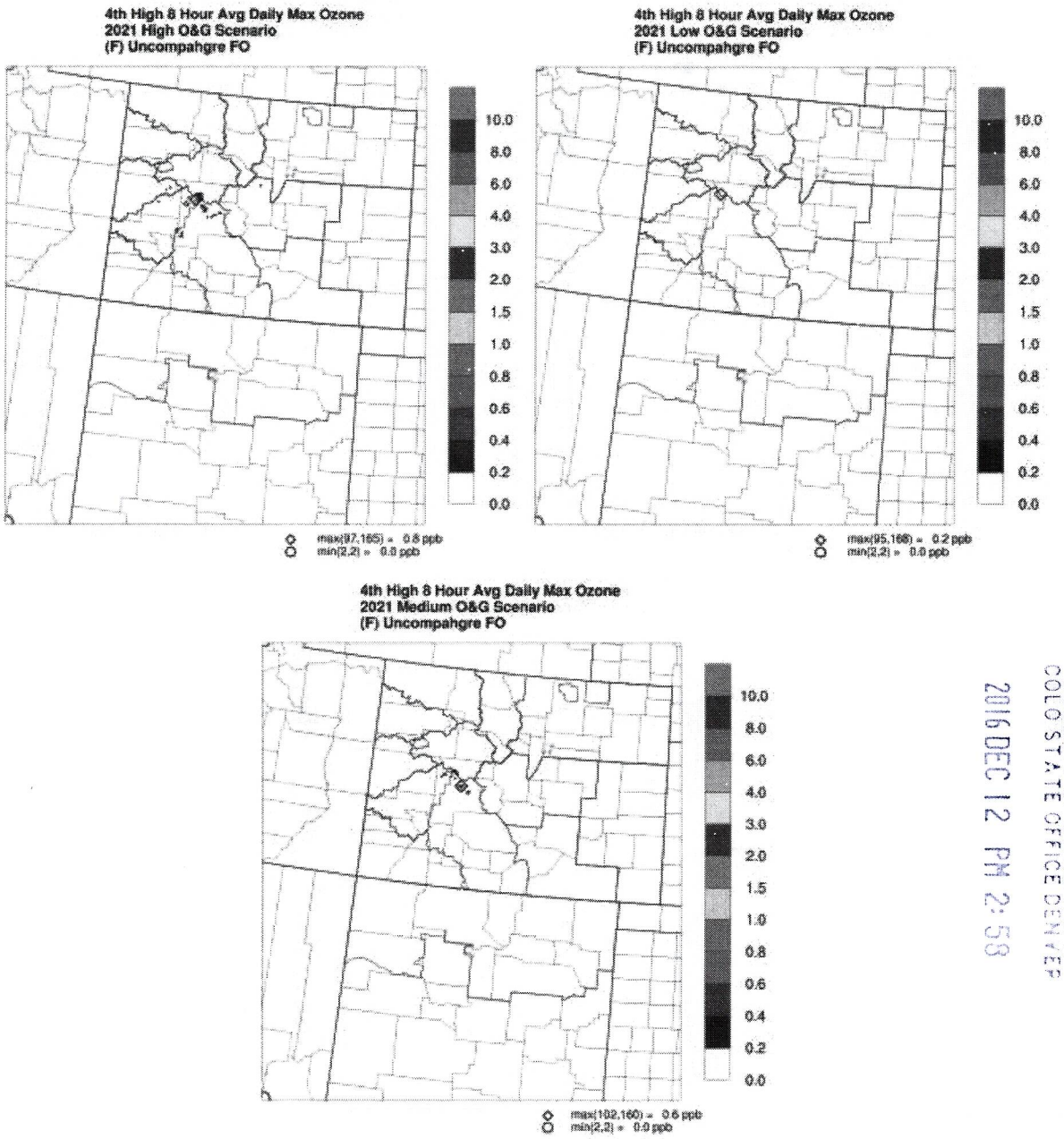

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Figure 5-6b. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from new Federal O&G within the UFO (Source Group F) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

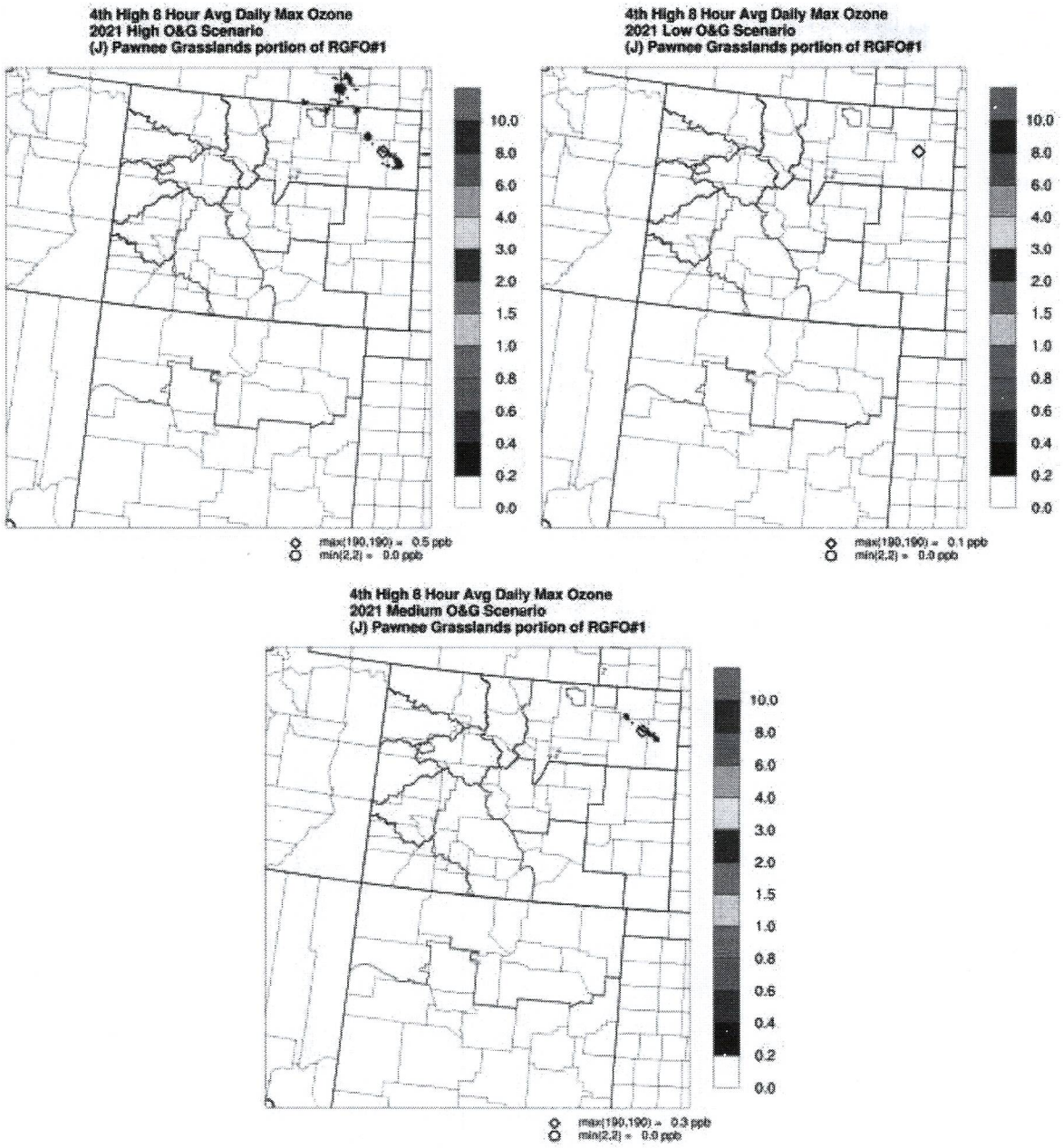

Figure 5-6c. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from new Federal O&G within the USFS Pawnee Grasslands (Source Group J) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

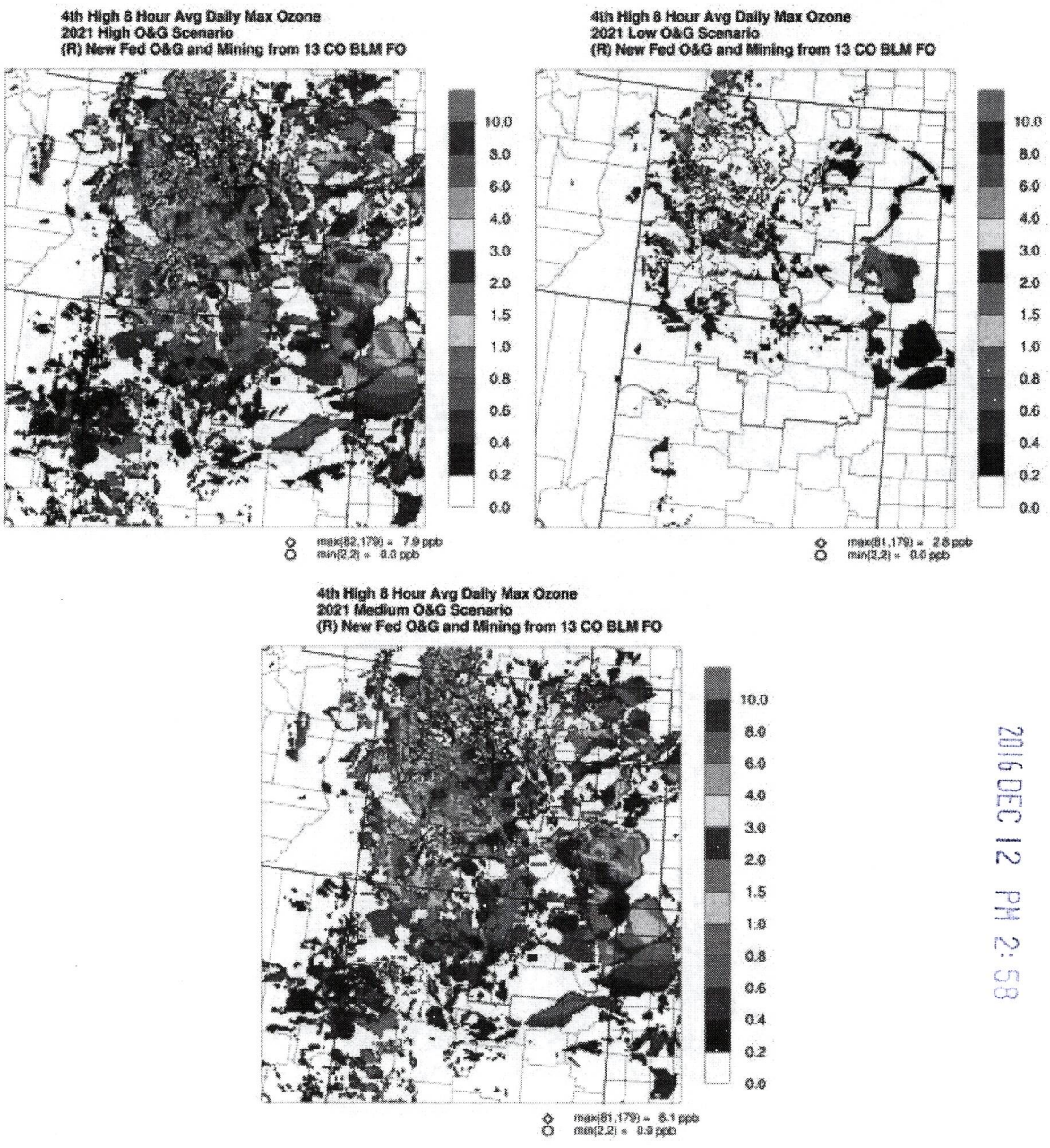

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Figure 5-6d. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from new Federal O&G and mining within the 13 Colorado BLM Planning Areas (Source Group R) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

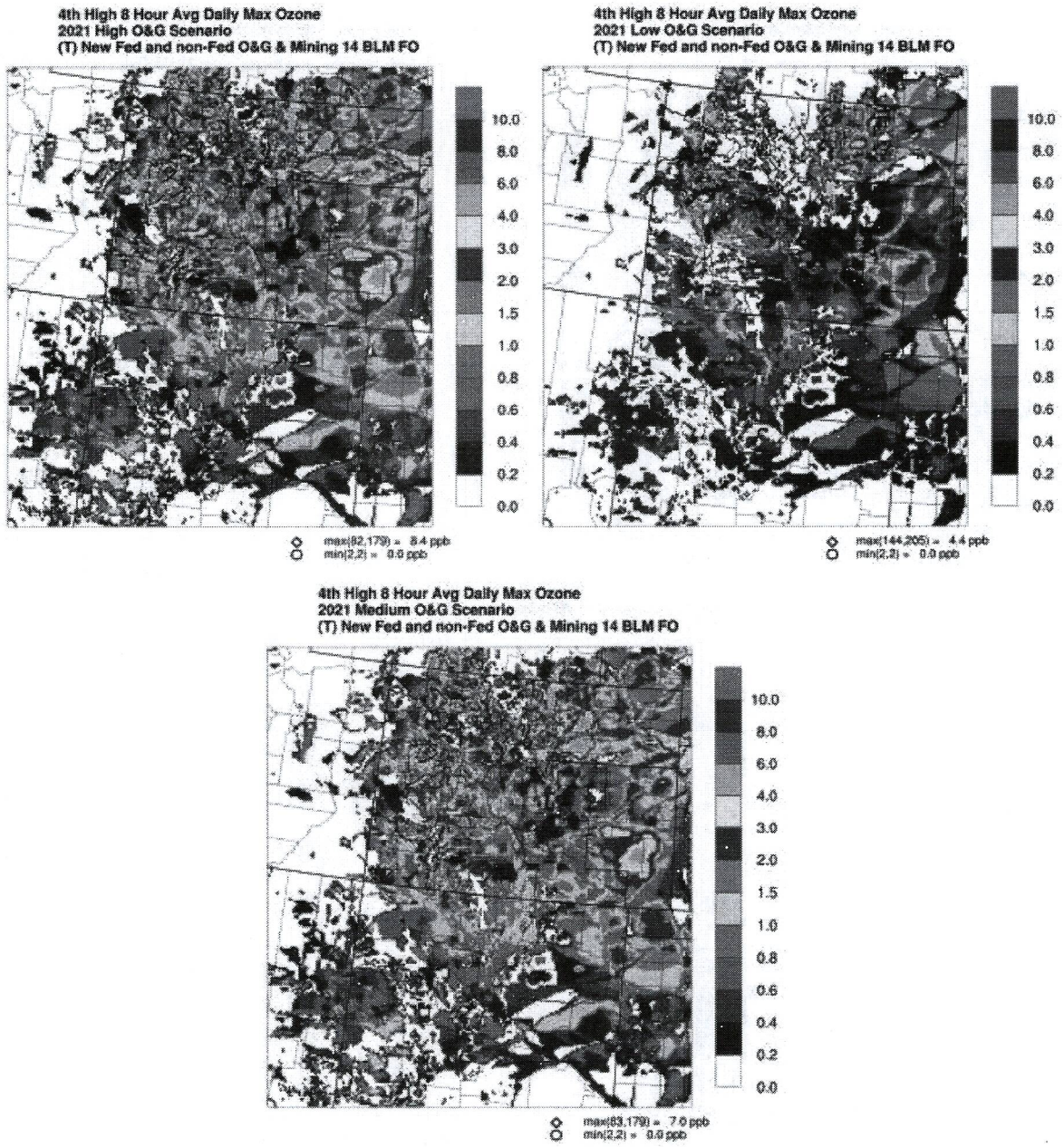

Figure 5-6e. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from new Federal and non-Federal O&G and mining within the 14 CO/NM BLM Planning Areas (Source Group T) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

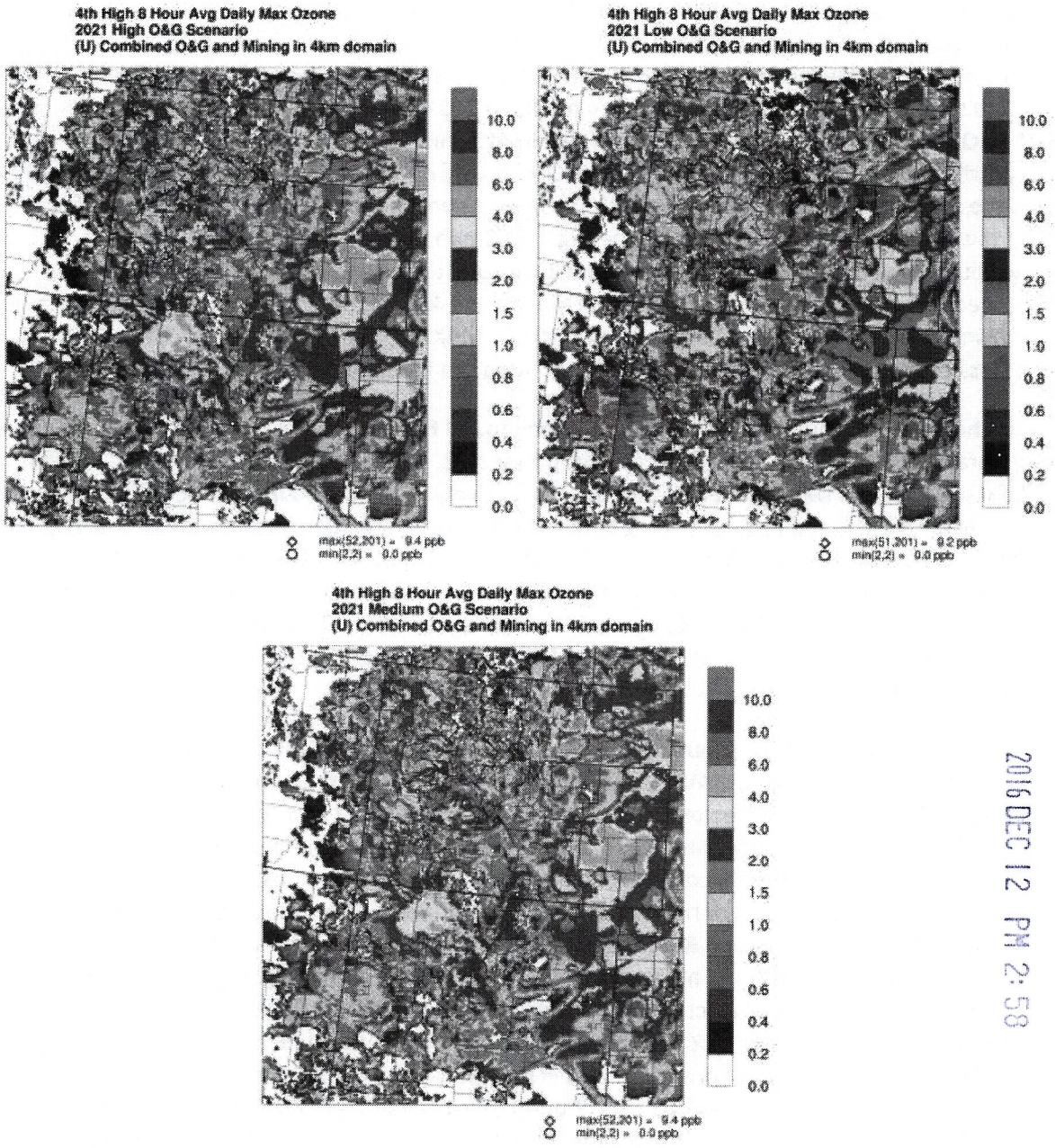

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Figure 5-6f. Contributions to fourth highest daily maximum 8-hour ozone due to emissions from existing, new Federal and non-Federal O&G within the entire CARMMS 4 km domain and Federal mining in Colorado (Source Group U) for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

5.6.2.2 Source Group Absolute Contributions to Ozone Exceedances

The contributions of each Source Group to 4th highest DMAX8 ozone above the current ozone NAAQS (76.0 ppb and higher) for the 2021 High, Low and Medium Development Scenarios are contained in Attachments G-1, G-2 and G-3, respectively. The Attachment G interactive Excel spreadsheet contains two sheets: "StatTable" that displays the maximum ozone contribution for each Source Group to modeled 2021 DMAX8 ozone greater than the NAAQS; and "Scatter_by_exceedance_region" that shows the ozone contribution of a Source Group, controlled by cell C1, to all grid cells with modeled 2021 4th high DMAX8 ozone greater than the NAAQS by region. Table 5-41 from StatTable in Attachment G lists the maximum ozone contribution to any modeled 2021 4th high DMAX8 ozone greater than the NAAQS. The WRFO is the individual BLM Planning Area with the largest contribution to 2021 modeled exceedances of the ozone NAAQS of 1.83 ppb for the High, 0.43 ppb for the Low and 1.66 ppb for the Medium Development Scenarios when the 2021 total ozone was 76.5, 77.0 and 76.3 ppb, respectively. All of the other individual BLM Planning Areas (Source Groups A through P) have maximum ozone contributions to modeled 2021 DMAX8 ozone in excess of the ozone NAAQS of less than 1 ppb for the 2021 High, Low and Medium Development Scenarios.

The highest contribution to 2021 DMAX8 ozone for all Federal O&G and mining within the 13 Colorado BLM Planning Areas (Source Group R) is 3.22, 0.86 and 2.84 ppb for the 2021 High, Low and Medium Development Scenarios, respectively. The contribution of new Federal and non-Federal O&G and Federal mining within the 14 BLM Planning Areas (Source Group T) to 2021 DMAX8 ozone exceedances are 5.32, 2.25 and 4.91 ppb for the High, Low and Medium Development Scenarios, respectively. The highest contribution of all O&G in the CARMMS domain to modeled 2021 DMAX8 ozone exceedances is 31.94, 30.73 and 31.79 ppb for the 2021 High, Low and Medium Development Scenarios that is primarily due to O&G emissions in the Uinta Basin.

Figure 5-7 displays the contribution of Federal O&G emissions from the GJFO BLM Planning Area to the 2021 4th high DMAX8 ozone at all grid cells in the domain that came from the "Scatter_by_exceedance_region" sheet in Attachments G-1, G-2 and G-3. GJFO has the highest contribution to ozone exceedances in the Uinta Basin with contributions of ~0.70, ~0.06 and ~0.60 ppb for the 2021 High, Low and Medium Development Scenarios, respectively (Figure 5-7a, left). The contributions of new Federal O&G and mining within the 13 Colorado BLM Planning Areas (Source Group R) to exceedances of the ozone NAAQS is shown in the right panels in Figure 5-7a with the highest contributions of ~3.0, ~0.8 and 2.5 ppb for the High, Low and Medium Scenarios, respectively, occurring in the Uinta Basin. Source Group R also contributes ~1.5, ~0.1 and ~0.8 ppb to ozone exceedances in the Denver area for the High, Low and Medium Development Scenarios. Add in new non-Federal O&G that is contained in Source Group T greatly increases the O&G contribution to exceedances in the Denver area with contributions of ~4, ~1 and ~ 1 ppb for the High, Low and Medium Development Scenarios, respectively (Figure 5-7b, left). Add in the O&G emissions from the Uinta Basin (Source Group U) results in contributions of ~30 ppb to ozone exceedances in the Uinta Basin (Figure 5-7b, right).

Table 5-41a. Maximum ozone contribution by Source Group to total modeled 2021 4th high DMAX8 ozone greater than the NAAQS for the 2021 High Development Scenario.

Group	Name	Max		
		Max Contribution (ppb)	Corresponding 4th MDA8	% Max Contribution
A	Little Snake FO	0.2586	76.7	0.34%
B	White River FO	1.8306	76.5	2.39%
C	Colorado River Valley FO (CRVFO)	0.1765	76.5	0.23%
D	Roan Plateau Planning area portion of CRVFO	0.1608	76.5	0.21%
E	Grand Junction FO	0.7570	77.3	0.98%
F	Uncompahgre FO	0.0725	76.5	0.09%
G	Tres Rios FO	0.6715	76.7	0.88%
H	Kremmling FO	0.0678	76.8	0.09%
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0073	76.0	0.01%
J	Pawnee Grasslands portion of RGFO#1	0.0321	76.0	0.04%
K	RGFO#2 – West-Central/South	0.0015	76.0	0.00%
L	RGFO#3 – South	0.0030	76.0	0.00%
M	RGFO#4 – East-Central	0.0039	76.0	0.01%
N	New Mexico Farmington District	0.2340	78.0	0.30%
O	Total Colorado River Field Office	0.3374	76.5	0.44%
P	Total Royal Gorge Field Office	0.0477	76.0	0.06%
Q	Mining from 13 Colorado BLM Planning Areas	0.1104	76.7	0.14%
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	3.2125	76.5	4.20%
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	5.2711	76.5	6.89%
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	5.3221	76.5	6.96%
U	Combined O&G and Mining in 4 km domain	31.9435	76.4	41.80%
V	Natural Emissions	2.6494	76.5	3.46%

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Table 5-41b. Maximum ozone contribution by Source Group to total modeled 2021 4th high DMAX8 ozone greater than the NAAQS for the 2021 Low Development Scenario.

Group (low O&G)	Name	Max		
		Max Contribution (ppb)	Corresponding 4th MDA8	% Max Contribution
A	Little Snake FO	0.0480	76.4	0.06%
B	White River FO	0.4321	77.0	0.56%
C	Colorado River Valley FO (CRVFO)	0.1406	77.0	0.18%
D	Roan Plateau Planning area portion of CRVFO	0.1043	77.0	0.14%
E	Grand Junction FO	0.0608	76.1	0.08%
F	Uncompahgre FO	0.0249	77.0	0.03%
G	Tres Rios FO	0.0926	76.0	0.12%
H	Kremmling FO	0.0021	76.3	0.00%
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0021	76.3	0.00%
J	Pawnee Grasslands portion of RGFO#1	0.0104	76.3	0.01%
K	RGFO#2 – West-Central/South	0.0000	76.9	0.00%
L	RGFO#3 – South	0.0002	77.0	0.00%
M	RGFO#4 – East-Central	0.0015	76.3	0.00%
N	New Mexico Farmington District	0.2342	78.0	0.30%
O	Total Colorado River Field Office	0.2449	77.0	0.32%
P	Total Royal Gorge Field Office	0.0140	76.3	0.02%
Q	Mining from 13 Colorado BLM Planning Areas	0.1164	76.4	0.15%
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	0.8622	77.0	1.12%
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	2.1963	77.0	2.85%
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	2.2502	77.0	2.92%
U	Combined O&G and Mining in 4 km domain	30.7272	77.0	39.93%
V	Natural Emissions	2.8167	77.0	3.66%

Table 5-41c. Maximum ozone contribution by Source Group to total modeled 2021 4th high DMAX8 ozone greater than the NAAQS for the 2021 Medium Development Scenario.

Group (medium O&G)	Name	Max		
		Max Contribution (ppb)	Corresponding 4th MDA8	% Max Contribution
A	Little Snake FO	0.2360	76.7	0.31%
B	White River FO	1.6579	76.3	2.17%
C	Colorado River Valley FO (CRVFO)	0.1461	76.3	0.19%
D	Roan Plateau Planning area portion of CRVFO	0.1353	78.0	0.17%
E	Grand Junction FO	0.6520	77.1	0.85%
F	Uncompahgre FO	0.0576	76.3	0.08%
G	Tres Rios FO	0.5825	76.7	0.76%
H	Kremmling FO	0.0594	76.8	0.08%
I	Royal Gorge FO Area#1 (RGFO#1) -- North	0.0003	77.1	0.00%
J	Pawnee Grasslands portion of RGFO#1	0.0019	77.1	0.00%
K	RGFO#2 – West-Central/South	0.0002	77.1	0.00%
L	RGFO#3 – South	0.0002	77.1	0.00%
M	RGFO#4 – East-Central	0.0019	76.3	0.00%
N	New Mexico Farmington District	0.1829	78.0	0.23%
O	Total Colorado River Field Office	0.2807	78.0	0.36%
P	Total Royal Gorge Field Office	0.0043	77.1	0.01%
Q	Mining from 13 Colorado BLM Planning Areas	0.1111	76.6	0.14%
R	Combined new Federal O&G and Mining from the 13 Colorado BLM Planning Areas	2.8433	76.3	3.73%
S	Combined new Federal and non-Federal O&G and Mining from 13 Colorado BLM Planning Areas	4.8718	76.3	6.39%
T	Cumulative Emissions Scenario – New Federal and non-Federal O&G from 14 BLM Planning Areas plus mining in the 14 BLM Planning Areas	4.9114	76.3	6.44%
U	Combined O&G and Mining in 4 km domain	31.7908	78.0	40.75%
V	Natural Emissions	2.6588	76.3	3.49%

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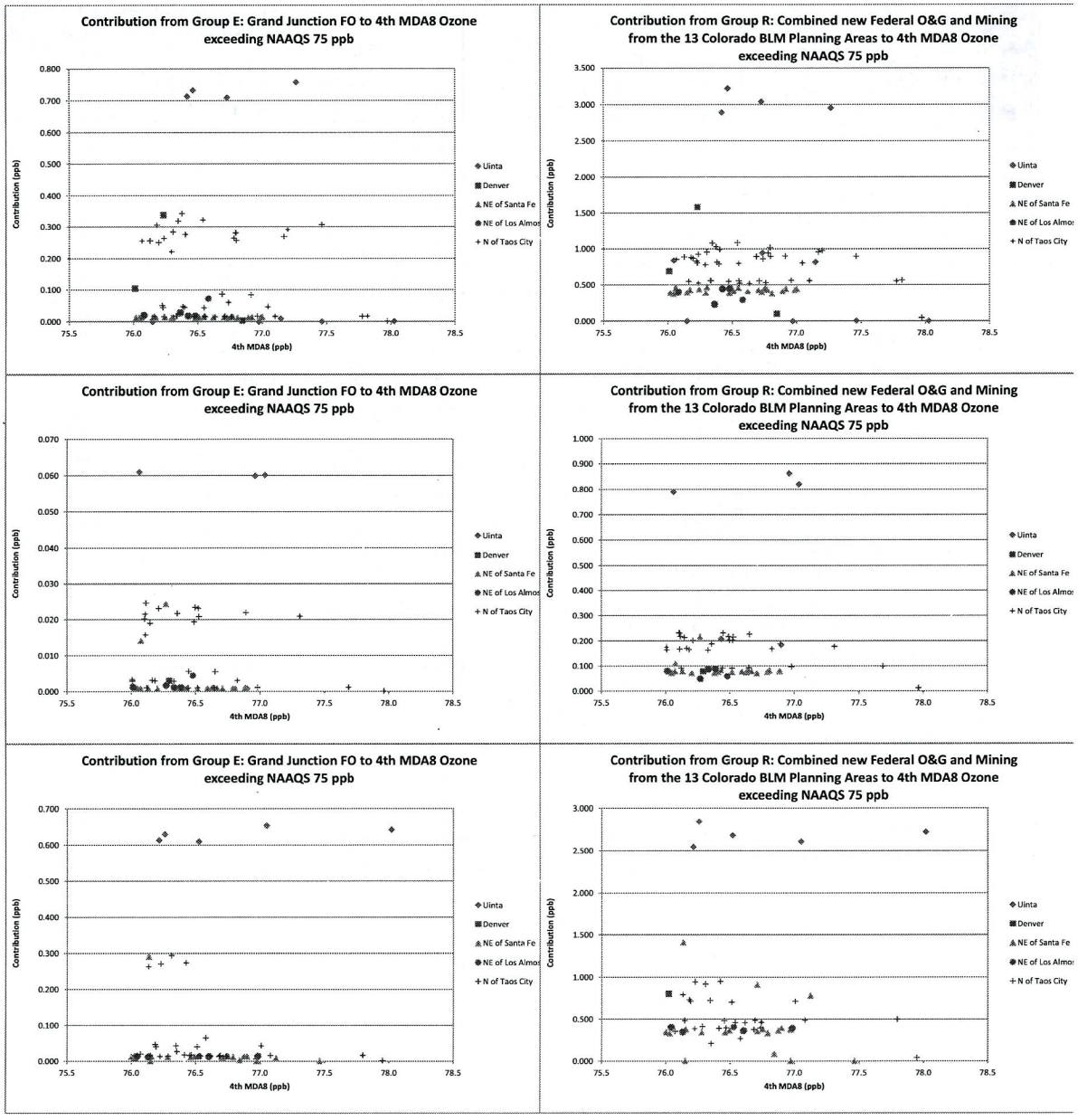

Figure 5-7a. Contributions of Federal O&G from the GJFO (Source Group E; left) and new Federal O&G and mining in the 13 Colorado Planning Areas (Source Group R; right) to modeled fourth highest daily maximum 8-hour ozone concentrations greater than the NAAQS for the 2021 High (top), Low (middle) and Medium (bottom) Development Scenarios.

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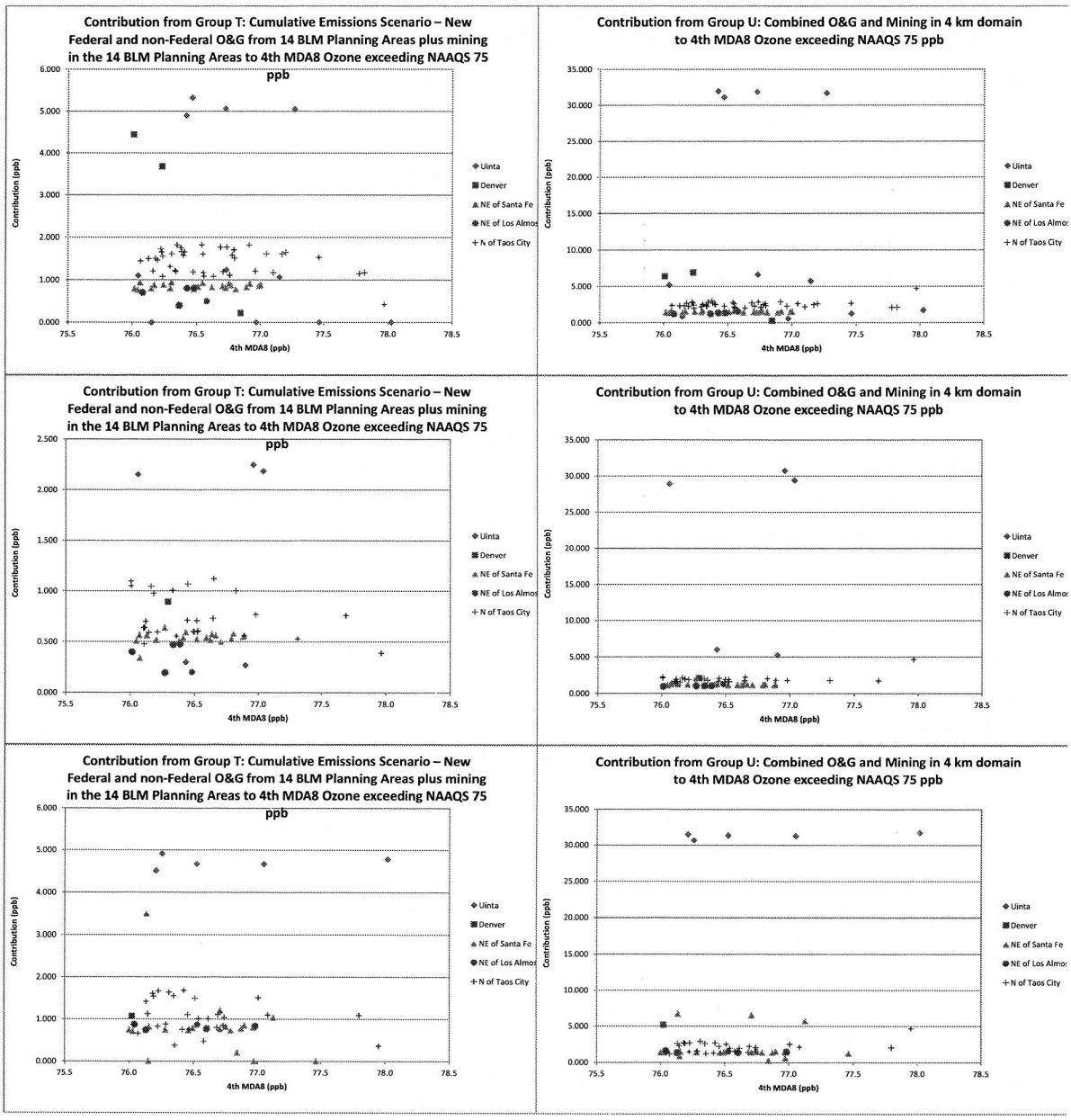

Figure 5-7b. Contributions of new Federal and non-Federal O&G and mining from the 14 BLM Planning Areas (Source Group T; left) and all O&G within the 4 km CARMMS domain plus Colorado Federal mining (Source Group U; right) to modeled fourth highest daily maximum 8-hour ozone concentrations greater than the NAAQS for the 2021 High (top), Low (middle) and Medium (bottom) Development Scenarios.

5.6.3 $PM_{2.5}$ NAAQS Analysis

There are two $PM_{2.5}$ NAAQS, one for a 24-hour averaging time that is expressed as a three-year average of the 98th percentile value in a year with a threshold of 35 $\mu g/m^3$ and an annual average over three-years with a threshold of 12 $\mu g/m^3$. With a complete year of modeling results, the 98th percentile corresponds to the 8th highest daily $PM_{2.5}$ concentration in a year.

5.6.3.1 24-Hour $PM_{2.5}$ NAAQS Analyses

Figure 5-8 displays the 8th highest 24-hour $PM_{2.5}$ concentrations for the 2008 Base Case and 2021 emission scenarios and their differences and the contributions of Natural Emissions to the 8th highest 24-hour $PM_{2.5}$ concentration. The maximum 8th high 24-hour $PM_{2.5}$ in 2008 (670 $\mu g/m^3$) and 2021 High, Low and Medium Development Scenarios (671 $\mu g/m^3$) far exceeds the 35 $\mu g/m^3$ NAAQS (Figure 5-8, top panels). This high value occurs on the southern border of the CARMMS 4 km domain and is due to emissions from wildfires, as shown by its absence when Natural Emissions are removed (Figure 5-8, bottom right). Even without Natural Emissions, there are several areas where the model-estimated 8th highest 24-hour $PM_{2.5}$ concentration exceeds the NAAQS in the 2021 emissions scenarios as shown in Figure 5-9 for the 2021 High Development Scenario. These 24-hour $PM_{2.5}$ exceedance areas are identified in Figure 5-9 with numbered labels. In the analysis below we group several exceedance grid cells together: North NM (Areas 13-18); Arizona (Areas 7-9); and Central NM (Areas 11-12).

Attachments H-1, H-2 and H-3 display Source Group's contribution to 8th highest 24-hour $PM_{2.5}$ concentrations when the total concentration is above the NAAQS for the, respectively, 2021 High, Low and Medium Development Scenarios. Figure 5-10 from Attachment H-1 displays the contributions of Natural Emissions (Source Group V) and Federal mining in Colorado (Source Group Q) to the 8th highest 24-hour $PM_{2.5}$ concentration in the 2021 High Development Scenario when it exceeds the 24-hour $PM_{2.5}$ NAAQS. The exceedances in Ruidoso NM (Area 10) and North NM (Areas 13-18) appear to be due to wildfires (Natural Emissions) based on the top panel in Figure 5-10. Mining on Federal lands (Source Group Q) is causing the exceedance in South Moffat County (Area 3) based on the bottom panel in Figure 5-10.

The contributions to the 8th highest daily $PM_{2.5}$ concentrations that exceed the NAAQS from Source Groups R and S and the 2021 High Development Scenario are shown in Figure 5-11. For Source Group R, the scale has been set at a maximum of 0.25 $\mu g/m^3$ (Figure 5-11, top) so the 45.8 $\mu g/m^3$ contribution from mining in South Moffat County that was seen in Figure 5-10 (bottom) is not shown. This figure indicates that new Federal O&G within the 13 CO BLM Planning Areas contribute less than 0.25 $\mu g/m^3$ when the modeled 2021 8th highest 24-hour $PM_{2.5}$ concentration exceeds the NAAQS (Figure 5-11, top). Adding in the non-Federal O&G emissions (Source Group S; Figure 5-11, bottom) we see contributions due to non-Federal O&G to modeled exceedances of the NAAQS as high as 15 $\mu g/m^3$ that is due to non-Federal O&G emissions in the RGFO Planning Area north of Denver (Weld County).

Figure 5-12 displays the contributions of Federal O&G from the GRFO, UFO and USFS-PG Planning Areas and combined Source Group R (new Federal O&G and mining in 13 Colorado Planning Areas) to the 8th highest 24-hour $PM_{2.5}$ concentrations for the 2021 High Development Scenario. Results for the 2021 Low and Medium Development Scenario are lower and can be

found in Attachment I. The maximum contribution to 8th highest 24-hour $PM_{2.5}$ concentration due to emissions from new Federal O&G in these four Source Groups and the 2021 High, Low and Medium Development Scenarios are: 1.2, 0.1 and 0.8 $\mu g/m^3$ (GJFO), 0.3, 0.1 and 0.2 $\mu g/m^3$ (UFO), 0.6, 0.1 and0.2 (USFS-PG) and 39.8, 29.8 and 39.8 $\mu g/m^3$ (Source Group R) (Table 5-42). The maximum contribution due to new Federal O&G and mining from all of the Colorado BLM Planning areas is 39.8 $\mu g/m^3$ that is due to a coal mine in the LSFO Planning Area, which explains the maximum contribution of Source Group R.

Figure 5-13 shows the contributions of new Federal and non-Federal O&G and mining in the 14 BLM Planning Areas (Source Group T) and all O&G emissions in the 4 km CARMMS domain (Source Group U) for the 2021 High, Low and Medium Development Scenarios. The maximum 24-hour $PM_{2.5}$ contribution in all four panels in Figure 5-12 is essentially identical (40 $\mu g/m^3$) and is due to a coal mine in the LSFO Planning Area. 24-hour $PM_{2.5}$ contributions in excess of 3 $\mu g/m^3$ can be seen in the D-J and Piceance Basins and the Uinta Basin for Source Group U.

Table 5-42 summarizes the maximum contribution to the 8th highest 24-hour $PM_{2.5}$ concentrations for all of the Source Groups and the 2021 High, Low and Medium Development Scenarios. For most BLM Planning Areas, the contribution of Federal O&G to the 8th highest 24-hour $PM_{2.5}$ concentrations is small, less than 1 $\mu g/m^3$. The exception to this is new Federal O&G emissions from the WRFO (5.6, 0.6 and3.2 $\mu g/m^3$) and GJFO (1.2, 0.1 and 0.8 $\mu g/m^3$) Planning Areas. As noted previously, mining on Federal lands in the LSFO contributes a maximum of 39.8 $\mu g/m^3$ to the 8th highest 24-hour $PM_{2.5}$ concentration; the mining contribution drives the maximum contribution for all of the combination Source Groups (Q through U).

The year 2021 minus year 2008 impacts difference plots (bottom left of Figures 5-8a, 5-8b and 5-8c) while comparing plots for Source Groups R and T indicates relatively large increases in 24-hour $PM_{2.5}$ concentrations primarily due to new non-Federal oil and gas in the RGFO. It should be noted that unpaved road traffic and construction fugitive dust emissions were calculated by the BLM COSO for all new RGFO Federal and non-Federal oil and gas development and the year 2008 emissions inventory did not account for total oil and gas related traffic / construction fugitive dust and therefore, the difference plots concentration changes (year 2021 minus year 2008) are overestimates.

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Table 5-42a. Maximum contribution to the 8th high 24-hour $PM_{2.5}$ concentrations ($\mu g/m^3$) for each of the Source Groups and the 2021 High, Low and Medium Development Scenarios.

Source Group	24-Hour $PM_{2.5}$ ($\mu g/m^3$)		
	High	Low	Medium
A. Little Snake FO	0.8	0.2	0.6
B. White River FO	5.6	0.6	3.2
C. CRVFO (No Roan)	0.4	0.2	0.3
D. Roan Plateau	0.3	0.1	0.3
E. Grand Junction FO	1.2	0.1	0.8
F. Uncompahgre FO	0.3	0.1	0.2
G. Tres Rios FO	0.3	0.0	0.2
H. Kremmling FO	0.1	0.0	0.0
I. Royal Gorge FO No. 1	0.2	0.0	0.1
J. Pawnee Grasslands	0.6	0.1	0.2
K. Royal Gorge FO No. 2	0.1	0.0	0.0
L. Royal Gorge FO No. 3	0.0	0.0	0.0
M. Royal Gorge FO No. 4	0.1	0.0	0.0
N. NMFFO (Mancos)	0.5	0.6	0.4
O. CRVFO (w/ Roan)	0.7	0.3	0.5
P. Royal Gorge FO (total)	0.7	0.2	0.2
Q. Federal Mining in CO	39.8	39.8	39.8
R. New Federal O&G/Mining in CO	39.8	39.8	39.8
S. New O&G/Mining in CO	40.0	39.8	39.9
T. New O&G/Mining in CO/NM	40.0	39.8	39.9
U. All O&G in 4 km Domain	40.0	40.0	40.0
V. Natural Emissions	658.2	658.2	658.2

Table 5-42b. Maximum contribution to the annual $PM_{2.5}$ concentrations ($\mu g/m^3$) for each of the Source Groups and the 2021 High, Low and Medium Development Scenarios.

Source Group	Annual $PM_{2.5}$ ($\mu g/m^3$)		
	High	Low	Medium
A. Little Snake FO	0.7	0.1	0.5
B. White River FO	4.4	0.7	2.6
C. CRVFO (No Roan)	0.3	0.2	0.2
D. Roan Plateau	0.2	0.1	0.2
E. Grand Junction FO	1.0	0.1	0.6
F. Uncompahgre FO	0.2	0.1	0.1
G. Tres Rios FO	0.4	0.1	0.2
H. Kremmling FO	0.0	0.0	0.0
I. Royal Gorge FO No. 1	0.1	0.0	0.0
J. Pawnee Grasslands	0.2	0.0	0.1
K. Royal Gorge FO No. 2	0.0	0.0	0.0
L. Royal Gorge FO No. 3	0.0	0.0	0.0
M. Royal Gorge FO No. 4	0.1	0.0	0.0
N. NMFFO (Mancos)	0.3	0.3	0.2
O. CRVFO (w/ Roan)	0.5	0.3	0.3
P. Royal Gorge FO (total)	0.3	0.1	0.1
Q. Federal Mining in CO	20.7	20.7	20.7
R. New Federal O&G/Mining in CO	20.7	20.7	20.7
S. New O&G/Mining in CO	20.7	20.7	20.7
T. New O&G/Mining in CO/NM	20.7	20.7	20.7
U. All O&G in 4 km Domain	20.8	20.7	20.8
V. Natural Emissions	26.4	26.4	26.4

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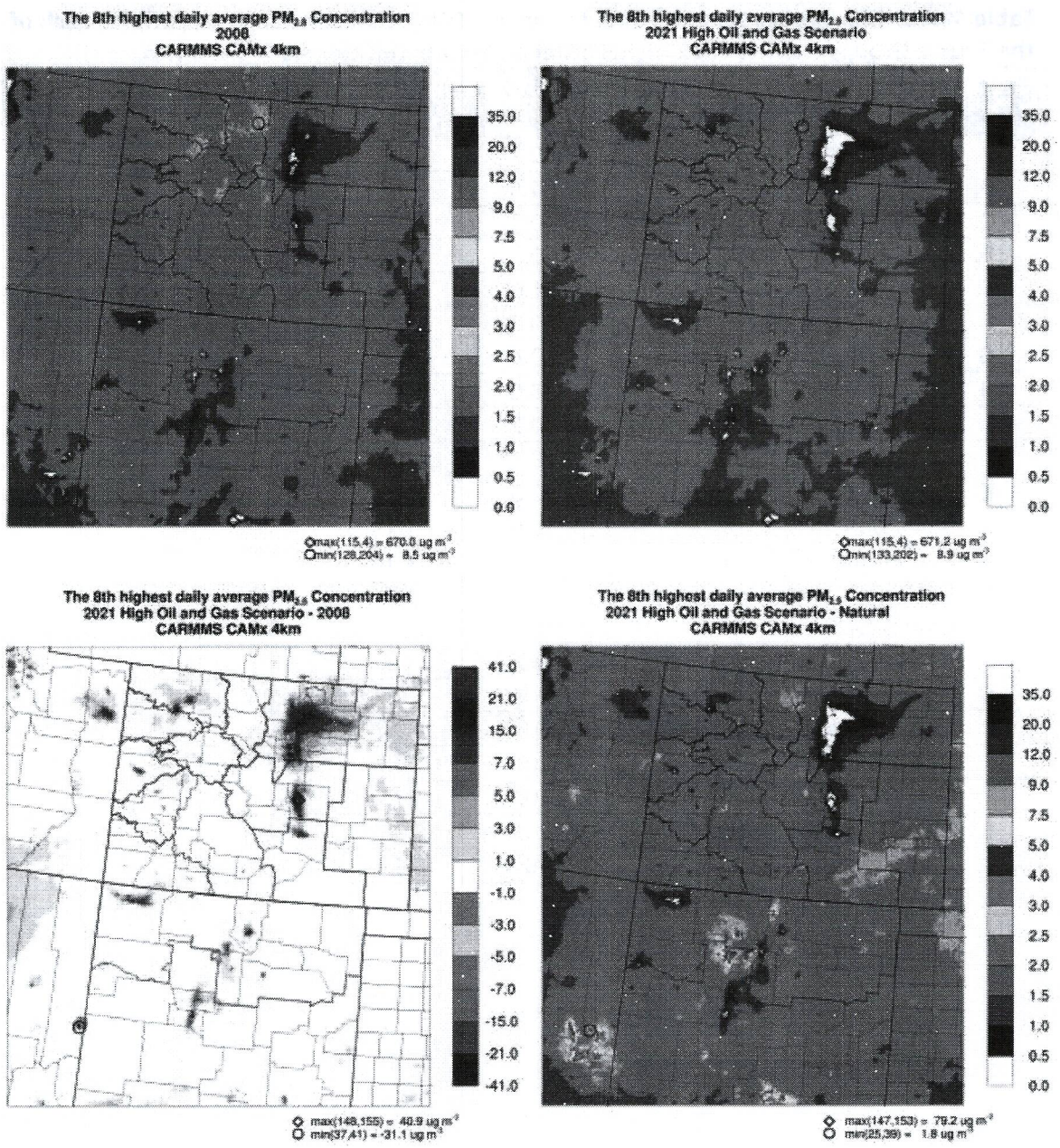

Figure 5-8a. Eighth highest 24-hour $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 High minus 2008 differences (bottom left) and Natural Emissions (bottom right).

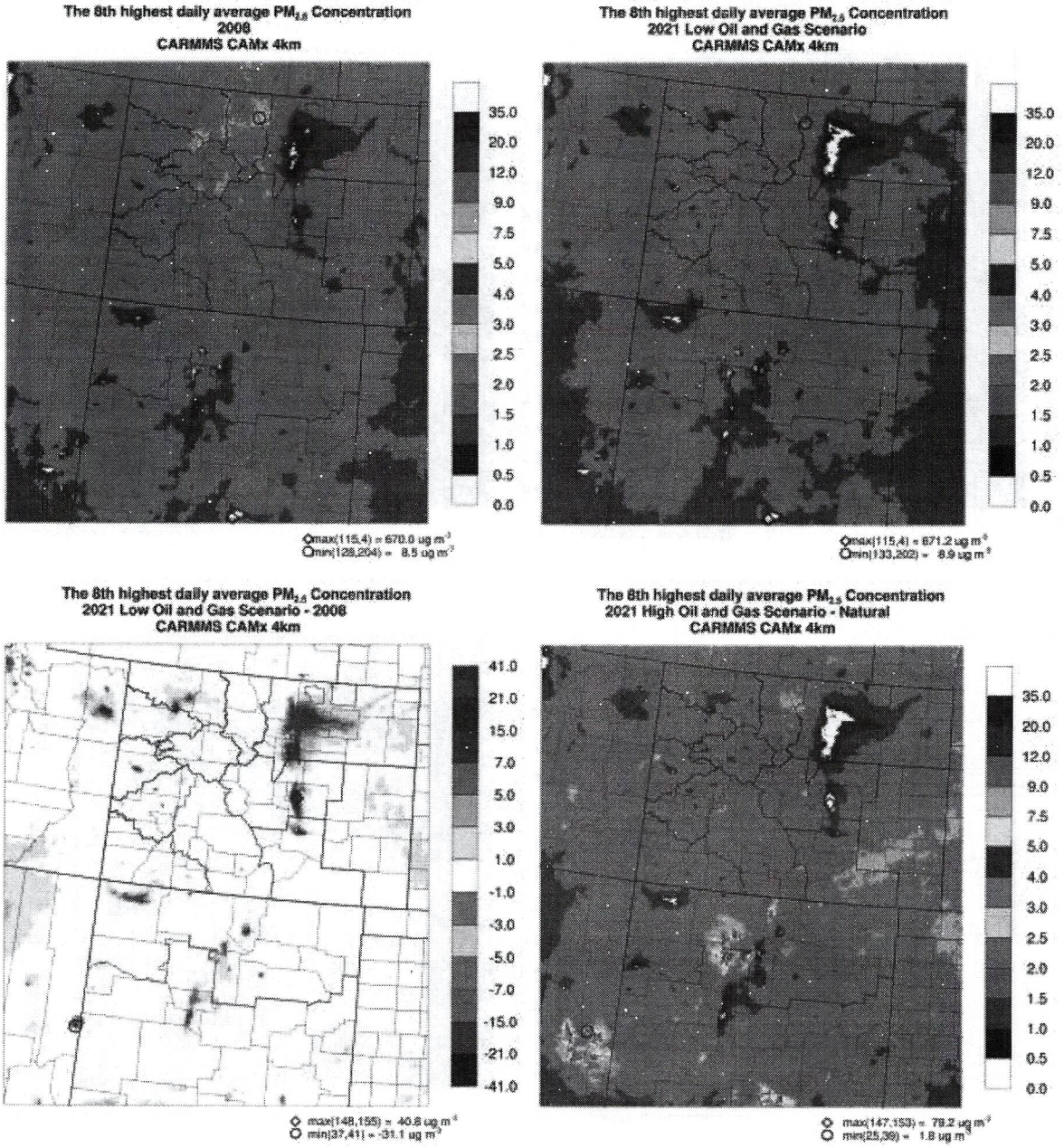

Figure 5-8b. Eighth highest 24-hour $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 Low Development Scenario (top right), 2021 Low minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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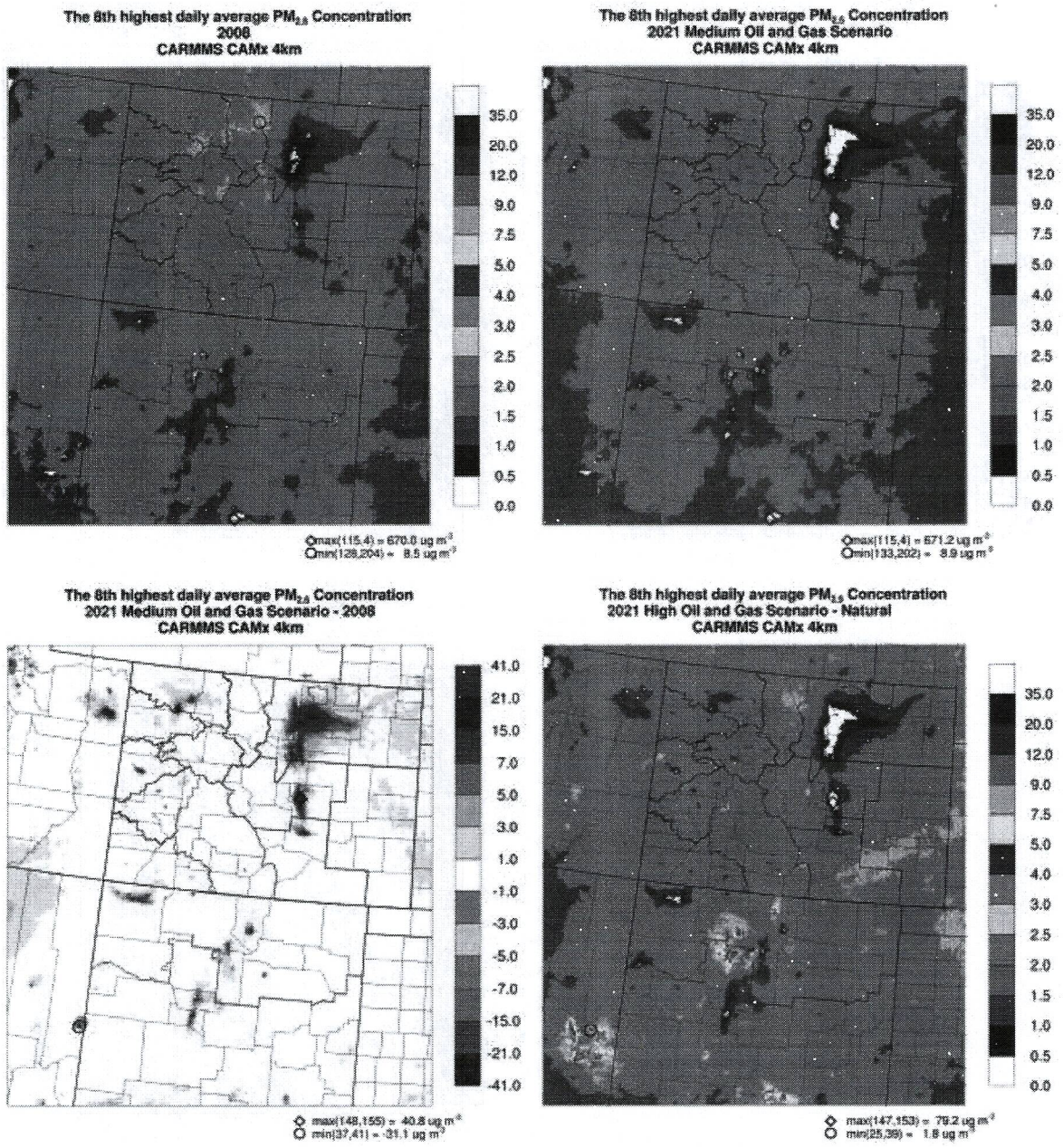

Figure 5-8c. Eighth highest 24-hour $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 Medium Development Scenario (top right), 2021 Medium minus 2008 differences (bottom left) and Natural Emissions (bottom right).

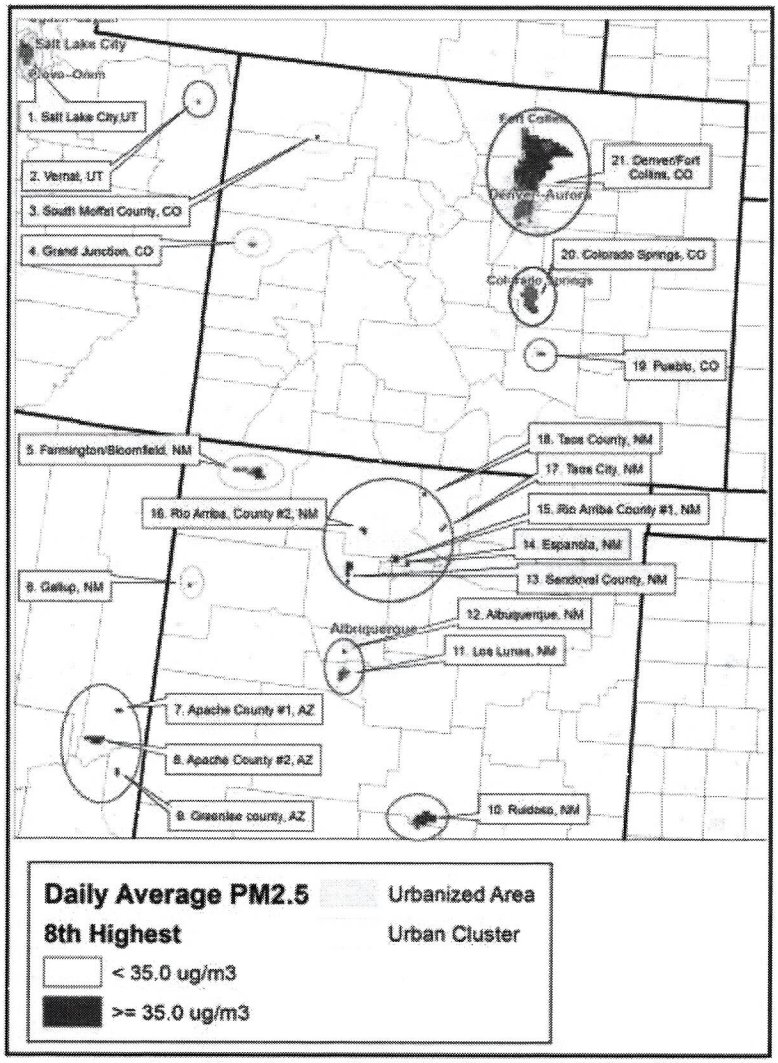

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Figure 5-9. Locations of grid cells with modeled 2021 High Development Scenario 8th highest 24-hour $PM_{2.5}$ concentrations above the 35 $\mu g/m^3$ NAAQS.

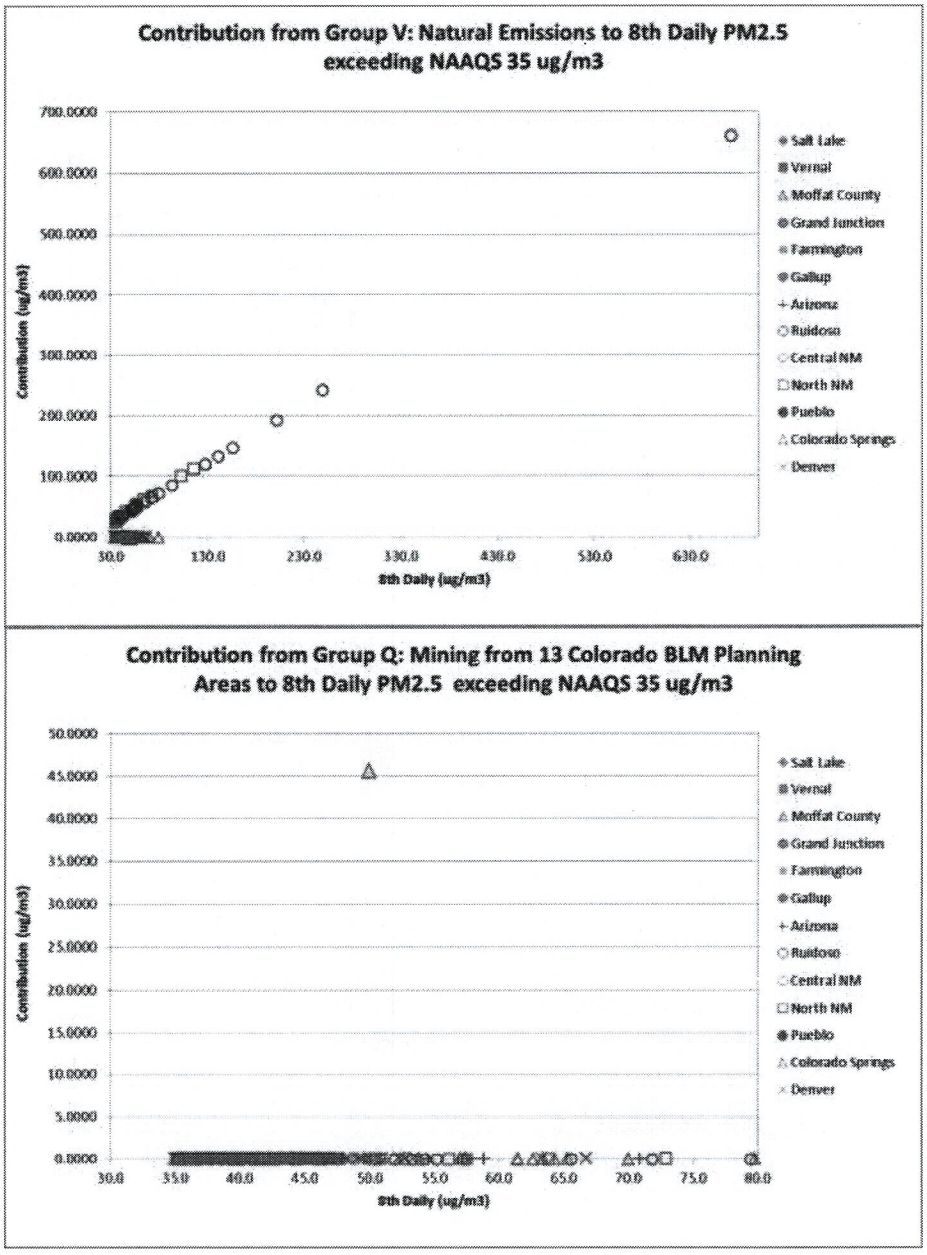

Figure 5-10. Natural Emissions (Source Group V, top) and Mining of Federal land in Colorado (Source Group Q, bottom) contributions to the modeled 8th highest 24-hour $PM_{2.5}$ concentration from the 2021 High Development Scenario.

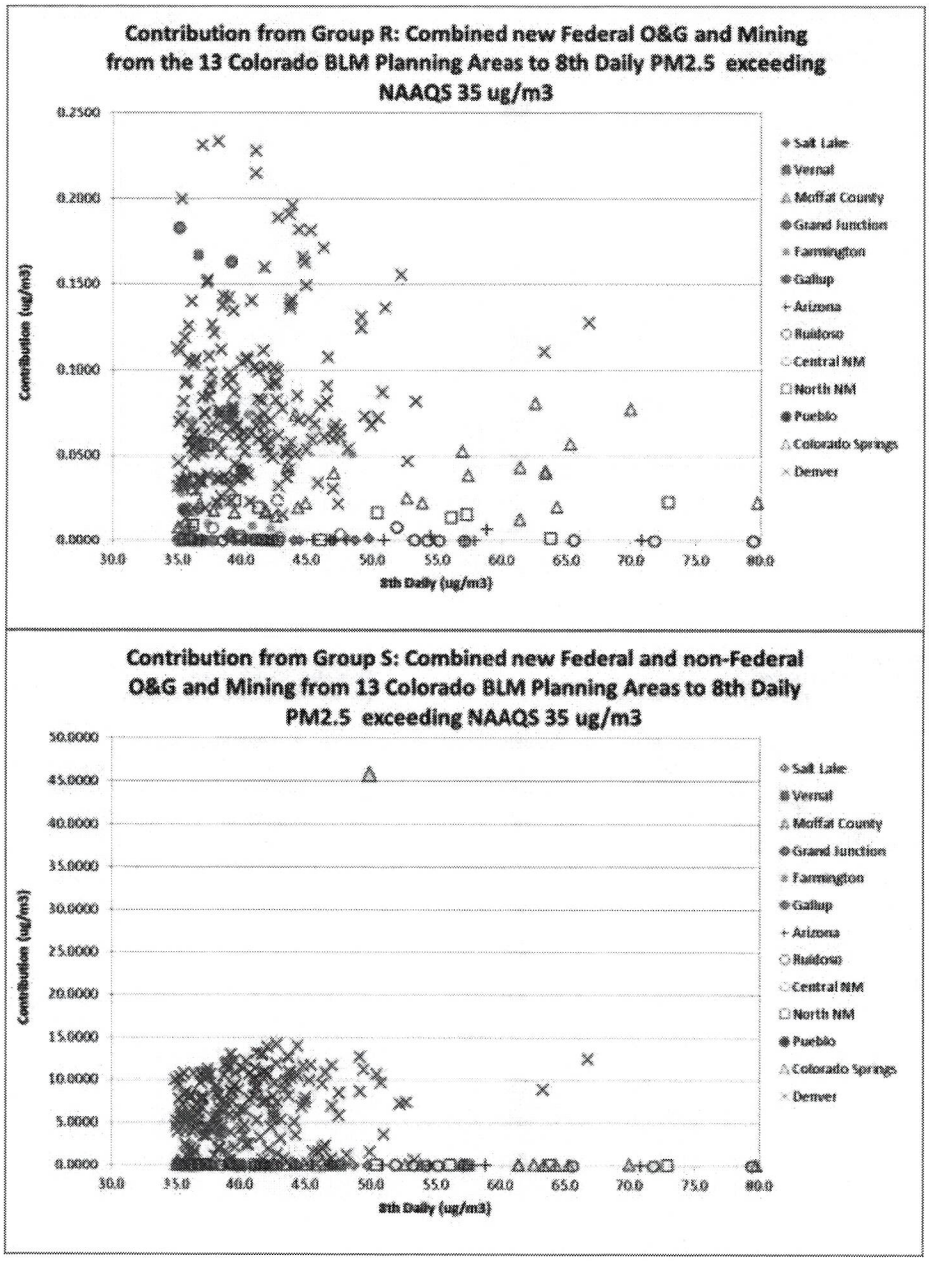

Figure 5-11. Natural Emissions (Source Group V, top) and Mining of Federal land in Colorado (Source Group Q, bottom) contributions to the modeled 8th highest 24-hour $PM_{2.5}$ concentration from the 2021 High Development Scenario.

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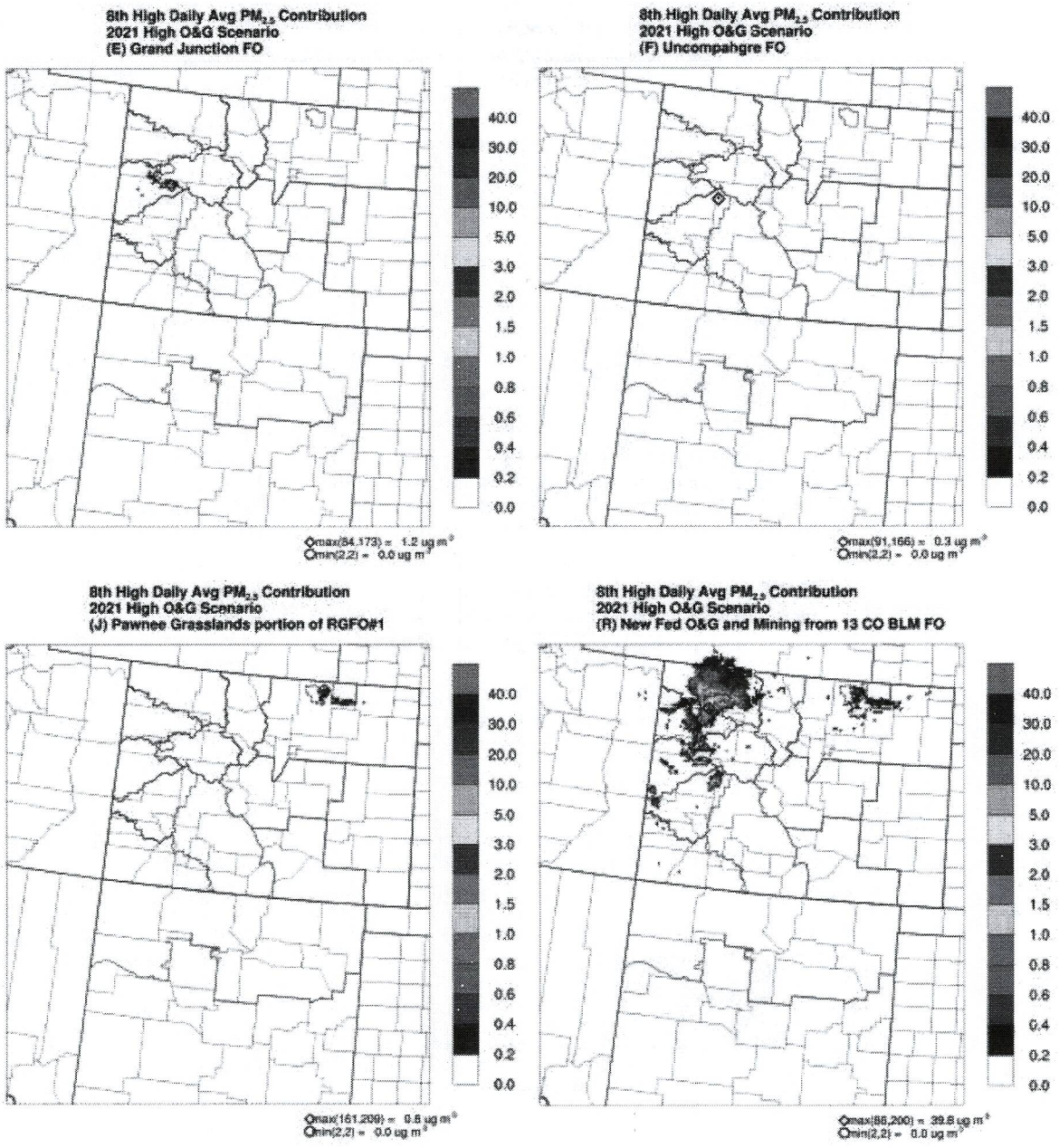

Figure 5-12. Contribution to 8th highest daily $PM_{2.5}$ concentrations due to emissions from new Federal O&G within the GJFO (top left), UFO (top right) and USFS-PG (bottom left) Planning Areas and new Federal O&G and mining within the 13 Colorado BLM Planning Areas (bottom right) for the 2021 High Development Scenario.

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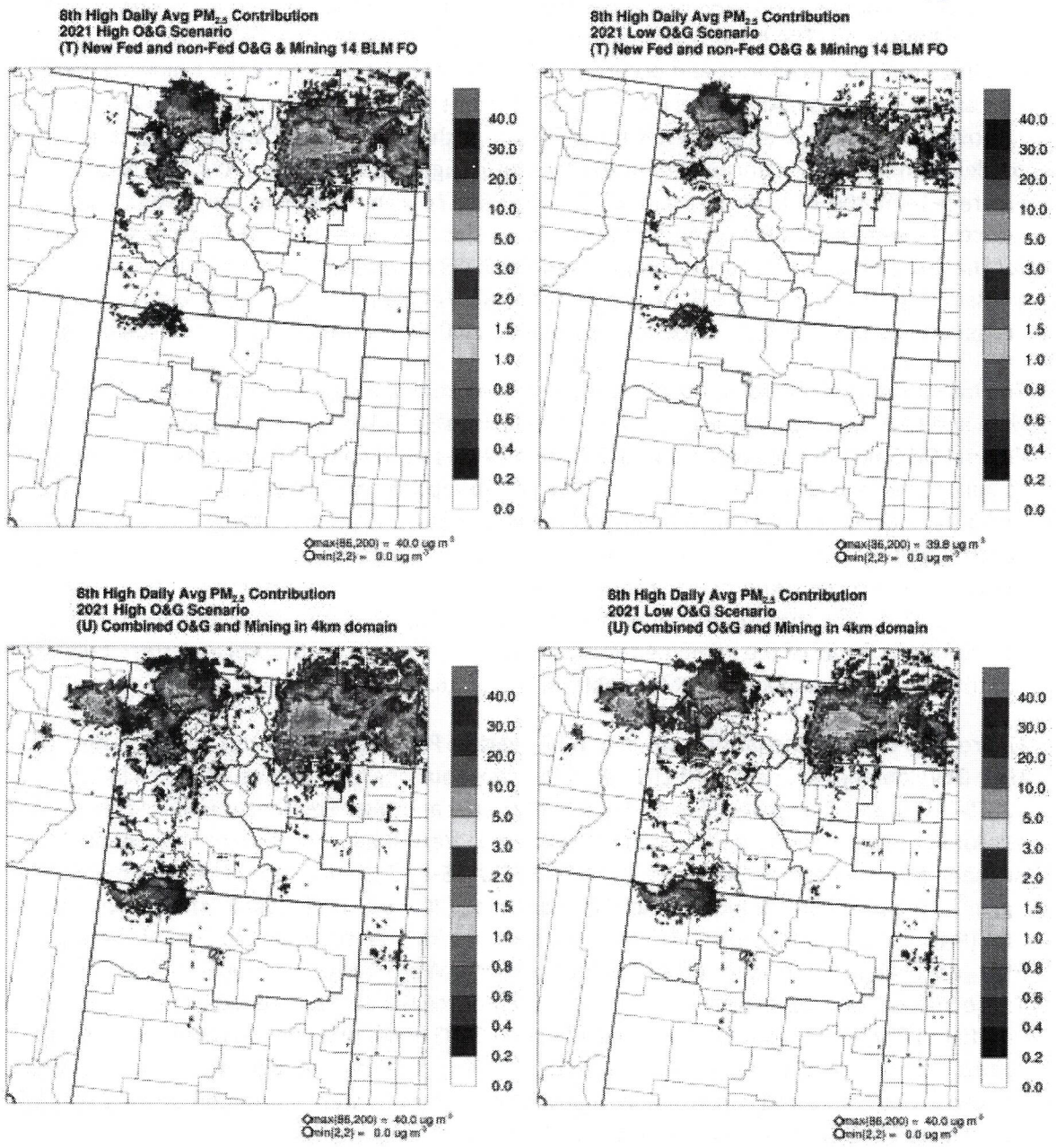

Figure 5-13. Contribution to 8th highest daily $PM_{2.5}$ concentrations due to emissions from new Federal and non-Federal O&G and mining within the 14 BLM Planning Areas (top) and all O&G emissions within the 4 km CARMMS domain (bottom) for the 2021 High (left) and Low (right) Development Scenarios.

5.6.3.2 Annual $PM_{2.5}$ NAAQS Analysis

Figure 5-14 displays the annual average $PM_{2.5}$ concentrations for the 2008 Base Case and 2021 emissions scenarios and their differences and the annual average $PM_{2.5}$ concentrations without Natural Emissions. The highest annual average $PM_{2.5}$ concentration is ~30 $\mu g/m^3$ in the 2008 and 2021 emission scenarios and occurs in the southern most portion of the CARMMS 4 km domain near Ruidoso, NM and is due to wildfires since it is gone when the natural emissions are removed. However, even without Natural Emissions there are several areas where the modeled annual $PM_{2.5}$ concentrations exceed the 12 $\mu g/m^3$ annual $PM_{2.5}$ NAAQS (red areas in Figure 5-14) in the 2008 Base case and 2021 High and Low Development Scenarios. There are noticeable increases in $PM_{2.5}$ concentrations in Moffat County in the BLM LSFO Planning Area for the 2021 emission scenarios compared to the 2008 base case that are due to higher emissions from mines (Figure 5-14, top two panels). For example, the Colowyo mine $PM_{2.5}$ emissions are 325 TPY in the 2008 base case and 3,400 TPY in the 2021 emission scenarios.

The maximum contribution of each Source Group to annual $PM_{2.5}$ concentrations for the 2021 High and Low Development Scenarios are shown in Table 5-42b. With two exceptions, new Federal O&G within each of the 14 BLM Planning Areas have contributions of less than 1 $\mu g/m^3$ to annual average $PM_{2.5}$ concentrations. The two exceptions are the WRFO (4.4, 0.7 and 2.6 $\mu g/m^3$) and GJFO (1.0, 0.1 and 0.6 $\mu g/m^3$) Planning Areas, and even for those two areas the contributions of the 2021 Low Development Scenario are below 1 $\mu g/m^3$. Mining on Federal lands in Colorado contributes a maximum of 20.7 $\mu g/m^3$ due to the coal mine in the LSFO Planning Area. The maximum annual $PM_{2.5}$ due to mining drives the maximum annual $PM_{2.5}$ contributions for all of the combined Source Groups Q through U. Natural emissions (wildfires) contribute a maximum annual $PM_{2.5}$ contribution of 26.4 $\mu g/m^3$.

Figure 5-15 displays the differences in annual average $PM_{2.5}$ concentrations between the 2021 High Development Scenario and 2021 with the contributions from Source Groups F (UFO), J (USFS-PG), R and T removed; results for the 2021 Low and Medium Development Scenarios are similar but lower and can be found in Attachment I. Very small contributions to annual $PM_{2.5}$ are seen for new Federal O&G from the UFO and USFS-PG Planning Areas (maximum of 0.2 $\mu g/m^3$). The high contribution of the LSFO coal mine (20.7 $\mu g/m^3$) is seen in the Source Group R plot (Figure 5-15, bottom left). Relatively high (> 3 $\mu g/m^3$) contributions to annual average $PM_{2.5}$ are seen in the Source Group T contributions in Weld County (Figure 5-15, bottom right). These higher Weld County $PM_{2.5}$ contributions in Source Group T compared to Source Group R are due to $PM_{2.5}$ emissions from new non-Federal O&G emissions, which is confirmed by the spatial emission plots in Figure 3-10. As noted for $PM_{2.5}$ 24-hour average impacts discussion, unpaved road traffic and construction fugitive dust emissions were calculated by the BLM COSO for all new RGFO Federal and non-Federal oil and gas development and the year 2008 emissions inventory did not account for total oil and gas related traffic / construction fugitive dust and therefore, the difference plots concentration changes (year 2021 minus year 2008) are overestimates.

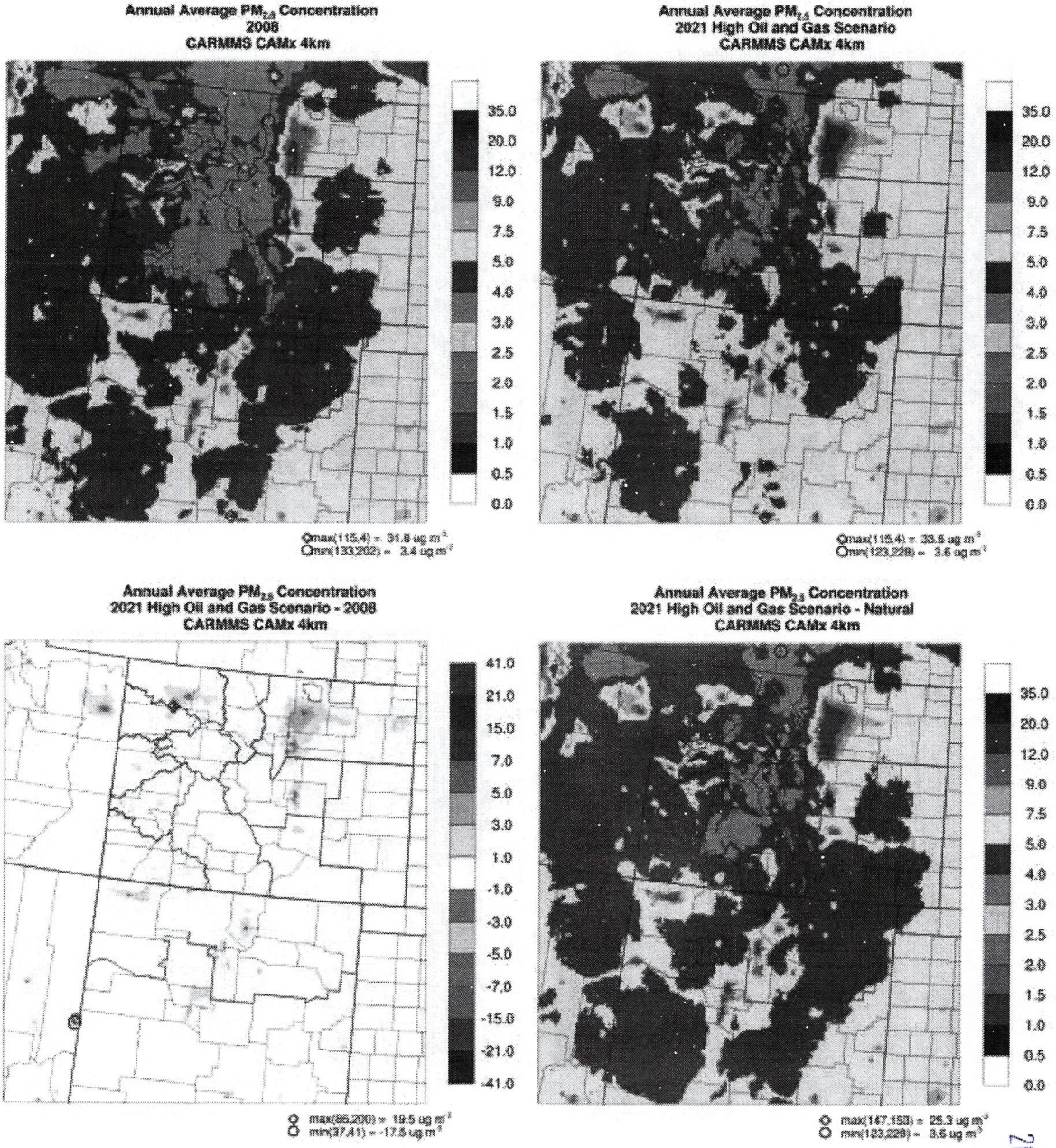

Figure 5-14a. Annual average $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 High minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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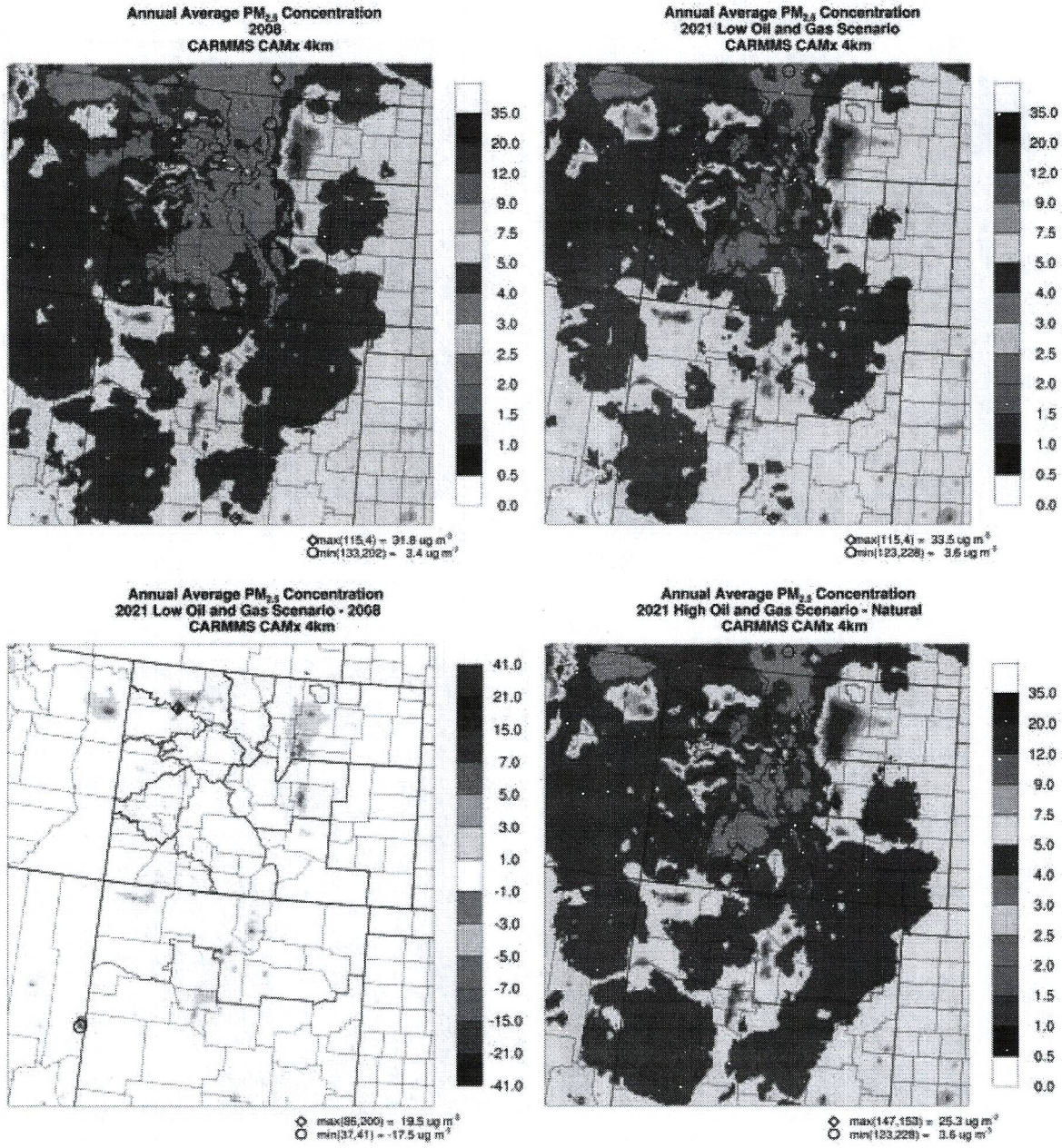

Figure 5-14b. Annual average $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 Low Development Scenario (top right), 2021 Low minus 2008 differences (bottom left) and Natural Emissions (bottom right).

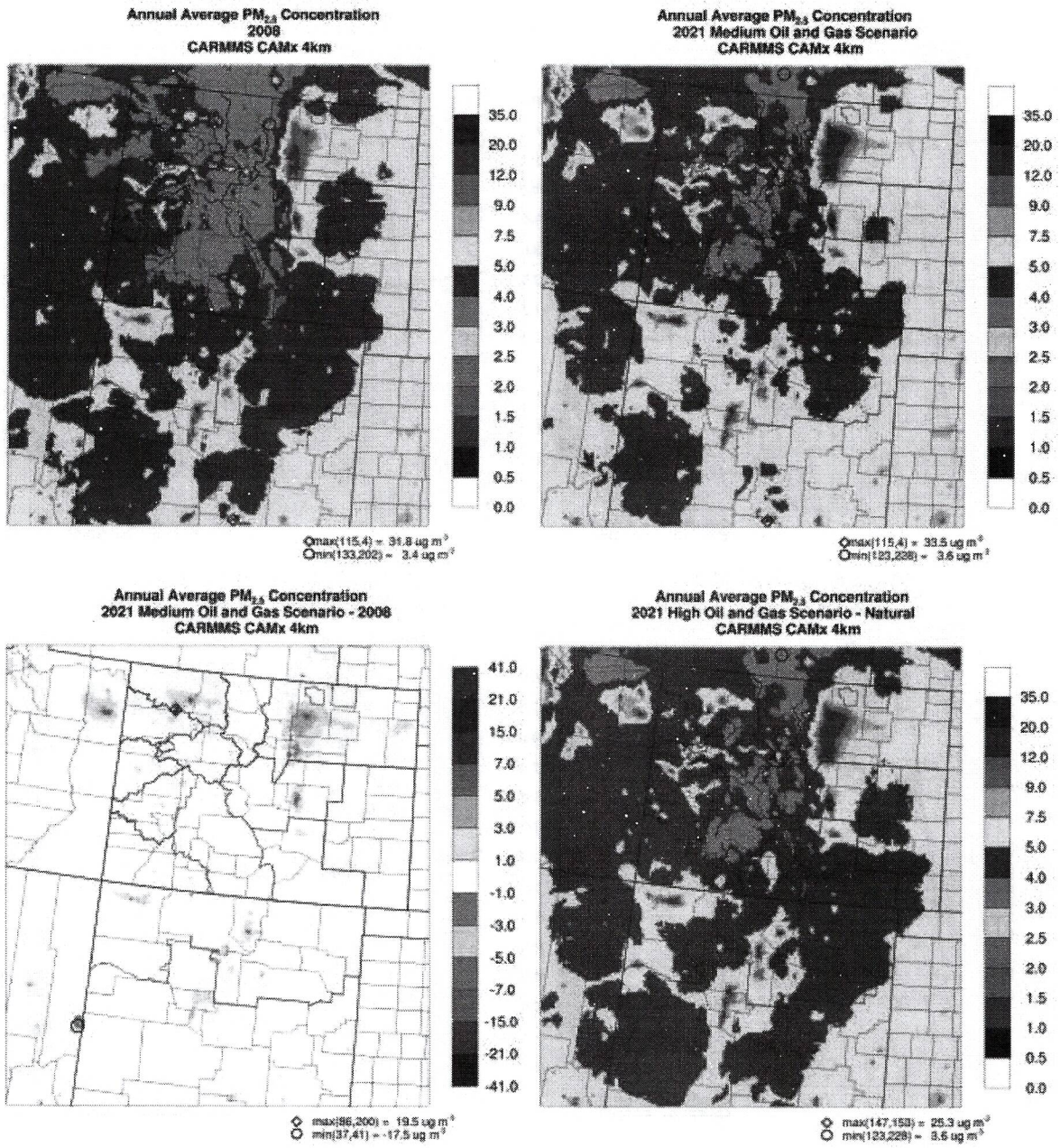

Figure 5-14c. Annual average $PM_{2.5}$ concentrations for the 2008 Base Case (top left), 2021 Medium Development Scenario (top right), 2021 Medium minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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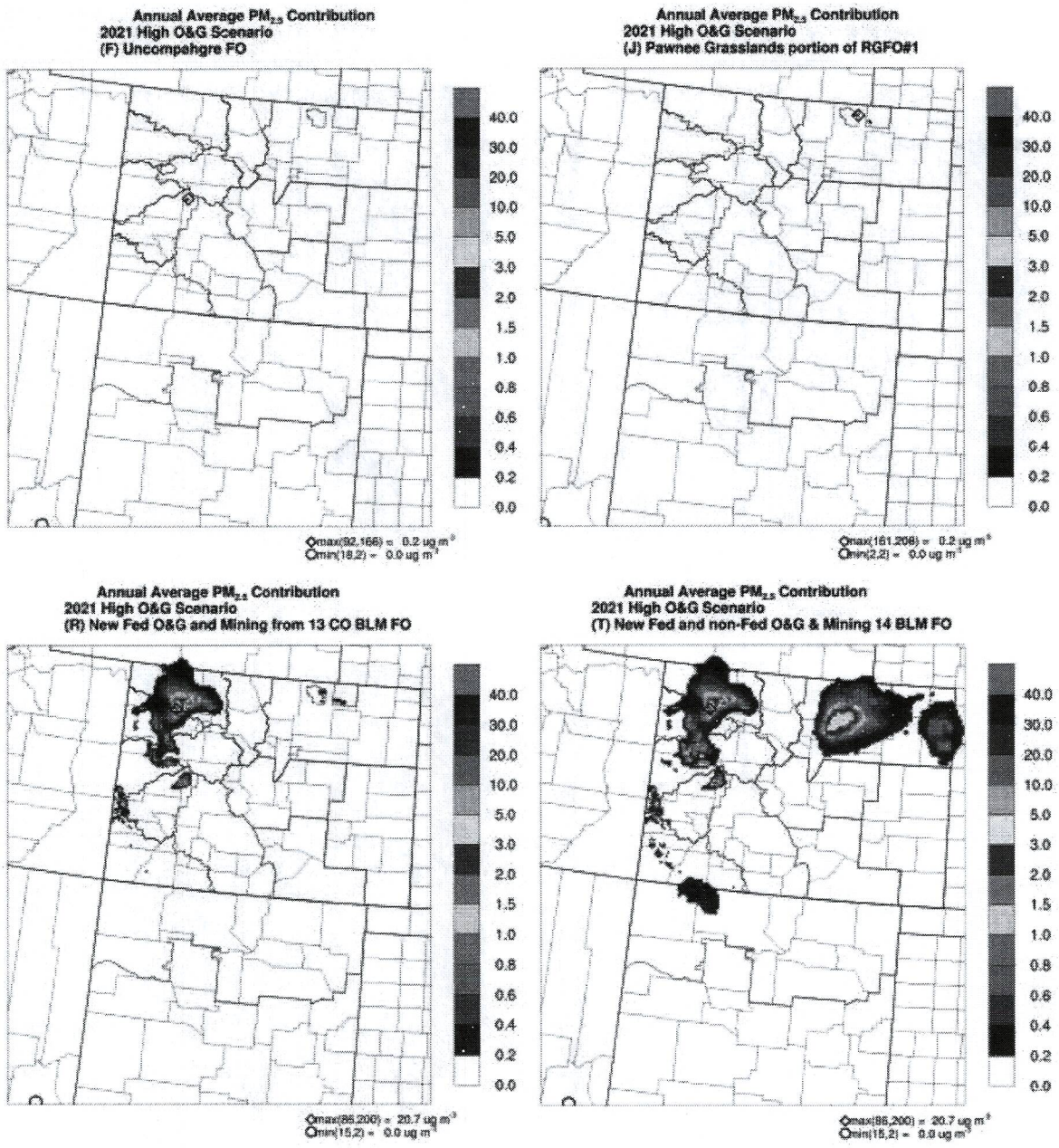

Figure 5-15. Contribution to annual average $PM_{2.5}$ concentrations due to emissions from new Federal O&G within the UFO (top left) and USGS-PG (top right) Planning Areas and new O&G and mining from the 13 Colorado BLM Planning Areas (bottom left) and new Federal O&G and mining and non-Federal O&G from the 14 CO/NM BLM Planning Areas for the 2021 High Development Scenario.

5.6.4 PM_{10} NAAQS Analysis

Figure 5-16 and 5-17 displays the 2021 High Development Scenario modeling results for 24-hour PM_{10} that can be compared to the 150 $\mu g/m^3$ 24-hour PM_{10} NAAQS. Much of the discussion on 24-hour $PM_{2.5}$ also holds for 24-hour PM_{10}, although there are less exceedances of the 24-hour PM_{10} NAAQS since the threshold is higher. Extremely high highest second high PM_{10} concentrations occur in the 2008 and 2021 emissions scenarios that exceed 1,000 $\mu g/m^3$ (Figure 5-16, top panels). However, when natural emissions are removed the highest PM_{10} concentration drops to ~390 $\mu g/m^3$, which is much lower but still above the 24-hour PM_{10} NAAQS. With two exceptions, the maximum contribution of new Federal O&G emissions to the 2nd highest 24-hour PM_{10} concentrations from each of the BLM Planning Areas individually is less than 3 $\mu g/m^3$. The two exceptions and the maximum contributions due to the 2021 High, Low and Medium Development Scenarios are the WRFO (32.2, 3.1 and 11.5 $\mu g/m^3$) and GJFO (7.9, 0.2 and 3.5 $\mu g/m^3$) Planning Areas. Mining on Federal lands contributes a maximum of 47.8 $\mu g/m^3$ to the 2nd high 24-hour PM_{10} concentrations in all three of the 2021 emission scenarios. The contributions due to new Federal O&G to 2nd high 24-hour PM_{10} for the UFO and USFS-PG and the 2021 High Development Scenario are shown in the top two panels of Figure 5-17 with very small contributions seen. The bottom two panels in Figure 5-17 show the contributions of Source Groups R and T to the 2nd high 24-hour PM_{10} concentration for the 2021 High Development Scenario that display the mining contribution in South Moffat County and new non-Federal O&G contribution in Weld County. The contributions of all of the Source Groups and all three 2021 emission scenarios to 24-hour PM_{10} concentrations can be found in Attachment I.

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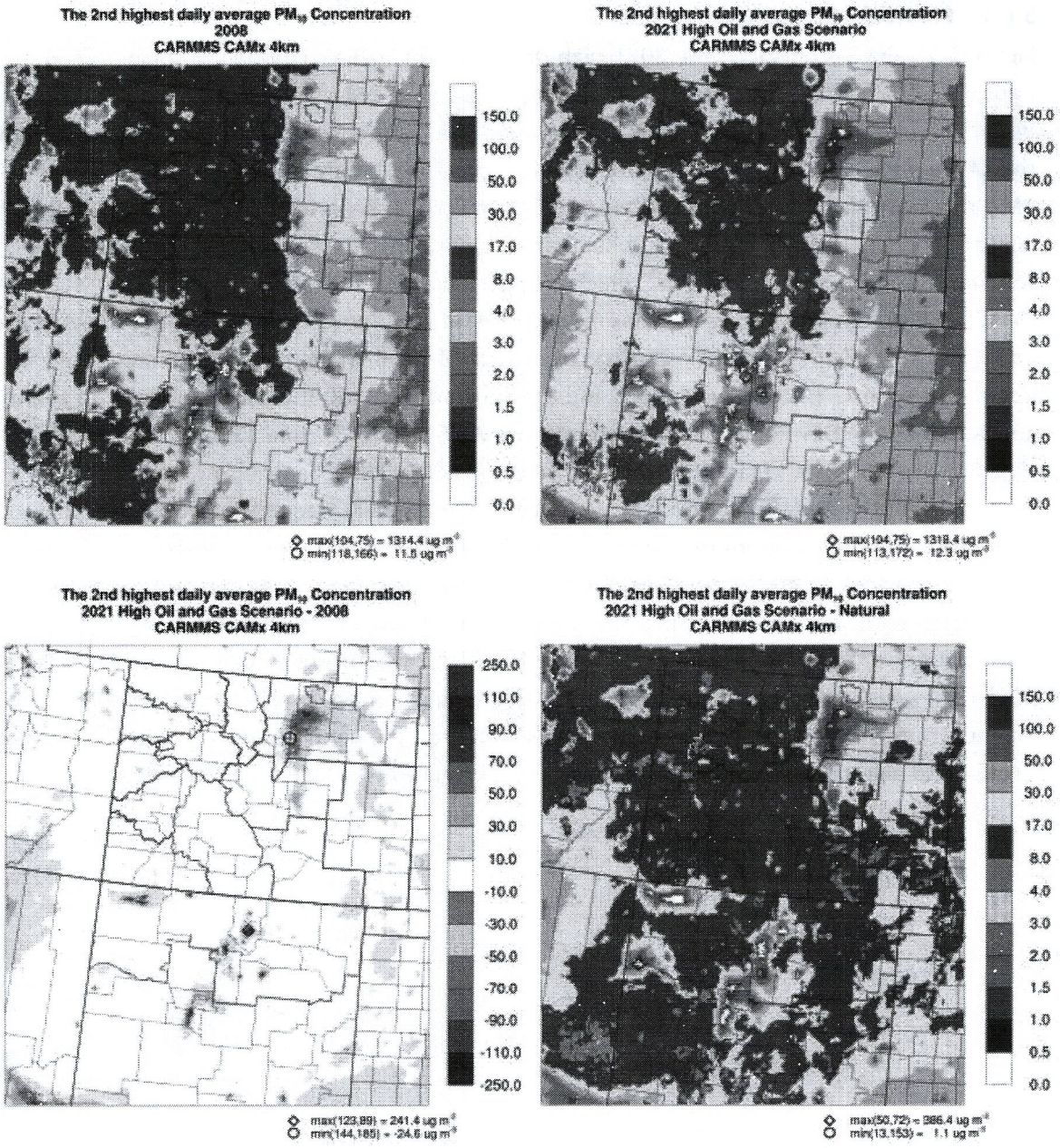

Figure 5-16. Second highest 24-hour average PM_{10} concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom left) and Natural Emissions (bottom right).

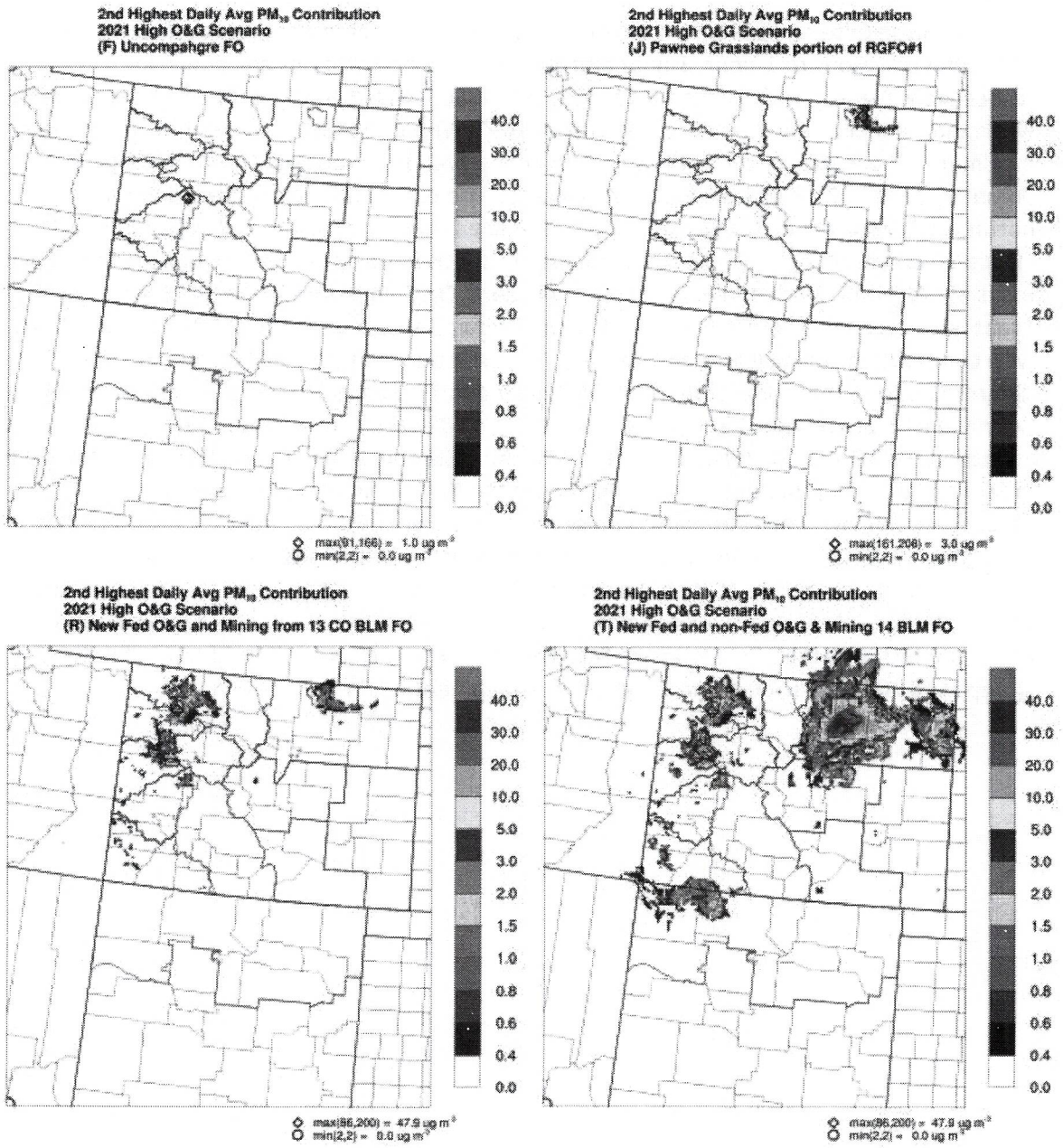

Figure 5-17. Contribution to second highest 24-hour average PM_{10} concentrations due to emissions from new Federal O&G within the UFO (top left) and USGS-PG (top right) Planning Areas and new O&G and mining from the 13 Colorado BLM Planning Areas (bottom left) and new Federal O&G and mining and non-Federal O&G from the 14 CO/NM BLM Planning Areas for the 2021 High Development Scenario.

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5.6.5 SO_2 NAAQS Analysis

The 2008 Base Case and 2021 High Development Scenario, their differences and contributions of Natural Emissions to 1-hour, 3-hour and annual SO_2 concentrations are shown in, respectively, Figures 5-18 through 5-21. The 1-hour SO_2 NAAQS is 196 $\mu g/m^3$ and it is exceeded when the colors in Figure 5-17 are yellow or hotter. With one exception, the 4th highest daily maximum 1-hour SO_2 concentrations are below the NAAQS throughout the 4 km CARMMS domain for the 2021 High Development Scenario. The exception is an isolated point in northeast Arizona where a value of 212 $\mu g/m^3$ is seen that is not due to natural emissions (see Figure 5-18, bottom right) or O&G and mining emissions in Colorado or New Mexico that is the focus of CARMMS. With one exception, new Federal O&G emissions in the 14 BLM Planning Areas have very small contributions to 1-hour, 3-hour, 24-hour and annual SO_2 concentrations with contributions being less than 1 $\mu g/m^3$. The exception is for the WRFO Planning Area (Source Group B) that contributes 78.4, 75.0, 42.7 and 18.0 $\mu g/m^3$ to the 1-hour, 3-hour, 24-hour and annual average SO_2 concentrations for the 2021 High and Medium Development Scenarios and 12.9, 12.0, 7.0 and 3.0 $\mu g/m^3$ for the 2021 Low Development Scenario. As noted in Section 3.7, a majority of the SO_2 emissions in the WRFO Planning Area are due to the Meeker and Willow Creek gas plants whose emissions were based on the CDPHE 2008 APEN data grown to 2021 based on the change in gas production within the Piceance Basin between 2008 and 2021. For the 2021 High Development Scenario the 2021 growth factor from 2008 was a factor of 3.4. Example spatial maps showing the SO_2 contributions for Source Groups R and T and the 2021 High Development Scenario are given in Figure 5-22 with other Source Groups and 2021 emission scenarios given in Attachment I.

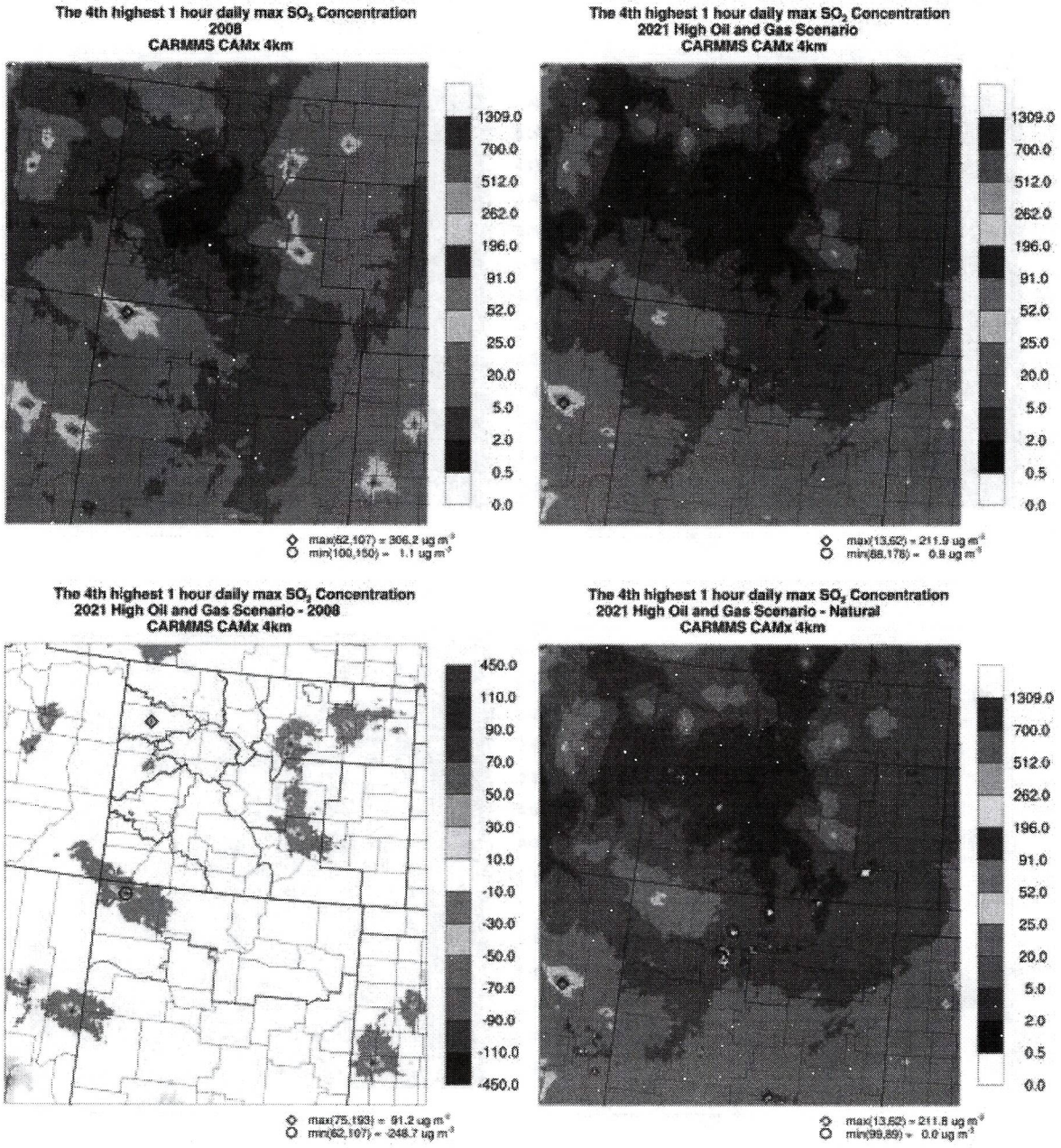

Figure 5-18. Fourth highest (99th percentile) daily maximum 1-hour average SO_2 concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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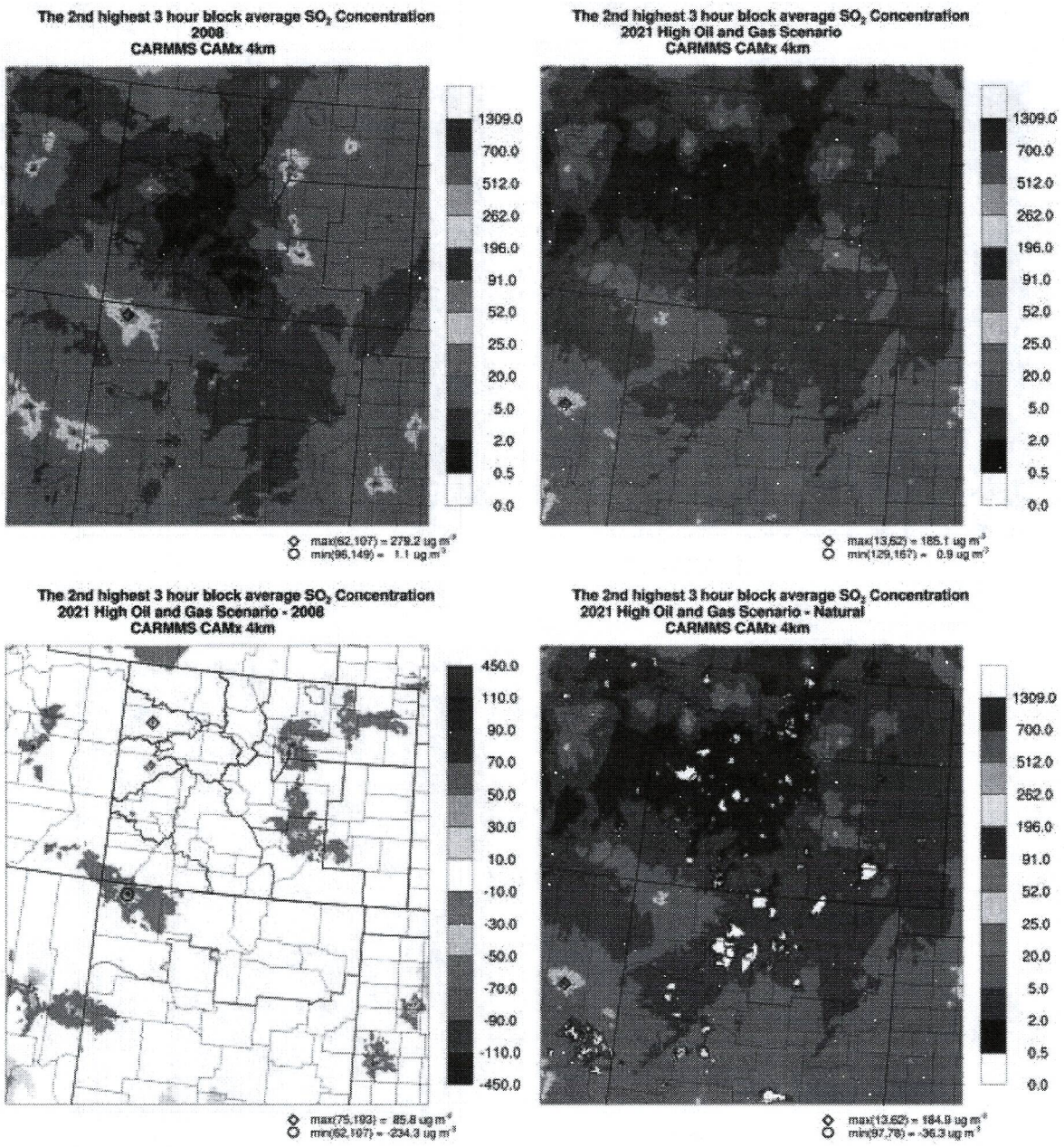

Figure 5-19. Second highest 3-hour average SO_2 concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom left) and Natural Emissions (bottom right).

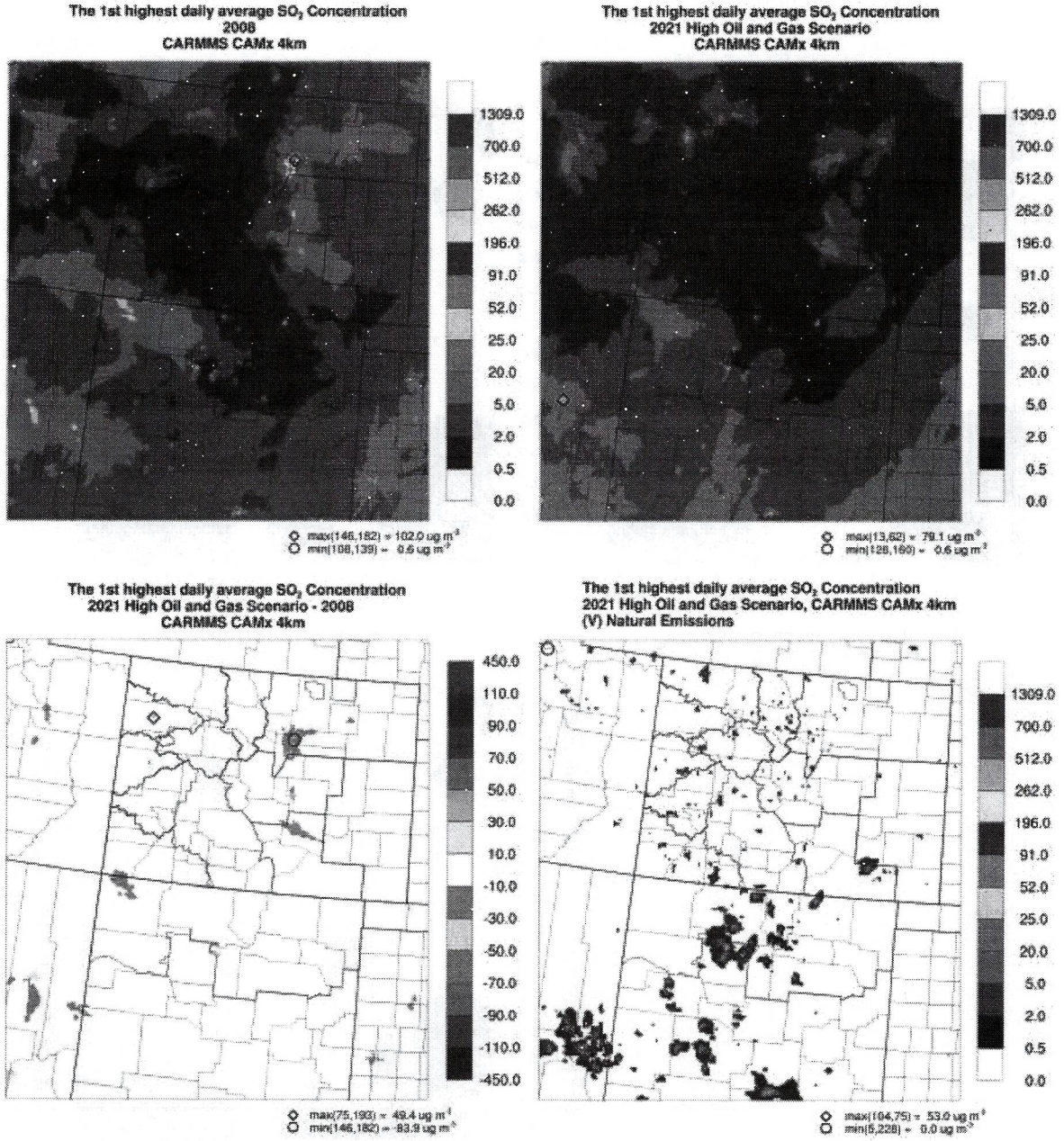

Figure 5-20. 24-hour average SO_2 concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom left) and Natural Emissions (bottom right).

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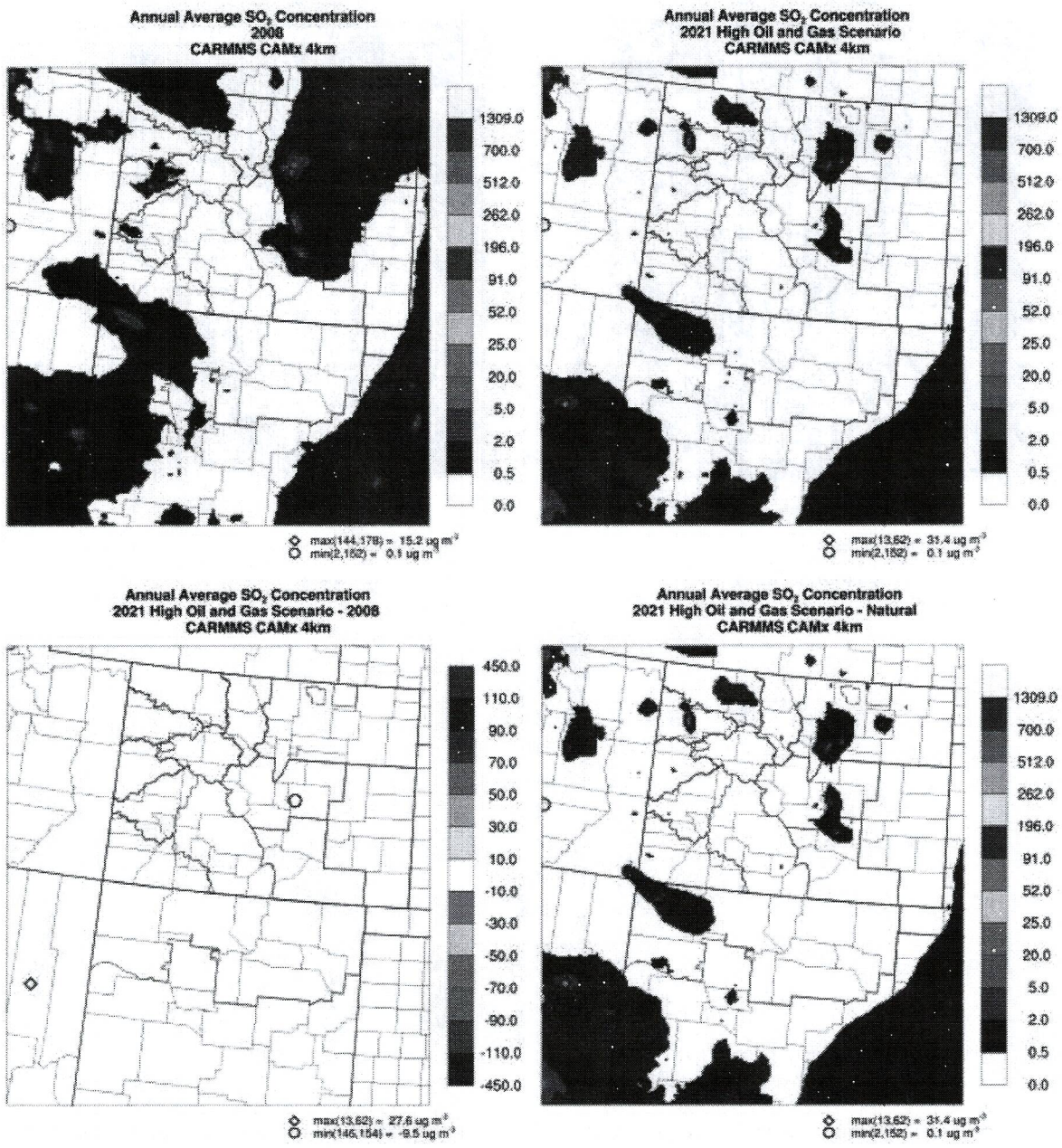

Figure 5-21. Annual average SO_2 concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom left) and Natural Emissions (bottom right).

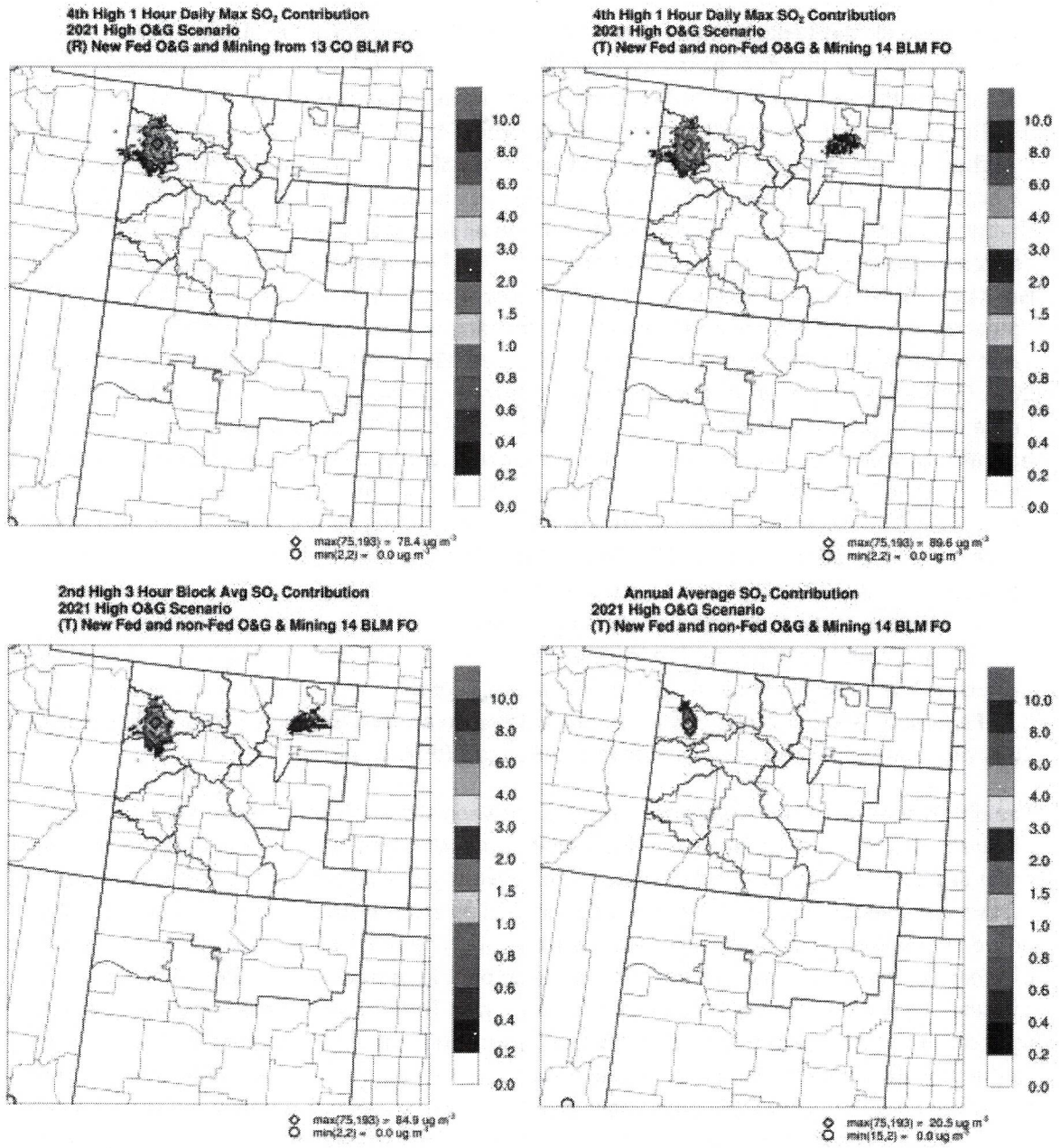

Figure 5-22. Contribution to fourth highest daily maximum hourly SO_2 concentrations due to emissions from new Federal O&G and mining within the 13 CO BLM Planning Areas (top left) and new Federal O&G and mining and non-Federal O&G within the 14 CO/NM BLM Planning Areas (top right). New Federal O&G and mining and new non-Federal O&G from 14 CO/NM BLM Planning Areas contributions to second highest 3-hour SO_2 (bottom left) and annual average SO_2 (bottom right) concentrations for the 2021 High Development Scenario.

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5.6.6 NO_2 NAAQS Analysis

Figure 5-23a displays spatial maps of the 98th percentile daily maximum 1-hour NO_2 concentrations for the 2008 Base Case and 2021 High, Low and Medium Development Scenarios with the differences in NO_2 concentrations between the 2021 emissions scenarios and the 2008 Base Case shown in Figure 5-23b. The 1-hour NO_2 NAAQS is 188 $\mu g/m^3$ (100 ppb) and the tile plots in Figure 5-23a have a cut-point at 188 $\mu g/m^3$ from red to white. For example, an exceedance of the 1-hour NO_2 NAAQS can be seen in the Denver area in the 2008 Base Case that goes away in the 2021 emission scenarios. In all four scenarios, the highest 1-hour NO_2 concentration occurs on the southern border of the 4 km CARMMS domain that is above the NAAQS. This NO_2 exceedance is due to wildfires so is present in the 2008 Base Case and 2021 scenarios since wildfires were assumed to be unchanged. The fact that the peak 1-hour NO_2 value at this wildfire location is identical for all three 2021 emission scenarios indicates that the 2021 O&G emissions have minimal contributions to it. Outside of this isolated wildfire location in the most southern part of the 4 km CARMMS domain, the 8th highest daily maximum 1-hourNO_2 concentrations only exceeds the 1-hour NO_2 NAAQS at one other location in the 2021 emission scenarios that is the most northeastern corner of Weld County. Although there are Federal O&G emissions increases nearby to this location, they do not occur at this high NO_2 concentration location (Figure 3-10). The fact that there is little reduction in this 1-hour NO_2 peak between the 2021 High and Low Development Scenarios (Figure 5-23b) suggests that the high NO_2 concentration in Weld County is due to other new sources in the 2021 emission scenario and could be attributed to increases in non-Federal oil and gas emissions. As indicated from the plots shown in Section 3.2.1, RGFO area 1 (Weld County is located in RGFO area 1) non-Federal oil and gas emissions for the Low Scenario are actually higher than projected year 2021 non-Federal oil and gas emissions for the High / RFD Scenario.

The differences in 1-hour NO_2 concentrations between the 2008 and 2021 emission scenarios (Figure 5-23b) indicate reductions in the Denver area, slight increases in the O&G development areas (e.g., Uinta, Piceance and D-J Basins) and several isolated occurrences of large increases in northern, eastern and southern Colorado as well as eastern Arizona and New Mexico. As noted above, the cause of the large NO_2 concentration increase at the point in northeast corner of Weld County is not clear but doesn't appear to be due to new Federal O&G emissions. As shown in Figure 3-10, there are some increases in non-Federal oil and gas emissions projected to occur in the vicinity of the predicted Weld County concentrations and are likely contributing to the modeled impacts. The NO_2 increase in Cheyenne County in eastern Colorado does not appear to be due to new O&G emissions since there are no new O&G emissions at that location in the 2021 emission scenarios (Figure 3-10). Upon further review of the year 2011 oil and gas APENs database that was used to define existing O&G emissions inventory, there is a large (> 1,200 TPY) NO2 emissions source located in the vicinity of the predicted concentrations in Cheyenne County. The increase in 2021 NO_2 concentrations in the southwest corner of Las Anima County in southern Colorado is at the location of new O&G emissions (primarily non-Federal) for the Raton Basin and likely due to O&G emissions, but the resultant total NO_2 concentrations are below the NAAQS. The final two locations of NO_2 concentration increases in eastern Arizona and New Mexico are away from any O&G emissions (Figure 3-10). Since the same increases are seen for the 2021 High, Low and Medium Development Scenarios (Figure 5-23b) then they are not due to Colorado based O&G emissions. They are likely due to EPA's

2020 emission projections used for non-O&G anthropogenic emissions in the 2021 emission scenarios, possibly the deployment of new electrical generating units.

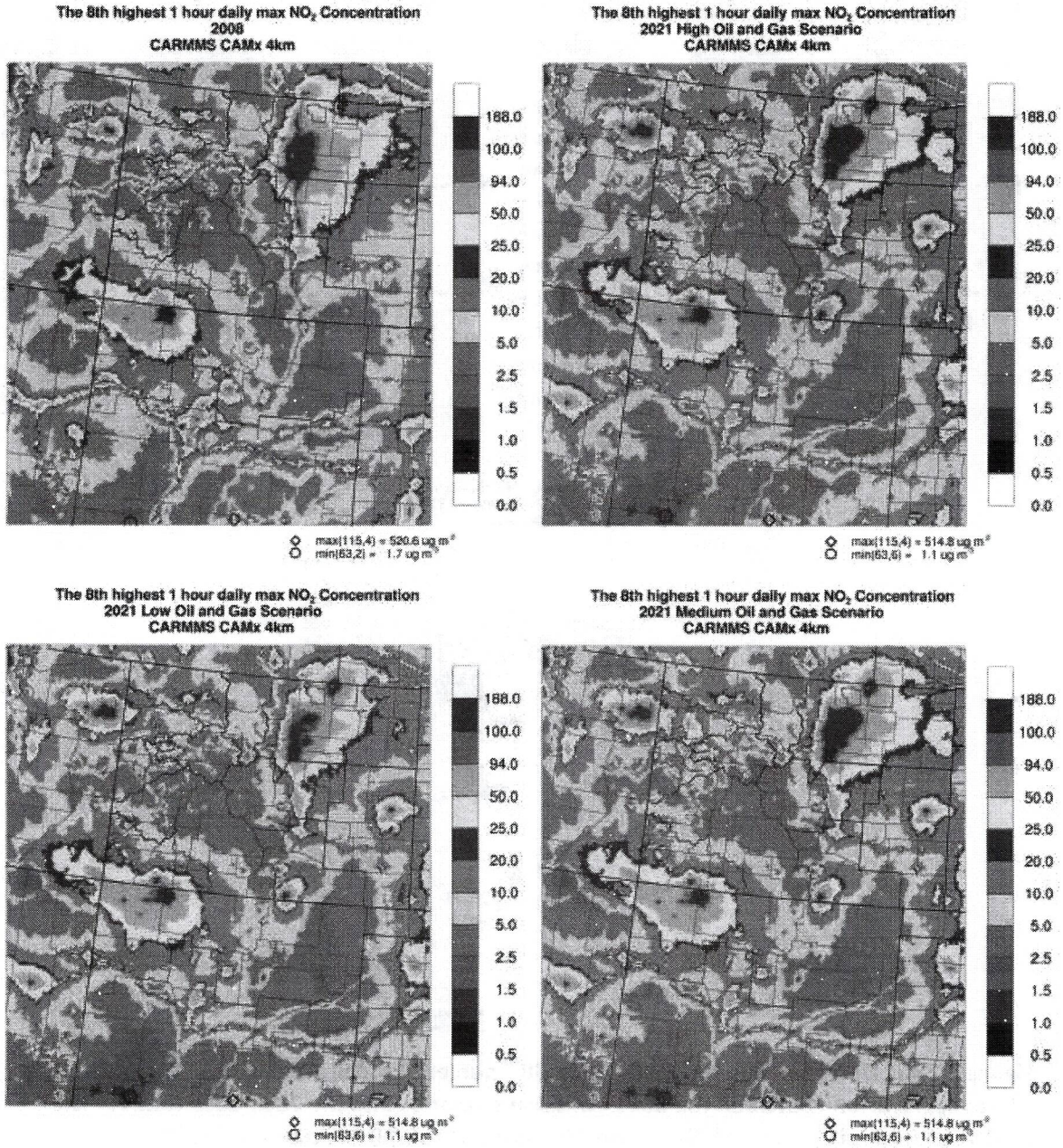

Figure 5-23a. Eighth highest (98th percentile) daily maximum 1-hour average NO_2 concentrations for the 2008 Base Case (top left), 2021 High Development Scenario (top right), 2021 Low Development Scenario (bottom left) and 2021 Medium Development Scenario (bottom right).

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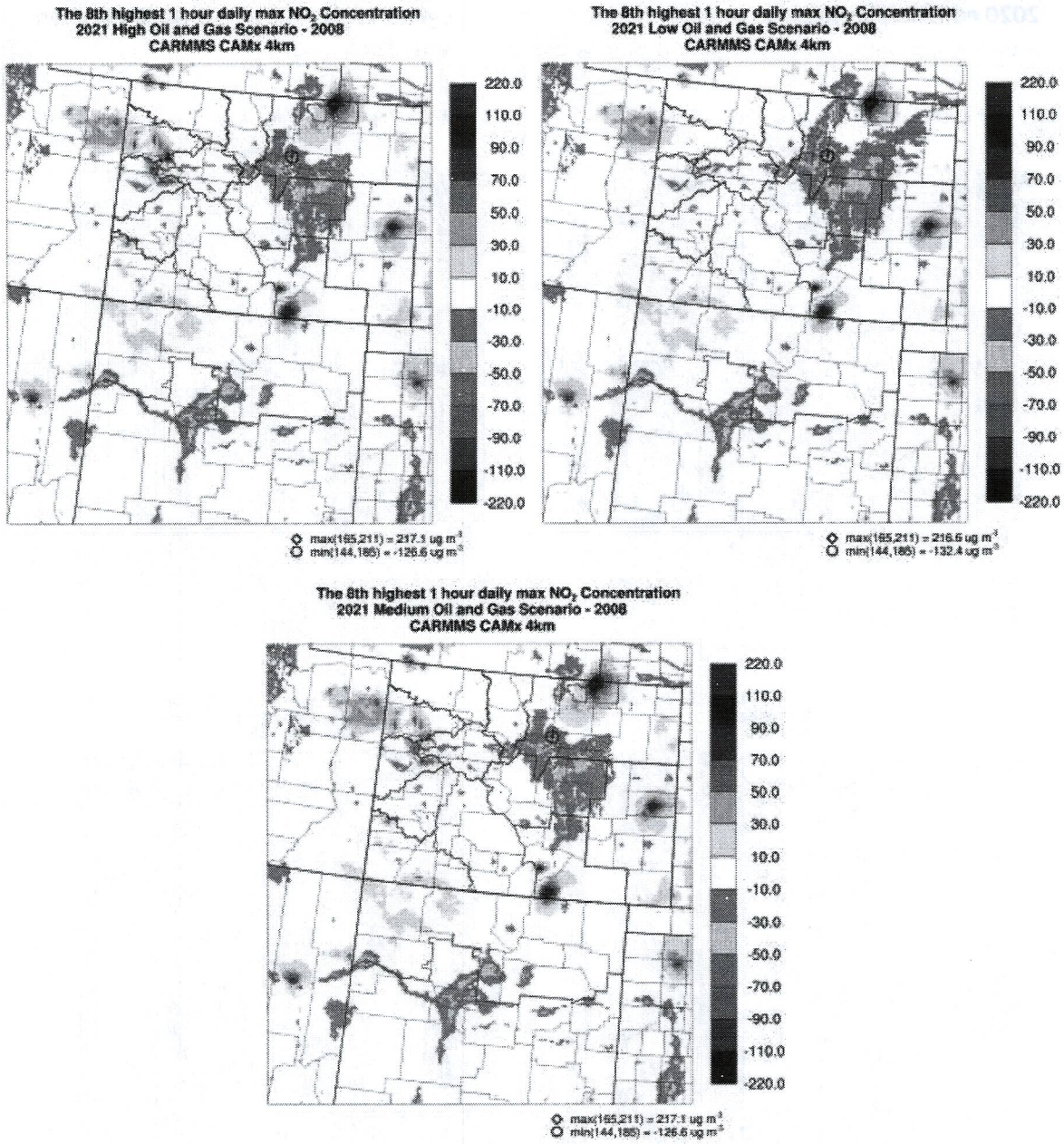

Figure 5-23b. Differences in eighth highest (98th percentile) daily maximum 1-hour average NO_2 concentrations between the 2021 emission scenarios and the 2008 Base Case for the 2021 High (top left), Low (top right) and Medium (bottom) Development Scenarios.

5.7 Source-Receptor Issues

Grid cells were assumed to represent receptors for Class I and sensitive Class I areas if there was any overlap between the grid cell and Class I/II area. Thus, there was the potential for emissions from oil and gas and other sources to be located in the same grid cell/receptor as a Class I/II area. However, in reality new oil and gas sources would not be located in a Class I area so such situations would likely overstate the oil and gas air quality impacts in a Class I area. This section identifies several instances when Class I/II areas are defined very close to new oil and gas emissions resulting air quality impacts that are likely higher than would actually occur.

New Federal O&G development on some of the BLM Planning Areas had relatively higher concentrations impacts at specific Class I areas. For example, new Federal O&G within the TRFO had Maximum annual NO_2 impacts at Mesa Verde Class I area of 1.97 $\mu g/m^3$ that was 79% of the annual NO_2 PSD Class I increment for the 2021 High Development Scenario. In addition, the visibility impacts at Mesa Verde due to new Federal O&G within TRFO Planning Area for the 2021 High Development Scenario had 35 days with $\Delta dv > 0.5$ and 4 days with $\Delta dv > 1.0$. Recall that grid cells used to represent receptors for Class I and sensitive Class II areas were defined if any portion of the Class I/II area intersected with the grid cell no matter how small the overlap is in order to be conservative (see Section 4.3.2). Figure 5-24 displays the grid cells used to represent the Mesa Verde Class I area along with new Federal O&G emissions from the TRFO Planning Area. The most northern Mesa Verde 4 km grid cell receptor is surrounded by emissions from the TRFO Planning Area with the Class I area covering approximately 20% of the 4 km grid cell so using this 4 km grid cell as a receptor for the Mesa Verde Class I area is probably appropriate. However, there have been other cases when the Class I/II area cover a very small portion of a grid cell that is used as a receptor for a Class I/II area. Perhaps a Class I/II area should be required to have a minimal overlap with a grid cell (e.g., 5%) in order for the grid cell to be considered as a receptor for the Class I/II area.

Another example of relatively larger impacts was seen for TRFO at the South San Juan Class II area (16 days with $\Delta dv > 0.5$). Figure 5-25 compares the grid cells used to represent the South San Juan Wilderness and compares them to new Federal O&G emissions from the TRFO Planning Area. In this case the emissions from the TRFO Planning Area occur in one of the grid cells being used to represent the South San Juan area and the grid cell contains a large portion of the Class II area. It might be beneficial to examine the TRFO O&G emissions to determine whether they are spatially located correctly.

A final example of relatively larger impacts is for new Federal O&G emissions from the NMFFO that had relatively large visibility impacts (210 days with $\Delta dv > 0.5$ and 50 days with $\Delta dv > 1.0$) at the Aztec Ruins Class II area. Aztec Ruins is a small area that is represented by two 4 km grid cells and sits in the middle of the NMFFO Mancos Shale development area. This is shown in Figure 5-26 with the two cells representing Aztec Ruins unlabeled but seen in the middle of the NMFFO O&G emissions.

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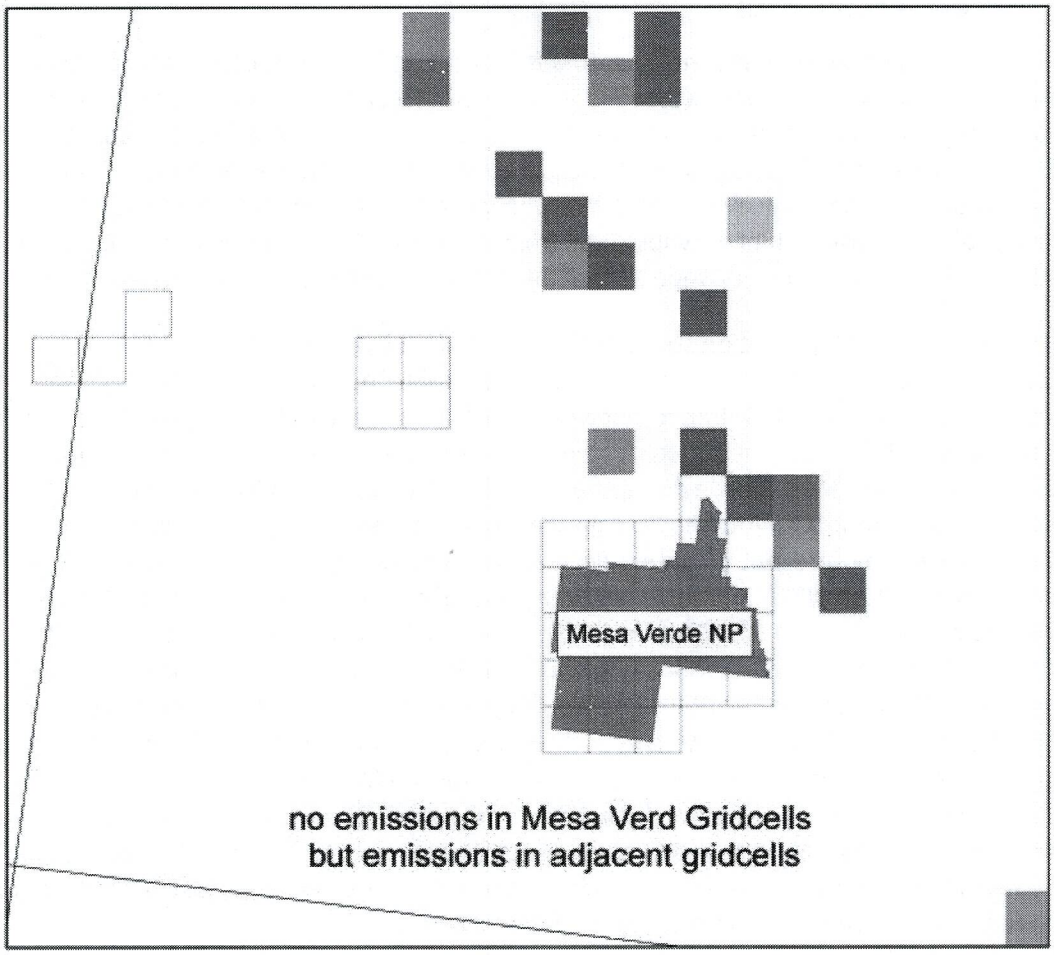

G07TRFO.asc <VALUE>	G14NMFD.asc <VALUE>	G02WRFO.asc <VALUE>	G05GJFO.asc <VALUE>
0	0	0	0
0.01 - 50	0.01 - 1	0.01 - 58	0.01 - 58
51 - 98	1.1 - 15	59 - 190	59 - 190
99 - 120	16 - 22	200 - 270	200 - 270
130 - 250	23 - 25	280 - 4,600	280 - 380

Figure 5-24. Grid cells used to represent the Mesa Verde Class I area with new Federal O&G emissions from the TRFO Planning Area.

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<VALUE>	<VALUE>	<VALUE>	<VALUE>
0	0	0	0
0.01 - 50	0.01 - 1	0.01 - 58	0.01 - 58
51 - 98	1.1 - 15	59 - 190	59 - 190
99 - 120	16 - 22	200 - 270	200 - 270
130 - 250	23 - 25	280 - 4,600	280 - 380

Figure 5-25. Grid cells used to represent the South San Juan Class II area with new Federal O&G emissions from the TRFO Planning Area.

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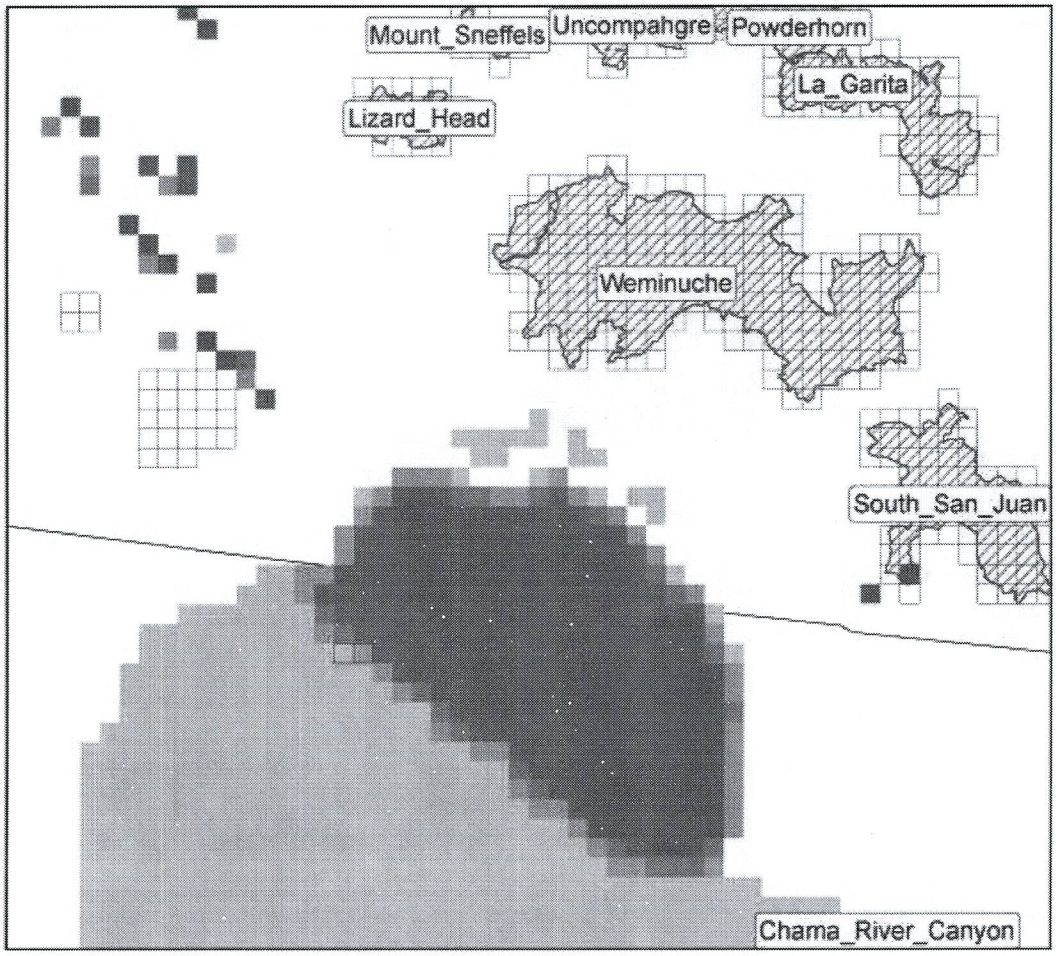

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0.01 - 58	0.01 - 58	0.01 - 50	0.01 - 1
59 - 190	59 - 190	51 - 98	1.1 - 15
200 - 270	200 - 270	99 - 120	16 - 22
280 - 4,600	280 - 380	130 - 250	23 - 25

Figure 5-26. Grid cells used to represent the Class I and sensitive Class II areas with new Federal O&G emissions from the NMFFO (Mancos Shale) Planning Area.

6.0 ACRONYMS

ACHD	Allegheny County Health Department
AES	Applied Envirosolutions
AMET	Atmospheric Model Evaluation Tool
APCA	Anthropogenic Precursor Culpability Assessment
APU	Auxiliary Power Units
ARMS	Air Resource Management Study
AQ	Air Quality
AQRV	Air Quality Related Value
AQS	Air Quality System
BC	Boundary Condition
BLM	Bureau of Land Management
CAFOS	Concentrated Animal Feeding Operations
CAMD	Clean Air Markets Division
CAMx	Comprehensive Air-quality Model with extensions
CAPS	Criteria Air Pollutants
CARMMS	Colorado Air Resource Management Modeling Study
CASTNet	Clean Air Status and Trends Network
CAVR	Clean Air Visibility Rule
CB05	Carbon Bond mechanism version 5
CD-C	Continental Divide-Creston
CDPHE	Colorado Department of Health and Environment
CEM	Continuous Emissions Monitor
CENRAP	Central Regional Air Planning Association
CMAQ	Community Multiscale Air Quality modeling system
CMU	Carnegie Mellon University
ConCEPT	Consolidated Community Emissions Processing Tool
CONUS	Continental United States
COSO	BLM Colorado State Office
CRVFO	Colorado River Valley Field Office
CPC	Center for Prediction of Climate
CSAPR	Cross State Air Pollution Rule
CSN	Chemical Speciation Network
DDM	Decoupled Direct Method
DEASCO3	Deterministic and Empirical Assessment of Smoke's Contribution to Ozone
Dv	deciview
ECA	Emissions Control Area
EGU	Electrical Generating Units
EIS	Environmental Impact Statement
EM	Emissions Model
EMS	Emissions Modeling System
EPA	Environmental Protection Agency
EPS	Emissions Processing System
ERG	Eastern Research Group
ESRL	Earth Systems Research Laboratory
FB	Fractional Bias
FE	Fractional Error

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FFO	New Mexico BLM Farmington Field Office
FINN	Fire Inventory from NCAR
FLM	Federal Land Manager
FRM	Federal Reference Method
FWS	Fish and Wildlife Service
GCM	Global Chemistry Model
GEOS-Chem	Goddard Earth Observing System (GEOS) global chemistry model
GJFO	Grand Junction Field Office
GSE	Ground Support Equipment
IAD	Impact Assessment Domain
IMPROVE	Interagency Monitoring of Protected Visual Environments
IMWD	Inter-Mountains West Processing Domain
IPAMS	Independent Petroleum Association of the Mountain States
JSFP	Joint Science Fire Program
FO	Kremmling Field Office
LCP	Lambert Conformal Projection
LTO	Landing and Takeoff Operations
LSFO	Little Snake Field Office
LSM	Land Surface Model
MADIS	Meteorological Assimilation Data Ingest System
MATS	Modeled Attainment Test Software
MEGAN	Model of Emissions of Gases and Aerosols in Nature
MM	Meteorological Model
MM5	Version 5 of the Mesoscale Model
MNGE	Mean Normalized Gross Error
MNB	Mean Normalized Bias
MOVES	Motor Vehicle Emissions Simulator
MOZART	Model for Ozone And Related chemical Tracers
NAAQS	National Ambient Air Quality Standard
NADP	National Acid Deposition Program
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NDBC	National Data Buoy Center
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NMB	Normalized Mean Bias
NME	Normalized Mean Error
NMED	New Mexico Environmental Department
NMFFO	New Mexico Farmington Field Office
NMIM	National Mobile Inventory Model
NMSO	BLM New Mexico State Office
NOAA	National Oceanic and Atmospheric Administration
NPRI	National Pollutant Release Inventory
NPS	National Park Service
NSPS	New Source Performance Standard
NSR	New Source Review
O&G	Oil and Gas
OA	Organic Aerosol
OSAT	Ozone Source Apportionment Technology

PAVE	Package for Analysis and Visualization
PBL	Planetary Boundary Layer
PGM	Photochemical Grid Model
PiG	Plume-in-Grid
PM	Particulate Matter
PPM	Piecewise Parabolic Method
PSAT	Particulate Source Apportionment Technology
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QC	Quality Control
RAQC	Regional Air Quality Council
RGFO	Royal Gorge Field Office
RMC	Regional Modeling Center
RMNP	Rocky Mountain National Park
RMP	Resource Management Plan
ROMANS	Rocky Mountain Atmospheric Nitrogen and Sulfur Study
SCC	Source Classification Code
SIP	State Implementation Plan
SMOKE	Sparse Matrix Kernel Emissions modeling system
SOA	Secondary Organic Aerosol
TCEQ	Texas Commission on Environmental Quality
TRFO	Tres Rios Field Office
UAM	Urban Airshed Model
UCR	University of California at Riverside
UFO	Uncompahgre Field Office
UNC	University of North Carolina
UPA	Unpaired Peak Accuracy
USFS	United States Forest Service
USFS-PG	United State Forest Service Pawnee Grasslands
UTSO	BLM Utah State Office
VERDI	Visualization Environment for Rich Data Interpretation
VISTAS	Visibility Improvements for States and Tribal Associations in the Southeast
VMT	Vehicle Miles Traveled
WBD	Wind Blown Dust model
WEA	Western Energy Alliance
WESTUS	Western United States
WRAP	Western Regional Air Partnership
WRFO	White River Field Office
WGA	Western Governors' Association
WRF	Weather Research Forecasting model

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APPENDIX A

2008 WRF Meteorological Modeling for CARMMS

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A.1 Introduction

The WRF model performance evaluation was conducted as part of WestJumpAQMS and is documented in a "WRF Application/Evaluation" report (ENVIRON and Alpine, 2012[1]). The WestJumpAQMS 2008 WRF model performance evaluation was based on a combination of qualitative and quantitative analyses. The qualitative approach was to compare the spatial distribution of the model estimated monthly total precipitation with the monthly Center for Prediction of Climate (CPC) precipitation analysis using graphical outputs. The quantitative approach was to examine tabulations and graphical displays of the model bias and error for surface wind speed, wind direction, temperature, and mixing ratio (humidity) and compare the performance statistics to benchmarks developed based on a history of meteorological modeling as well as past meteorological model performance evaluations. The statistics were calculated using the publicly available METSTAT evaluation tool, which calculates the statistical performance metrics and can produce time series of predicted and observed meteorological variable and performance statistics. The observed database for winds, temperature, and water mixing ratio that were used in this analysis is from the National Oceanic and Atmospheric Administration (NOAA), Earth System Research Laboratory (ESRL) Meteorological Assimilation Data Ingest System (MADIS). The locations of the MADIS monitoring sites within the 36 and 12 km WRF modeling domains are shown in Figures A-1 and A-2. The rain observations were taken from the NOAA CPC[2] retrospective rainfall archives.

The WestJumpAQMS 2008 WRF Application/Evaluation report evaluated the WRF surface meteorological parameters using METSTAT across the 36 km CONUS, 12 km WESTUS and 4 km IMWD modeling domains and compared them against meteorological model performance benchmarks. Provided with the WestJumpAQMS WRF Application/Evaluation report was the evaluation of the WRF model performance at each individual surface monitoring site in the inter-mountains western states. The results for all sites in Colorado are available on the WestJumpAQMS website[3] with a few examples of the WRF Colorado model performance given below.

[1] http://www.wrapair2.org/pdf/WestJumpAQMS_2008_Annual_WRF_Final_Report_February29_2012.pdf
[2] http://www.cpc.ncep.noaa.gov/products/precip/realtime/retro.shtml
[3] http://www.wrapair2.org/pdf/westjump.wrf.site.co.2012-04-04.pdf

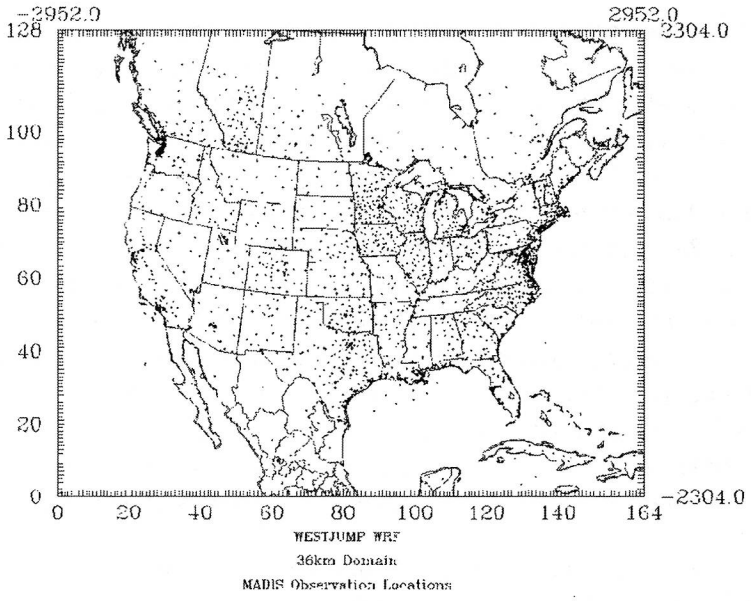

Figure A-1. Locations of MADIS surface meteorological modeling sites within the WestJumpAQMS WRF 36 km modeling domain.

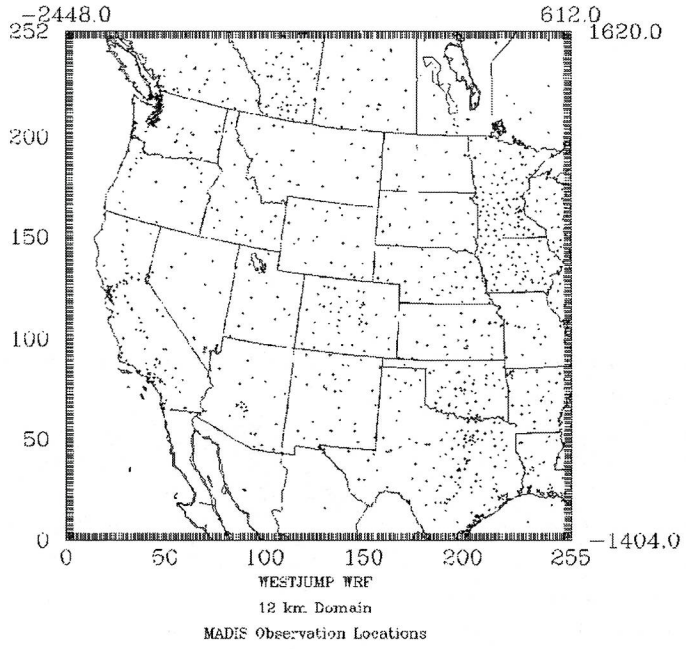

Figure A-2. Locations of MADIS surface meteorological modeling sites within the WestJumpAQMS WRF 12 km modeling domain.

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A.2 Meteorological Model Performance Benchmarks

Meteorological model performance evaluation benchmarks have been developed after examining the model performance of ~30 meteorological model simulations that produced "good" air quality model performance, primarily to support ozone SIPs (Emery et al., 2001). The key to the benchmarks is to understand how good or poor the results are relative to other model applications run for the U.S. These meteorological model performance benchmarks include measures of bias and error in surface temperature, wind speed and direction and water vapor mixing ratio. Because the benchmarks were developed primarily for meteorological model simulations to support urban ozone planning they represent model performance under fairly "simple" conditions. That is, usually fairly flat terrain (although sometimes with coastal conditions) with simple meteorological conditions (e.g., stationary high pressure). Meteorological model performance within the complex terrain of the Inter-Mountain West would be expected to be not as good as in these simple conditions. Thus, for some of the meteorological model performance metrics (i.e., temperature) more "complex" performance benchmarks have been developed (Kemball-Cook et al., 2005; McNally, 2009).

The equations for bias, error and Root Mean Squared Error (RMSE) are given below. Table A-1 list the simple and complex meteorological model performance benchmarks that the WRF 2008 simulation model performance was compared against. It is important to emphasize that the benchmarks are not passing/failing grades, rather they are metrics that allow the intercomparison of meteorological model performance.

$$\text{Bias} = \frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)$$

$$\text{Error} = \frac{1}{N}\sum_{i=1}^{N}|P_i - O_i|$$

$$\text{RMSE} = \left[\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)^2\right]^{1/2}$$

Table A-1. Simple and complex meteorological model performance benchmarks for surface meteorological model performance evaluation.

Meteorological	Benchmark		
Variable	Simple (Emery et al., 2001)	Complex (McNally, 2009)	Complex (Kemball-Cook et al., 2005)
Temperature Bias	≤±0.5°K	≤±1.0 K	≤±2.0 K
Temperature Error	≤2.0°K	≤3.0 K	≤3.5 K
Mixing Ratio Bias	≤±1.0 g/kg	--	NA
Mixing Ratio Error	≤2.0 g/kg	--	NA
Wind Speed Bias	≤±0.5 m/s	--	≤±1.5 m/s
Wind Speed RMSE	≤2.0 m/s	--	≤2.5 m/s
Wind Direction Bias	≤±10 degrees	--	NA
Wind Direction Error	≤30 degrees	--	≤±55 degrees

A.3 Summary of 2008 WRF Model Performance Evaluation for the CARMMS Region

The WestJumpAQMS WRF Application/Evaluation report evaluated WRF across several preliminary Impact Assessment Domains as shown in Figure A-3. The CO_UT 4 km IAD most closely resembles the CARMMS 4 km modeling domain so those results are discussed below. WestJumpAQMS also evaluated WRF's surface meteorological model performance separately for each site in Colorado that is discussed at the end of this section.

A.3.1 Surface Meteorological Model Performance

Figure A-4 display soccer plots of monthly humidity (mixing ratio) and temperature model performance within the CO_UT 4 km IAD domain (see Figure A-3) for the WestJumpAQMS 2008 4 km WRF simulation. Soccer plots plot a model's bias versus error and compares them with the model performance benchmark, where in these figures from the WestJumpAQMS WRF Application/Evaluation report (ENVIRON and Alpine, 2012) the Simple and McNally (2009) Complex benchmarks are used (see Table A-1). The WRF 36, 12 and 4 km humidity model performance achieves the Simple Performance Benchmark within the CO_UT 4 km IAD domain (Figure A-4, left). The monthly humidity performance for the WRF 4 km simulation is exhibiting near zero bias and very low error that achieves the Performance Benchmarks.

The WRF 36 km temperature performance has a bias that achieves the ≤±1.0 K McNally and ≤±2.0 K Kemball-Cook Complex Benchmarks (Figure A-4, right). However, the WRF 12 and 4 km simulation temperature exhibits a positive bias ranging from 0.0 to 1.3 K so that some months fall outside of the McNally but are within the Kemball-Cook Complex Benchmarks. The last four months of the year have a positive bias that is greater than 1.0 K. The WRF 12 and 4 km simulation temperature error falls between the Simple (2.0 K) and Complex 3.0/3.5 K) Benchmarks.

The WRF wind speed bias and error falls between the Simple and Complex benchmarks (Figure A-5, left). WRF exhibits a low wind speed bias across the CO-UT 4 km IAD domain with the negative bias greater for the warm than the cool months. The WRF 12 and 4 km wind direction has a near zero bias that is always within ±5 degrees that achieves the Simple Benchmark (≤±10 degrees). However, the wind direction error falls between the Simple (≤30 degrees) and Complex ≤55 degree benchmarks

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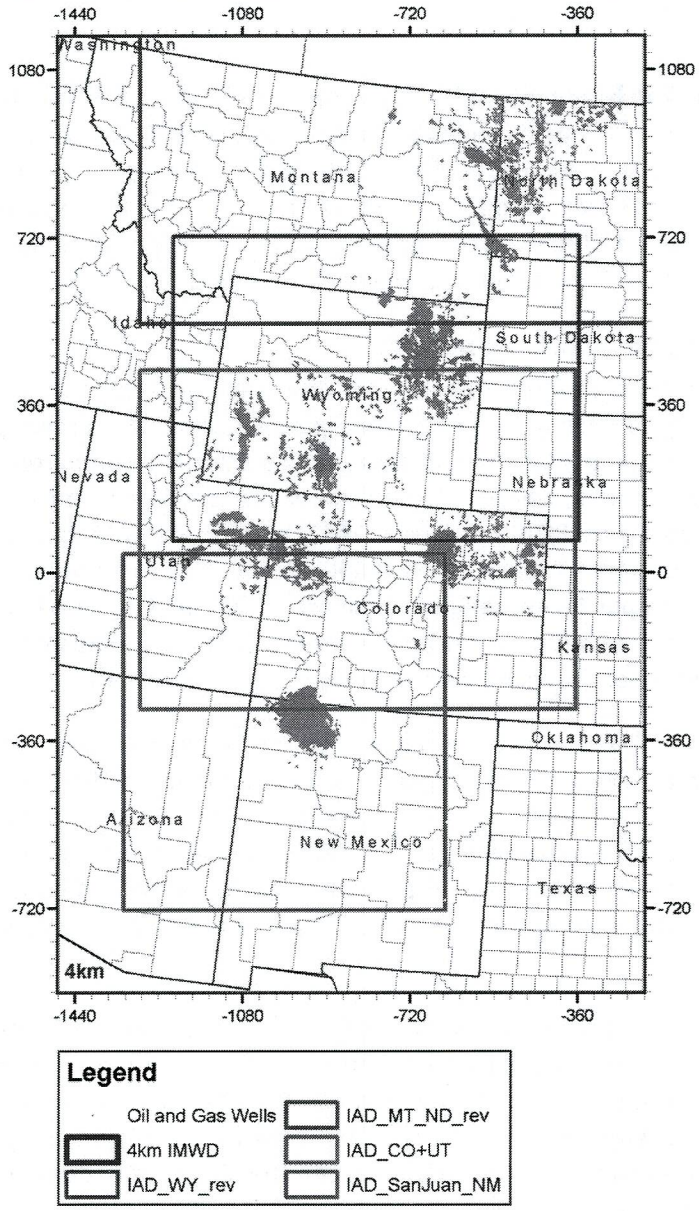

Figure A-3. Locations of the preliminary 4 km Impact Assessment Domains (IADs) used in the WestJumpAQMS 2008 WRF evaluation.

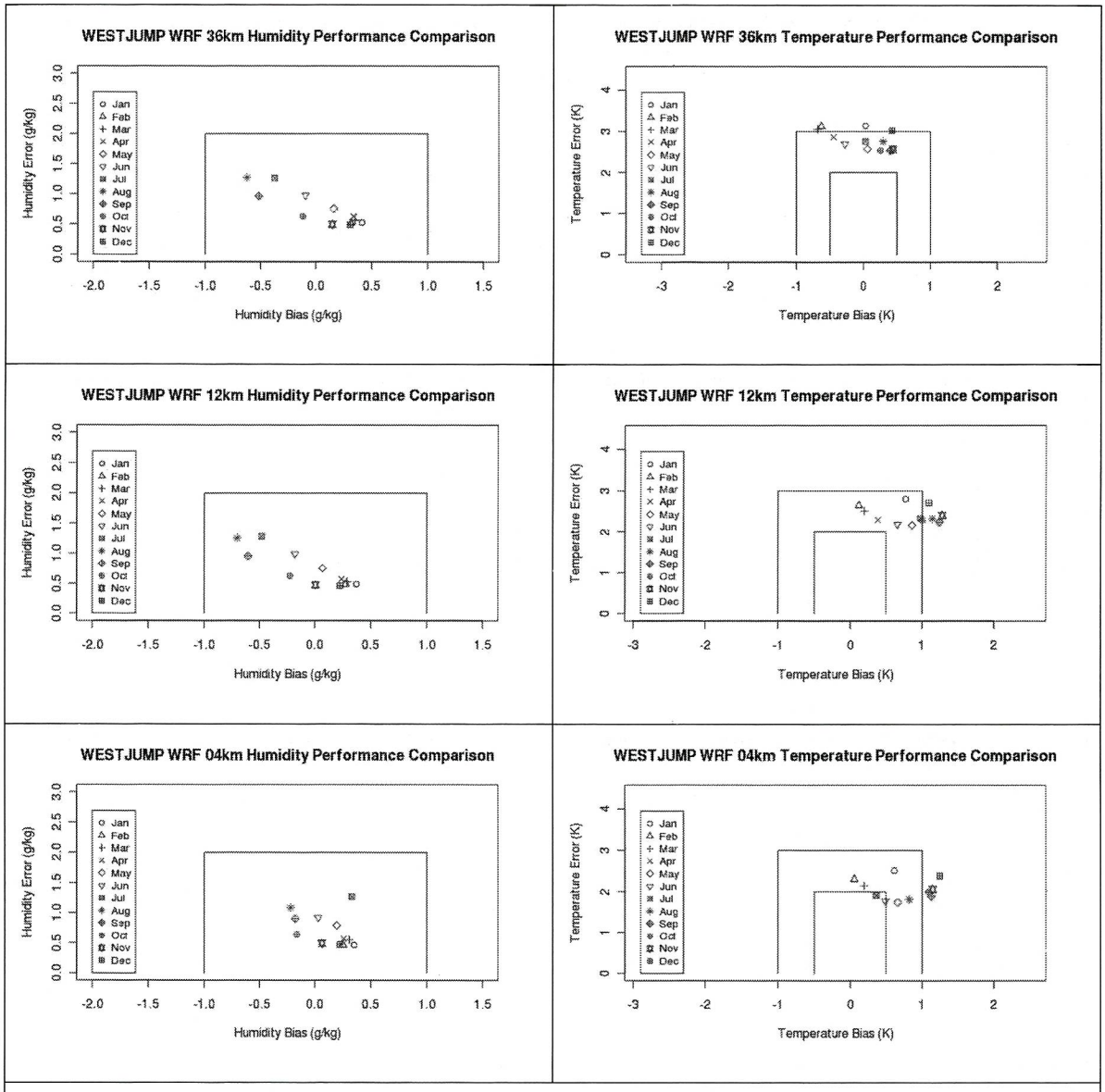

Figure A-4. Monthly Humidity (left) and Temperature (right) performance for all sites in the preliminary CO_UT 4 km Impact Assessment Domain for the 36 km (top), 12 km (middle) and 4 km (bottom) WestJumpAQMS WRF simulations.

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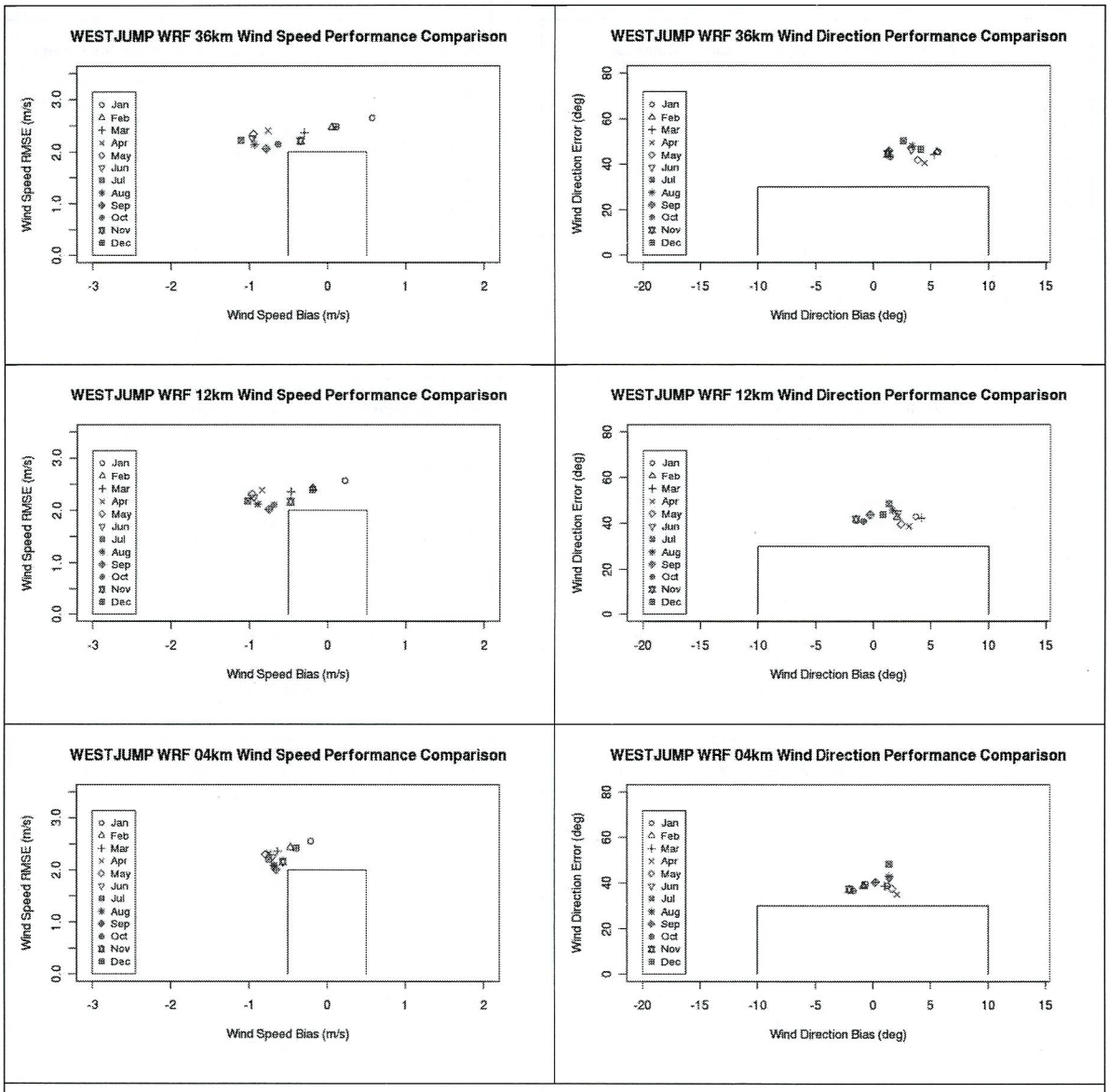

Figure A-5. Wind Speed (left) and Wind Direction (right) performance for all sites in the preliminary CO_UT 4 km Impact Assessment Domain for the 36 km (top), 12 km (middle) and 4 km (bottom) WestJumpAQMS WRF simulations.

A.3.2 Precipitation Evaluation

Figure A-6 compares monthly total precipitation across the 4 km IMWD for the CPC analysis fields based on observations, the WRF 4 km estimates and the four months of January, April, July and October (see WestJumpAQMS WRF report for remainder of months, ENVIRON and Alpine, 2012). The much higher resolution in the WRF 4 km precipitation fields is readily apparent compared to the coarser CPC fields and must be accounted for in the interpretation of precipitation model performance. In January 2008, the spatial distribution of the CPC and WRF monthly precipitation fields are very similar with most of it occurring in the western half of the domain and much dryer conditions east of the Front Range. The CPC and WRF estimate similar areas of higher precipitation intensity, although the WRF has smaller areas of higher intensity than the CPC analysis fields due to the higher resolution (Figure A-6a, top).

In April 2008, both the CPC analysis and WRF monthly precipitation exhibit a diagonal northwest to southeast orientation in the precipitation pattern with areas of higher intensity occurring over the Bitterroot Range on the ID-MT border, stretching down along the continental divide and in NB, KS and OK (Figure A-6a, bottom).

In July 2008, the desert southwest summer monsoon is clearly evident in the CPC and WRF precipitation fields with the highest intensity occurring in Arizona and New Mexico (Figure A-6b, top). Higher precipitation amounts are also seen in the high plains in the eastern part of the 4 km IMWD, with the Rocky Mountains in the western part of the 4 km IMWD being much dryer.

In October 2008, both the CPC and WRF have very similar spatial patterns of monthly precipitation with the highest intensity precipitation occurring in Kansas stretching down to OK and TX, with WRF estimating higher intensity in OK/TX than seen in the CPC fields (Figure A-6b, bottom).

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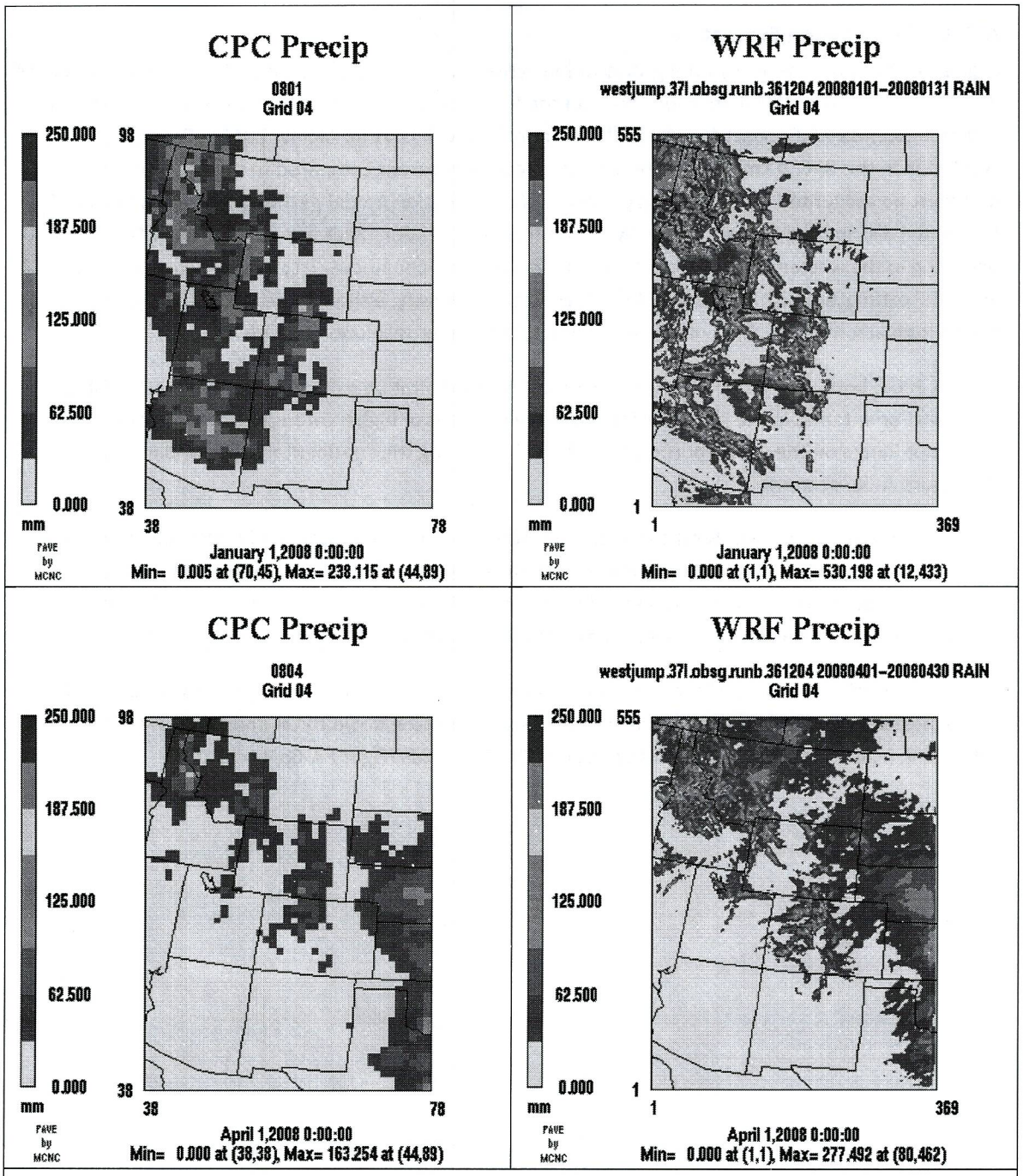

Figure A-6a. Comparison of January (top) and April (bottom) 2008 monthly precipitation amounts (mm) over the 4 km Inter-Mountain West Domain (IMWD) from the CPC analysis of observations (left) and estimated by the WestJumpAQMS 4 km WRF simulation.

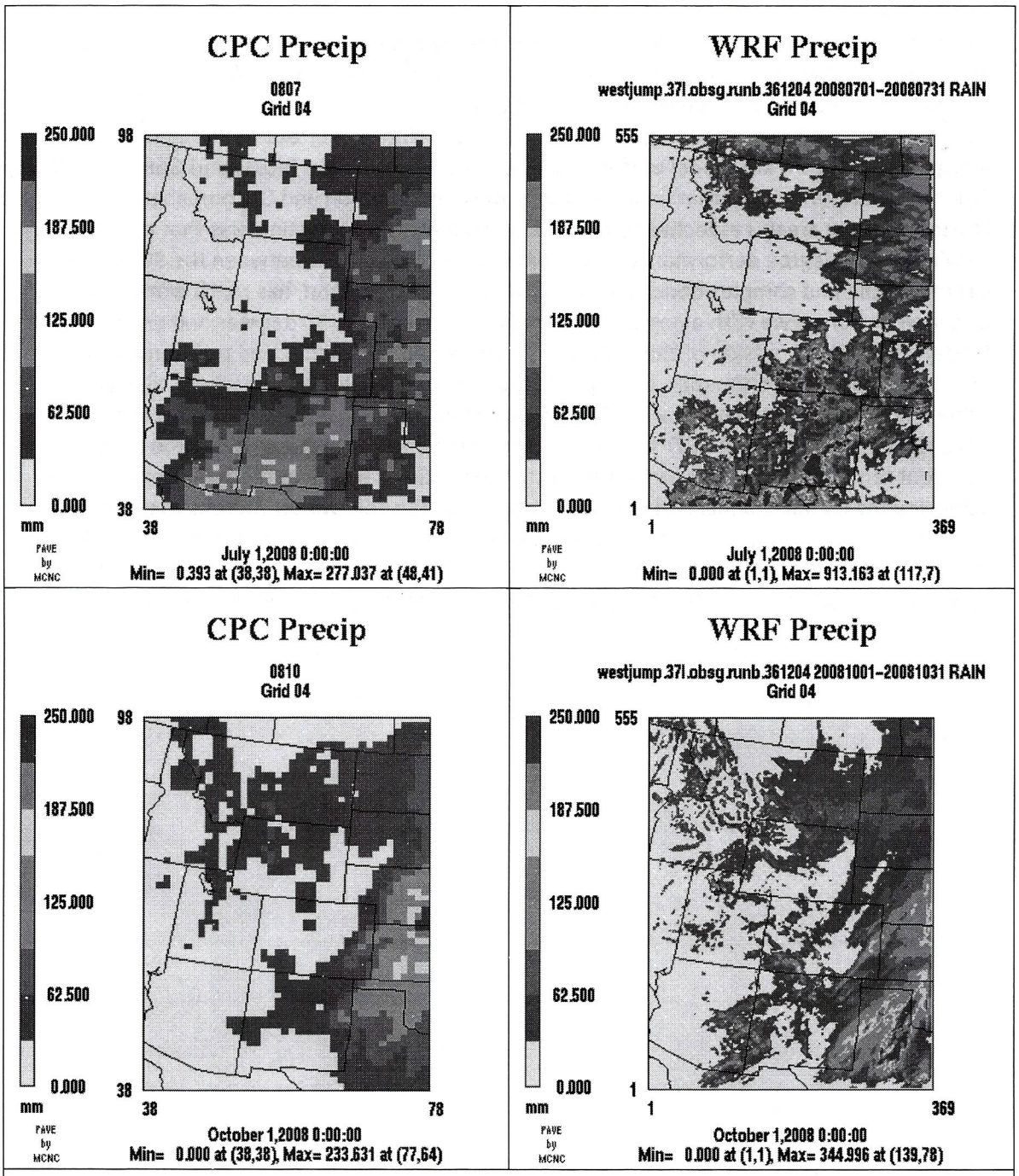

Figure A-6b. Comparison of July (top) and October (bottom) 2008 monthly precipitation amounts (mm) over the 4 km Inter-Mountain West Domain (IMWD) from the CPC analysis of observations (left) and estimated by the WestJumpAQMS 4 km WRF simulation.

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A.3.3 Performance at Individual Monitoring Sites

WestJumpAQMS performed WRF 4 km surface meteorological model performance at individual monitoring sites in Colorado that is posted to its website[4]. The WRF performance varies greatly by site, which may be due in part to each site having its own local influences that cannot be captured by the 4 km WRF average meteorological conditions. For example, Figures A-7 and A-8 displays the WRF 4 km model performance at the Grand Junction (KGJT) and Gunnison (KGUC) Colorado monitoring sites that lie within the BLM Grand Junction and Uncompahgre Field Offices planning areas, respectively. KGJT has a negative wind direction bias that mostly falls within the ±10 degree performance benchmark and error that falls between the 30 and 55 degree simple and complex benchmarks. KGUC, on the other hand, has much worse wind direction performance with a positive bias that ranges from 0 to 30 degrees and errors of 50 to 80 degrees that fall outside of the benchmark ranges. Similar wind speed performance is seen with mostly an underestimation bias right at the -0.5 m/s simple benchmark but always achieving the complex benchmarks. The humidity benchmarks are almost always achieved at both sites with only July at KGJT falling outside of the benchmark due to being too moist. Different temperature model performance characteristics are seen at the two sites with KGJT achieving the complex benchmark (≤±1.0 K) except for the cold winter months that are too warm by from 1.5 to 3.0 K. Whereas KGUC always achieves the complex benchmark with monthly temperature bias and error clustered around the -0.5 K and 2.0 K simple benchmark bias and error point, except for January that has an overestimation bias of ~0.75 K.

[4] http://www.wrapair2.org/pdf/westjump.wrf.site.co.2012-04-04.pdf

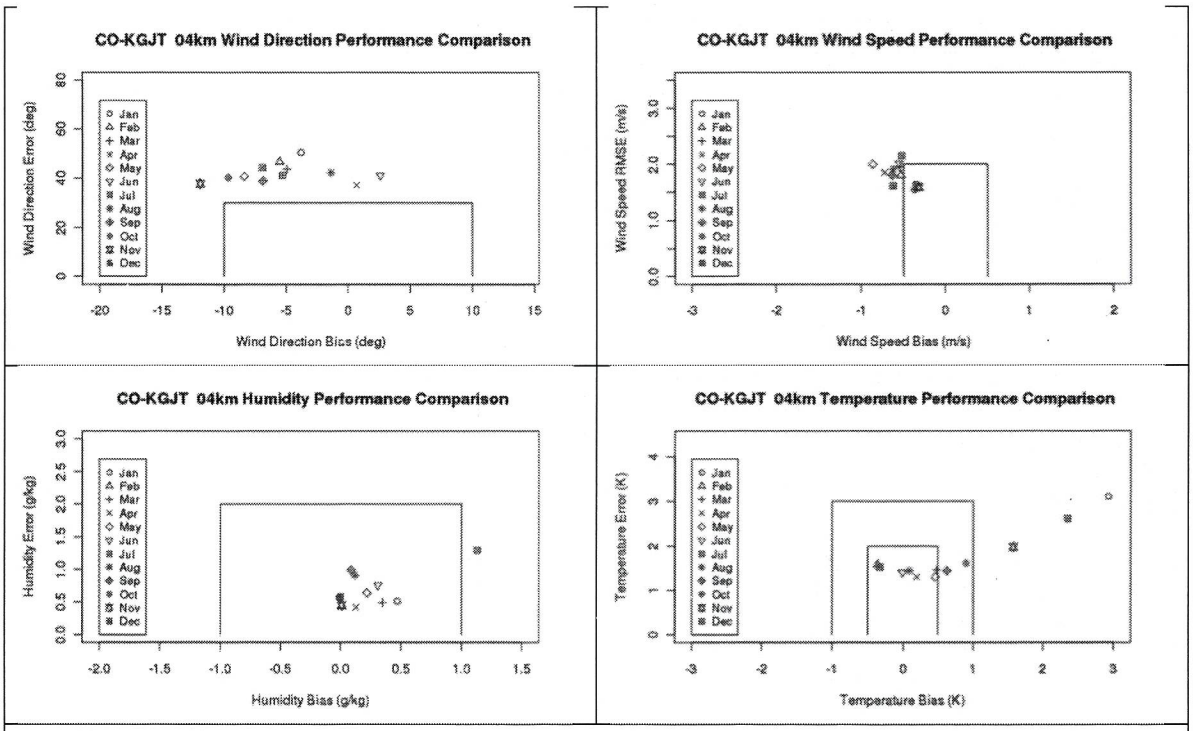

Figure A-7. Monthly WRF 4 km surface meteorological model performance at the Grand Junction (KGJT), Colorado monitoring site.

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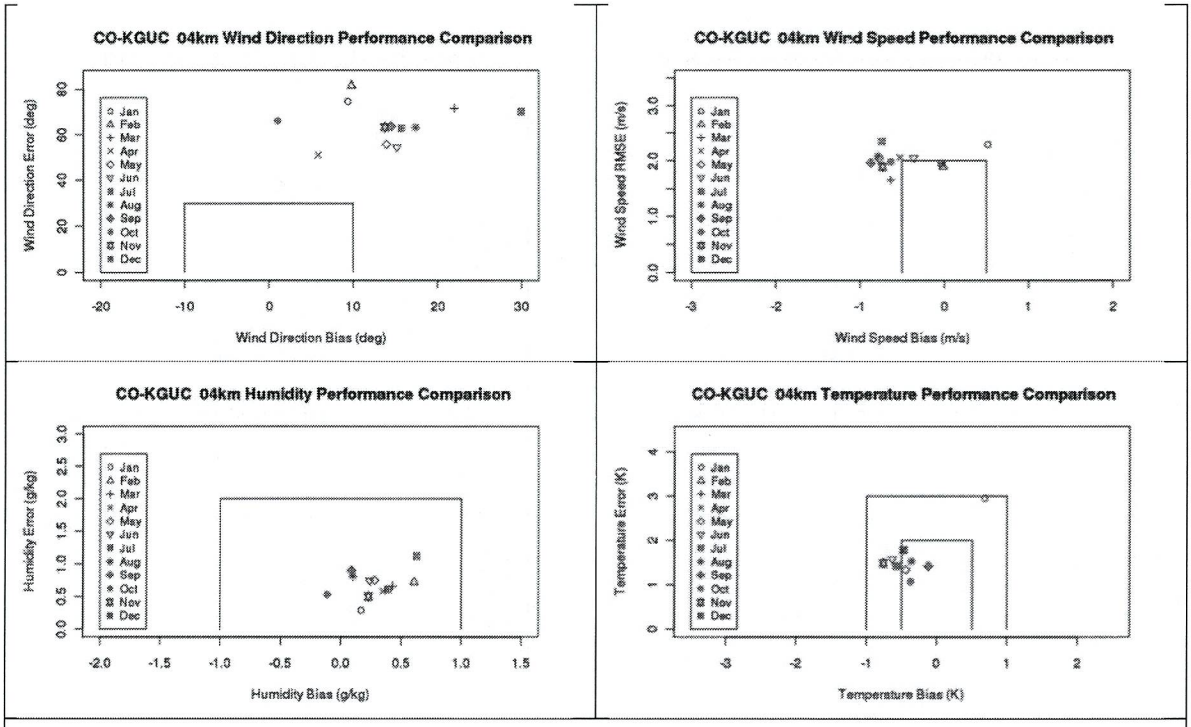

Figure A-8. Monthly WRF 4 km surface meteorological model performance at the Gunnison (KGUT), Colorado monitoring site.

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APPENDIX B

2008 CAMX Base Case Model Performance Evaluation

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B.1 Introduction

The CAMx PGM was selected for modeling air quality and AQRV impacts due to oil and gas and other activity within the Colorado and northern New Mexico BLM-planning areas. CAMx was selected over CMAQ due to the availability of the CAMx source apportionment tool and the need to obtain separate air quality and air quality related value (AQRV) contributions due to emissions of BLM authorized oil and gas sources in numerous Colorado and northern New Mexico BLM planning areas. CAMx Version 6.1 (V6.1, released April, 2014) was used in the CARMMS future year modeling analysis. However, CAMx V6.0 (September 2013 release) was used for the 2008 Base Case modeling. The CAMx V6.1 future year and CAMx V6.0 2008 Base Case models were configured to obtain identical results, although the CAMx V6.1 future year source apportionment took advantage of a new point source emissions "compact format" feature that greatly reduces the disk space requirements and consequently computational resources for the future year source apportionment modeling.

B.2 CAMx Model Configuration

The CAMx PGM 2008 Base Case modeling was configured as shown in Table B-1 and described below.

Advection and Diffusion Methods: The piecewise parabolic method (PPM) advection solver was used for horizontal transport (Colella and Woodward, 1984) along with the spatially varying (Smagorinsky) horizontal diffusion approach. CAMx will use K-theory for vertical diffusion using the CMAQ-like vertical diffusivities from WRFCAMx.

Chemical Mechanism: The CB05 gas-phase chemical mechanism was selected for the CAMx 2008 Base Case modeling to be consistent with WestJumpAQMS.

Spin-Up Initialization: A minimum of ten days of model spin up (i.e., using meteorological and emission conditions for December 21-31, 2007) was used to initialize the PGM.

Model Run Strategy: CAMx includes two approaches for using multiple central processing units (CPUs) for multi-processing: (1) Message Passing Interface (MPI) that performs modeling domain decomposition, passes the model solution for each subdomain to different CPUs at each time step, and then reassembles the solution across the whole domain at the end of the time step; and (2) Open Multiprocessing (OpenMP) that uses compiler directives to use multiple CPUs in the model simulation. An optimal configuration of MPI and OpenMP will be determined for the Linux Cluster being used to minimize the model throughput time. After benchmarking several different configurations, the CAMx CARMMS current and future year model simulations were run separately for four quarters using ~10 days of spin-up and using 24 CPUs for each quarter (i.e., using 96 CPUs at once) with 6 MPI domain decomposition and each MPI subdomain was run with 4 OpenMP multi-processing CPUs (24 = 6 x 4).

Boundary Conditions: Boundary conditions (BCs) for the 36 km CONUS domain CAMx simulation were based on output from the Model for OZone And Related chemical Tracers

(MOZART,[1]) global chemistry model. BCs for the CARMMS CAMx 2008 4 km based case simulation were based on the WestJumpAQMS CAMx 2008 36/12 km Base Case simulation.

Photolysis Rates: For photolysis rates, CAMx requires a lookup table of photolysis rates as well as gridded albedo/haze/ozone/snow as input. Day-specific ozone column data are based on the Total Ozone Mapping Spectrometer (TOMS) data measured using the satellite-based Ozone Monitoring Instrument (OMI[2]). Albedo is based on land use data, which includes enhanced albedo values when snow cover is present. For CAMx there is an ancillary snow cover input that is based on WRF output that overrides the land use based albedo input to use an enhanced snow cover albedo value. The Tropospheric Ultraviolet and Visible (TUV) Radiation Model[3] photolysis rate processor was used. CAMx is configured to use the in-line TUV to adjust for cloud cover and account for the effects aerosol loadings have on photolysis rates; this latter effect on photolysis may be especially important in adjusting the photolysis rates due to the occurrence of PM concentrations associated with emissions from fires. Note that the same photolysis rates are used in the 2008 Base Case and 2021 future year modeling.

Landuse: Landuse fields were generated based on U.S. Geological Survey (USGS) Geographic Information Retrieval and Analysis System (GIRAS) data[4]. The WRF estimate snow cover data is used to override the USGS land cover categories when snow cover is present.

Meteorological Inputs: The WestJumpAQMS 2008 WRF-derived meteorological fields were processed to generate CAMx meteorological inputs for the CARMMS 4 km domain and 2008 using the WRFCAMx processor.

Plume in Grid: The subgrid-scale Plum-in-Grid module was not used in the CARMMS modeling.

Other Model configuration options are detailed in Table B-1.

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[1] http://www.acd.ucar.edu/wrf-chem/mozart.shtml
[2] http://ozoneaq.gsfc.nasa.gov/
[3] http://cprm.acd.ucar.edu/Models/TUV/
[4] http://pubs.usgs.gov/ds/2006/240/

Table B-1. CAMx model configurations for BLM CARMMS 2008 4 km Base Case simulation.

Science Options	Configuration	Details
Model Codes	CAMx V6.0 – May 2013 Release	CAMx V6.1 (April 2014) used in 2021 future year modeling
Horizontal Grid Mesh- Regional Run to generate Boundary Conditions (BC) for the 4 km impact assessment domain	36/12 km	36/12 km run to generate BC for CARMMS 4 km impact assessment domain. 36/12 km run with 2 way grid nesting
36 km grid	148 x 112 cells	36 km CONUS RPO domain
12 km grid	239 x 206 cells	12 km WESTUS domain from WestJumpAQMS domain
Horizontal Grid Mesh- CARMMS Impact Assessment Runs	4 km	216 x 234
Vertical Grid Mesh	25 vertical layers, defined by WRF	Layer 1 thickness ~24- m. Model top at ~19-km above MSL
Grid Interaction	36/12 km two way nesting provide one-way grid nesting to 4 km CARMMS domain	CARMMS 4 km stand-alone domain
Initial Conditions	10 day spin-up	
Boundary Conditions	36 km CONUS domain from MOZART global chemistry model	4 km domain BCs from 36/12 km regional run
Emissions		
Baseline Emissions Processing	SMOKE, MOVES and MEGAN	
Sub-grid-scale Plumes	No Plume-in-Grid for major NO_X sources	
Chemistry		
Gas Phase Chemistry	CB05	
Meteorological Processor	WRFCAMx	
Horizontal Diffusion	Spatially varying	Smagorinsky
Vertical Diffusion	CMAQ-like in WRFCAMx	
Diffusivity Lower Limit	Kz_min = 0.1 to 1.0 m^2/s or 2.0 m_2/s	
Deposition Schemes		
Dry Deposition	Zhang dry deposition scheme	Zhang et al., 2001; 2003
Wet Deposition	CAMx -specific formulation	rain/snow/graupel/virga
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) -- Fast Solver	
Vertical Advection Scheme	Implicit scheme w/ vertical velocity update (CAMx)	
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	Colella and Woodward, 1984
Integration Time Step	Wind speed dependent	~0.1-1 min for 4 km domain

B.3 2008 CAMx Base Case Modeling

WestJumpAQMS performed CAMx modeling using two-way grid nesting on the regional 36 km CONUS and 12 km WESTUS domains using the 2008 Base Case emission scenario to develop boundary conditions (BCs) for the smaller 4 km CARMMS domain. WestJumpAQMS then ran CAMx for the 4 km CARMMS impact assessment domain using 2008 Base Case emissions and BCs from the CAMx 2008 Base Case 36/12 km run.

B.4 Photochemical Model Performance Evaluation

The CAMx 2008 Base Case modeling and model performance evaluation was conducted under the WestJumpAQMS. Originally CARMMS was going to completely rely on the WestJumpAQMS model evaluation of the CARMMS 2008 Base Case simulation and CARMMS did not intend to perform any additional 2008 Base Case modeling or model performance evaluation. WestJumpAQMS conducted a comprehensive detailed model performance of the CAMx 2008 36/12 km Base Case simulation across the 36 km CONUS and 12 km WESTUS domains, and within each western State for ozone, total $PM_{2.5}$ mass, speciated $PM_{2.5}$, sulfur and nitrogen wet deposition and for several ozone and $PM_{2.5}$ precursor (e.g., SO_2 and NO_X) and related (e.g., HNO3) species. Section 4.5.3 of the WestJumpAQMS final report (ENVIRON, Alpine and UNC[5]) presented the evaluation the CARMMS 2008 4 km Base Case simulation across the CARMMS 4 km domain.

B.4.1 February 28, 2014 IAQRT Meeting

The WestJumpAQMS model evaluation results for the CARMMS CAMx 4 km Base Case simulation were presented to the Interagency Air Quality Review Team (IAQRT) on February 28, 2014 at the BLM Colorado State Office (COSO). EPA expressed several concerns regarding the adequacy of the model performance evaluation of the CARMMS 2008 4 km Base Case. In particular they believed that the ozone model performance evaluation should be performed using a 60 ppb observed ozone cut-off instead of the 40 ppb cut-off used by WestJumpAQMS. In addition, they expressed concerns about just calculating monthly model performance statistics across the entire 4 km CARMMS modeling domain.

The evaluation of the CAMx model for the CARMMS 2008 base case simulation produced many more evaluation products than provided in the WestJumpAQMS final report. However, it did not calculate ozone model performed statistics using a 60 ppb observed ozone cut-off threshold as desired by EPA. So we calculated additional ozone model performance statistics using the 60 ppb ozone cut-off threshold. The spreadsheet of monthly ozone bias and error model performance statistics and their comparison with the ozone bias (≤±15%) and error (≤35%) performance goals was updated as follows:

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[5] http://www.wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf

Ozone Averaging Times

- Hourly
- Daily maximum 8-Hour Ozone Concentrations

Ozone Monitoring Networks

- AQS
- CASTNet

Bias and Error Statistical Metrics

- Fractional Bias and Error
- Normalized Mean Bias and Error
- Mean Normalized Bias and Error

As discussed below, with the exception of some winter months, the monthly ozone statistical performance metrics across the CARMMS 4 km domain still achieved EPA's performance goals even using the 60 ppb cut-off threshold for both averaging times and monitoring networks and three types of bias/error performance metrics.

Regarding more details on the CARMMS CAMx 4 km base case MPE, we packaged up the model performance products in a zipped file that includes many differences types of monthly model performance metrics and species for sites in the CARMMS 4 km modeling domain. Model performance displays include scatter plots and time series plots of predicted and observed concentrations, in addition to a full suite of model performance evaluation statistical metrics, and are provided for each month of 2008 as follows:

- All sites in the CARMMS 4 km domain and all hours/days in a month.
- At each individual site in the CARMMS 4 km domain and all hours/days in a month.
- For each day in 2008 across all sites in the CARMMS 4 km domain.

Model performance displays and statistics are provided for numerous gas-phase (e.g., ozone and NO_X) and particulate matter (PM) species (e.g., SO4, NO3, NH4, EC, OA). EPA specifically requested model performance for ammonia (NH3) and ammonium (NH4). However, there were no routine NH3 measurements available in 2008 and NH4 was just measured at the CSN network. Although we also evaluated CAMx against derived ammonium (NH4d) at IMPROVE sites that is obtained using the IMPROVE SO4 and NO3 measurements and assuming they are completely neutralized by NH4; note this will overstate actual NH4 values because SO4 is not always neutralized and both SO4 and NO3 can be neutralized by other cations besides NH4.

The detailed model performance displays and metrics for the CARMMS CAMx 2008 base case simulation is contained in the zipped file "CARMMS_2008_4km_MPE_Details.zip" that contains over 4,500 separate model performance displays and is larger than 70 Mb.

Below we present the WestJumpAQMS evaluation of the CARMMS 2008 Base Case simulation across the 4 km CARMMS domain with the addition of the ozone metrics using the 60 ppb cut-off concentrations discussed above. However, we do not present the evaluation down to the individual site as the amount of information is too overwhelming.

B.4.2 Observed Monitoring Networks

The following routine air quality measurement data networks were used in the CAMx model performance evaluation:

EPA AQS Surface Air Quality Data: Data files containing hourly-averaged concentration measurements at a wide variety of state and EPA monitoring networks are available in the Air Quality System (AQS[6]) database throughout the U.S. These data sets will be reformatted for use in the model evaluation software tools. There are several types of networks within the AQS that measure different species. The standard hourly AQS AIRS monitoring stations typically measure hourly ozone, NO_2, NO_X and CO concentration and there are thousands of sites across the U.S. The Federal Reference Method (FRM) network measures 24-hour total $PM_{2.5}$ mass concentrations using a 1:3 day sampling frequency, with some sites operating on an everyday frequency. The Chemical Speciation Network (CSN) measures speciated $PM_{2.5}$ concentrations including SO_4, NO_3, NH_4, EC, OC and elements at 24-hour averaging time period using a 1:3 or 1:6 day sampling frequency.

IMPROVE Monitoring Network: The Interagency Monitoring of Protected Visual Environments (IMPROVE[7]) network collects 24-hour average $PM_{2.5}$ and PM_{10} mass and speciated $PM_{2.5}$ concentrations (with the exception of ammonium) using a 1:3 day sampling frequency. IMPROVE monitoring sites are mainly located at more rural Class I area sites that correspond to specific National Parks and Wilderness Areas across the U.S., with most of the sites located in the western U.S. Although there are also some IMPROVE protocol sites that can be more urban-oriented.

CASTNet Monitoring Network: The Clean Air Status and Trends Network (CASTNet[8]) operates approximately 80 monitoring sites in mainly rural areas across the U.S. CASTNet sites typically collected hourly ozone, temperature, wind speed and direction, sigma theta, solar radiation, relative humidity, precipitation and surface wetness. CASTNet also collects weekly (Tuesday to Tuesday) samples of speciated $PM_{2.5}$ sulfate, nitrate, ammonium and other relevant ions and weekly gaseous SO_2 and nitric acid (HNO_3).

NADP Network: The National Acid Deposition Program (NADP[9]) collects weekly samples of SO_4, NO_3 and NH_4 in precipitation (wet deposition) in their National Trends Network (NTN) at over a 100 sites across the U.S. that are mainly located in rural areas away from big cities and major point sources. Seven NADP sites also collect daily wet deposition measurements (AIRMON) when precipitation occurs. Over 20 of the NADP sites also collect weekly mercury (MDN)

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[6] http://www.epa.gov/ttn/airs/airsaqs/aqsweb/
[7] http://vista.cira.colostate.edu/IMPROVE/
[8] http://java.epa.gov/castnet/
[9] http://nadp.sws.uiuc.edu/NADP/

samples. Note that observed sulfate and nitrate dry deposition can be estimated at CASTNet sites using concentrations and a micro-meteorological model that produces a deposition velocity. But these are not true observations, but model estimates of dry deposition flux using observed atmospheric concentrations and meteorological variables and a micro-meteorological deposition model.

B.4.3 Model Performance Goals

Over two decades ago EPA developed PGM ozone model performance goals that are listed in Table B-2 (EPA, 1991). During the regional haze RPO process, additional model performance goals and criteria were developed for PM species (Boylan, 2004; Morris et al., 2009c,d) that are listed in Table B-3. Note that the EPA 1991 ozone model performance goals were applied to the mean normalized bias (MNB) and mean normalized gross error (MNGE) model performance statistics that are calculated for all predicted and observed hourly ozone pairs matched by time and location for which the observed hourly ozone is above a threshold, with a 60 ppb threshold recommended. However, the 60 ppb ozone cut-off was selected for urban ozone modeling of areas with high ozone concentrations addressing the 1-hour ozone NAAQS of 124 ppb. Ozone is much lower these days so an observed ozone cut-off threshold concentration of 40 ppb was used for calculating the MNB and MNGE ozone statistics in addition to the 60 ppb cut-off value. For PM performance statistics, the Fractional Bias (FB) and Fractional Error (FE) bias/error performance metrics are compared against goals and criteria developed during the Regional Planning Organizations (RPOs) modeling to support the Regional Haze Rule (Boylan, 2004; Morris et al., 2009c,d). Table B-4 lists the definitions of the model performance statistical metrics.

More recently, EPA compiled and interpreted the model performance from 69 PGM modeling studies in the peer-reviewed literature between 2006 and March 2012 and developed recommendations on what should be reported in a model performance evaluation (Simon, Baker and Phillips, 2012). Although these recommendations are not official EPA guidance, they are useful for consideration in the BLM CARMMS model performance evaluation:

- PGM MPE studies should at a minimum report the Mean Bias (MB) and Mean Error (ME or RMSE), and Normalized Mean Bias (NMB) and Normalized Mean Error (NME) and/or Fractional Bias (FB) and Fractional Error (FE). Both the MNB and FB are symmetric around zero with the FB bounded by -200% to +200%.
- Use of the Mean Normalized Bias (MNB) and Gross Error (MNGE) is not encouraged because they are skewed toward low observed concentrations and can be misinterpreted due to the lack of symmetry around zero.
- The model evaluation statistics should be calculated for the highest resolution temporal resolution available and for important regulatory averaging times (e.g., daily maximum 8-hour ozone).
- It is important to report processing steps in the model evaluation and how the predicted and observed data were paired and whether data are spatially/temporally averaged before the statistics are calculated.

- Predicted values should be taken from the grid cell that contains the monitoring site, although bilinear interpolation to the monitoring site point can be used for higher resolution modeling (< 12 km).
- $PM_{2.5}$ should also be evaluated separately for each major component species (e.g., SO_4, NO_3, NH_4, EC, OA and OPM2.5).
- Evaluation should be performed for subsets of the data including, high observed concentrations (e.g., ozone > 60 ppb[10]), by subregions and by season or month.
- Evaluation should include more than just ozone and $PM_{2.5}$, such as SO_2, NO_2 and CO.
- Spatial displays should be used in the model evaluation to evaluate model predictions away from the monitoring sites. Time series of predicted and observed concentrations at a monitoring site should also be used.
- It is necessary to understand measurement artifacts in order to make meaningful interpretation of the model performance evaluation.

Given these recommendations we will stress the FB and FE and NMB and NME measures of bias and error over the MNB and MNGE.

Table B-2. Hourly ozone model performance goals from EPA's 1991 PGM modeling guidance.

Goal	Metric	Definition	Comment
≤±20%	Unpaired Peak Accuracy (UPA)	$\frac{P - O_{peak}}{O_{peak}}$	Compare highest predicted and observed daily maximum hourly ozone concentrations unmatched by location and hour but matched by day.
≤±15%	Mean Normalized Bias (MNB)	$\frac{1}{N}\sum_{i=1}^{N}\frac{(P_i - O_i)}{O_i}$	Predicted and observed hourly ozone concentrations matched by time and location when observed ozone is 60 ppb or greater. Use a 40 ppb cut-off in CARMMS.
≤35%	Mean Normalized Gross Error (MNGE)	$\frac{1}{N}\sum_{i=1}^{N}\frac{\lvert P_i - O_i\rvert}{O_i}$	Predicted and observed hourly ozone concentrations matched by time and location when observed ozone is 60 ppb or greater. Use a 40 ppb cut-off in CARMMS.

Table B-3. Ozone and PM model performance goals and criteria for bias and error (Boylan, 2004; Morris et al., 2009c,d).

Bias	Error	Comment
≤±15%	≤35%	Ozone model performance Goal from the 1991 guidance that would be considered very good model performance for PM species (EPA, 1991).
≤±30%	≤50%	PM model performance Goal, considered good PM performance (Boylan, 2004).
≤±60%	≤75%	PM model performance Criteria, considered average PM performance. Exceeding this level of performance for PM species with significant mass may be cause for concern (Boylan, 2004).

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[10] Note that because of the low ozone concentrations in the Montana/Dakotas the Simon, Baker and Phillips (2012) 60 ppb threshold recommendation should be lowered to 40 ppb.

Table B-4. Definition of model performance evaluation statistical measures used to evaluate PGMs in the past.

Statistical Measure	Mathematical Expression	Notes
Accuracy of paired peak (AP)	$\frac{P - O_{peak}}{O_{peak}}$	Comparison of the peak observed value (O_{peak}) with the predicted value at same time and location
Coefficient of determination (r2)	$\frac{\left[\sum_{i=1}^{N}(P_i - \overline{P})(O_i - \overline{O})\right]^2}{\sum_{i=1}^{N}(P_i - \overline{P})^2 \sum_{i=1}^{N}(O_i - \overline{O})^2}$	Pi = prediction at time and location i; Oi = observation at time and location i; $\overline{P}$ = arithmetic average of Pi, i=1,2,..., N; $\overline{O}$ = arithmetic average of Oi, i=1,2,...,N
Normalized Mean Error (NME)	$\frac{\sum_{i=1}^{N}\lvert P_i - O_i\rvert}{\sum_{i=1}^{N} O_i}$	Reported as %
Root Mean Squared Error (RMSE)	$\left[\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)^2\right]^{1/2}$	Reported as %
Fractional Gross Error (FE)	$\frac{2}{N}\sum_{i=1}^{N}\left\lvert\frac{P_i - O_i}{P_i + O_i}\right\rvert$	Reported as % and bounded by 0% to 200%
Mean Absolute Gross Error (MAGE)	$\frac{1}{N}\sum_{i=1}^{N}\lvert P_i - O_i\rvert$	Reported as concentration (e.g., µg/m^3)
Mean Normalized Gross Error (MNGE)	$\frac{1}{N}\sum_{i=1}^{N}\frac{\lvert P_i - O_i\rvert}{O_i}$	Reported as %
Mean Bias (MB)	$\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)$	Reported as concentration (e.g., µg/m^3)
Mean Normalized Bias (MNB)	$\frac{1}{N}\sum_{i=1}^{N}\frac{(P_i - O_i)}{O_i}$	Reported as %
Mean Fractionalized Bias (Fractional Bias, FB)	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as %, bounded by -200% to +200%
Normalized Mean Bias (NMB)	$\frac{\sum_{i=1}^{N}(P_i - O_i)}{\sum_{i=1}^{N} O_i}$	Reported as %
Bias Factor (BF)	$\frac{1}{N}\sum_{i=1}^{N}\left(\frac{P_i}{O_i}\right)$	Reported as BF:1 or 1: BF or in fractional notation (BF/1 or 1/BF).

B.4.4 Model Performance Evaluation Approach

The WestJumpAQMS CAMx 2008 base case model performance evaluation focused on evaluating the model for its primary intended purpose, estimating the air quality and AQRV impacts within the 4 km CARMMS modeling domain. Based on EPA modeling guidance (EPA, 1991; 2007), the recommendations of Simon, Baker and Philips (2012) and previous studies, the WestJumpAQMS CAMx model performance evaluation included the following:

- The PGM should be evaluated across all relevant species for which observations are available, including ozone, NO, NO_2, NO_X, HNO_3, SO_2, $PM_{2.5}$, PM_{10}, speciated $PM_{2.5}$ (SO_4, NO_3, NH_4, EC, OA and OPM2.5) and wet sulfur and nitrogen deposition.
- Numerous statistical performance measures should be calculated (Table B-4) and reported following the recommendations of Simon, Baker and Phillips (2012)
- The native sampling frequency of the observations will be used in the evaluation, along with important regulatory averaging times (e.g., daily maximum 8-hour ozone, annual $PM_{2.5}$ and annual wet deposition).
- The PGM evaluation should also include geographic, temporal and concentration stratifications.
- The PGM results should be more thoroughly evaluated for the 4 km CARMMS domain.
- Seasonal and monthly evaluation should be included.
- Evaluation for high observed concentrations should be made.
- Several graphical displays of model performance may be used, including, but not limited to:
    - Scatter Plots of predicted and observed concentrations/depositions.
    - Spatial Maps of performance, including spatial maps of model predictions with superimposed observations and interpolated spatial maps of bias and error.
    - Time Series Plots of predicted and observed concentrations using native observation averaging time.
    - Soccer Plots that compare model performance statistics with model performance goals (Table B-3).

Details on the CAMx 2008 model performance evaluation are provided in the WestJumpAQMS final report and supporting material. Below we summarized the CAMx model performance evaluation statistical metrics for just within the CARMMS 4 km modeling domain that is the subject of this study.

B.5 Model Evaluation within the 4 km CARMMS Domain

WestJumpAQMS developed a separate CAMx 4 km modeling database for the 2008 annual period and the 4 km CARMMS modeling domain (see Figure 2-1) that covers all of Colorado, the northern two-thirds of New Mexico as well as eastern Utah and northeastern Arizona. WestJumpAQMS conducted a separate model performance evaluation of the CAMx 2008 base case simulation for the CARMMS 4 km domain that is summarized from the WestJumpAQMS final report (ENVIRON, Alpine and UNC, 2013) in this section. Also presented below are some supplemental ozone evaluation results as suggested by the IAQRT in their February 28, 2014 meeting.

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Figures B-1 through B-4 displays the monthly and annual daily maximum 8-hour (DMAX8) and hourly ozone model performance statistics across all CASTNet (top) and AQS (bottom) sites in the 4 km CARMMS domain using observed ozone cut-off concentrations of 40 and 60 ppb. The Fractional Bias and Error (FB and FE) and Normalized Mean Bias and Error (NMB and NME) performance statistics are used in these Figures. The Mean Normalized Bias and Error (MNB and MNE) statistics are not presented following the recommendations of Simon, Baker and Philips (2012). The CARMMS ozone model performance statistics are compared against EPA's 1991 bias (≤±15%) and error (≤35%) ozone model performance goals (Table B-2). The CAMx 4 km model pDMAX8 ozone performance evaluation across CASTNet and AQS monitors within the CARMMS 4 km domain using the FB 40 ppb cut-off are ≤±6% with an annual FB of less than 2%, which achieves the ozone bias ≤±15% performance goal by a wide margin (Figure B-1a). Similarly, the monthly DMAX8 ozone FE tends to be between 5% and 12%, so achieves the ozone performance goal of ≤35% by over a factor of 2 (Figure B-1a). Some of the underestimation of the DMAX8 ozone at the Colorado CASTNet sites (e.g., in May) may be due in part to the model's inability to fully simulate stratospheric ozone intrusion events (e.g., at Gothic). Figure B-1b presents similar DMAX8 ozone modeling results for the NMB and NME performance statistics using a 40 ppb cut-off that also exhibit very good model performance statistics that achieves the ozone model performance goals.

Figure B-2 presents similar DMAX8 ozone performance statistics as Figure B-1 only using a 60 ppb ozone cut-off value instead of 40 ppb. With a focus on higher observed ozone concentrations then it is not surprising that the model exhibits an underestimation bias. The maximum underestimation bias occurs in the late winter and spring when stratospheric ozone and winter ozone events occur that the model has difficulty in reproducing. The DMAX8 ozone with 60 ppb cut-off performance statistics still achieve the ozone error performance goal for all months and bias goal for all months except February 2008.

Figure B-3 and B-4 are like Figure B-1 and B-2 only for hourly ozone model performance instead of DMAX8 ozone. The hourly ozone model performance using a 40 ppb cut-off value achieves the ozone goals for all months of the year (Figure B-3); it is encouraging that much better ozone performance is seen during the summer ozone season. Using a 60 ppb ozone cut-off, the hourly ozone underestimation bias is so great during the winter months that it exceeds the ozone model performance goal (Figure B-4). However, during the summer when the observed and model ozone is higher and is the primary ozone period of concern, CAMx achieves the ozone model performance goals.

The CAMx 4 km total $PM_{2.5}$ mass performance across the FRM, IMPROVE and CSN sites in the 4 km CARMMS domain is shown in Figure B-5. The model tends to overestimate $PM_{2.5}$ in the winter falling to a near zero bias in the summer. However, the overestimation bias is usually within the PM Performance Criteria with only 5 of the 36 monthly FBs (14% of the time) failing to achieve the PM Performance Criteria. 14 months achieve the PM Performance goal (~40% of the time), which occur in the summer and months adjacent to the summer.

Figures B-6 and B-7 display the CAMx 4 km model performance related to sulfur species that includes SO4 at IMPROVE, CSN and CASTNet monitoring networks, SO2 at CASTNet and wet SO4 deposition at NADP. SO4 tends to be overestimated in the winter and underestimated in the spring, summer and early fall. SO2 is also overestimated in the winter and fall with near zero bias to underestimating in the spring and summer, which indicates that the summer SO4 underestimation is not due to insufficient oxidation of available SO2 concentrations. The wet SO4 deposition also is overestimated in the winter and underestimated in the summer suggesting that too rapid wet depositions is not the cause of the summer SO4 underestimation tendency. The summer underestimation of wet SO4 deposition also suggests that the overstated WRF convective precipitation is not overly washing out the atmospheric pollutants.

Figures B-8 and B-9 displays CAMx 4 km model performance statistics related to nitrogen species including NO3, HNO3 and combined NO3 plus HNO3. Monthly NO3 performance at the IMPROVE sites almost always achieves the PM Performance Goal, whereas it is generally underestimated across the CSN and CASTNet networks with the largest underestimation bias occurring in the summer. On the other hand, HNO3 tends to be overestimated by the CAMx 4 km CARMMS base case and the performance of total nitrate (HNO3+NO3) exhibits much better performance with near zero bias in the spring and summer that achieves the PM Performance Goals. These results suggest that some of the NO3 underestimation bias may be due to not enough conversion of the gaseous HNO3 to particulate NO3. This could be due to insufficient ammonia present to buffer the nitric acid or not fully accounting for other basic compounds that can neutralize nitric acid (e.g., Calcium, Sodium, etc.). Thermodynamic variables could also partly account for this if the temperatures were too hot or the atmosphere not moist enough.

NH4 model performance across he IMPROVE, CSN and NADP networks in the CARMMS 4 km domain is shown in Figure B-10. NH4 is underestimated, which is consistent with the SO4 and NO3 underestimation bias, with the performance being better across the CSN network that always achieves the PM Performance Criteria and sometimes achieves the PM Performance Goal. The underestimation bias is greater across the IMPROVE network due to the use of derived NH4d in the evaluation that overestimates actual ambient NH4 concentrations. The NH4 wet deposition exhibits near zero or an underestimation bias indicating that the NH4 underestimation tendency is not due to overstated wet scavenging.

The CAMx 4 km model performance for gaseous NO_X and NO_Y across AQS and nonmethane organic compounds (NMOC) across PAMS monitoring sites are shown in Figure B-11. NO_X is underestimated in the winter with near zero bias in the summer, whereas NO_Y is overestimated in the summer, underestimated in the winter and has near zero bias in the spring. Given that these measurements may have artifacts and picking up other reactive nitrogen species, it is hard to interpret the evaluation. NMOC is underestimated throughout the year, which may be due in part to the fact they tend to be sited in urban areas.

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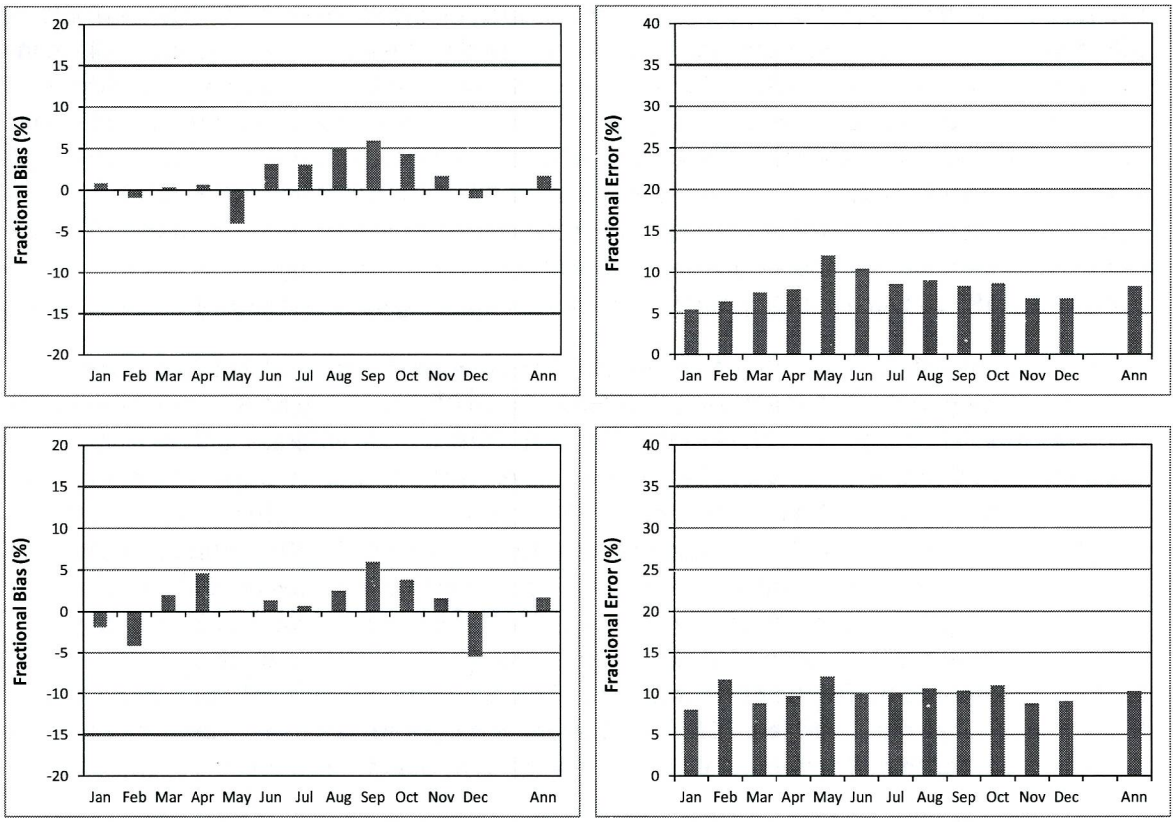

Figure B-1a. CAMx 4 km daily maximum 8-hour ozone model performance for Fractional Bias (left) and Fractional Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 40 ppb observed ozone cut-off value.

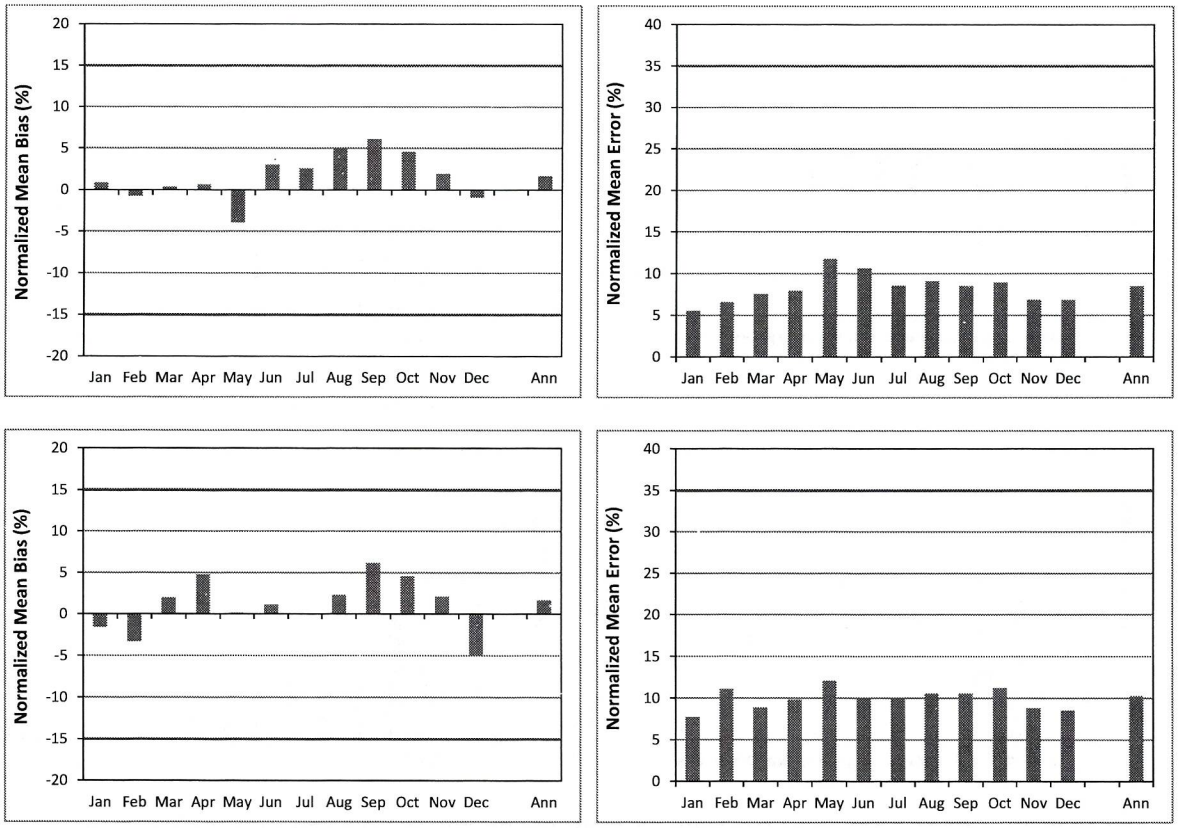

Figure B-1b. CAMx 4 km daily maximum 8-hour ozone model performance for Normalized Mean Bias (left) and Normalized Mean Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 40 ppb observed ozone cut-off value.

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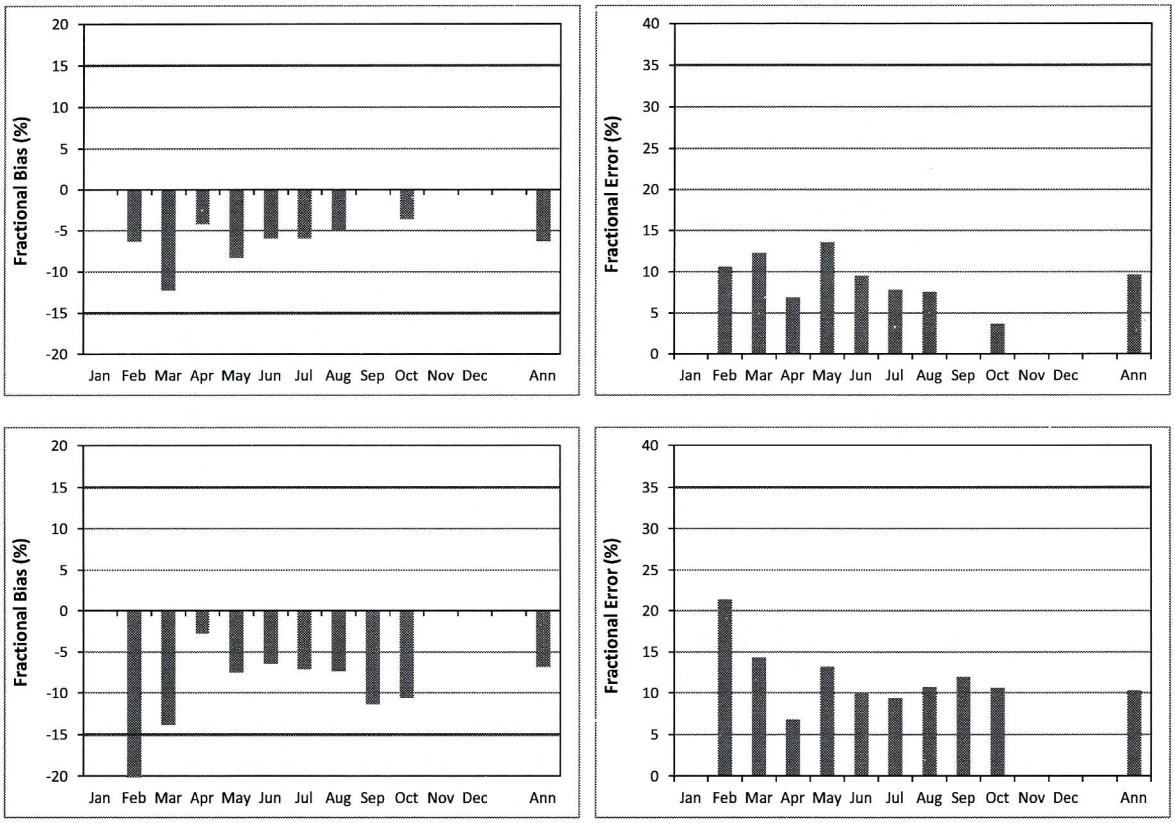

Figure B-2a. CAMx 4 km daily maximum 8-hour ozone model performance for Fractional Bias (left) and Fractional Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 60 ppb observed ozone cut-off value.

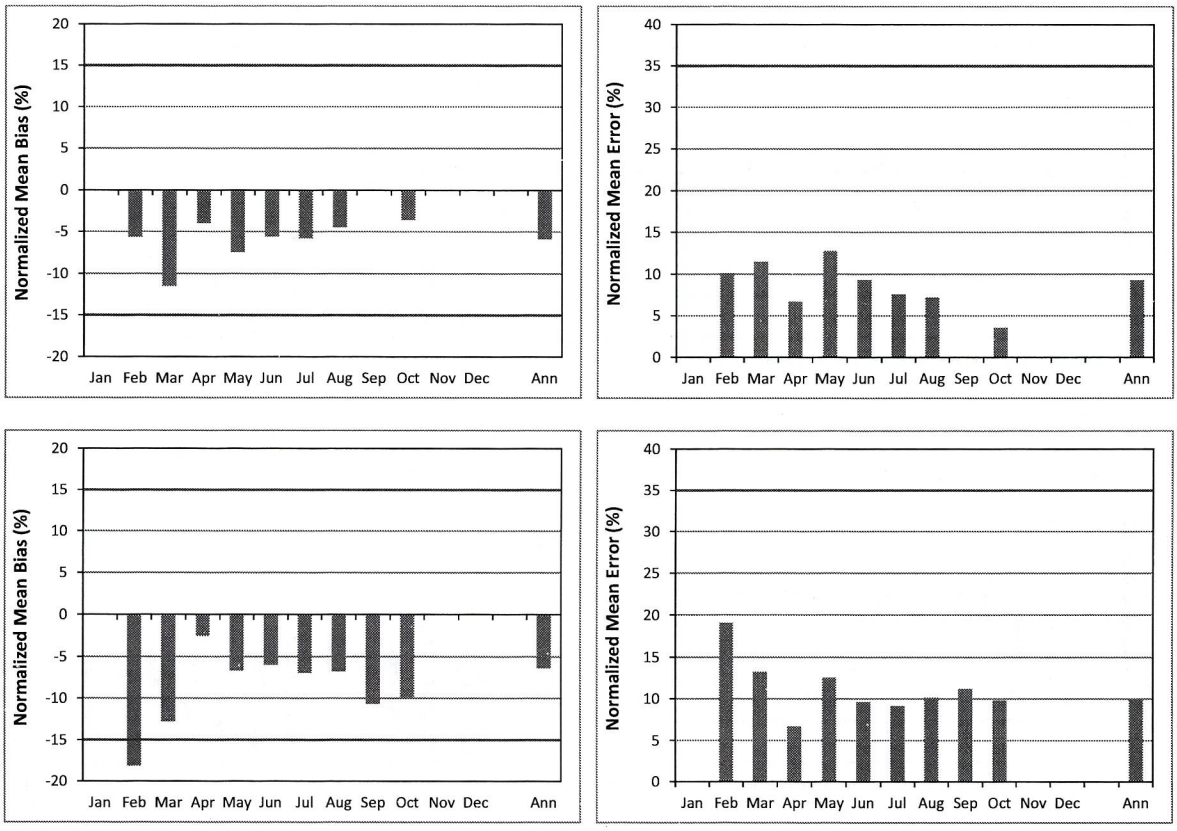

Figure B-2b. CAMx 4 km daily maximum 8-hour ozone model performance for Normalized Mean Bias (left) and Normalized Mean Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 60 ppb observed ozone cut-off value.

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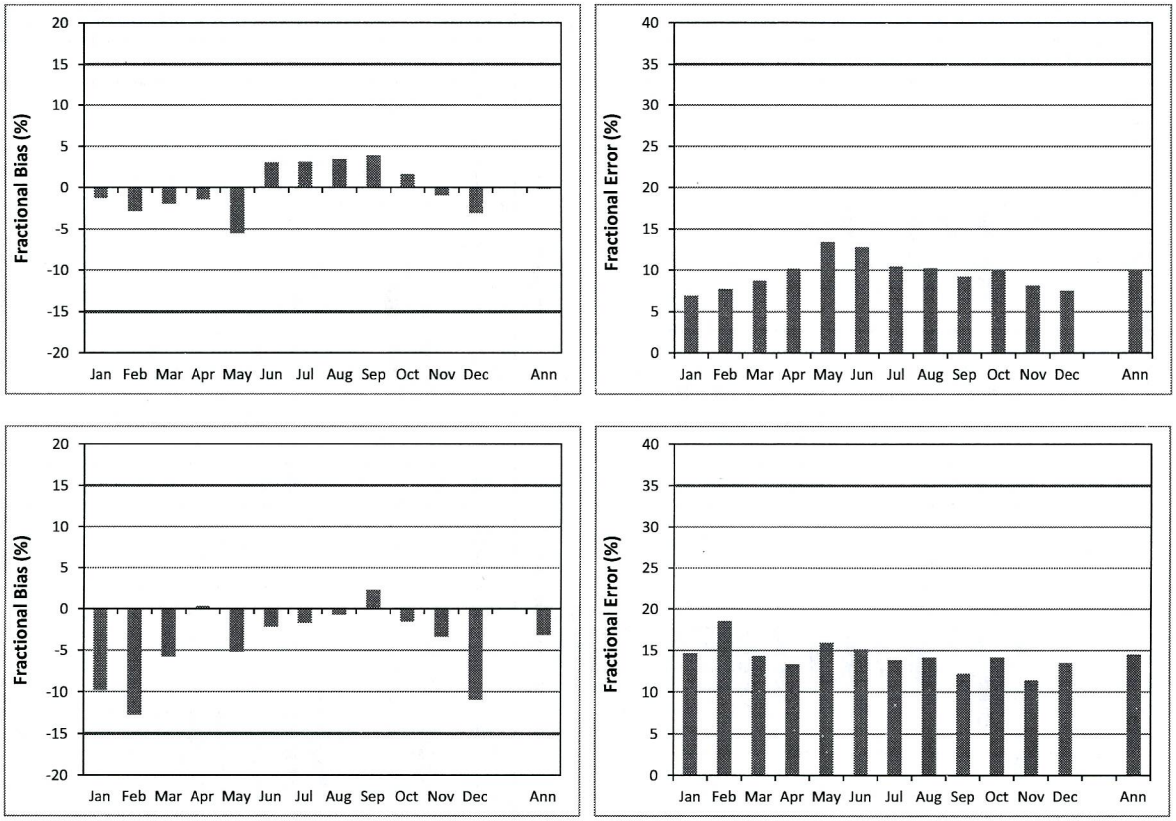

Figure B-3a. CAMx 4 km hourly ozone model performance for Fractional Bias (left) and Fractional Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 40 ppb observed ozone cut-off value.

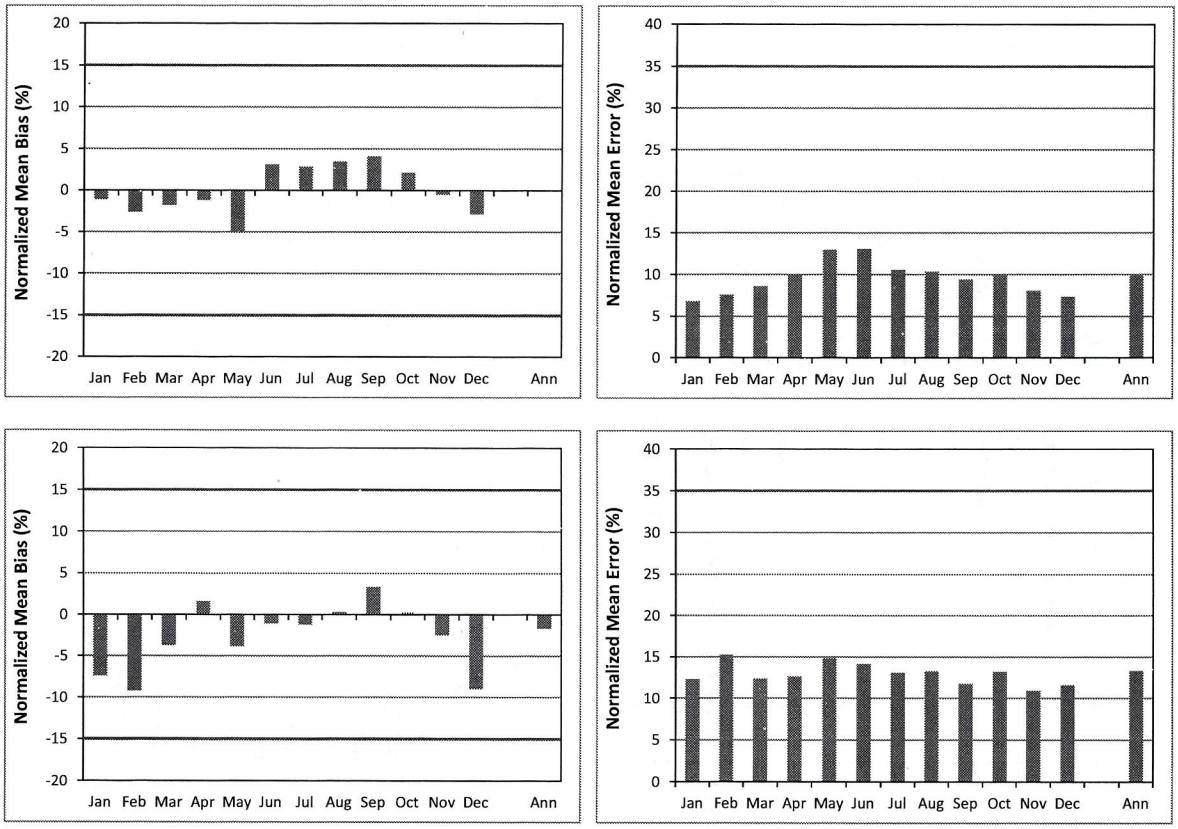

Figure B-3b. CAMx 4 km hourly ozone model performance for Normalized Mean Bias (left) and Normalized Mean Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 40 ppb observed ozone cut-off value.

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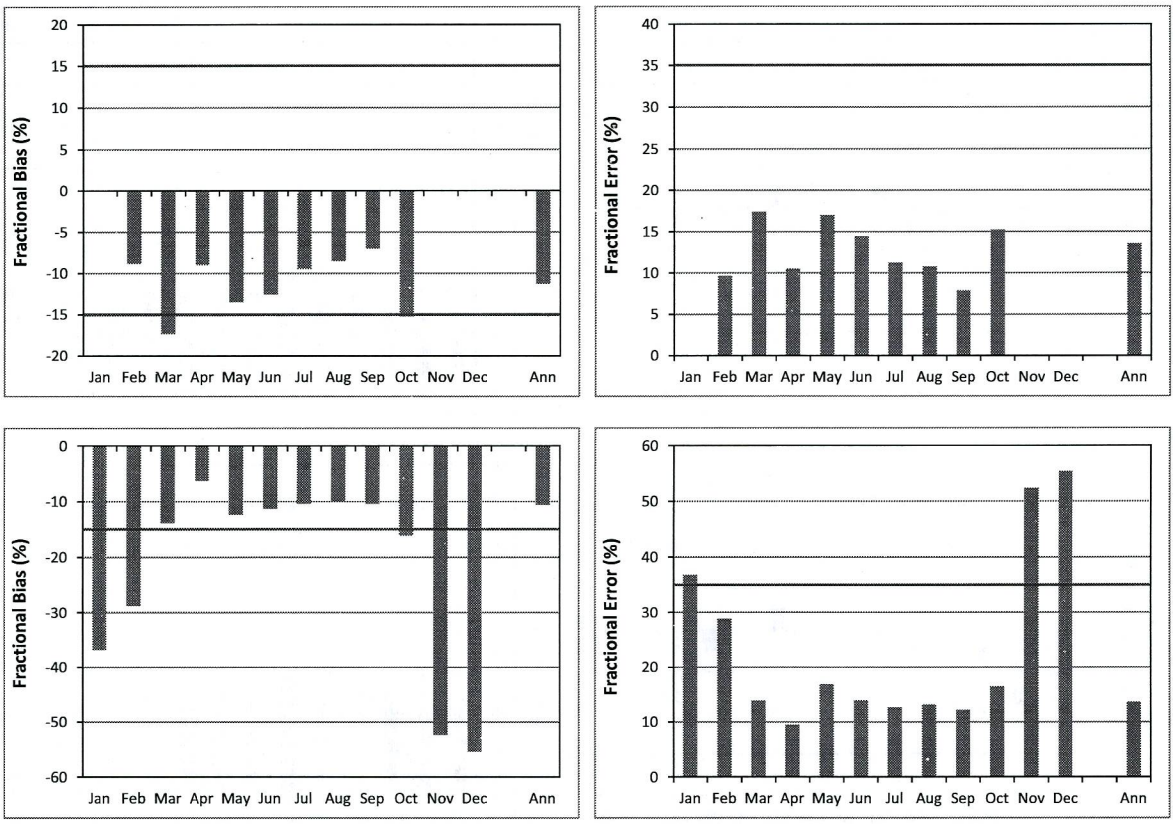

Figure B-4a. CAMx 4 km hourly ozone model performance for Fractional Bias (left) and Fractional Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 60 ppb observed ozone cut-off value.

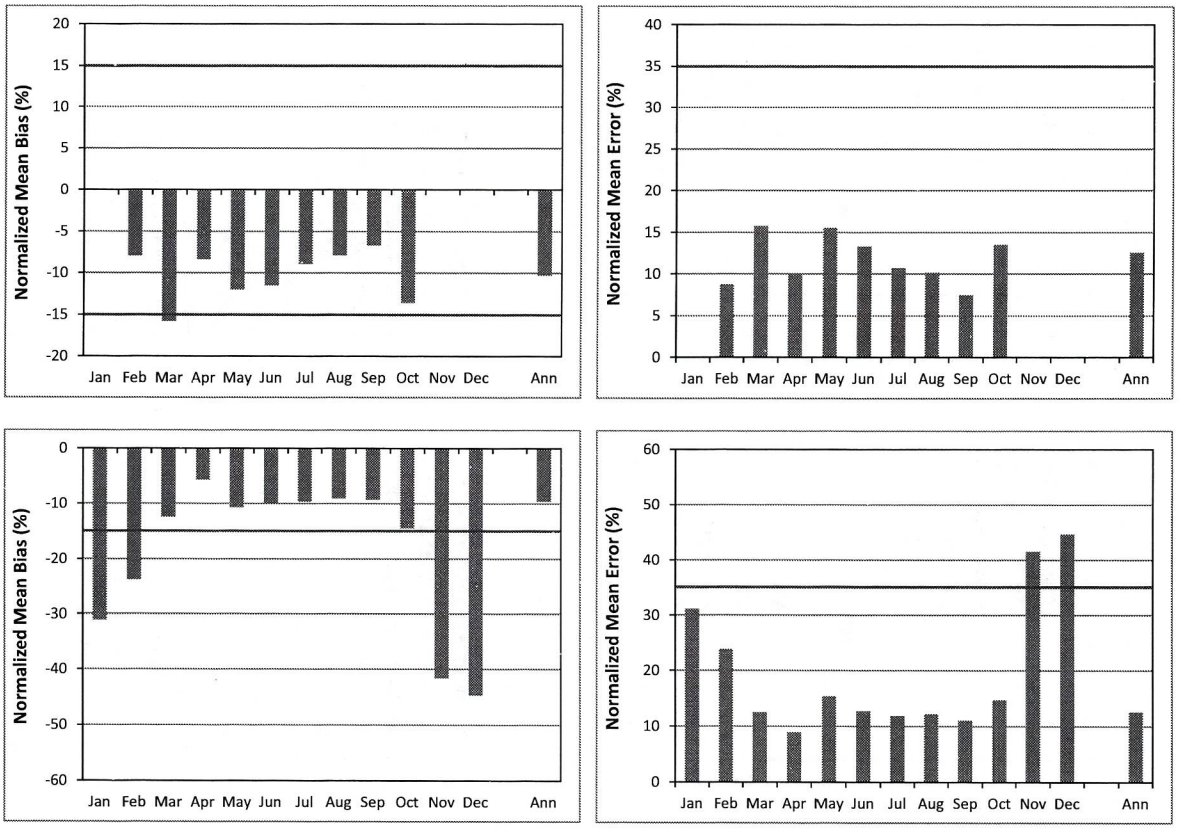

Figure B-4b. CAMx 4 km hourly ozone model performance for Normalized Mean Bias (left) and Normalized Mean Error (right) across CASTNet (top) and AQS (bottom) monitors within the CARMMS 4 km domain using a 60 ppb observed ozone cut-off value.

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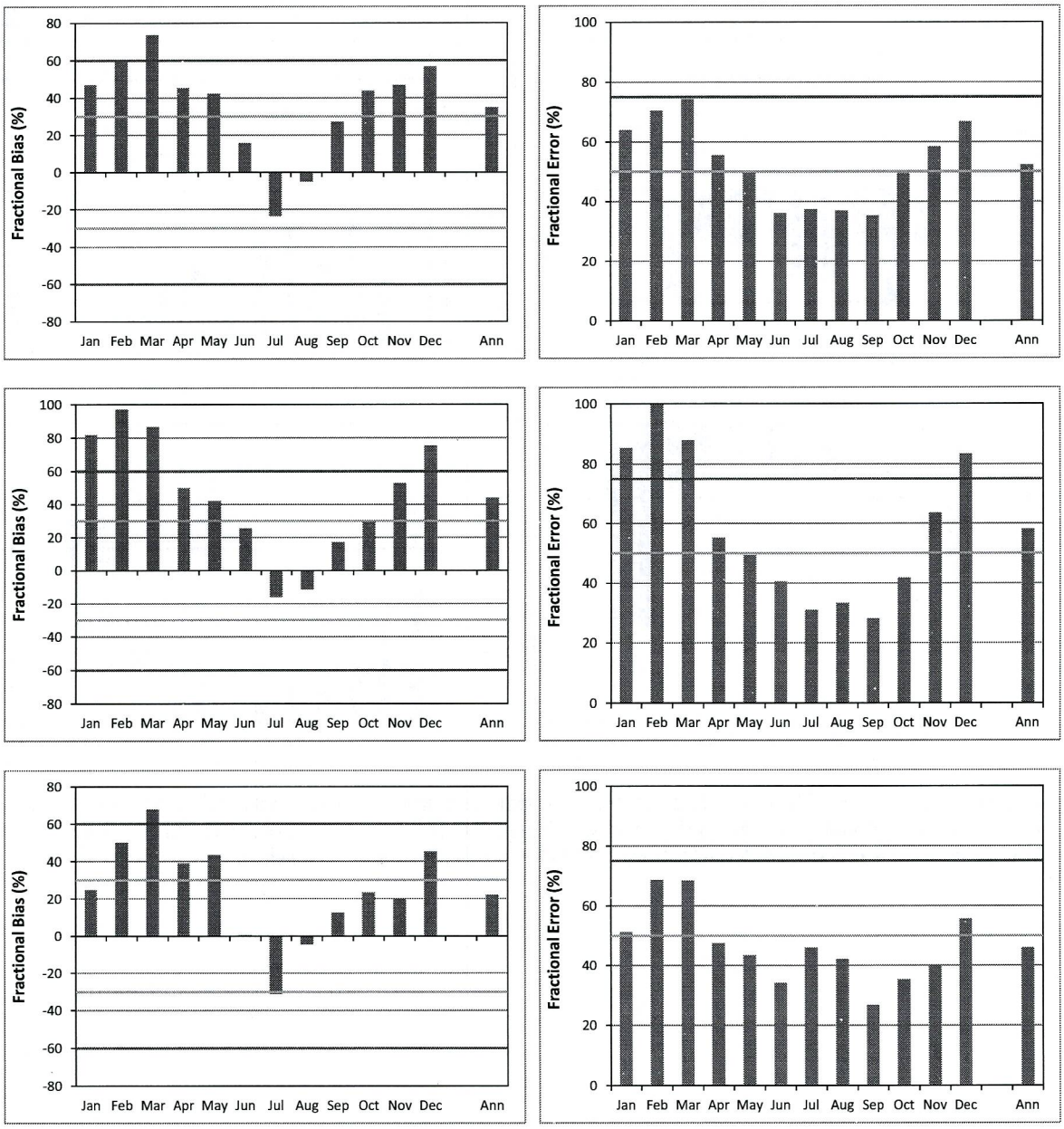

Figure B-5. CAMx 4 km $PM_{2.5}$ model performance for FB (left) and FE (right) across FRM (top), IMPROVE (middle) and CSN (bottom) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

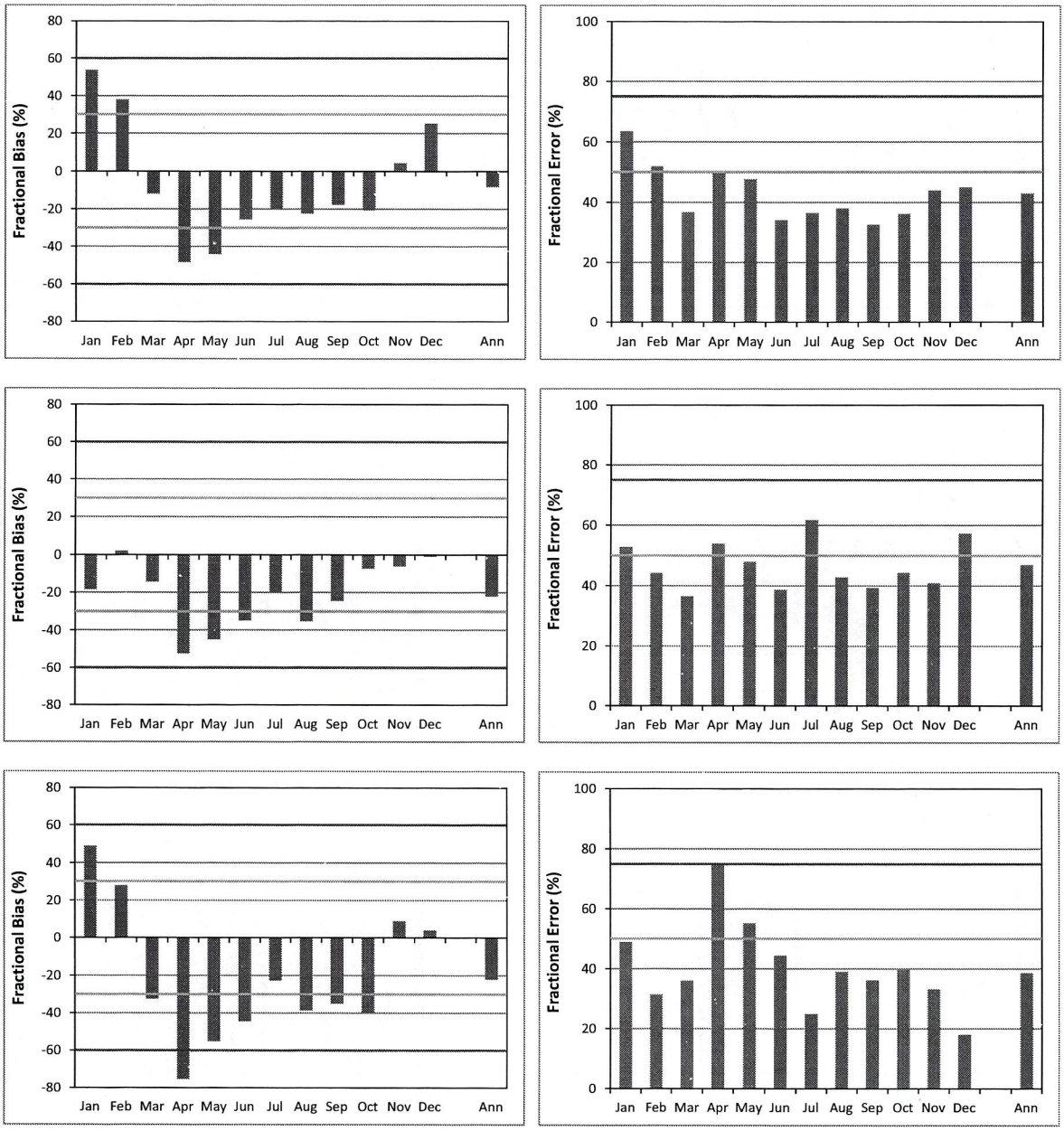

Figure B-6. CAMx 4 km Sulfate (SO4) model performance for FB (left) and FE (right) across IMPROVE (top), CSN (middle) and CASTNet (bottom) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

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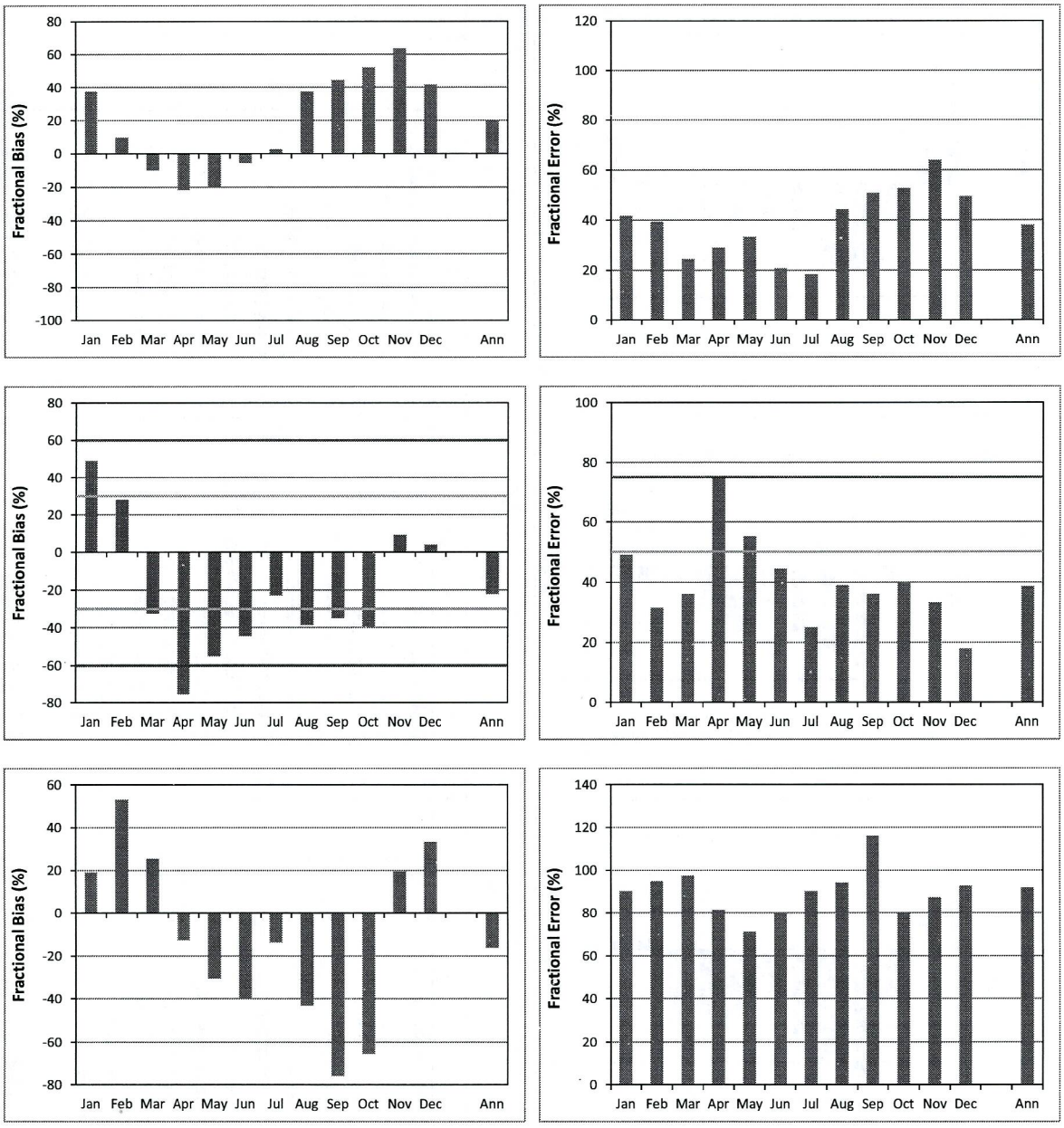

Figure B-7. CAMx 4 km SO2 (top) and SO4 (middle) at CASTNet and SO4 Wet Deposition (bottom) at NADP model performance for FB (left) and FE (right) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

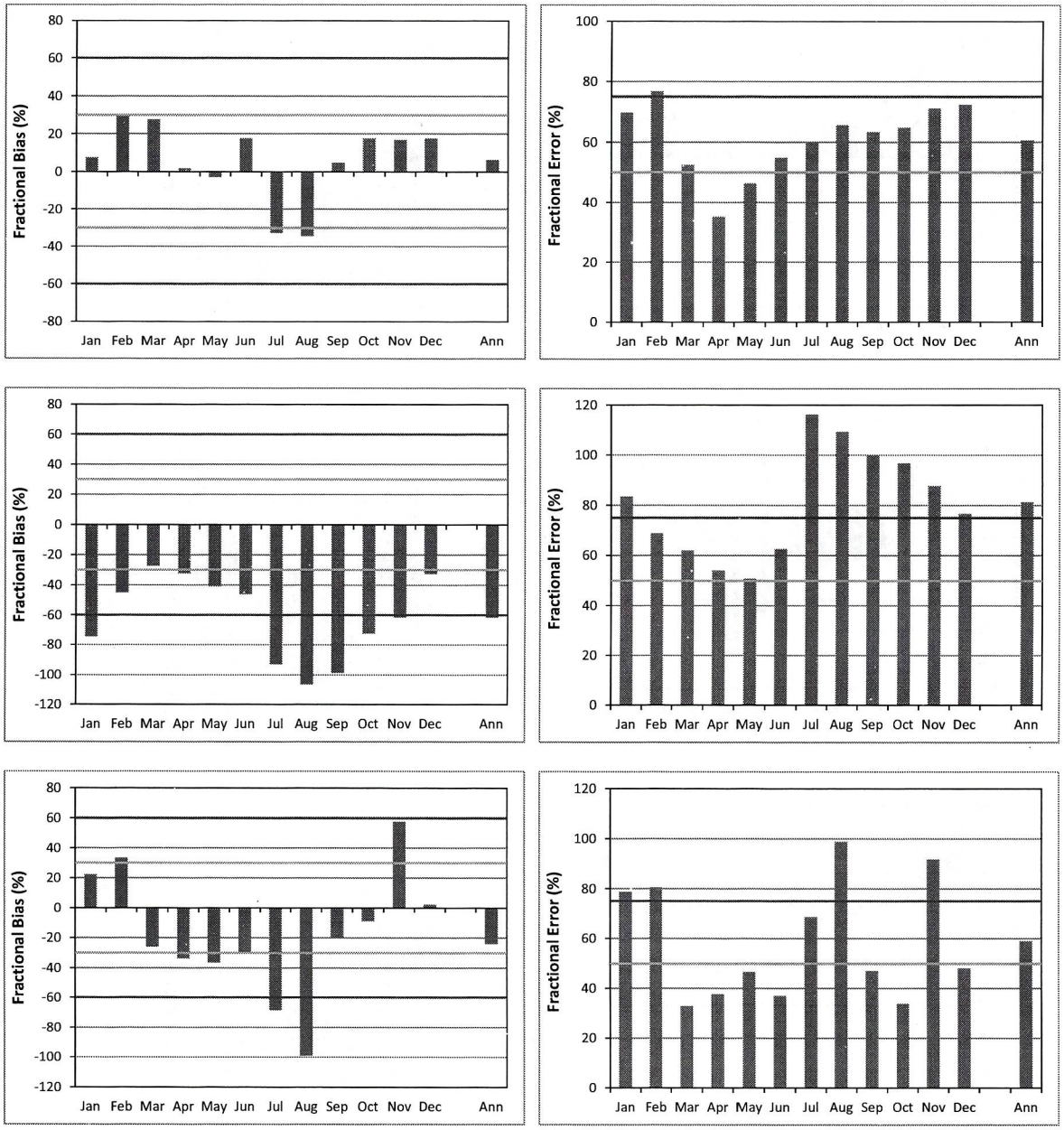

Figure B-8. CAMx 4 km NO3 model performance for FB (left) and FE (right) across IMPROVE (top), CSN (middle) and CASTNet (bottom) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

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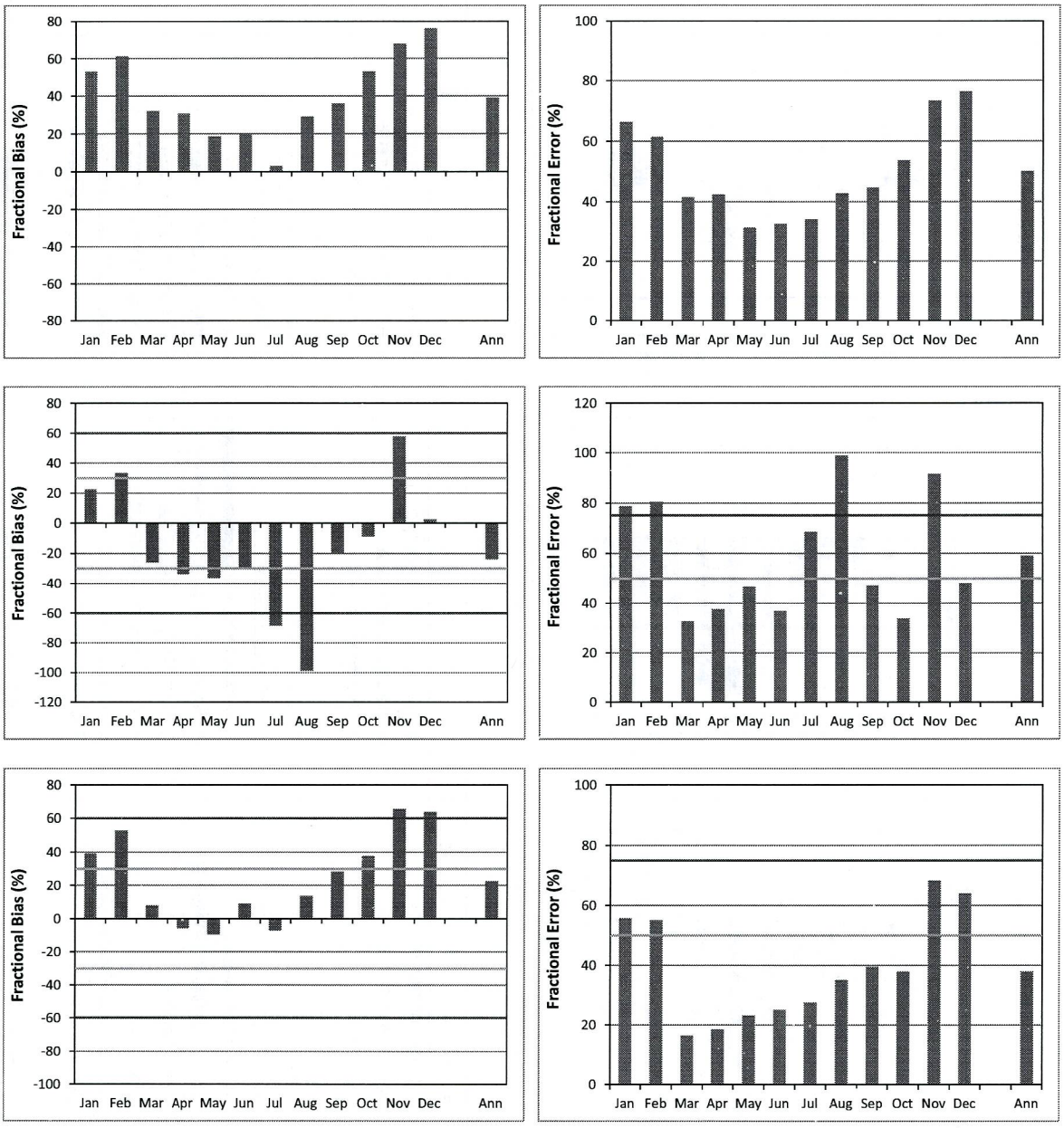

Figure B-9. CAMx 4 km HNO3 (top), NO3 (middle) and tHNO3+NO3 (bottom) model performance for FB (left) and FE (right) across CASTNet monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

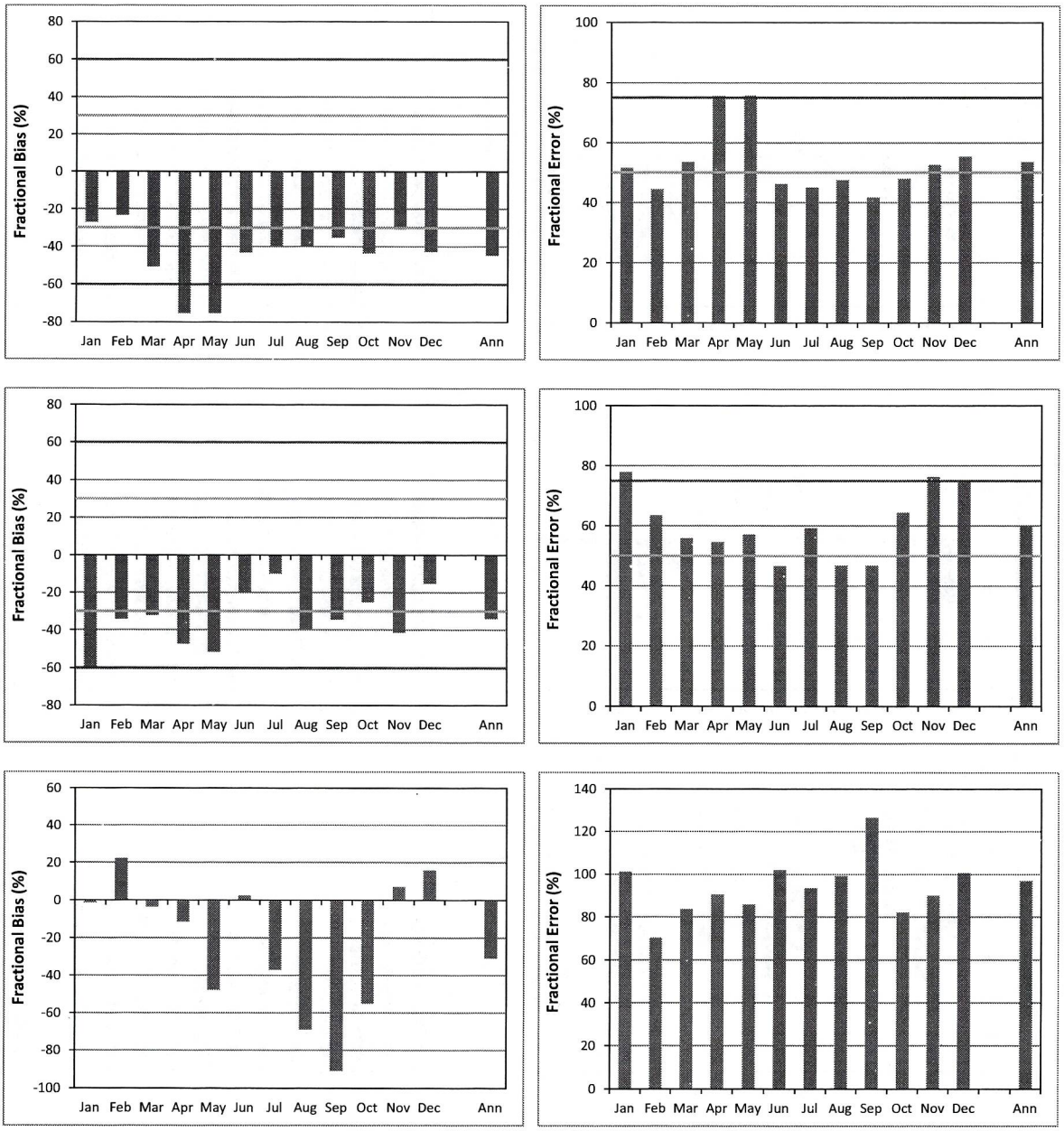

Figure B-10. CAMx 4 km NH4 concentration and wet deposition model performance for FB (left) and FE (right) across IMPROVE (top), CSN (middle) and NADP (bottom) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

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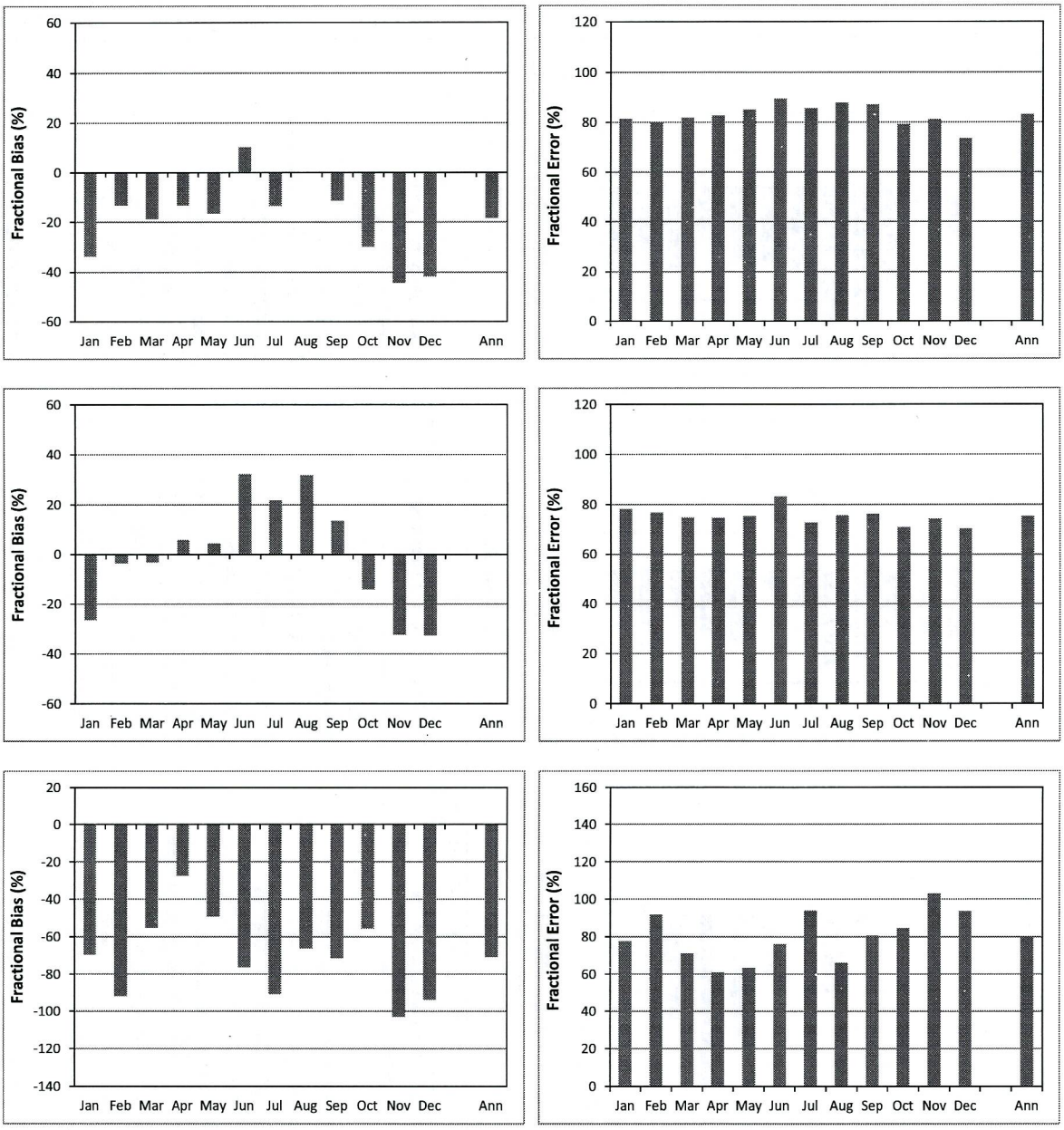

Figure B-11. CAMx 4 km NO_X (top), NO_Y (middle) and NMOC (bottom) model performance for FB (left) and FE (right) across AQS and PAMS) monitors within the CARMMS 4 km Impact Assessment Domain (IAD).

December 2014

APPENDIX C

CARMMS Technical Memorandum
Draft Final CARMMS Oil and Gas Emission Calculator Documentation
August 15, 2013

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MEMORANDUM

To: Chad Meister and Forrest Cook, BLM Colorado State Office
From: John Grant, Jim Zapert, and Ralph Morris
Subject: Draft Final CARMMS Oil and Gas Emission Calculator Documentation

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1.0 INTRODUCTION

1.1 Scope and Goals

The purpose of this document is to explain the emissions calculation procedures used in the oil and gas emission calculators that have been developed for the Western Colorado Air Resource Management Modeling Study (West-CARMMS). We have improved existing emissions calculators and develop representative calculators for "typical" crude oil, conventional gas (with condensate), coal bed natural gas (CBNG), and shale gas within the region. New information has been incorporated for drilling times; engine configurations; condensate and produced water production; well pad versus offsite gas treatment and storage; well-head, infield, and pipeline compression; and gas/oil production. The ability to readily modify input assumptions such as production parameters, emission control assumptions, and wellhead equipment configurations has also been incorporated into the calculator.

The refined emission calculators will be used to develop the baseline and future-year emissions inventories under Task 2 for the Western Colorado Bureau of Land Management (BLM) planning areas (see Figure 1-1).

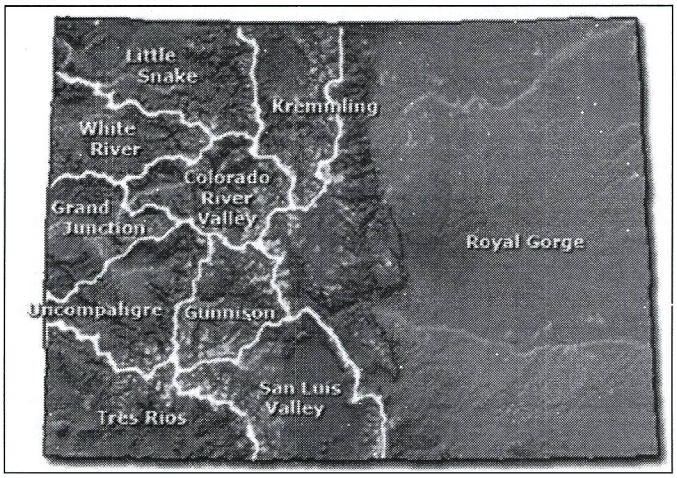

Figure 1-1. Colorado Field Office Planning Areas.

1.2 Overview of Calculators

Emission calculators have been developed for each of the following well types.

- Conventional gas
- Conventional oil
- Shale gas
- Coalbed natural gas (CBNG)

For each well type a separate, a self-contained emission calculator spreadsheet contains all of the inputs and calculations need to generate wellsite emissions.

Additionally, a calculator has been developed to estimate midstream emissions for each area. The midstream emission calculator draws upon Colorado Department of Public Health (CDPHE) Air Pollutant Emission Notice (APEN) emissions for base year emission estimates. Future year midstream emission projections are dependent on the change in oil and gas production in a given planning area which can be updated based on linkages to the by well type emission calculators.

1.2.1 Pollutants

The emission calculators include estimates of emissions of criteria air pollutants (CAPs), greenhouse gases (GHGs), and hazardous air pollutants (HAPs) as follows:

- Criteria Pollutants
  - Carbon monoxide (CO)
  - Nitrogen oxides (NO_X)
  - Particulate matter less than or equal to 10 microns in diameter (PM_{10})
  - Particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$)
  - Sulfur dioxide (SO_2)
  - Volatile Organic Compounds (VOCs)
- Greenhouse Gases
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
- Hazardous Air Pollutants (HAPs)

While lead (pb) is a criteria pollutant, emissions of lead in the BLM western Colorado planning areas are expected to be extremely low and are therefore not included in this analysis.

HAP emissions were estimated for each emissions source. For oil and gas emissions sources, HAP emissions from venting and combustion source categories were estimated for formaldehyde, n-hexane, benzene, toluene, ethylbenzene, and xylenes (BTEX).

Anthropogenic greenhouse gas emission inventories typically include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Fluorinated gases are not expected

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to be emitted in appreciable quantities by any category considered in this emission inventory and were therefore not included in this analysis.

1.2.2 Temporal

The calculators estimate annual emissions associated with oil and gas exploration. Per the West-CARMMS scope of work, base year emissions are estimated for 2011 with annual emission forecasts to 2021.

2.0 CALCULATOR DEVELOPMENT

2.1 Calculator Inputs

The emission calculator for each well type allows for specification of the following inputs.

- Base year oil and gas activity (gas production, oil production, spud counts, active well counts)
- Well decline estimates
- Level of control by source category
- Gas composition
- Equipment configurations (e.g. drill rigs, fracing rigs)
- Gas venting activity (e.g. completions, blowdowns)

The inputs are implemented to estimate by source category emissions as described below. Appendices A, B, C, and D show the by source category inputs for each well type.

The midstream emission calculator includes estimates of base year 2011 gas plant and compressor station emissions taken from CDPHE APEN data. Base year midstream emissions are projected to future years based upon the gas production in each planning area. Appendix C5 shows base year 2011 midstream emissions by field office and facility as reported in APENS data.

2.2 Emission Calculations

Emission calculations for all emission-generating activities were developed based on typical emission inventory methodology. Methods used to estimate emissions from each source category are explained in Section 2.2.1. For each source category, emissions for the base year were estimated. Emissions were then forecasted to future years, accounting for activity growth and for applicable sources emissions controls.

The methodologies described here are used consistently in all four calculators by well type; however the input data of each calculator was selected to best reflect the operational characteristics of each well type (oil, gas, CBNG, and shale gas) and thus obtained from literature sources including the following Air Quality Technical Support Documents (AQTSD) from Colorado field office planning areas and BLM emission calculators listed below; shale gas calculator inputs were taken from a recent shale gas project (Bull Mountain, Zapert, 2013) in the Uncompahgre field office:

- White River AQTSD (URS, 2012a)
- Colorado River Valley AQTSD (URS, 2012b)
- Grand Junction AQTSD (ENVIRON, 2012a)
- Uncompahgre AQTSD (ENVIRON, 2012b)
- BLM Crude Oil Well Gas Emission Calculator (BLM, 2013a)
- BLM Coalbed Natural Gas Well Emission Calculator (BLM, 2013b)

Emissions are generated in three main phases of oil and gas systems:

- Emissions from Well Construction and Development
- Emissions from the Production Phase (occurring at-or-nearby the well pad)
- Emissions from Midstream Sources (Central Gas Compression and Processing)

The methodologies implemented to estimate base year and future year emissions from oil and gas sources are explained in this section.

2.2.1 Emissions from Well pad Construction and Development

Emissions from Well pad Construction and Development include those generated by equipment, vehicles and activities related to well pad construction, access roads construction, pipeline construction, wellbore drilling and well completions. Table 2-1 includes the emission sources identified for the well pad construction and development phase. Pollutant emissions are initially estimated on a per surrogate basis and later scaled with the projected surrogate estimate to obtain area-wide annual emissions from each source.

Table 2-1. Construction source categories and scaling surrogates.

Equipment Source Category	Emissions units per event	Scaling Surrogate
Well Pad, Access Road, and Pipeline Construction Equipment	tons/new pad	New pads per year
Well Pad, Access Road and Pipeline Construction Traffic	tons/new pad	New pads per year
Drilling Equipment and Completion Equipment	tons/spud	Spuds per year
Fracing Equipment	tons/spud	Spuds per year
Refracing Equipment	tons/well	Active wells per year
Drilling and Well Completion Traffic	tons/spud	Spuds per year
Rig Hauling and Rig Moving Traffic	tons/pad	New pads per year
Well Pad, Access Road and Pipeline Construction Wind Erosion	tons/new pad	New pads per year
Well Completion Venting	tons/spud	Spuds per year

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2.2.1.1 Well Pad, Access Road, and Pipeline Construction Equipment

This category refers to emissions associated with off-road engines used during construction of well pads, access roads and pipelines and is also inclusive of well pad reclamation activity. Detailed data for each engine type such as horsepower rating, hours of operation, fuel type,

engine technology and load factors were derived from the literature. The EPA NONROAD2008a model (USEPA, 2009b) was used to compile emission factors for each equipment type. The N_2O emissions factor was obtained from the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009). Engines were classified in three types as activity data and emissions factors vary by utility: well pad construction equipment, access road construction equipment and pipeline construction equipment.

Emissions on a per event (new well pads) basis for an engine type for which data was provided were estimated according to Equation 1:

$$E_{engine\ k,i} = \frac{EF_i \times HP \times LF \times t_{event} \times n}{907{,}185} \qquad \text{Equation (1)}$$

where:

E_{engine} are emissions of pollutant *i* from an engine type k [ton/pad]
EF_i is the emissions factor of pollutant *i* [g/hp-hr]
HP is the horsepower of the engine k [hp]
LF is the load factor of the engine k
t_{event} is the number of hours the engine is used [hr/pad]
907,185 is the mass unit conversion [g/ton]
n is the number of type-k engines

2.2.1.1.1 Area-Wide Annual Emissions from Source Category

Annual emissions from well pad construction equipment by pollutant were estimated from the sum of engine emissions from each of the construction engine types ($E_{engineTOTAL,i} = \sum E_{engine\ k,i}$) according to Equation 2:

$$E_{well\ pad\ equip,\ i} = E_{engineTOTAL,i} \times S_{well\ pad} \qquad \text{Equation (2)}$$

where:

$E_{well\ pad\ equip}$ are annual emissions of pollutant i from well pad construction and development equipment [ton/yr]
$E_{engineTOTAL,i}$ is sum of all engine emissions per event [ton/pad]
$S_{well\ pad}$ is the scaling surrogate for well pad construction [new pads/yr]

2.2.1.2 Well Pad, Access Road and Pipeline Construction Traffic

This category refers to the exhaust emissions from light-duty and heavy-duty vehicle traffic during well pad, access road and pipeline construction. Emission factors were developed using the MOVES2010a model (USEPA, 2010). For each field office, by project year representative county emissions factors were developed. The emission factors were prepared for two vehicle classes, heavy duty trucks (source type combination short-haul truck) and pick-up trucks (source type light commercial truck). MOVES2010a emissions factors were modeled to include exhaust running, idle and start, brake wear, tire wear, and evaporative processes. The N_2O emission factor was obtained from 2012 Climate Registry Default Emission Factors (TCR, 2012).

The representative county for each field office and annual average per mile emission factors by county, year and vehicle type are summarized in Appendix C-6.

Emissions from two distinct fleet types were estimated in this source category dependent on the vehicle destination/use: (1) well pad and access road construction vehicles and (2) pipeline construction vehicles. Annual vehicle miles traveled (VMT) to well site were available for each vehicle class (light duty and heavy duty) within each fleet type (well pad and access road, and pipeline construction), thus exhaust emissions for each of four vehicle groups were calculated using the MOVES2010a emission factors on a grams per mile basis, as shown in Equation 3.

$$E_{traffic,\ i} = \frac{EF_i \times N_{trips} \times D}{907185} \qquad \text{Equation (3)}$$

where:

$E_{traffic,\ i}$ is traffic exhaust emissions for pollutant i per well pad [ton/pad]
EF_i is the average emission factor of pollutant i [g/mile]
N_{trips} is the annual number of round trips per activity [trips/pad]
D is the round trip distance [miles/trip]
907185 is the mass conversion [g/ton]

2.2.1.2.1 Area-Wide Annual Emissions from Source Category

Annual emissions for well pad, pipeline and access road construction traffic by pollutant were propagated with the appropriate scaling surrogate according to Equation 4:

$$E_{well\ pad\ traffic,\ i} = E_{traffic,\ i} \times S_{well\ pad} \qquad \text{Equation (4)}$$

where:

$E_{well\ pad\ traffic,\ i}$ is the annual exhaust emissions of pollutant i from well pad, pipeline and access road construction traffic [ton/yr]
$E_{traffic,\ i}$ are the emissions of pollutant i per new well pad [ton/wellpad]
$S_{well\ pad}$ is the scaling surrogate for well pad and access road construction traffic [new pads/yr]

2.2.1.3 Drilling, Completion and Hydraulic Fracturing Equipment

This section refers to emissions associated with off-road engines used during drilling and completion activities. Detailed data for each engine type per source category such as horsepower rating, hours of operation, fuel type, engine technology and load factors was derived from the literature. Emissions for four distinct engine groups were estimated: (1) drilling equipment, (2) completion equipment, (3) fracing equipment, and (4) refracing equipment. Emissions were estimated separately by engine type as inputs and surrogates (see Table 2-1) varied by type; however the same methodology delineated by Equations 5 and 6 was used in all calculations.

For drilling, completion and hydraulic fracturing equipment, the EPA Tier 2 Federal Diesel Engine Standard emission rates were applied for NO_X, VOC, CO, PM_{10} and $PM_{2.5}$ emissions. The

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N_2O emissions factor was obtained from the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009). Emissions on a per event (spuds or active wells) basis for an engine type were estimated according to Equation 5:

$$E_{engine\ k,i} = \frac{EF_i \times HP \times LF \times t_{event} \times n}{907{,}185} \qquad \text{Equation (5)}$$

where:

E_{engine} are exhaust emissions of pollutant *i* from an engine type k [ton/event]
EF_i is the emissions factor of pollutant *i* [g/hp-hr]
HP is the horsepower of the engine k [hp]
LF is the load factor of the engine k
t_{event} is the number of hours engine k is used [hr/event]
907,185 is the mass unit conversion [g/ton]
n is the number of type-k engines

2.2.1.3.1 Area-Wide Annual Emissions from Source Category

Annual equipment emissions by pollutant were estimated separately for each of the four engine groups and scaled with the appropriate scaling surrogate according to Equation 6:

$$E_{D\&C\ equipment,\ i} = E_{engineTOTAL,i} \times S_{event} \qquad \text{Equation (6)}$$

where:

$E_{D\&C\ equipment,i}$ is annual emissions of pollutant i from completion/drilling equipment [ton/yr]
$E_{engineTOTAL,i}$ is sum of all engine emissions per event [ton/event]
S_{event} is the scaling surrogate for completion/drilling operations [event/yr] according to Table 2-1.

2.2.1.4 Drilling and Well Completion Traffic

This section refers to on-road emissions from light-duty and heavy-duty vehicle traffic during drilling and completion operations. Methodology to estimate traffic emissions from these source categories was similar to that of source category *Well Pad, Access Road and Pipeline Construction Traffic.* However, emissions for *Drilling Traffic* and *Completion Traffic* were calculated separately since activity inputs and surrogates varied by source category. Input data to estimate the annual vehicle miles traveled (VMT) per activity was derived from the literature for each vehicle class (light duty and heavy duty) within each fleet. Fleets were defined by the vehicle destination or utility, which vary by the type of oil and gas development (conventional and CBNG versus shale). These are shown in Table 2-2 below. Annual average emission factors from EPA's MOVES2010a model as described in Section 2.2.1.2 were applied.

Table 2-2. Vehicle fleets used during drilling and completion.

Vehicle Use/Destination	Vehicle Class		Fleet group ID
	Type	Class	
Drilling Traffic	Semi Trucks	Heavy Duty Truck	1
	Pickup Trucks	Light Duty Truck	2
Rig Move Drilling Traffic	Semi Trucks	Heavy Duty Truck	3
Rig Hauling	Semi Trucks	Heavy Duty Truck	4
Well Completion & Testing	Semi Trucks	Heavy Duty Truck	5
	Pickup Trucks	Light Duty Truck	6

Exhaust emissions for each of the fleet groups were calculated using the appropriate MOVES2010a emission factors on a grams per mile basis, as shown in Equation 7:

$$E_{traffic,\ i} = \frac{EF_i \times N_{trips} \times D}{907185} \qquad \text{Equation (7)}$$

where:

$E_{traffic,\ i}$ is the traffic emissions for pollutant i per spud [tons/spud]
EF_i is the average emission factor of pollutant i [g/mile]
N_{trips} is the annual number of round trips per activity [trips/spud]
D is the round trip distance [miles/trip]
907185 is the mass unit conversion [g/ton]

Given that emissions from the vehicle fleets are based on the same surrogate (spuds), total emissions from drilling and completion traffic will be the sum of emissions per spud from each fleet (calculated with Equation 7), as shown in Equation 8:

$$E_{traffic,D\&C,\ i} = \sum_{fleet=1}^{7} \left(E_{traffic,\ i}\right)_{fleet} \qquad \text{Equation (8)}$$

where

$E_{traffic,D\&C,\ i}$ is the total drilling and completions emissions of pollutant i per spud [ton/spud]
$E_{traffic,\ i}$ is the traffic emissions for pollutant i per spud for a vehicle fleet [tons/spud]

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2.2.1.4.1 Area-Wide Annual Emissions from Source Category

Annual emissions for drilling/completion traffic by pollutant were propagated with the appropriate scaling surrogate (spuds per year) according to Equation 9:

$$E_{traffic,\ i} = E_{traffic,D\&C,\ i} \times S_{spud} \qquad \text{Equation (9)}$$

where:

$E_{category\ traffic,\ i}$ are annual emissions of pollutant i from drilling/completion traffic [ton/yr]
$E_{traffic,D\&C,\ i}$ is the total drilling and completions emissions of pollutant i per spud [ton/spud]

S_{spud} is the scaling surrogate for drilling/completion traffic [spuds/yr]

2.2.1.5 Construction Equipment Fugitive Dust

Fugitive dust emissions from disturbed land by well pad construction and reclamation equipment were estimated based on AP-42 Chapter 13 Section 13.2.3 guidance for estimating emissions from Heavy Construction Operations (USEPA, 1995). A construction fugitive dust emission factor for total suspended particles (TSP) is available in the AP-42 guidance (1.2 tons-TSP/acre/month of activity).

Total suspended particle emissions from wellpad construction equipment on a per wellpad basis are estimated based on Equation 10:

$$E_{equip.dust,TSP} = EF \times A \times t \times \frac{(1-C)}{30} \qquad \text{Equation (10)}$$

where:

$E_{equip,dust,TSP}$ is the TSP emissions from construction equipment fugitive dust [tons/wellpad]
A is the average number of acres disturbed per wellpad [acres/wellpad]
t is the number of construction days per wellpad [days]
C is the control efficiency
30 is the conversion factor for days/month

Conversion factors for TSP to particulate matter PM_{10} (EPA, 2006b) and from PM_{10} to $PM_{2.5}$ (Midwest Research Institute, 2006) were used to estimate other fugitive dust pollutant emissions (PM_{10} and $PM_{2.5}$). A control efficiency of 50% was assumed for well pad construction watering control.

2.2.1.5.1 Area-Wide Annual Emissions from Source Category

Annual emissions for construction equipment fugitive dust, by pollutant i, were propagated with the appropriate scaling surrogate (wellpads per year) according to Equation 11:

$$E_{equip,dust,i_{TOTAL}} = E_{equip.dust,i} \times S_{new\ pads} \qquad \text{Equation (11)}$$

where:

$E_{equip,dust,i_{TOTAL}}$ is the annual dust emissions of pollutant i from construction equipment [ton/yr]
$E_{equip.dust,i}$ is the fugitive dust emissions of pollutant i from construction equipment per pad [tons/wellpad]
$S_{new\ pads}$ is the scaling surrogate for construction equipment fugitive dust [new pads/yr]

2.2.1.6 Fugitive Dust Emissions from Construction, Drilling and Completion Support Vehicles

Fugitive dust emissions from vehicle travel on unpaved roads were estimated based on the AP-42 technical guidance in Section 13.2.2.1 Unpaved Roads (USEPA, 2006a). Road dust emission factors for vehicles traveling on unpaved surfaces at industrial sites can be estimated with Equation 12.

$$EF_i = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b \quad \text{Equation (12)}$$

where:

EF is the size-specific particulate emissions factor for pollutant i (lb/mile)
s is the surface material silt content (%)
W is the mean vehicle weight (tons)
k, a, b are empirical constants according to Table 2-3.

Table 2-3. Empirical constants by pollutant to estimate road dust emissions factor.

Parameter	PM_{10}	$PM_{2.5}$
k	1.5	0.15
a	0.9	0.9
b	0.45	0.45

Because the emissions factor is a function of vehicle weight, individual emissions factor for heavy duty vehicles and light duty vehicles were derived with Equation 12. To account for natural mitigation of road dust emissions due to annual precipitation and from watering control, Equation 13 was applied:

$$EF_{mitigated} = EF_i \times \frac{365-P}{365} \times \frac{100-CE}{100} \quad \text{Equation (13)}$$

where:

$EF_{mitigated}$ is the annual average emission factor for uncontrolled conditions including natural mitigation [lb/mile]
EF_i is the size-specific emission factor [lb/mile]
P is number of precipitation days (>0.01" rainfall) at the site
CE is the control efficiency for watering in unpaved roads; CE =50%

Emissions were estimated for all types of vehicles involved in construction, drilling and completion activities. The vehicle groups were classified according to their vehicle class and utility, and literature data was collected to estimate annual vehicle miles traveled per activity (or event), which varied by vehicle groups and by the type of oil and gas development (conventional oil, conventional gas, CBNG, and shale). The vehicle fleets used in each type of development are shown in Table 2-4.

Table 2-4. Vehicles groups related to fugitive road dust emissions in well construction and development.

Vehicle group ID	Utility/destination	Vehicle Class	Event (surrogate)
1	Well Pad Access Road Construction	Heavy Duty Truck	New pads
2		Light Duty Truck	
3	Pipeline Construction	Heavy Duty Truck	
4		Light Duty Truck	

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Vehicle group ID	Utility/destination	Vehicle Class	Event (surrogate)
5	Drilling Traffic	Heavy Duty Truck	Spuds
6		Light Duty Truck	
7	Rig Move Drilling Traffic	Heavy Duty Truck	New pads
8		Light Duty Truck	
9	Rig Hauling	Heavy Duty Truck	
10	Well Completion & Testing	Heavy Duty Truck	Spuds
11		Light Duty Truck	
12	Fuel Haul Truck	Heavy Duty Truck	Spuds

Fugitive dust road emissions were calculated using the mitigated emissions factor ($EF_{mitigated}$) from Equation 13, along with the vehicle miles traveled for each vehicle group as shown in Equation 14.

$$E_{traffic,\ i} = \frac{EF_{mitigated} \times N_{trips} \times D}{2000} \qquad \text{Equation (14)}$$

where:

$E_{traffic,\ i}$ is the traffic fugitive dust emissions for pollutant i per event [ton/event]

$EF_{mitigated}$ is the average emission factor of pollutant i for fugitive dust emissions [lb/mile]

N_{trips} is the annual number of round trips per activity [trips/event]
D is the round trip distance [miles/trip]
2000 is the mass conversion [lb/ton]

2.2.1.6.1 Area-Wide Annual Emissions from Source Category

Annual emissions for road fugitive dust from construction/drilling/completion traffic were propagated with the appropriate scaling surrogate according to Equation 15:

$$E_{dust,traffic,\ i} = E_{traffic,\ i} \times S_{event} \qquad \text{Equation (15)}$$

where:

$E_{dust,traffic,\ i}$ are annual emissions of pollutant i for road fugitive dust from construction/drilling/completion traffic [ton/yr]
$E_{traffic,\ i}$ are the emissions of pollutant i per event (spuds or new pads) [ton/event]
S_{event} is the scaling surrogate for the vehicle group [event/yr]

2.2.1.7 Construction Wind Erosion

Wind erosion dust emissions associated with well pad construction, and road, pipeline construction operations, and well pad reclamation activity were estimated based on AP-42 guidance for the estimation of emissions from industrial wind erosion (USEPA, 2006b). Wind erosion emissions per well pad were estimated based on Equation 16:

$$E_{dust,i} = \frac{P \times A \times r}{907{,}185}$$ Equation (16)

where:

$E_{dust,\ i}$ are dust emissions for pollutant i from construction wind erosion [ton/pad]
P is the erosion potential [g/m^2]
A is the well pad construction area [m^2/pad]
r is the particle size multiplier for PM_{10} or $PM_{2.5}$
907,185 is a mass unit conversion [g/ton]

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The erosions potential is a function of the wind friction velocity, as shown in equation 17 and 18:

$$P = 58 \times (u^* - u_t)^2 + 25(u^* - u_t)$$ Equation (17)

where:

u^* is the friction velocity (m/s)
u_t is the threshold friction velocity (m/s)

$$P = 0 \qquad for \qquad (u^* \le u_t)$$ Equation (18)

Friction velocity estimates (u*) were made by multiplying the average annual fastest wind speed by 0.053 per AP-42 guidance (USEPA, 2006b). Particle size multipliers of 0.5 and 0.075 were assumed for PM_{10} and $PM_{2.5}$ respectively per AP-42 guidance.

2.2.1.7.1 Area-Wide Annual Emissions from Source Category

The annual construction dust wind erosion emissions were scaled by multiplying per well pad emissions by the scaling surrogate (new pads) according to Equation 19:

$$E_{wind\ erosion\ total,\ i} = E_{dust,\ i} \times S_{well\ pad}$$ Equation (19)

where:

$E_{.dust\ erosion\ total,i}$ are the annual emissions of pollutant *i* from construction dust wind erosion [ton/yr]
$E_{dust,\ i}$ are the dust emissions of pollutant i per well pad [ton/pad]
$S_{well\ pad}$ is the scaling surrogate for construction dust wind erosion [pad/yr]

2.2.1.8 Well Completion Venting

This section describes emissions from well completion venting. The calculation methodology for estimating venting emissions from a single completion event is shown below in Equation 20:

$$E_{completion,i} = \left[\frac{P \times Q_{completion}}{\frac{R}{MW_{gas}} \times T \times 3.5 \times 10^{-5}}\right] \times \frac{f_i}{907185} \times (1 - 0.95F_{flare} - F_{green})$$ Equation (20)

where:

$E_{completion,i}$ is the uncontrolled emissions of pollutant *i* from a single completion event [ton/event]
P is atmospheric pressure [1 atm]
$Q_{completion}$ is the volume of gas generated per completion [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_i is the mass fraction of pollutant *i* in the completion venting gas
F_{green} is the fraction of completions that were controlled by green completion techniques
F_{flare} is the fraction of completions controlled by flare
0.95 is the control efficiency of the flare

2.2.1.8.1 Extrapolation to Area-Wide Annual Emissions

Annual emissions are obtained by scaling-up emissions per event by the number of spuds for a particular year. The total emissions from completion venting are estimated following Equation 21:

$$E_{completion,TOTAL,i} = E_{completion,i} \times S_{spuds} \qquad \text{Equation (21)}$$

where:

$E_{completion,TOTAL}$ are the annual emissions for pollutant i from completion venting [tons/year]
$E_{completion,i}$ are the completion emissions from a single completion event [tons/event], event=spuds
S_{spuds} is the scaling surrogate for completion venting in a particular year [spuds/year]

2.2.1.9 Well Completion Flaring

This section describes the methodology for estimating flaring emissions from completion venting as described in Equation 22. It was assumed the efficiency of the flare was 95 percent.

$$E_{flare,completion} = \left(\frac{EF_i \times Q_{completion} \times F_{flared} \times HV}{1000} \right) \Big/ 2000 \qquad \text{Equation (22)}$$

where:

$E_{flare,completion}$ is the area-wide flaring emissions of pollutant i for well completions [ton/event]
EF_i is the flaring emissions factor for pollutant *i* [lb/MMBtu]
$Q_{completion}$ is the volume of gas generated per completion [MCF/event]
HV is the local heating value of the gas [BTU/SCF]
F_{flared} is the fraction of well completions with flares

2.2.1.9.1 Extrapolation to Area-Wide Annual Emissions

Annual area-wide flaring emissions for well completions are scaled-up using the total number of spuds per year as shown in Equation 23:

$$E_{heater,TOTAL,i} = E_{heater,i} \times S_{TOTAL}$$ Equation (23)

where:

$E_{heater,TOTAL}$ is the annual emissions from well completion flaring for pollutant i [[ton/yr]
E_{heater} is the emissions from well completion flaring for pollutant i per event [ton/event]
S_{TOTAL} is the total number of spuds for a particular year [spuds]. The number of well completions is assumed equal to the spuds count for the year.

2.2.2 Emissions from the Production Phase

Emissions from the Production phase include those generated by equipment, vehicles and activities related to oil and gas production at well sites after a well has been completed. Pollutant emissions are initially estimated on a per event basis and later scaled with the projected number of events per year (scaling surrogate) to obtain Area-wide annual emissions from each source.

2.2.2.1 Well Workovers Equipment

This category refers to emissions associated with off-road engines used during well workovers. Detailed data for a typical workover engine such as horsepower rating, hours of operation, fuel type, engine technology and load factor was derived from the literature. The EPA NONROAD2008a model (EPA, 2009b) was used to compile emission factors for 'other oil field equipment' representative of workover engines. The N_2O emissions factor was obtained from the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009).

Emissions on a per well basis for a workover engine were estimated according to Equation 24:

$$E_{engine,\ i} = f \times \frac{EF_i \times HP \times LF \times t \times n}{907{,}185}$$ Equation (24)

where:

E_{engine} are emissions of pollutant *i* from a workover engine [ton/well]
EF_i is the emissions factor of pollutant *i* [g/hp-hr]
HP is the horsepower of the engine [hp]
LF is the load factor of the engine
t is the number of hours of use per day [hr/day]
907,185 is the mass unit conversion [g/ton]
n is the number of operating days per well [days/well]
f is the well workover frequency per year

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2.2.2.1.1 Area-Wide Annual Emissions from Source Category

Annual emissions from well workover equipment by pollutant were estimated according to Equation 25:

$$E_{WO-equip,\ i} = E_{engine\,i} \times S_{wells}$$ Equation (25)

where:

$E_{WO\text{-}equip,\,i}$ are annual emissions of pollutant i from workover equipment [ton/yr]
$E_{engine,\,i}$ is emissions of pollutant i from workover equipment per well [ton/well]
$S_{well\,pad}$ is the scaling surrogate for workovers [active wells/yr]

2.2.2.2 Production Traffic (Well workovers, Road Maintenance, Well Pad Reclamation and Production)

This section describes the estimation of exhaust emissions from light-duty and heavy-duty vehicle traffic used for Well Workovers, Maintenance, Well Pad Reclamation and Production. This excludes traffic from tank loading and compressor stations maintenance. Vehicle classes within the four source categories are shown in Table 2-5. Emissions from these vehicle fleets were first estimated on a per well basis and later on scaled to annual Area-wide emissions with the scaling surrogate, active wells per year.

Table 2-5. Vehicle fleets comprising production traffic.

Vehicle fleets ID	Utility (source category)	Vehicle Class	Event (surrogate)
1	Well Workover Commuting Vehicles	Light Duty Truck	Active Wells
2		Heavy Duty Truck	
3	Road Maintenance	Light Duty Truck	
4	Road and Well Pad Reclamation	Light Duty Truck	

Emission factors were developed using the MOVES2010a model as described in Section 2.2.1.2 above.

Exhaust emissions for the five vehicle groups were estimated as shown in Equation 26.

$$E_{fleet,traffic,\,i} = \frac{EF_i \times N_{trips} \times D}{907185} \qquad \text{Equation (26)}$$

where:

$E_{fleet,traffic,\,i}$ is the fleet's traffic emissions for pollutant i per well [tons/well]
EF_i is the average emission factor of pollutant i [g/mile]
N_{trips} is the annual number of round trips per activity [trips/well]
D is the round trip distance [miles/trip]
907185 is the mass unit conversion [g/ton]

2.2.2.2.1 Area-Wide Annual Emissions from Source Category

Annual emissions for each category (fleet) of production traffic were propagated with the appropriate scaling surrogate (active wells per year) according to Equation 27:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,,\,i} \times S_{wells} \qquad \text{Equation (27)}$$

where:

$E_{fleet,TOTAL,\ i}$ are annual emissions of pollutant i from a production fleet [ton/yr]

$E_{fleet,traffic,\ i}$ is the emissions of pollutant i per well for a production traffic fleet [ton/well]

S_{wells} is the scaling surrogate for the source category [active wells/yr]

2.2.2.3 Fugitive Dust Emissions from Production Traffic (Well Workovers, Road Maintenance, Well Pad Reclamation and Other Production)

Fugitive dust emissions from vehicle travel on unpaved roads were estimated based on the AP-42 technical guidance Section 13.2.2.1 Unpaved Roads (EPA, 2006a). Road dust emission factors for vehicles traveling on unpaved surfaces at industrial sites can be estimated with Equation 28.

$$EF_i = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b \qquad \text{Equation (28)}$$

Where:

EF is the size-specific particulate emissions factor for pollutant i (lb/mile)

s is the surface material silt content (%)

W is the mean vehicle weight (tons)

k, a, b are empirical constants according to Table 2-6.

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Table 2-6. Empirical constants by pollutant to estimate road dust emissions factor.

Parameter	PM_{10}	$PM_{2.5}$
k	1.5	0.15
a	0.9	0.9
b	0.45	0.45

Because the emissions factor is a function of vehicle weight, individual emissions factor for heavy duty vehicles and light duty vehicles were calculated with Equation 28. To account for natural mitigation of road dust emissions due to annual precipitation and from watering control, Equation 29 was applied:

$$EF_{mitigated} = EF_i \times \frac{365-P}{365} \times \frac{100-CE}{100} \qquad \text{Equation (29)}$$

Where:

$EF_{mitigated}$ is the annual average emission factor for uncontrolled conditions including natural mitigation [lb/mile]

EF_i is the size-specific emission factor [lb/mile]

P is number of precipitation days (>0.01" rainfall) at the site

CE is the control efficiency for watering in unpaved roads

Vehicle fleets comprising production traffic are shown in Table 2-5. Fugitive dust emissions from these vehicle fleets were first estimated on a per well basis and later scaled to annual Area-wide emissions with the scaling surrogate, active wells per year.

Fugitive dust road emissions per well were calculated using the mitigated emissions factor ($EF_{mitigated}$) from Equation 29, along with the vehicle miles traveled for each vehicle group. This is shown in Equation 30

$$E_{fleet,traffic,\ i} = \frac{EF_{mitigated} \times N_{trips} \times D}{2000} \qquad \text{Equation (30)}$$

where:

$E_{fleet,traffic,\ i}$ is the traffic fugitive dust emissions for pollutant i per well [ton/well]
$EF_{mitigated}$ is the average emission factor of pollutant i for fugitive dust emissions [lb/mile]
N_{trips} is the annual number of round trips per activity [trips/well]
D is the round trip distance [miles/trip]
2000 is the mass conversion [lb/ton]

2.2.2.3.1 Area-Wide Annual Emissions from Source Category

Annual fugitive dust emissions for each category (fleet) of Production traffic were propagated with the appropriate scaling surrogate (active wells per year) according to Equation 31:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,,\ i} \times S_{wells} \qquad \text{Equation (31)}$$

where:

$E_{fleet,TOTAL,\ i}$ are annual fugitive dust emissions of pollutant i from a production fleet [ton/yr]
$E_{fleet,traffic,\ i}$ is the fugitive dust emissions of pollutant i per well for a production traffic fleet [ton/well]
S_{wells} is the scaling surrogate for the source category [active wells/yr]

2.2.2.4 Blowdown venting

This section refers to the estimation of emissions from venting during well blowdowns. The calculation methodology for estimating emissions from a single blowdown event is shown below in Equation 32:

$$E_{blowdown,i} = \left(\frac{P \times (V_{vented})}{\left(R/MW_{gas} \right) \times T \times 3.5 \times 10^{-5}} \right) \times \frac{f_i}{907185} \qquad \text{Equation (32)}$$

where:

$E_{blowdown,i}$ is the emissions of pollutant *i* from a single blowdown event [ton/event]
P is atmospheric pressure [1 atm]

V_{vented} is the volume of vented gas per blowdown (uncontrolled) [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_i is the mass fraction of pollutant i in the vented gas

2.2.2.4.1 Area-Wide Annual Emissions from Source Category

The total emissions from all annual blowdowns events occurring are estimated with Equation 33:

$$E_{blowdown,TOTAL} = E_{blowdown,i} \times N_{blowdown} \times S_{wells} \qquad \text{Equation (33)}$$

where:

$E_{blowdown,TOTAL}$ are the total annual emissions from blowdowns [tons/yr]
$E_{blowdown,i}$ are the blowdown emissions from a single blowdown event [tons/event]
$N_{blowdown}$ is the frequency of blowdowns per well per year [events/yr-well]
S_{wells} is the total number of active wells for a particular year [wells]

2.2.2.5 Well Recompletion Venting

This section describes emissions from well recompletion venting. The calculation methodology for estimating venting emissions from a single recompletion event is shown below in Equation 34:

$$E_{recompletion,i} = \left[\frac{P \times Q_{recompletion}}{\frac{R}{MW_{gas}} \times T \times 3.5 \times 10^{-5}}\right] \times \frac{f_i}{907185} \qquad \text{Equation (34)}$$

where:

$E_{recompletion,i}$ is the uncontrolled emissions of pollutant i from a single recompletion event [ton/event]
P is atmospheric pressure [1 atm]
$Q_{recompletion}$ is the volume of gas generated per recompletion [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_i is the mass fraction of pollutant i in the recompletion venting gas

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2.2.2.5.1 Extrapolation to Annual Area-Wide Emissions

Annual emissions are obtained by scaling-up emissions per event with the total number of recompletion events in a particular year. The total emissions from recompletion venting are estimated following Equation 35:

$$E_{recompletion,TOTAL,i} = E_{recompletion,i} \times f \times S_{well\ count} \qquad \text{Equation (35)}$$

where:

$E_{completion,TOTAL}$ are the annual emissions for pollutant i from recompletion venting [tons/year]

$E_{completion,i}$ are the venting emissions from a single recompletion event [tons/event]

f is the frequency of recompletion events per well per year [events/yr-well]

$S_{well\ count}$ is the scaling surrogate for recompletion venting in a particular year [active wells]

2.2.2.6 Wellhead Fugitives

This source category refers to fugitive emissions or *leaks* from well equipment such as pump seals, valves, connectors, flanges, etc. Fugitive emissions were estimated for three main streams identified: gas service stream, liquids service stream and high oil stream. VOC, CO_2 and CH_4 emissions per stream were estimated using device-specific TOC emission factors for oil and gas production (USEPA, 1995b) and equipment counts. Input data was obtained from the literature on total device counts per well by type of equipment and by the type of service to which the equipment applies – gas, liquids and high oil.

Fugitive VOC emissions for an individual device in a given stream (gas, liquids, and high oil) were estimated according to Equation 36:

$$E_{fugitiveVOC,k} = EF_{TOC} \times N \times t_{annual} \times Y \qquad \text{Equation (36)}$$

where:

$E_{fugitive\ VOC,\ k}$ is the fugitive VOC emissions for a given device k [ton/yr-well]

EF_{TOC} is the emission factor of TOC [kg/hr/device]

N is the total number of devices type-k for a given stream per well [devices/well]

Y is the ratio of VOC to TOC in the vented gas

Total VOC fugitive emissions for a given stream are equal to the sum of all fugitive emissions from devices in that stream per Equation 37:

$$E_{fugitiveVOC,stream} = \sum E_{fugitiveVOC,\ k} \qquad \text{Equation (37)}$$

where:

$E_{fugitive\ VOC,stream}$ is the total fugitive VOC emissions in a given stream per well [ton/yr-well]

CO_2 and CH_4 fugitive emissions per stream were estimated according to Equations 38 and 39:

$$E_{fugitiveCH4,stream} = E_{fugitiveVOC,stream} \times \frac{weight\ fraction_{CH4}}{weight\ fraction_{VOC}} \qquad \text{Equation (38)}$$

$$E_{fugitiveCO2,stream} = E_{fugitiveVOC,stream} \times \frac{weight\ fraction_{CO2}}{weight\ fraction_{VOC}} \qquad \text{Equation (39)}$$

where:

$E_{fugitive\ CO2,stream}$ is the total fugitive CO_2 emissions in a given stream per well [ton/yr-well]

$E_{fugitive\ CH4,stream}$ is the total fugitive CH_4 emissions in a given stream per well [ton/yr-well]
Weight fractions per pollutant were based on gas compositions. For gas and well streams, sales gas composition was used. For condensate stream, fugitive-post flash compositions were used.

2.2.2.6.1 Area-Wide Annual Emissions from Source Category

Fugitive emissions were propagated annually according to Equation 40 using the scaling surrogate, active well counts:

$$E_{fugitive,\ i} = E_{fugitive\ i,stream} \times S_{well\ count} \qquad \text{Equation (40)}$$

where:

$E_{fugitive,\ i}$ are the annual fugitive emissions for pollutant i in a given stream [ton/yr]
$E_{fugitive\ I,\ stream}$ are fugitive emissions of pollutant i in a stream per well [ton/yr-well]
$S_{well\ count}$ is the number of active wells for a particular year [active wells]

2.2.2.7 Pneumatic Devices

Emissions for pneumatic devices will vary by the bleed rate of the device. The methodology for estimating the emissions from a mix of pneumatic devices i (liquid level controllers, pressure controllers, etc.) for a single typical well is shown in Equation 41:

$$E_{pneumatic,j} = \frac{f_j}{907185}\left(\sum_i \dot{V}_i \times N_i \times t_{annual}\right) \times \frac{P}{\left(\left(R/MW_{gas}\right) \times T \times 3.5 \times 10^{-5}\right)} \qquad \text{Equation (41)}$$

where:

$E_{pneumatic,j}$ is the total emissions of pollutant *j* from all pneumatic devices for a typical well [ton/year/well]
$\dot{V}_i$ is the volumetric bleed rate from device *i* [MCF/hr/device]
N_i is the average number of devices *i* found in a well [devices/well]
t_{annual} is the number of hours per year that devices were operating [8760 hr/yr]
P is the atmospheric pressure [1 atm]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_j is the mass fraction of pollutant *j* in the vented gas

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2.2.2.7.1 Extrapolation to Area-Wide Annual Emissions

Annual emissions from pneumatic devices were estimated according to Equation 42:

$$E_{pneumatic,TOTAL,j} = E_{pneumatic,j} \times N_{well} \qquad \text{Equation (42)}$$

where:

$E_{pneumatic,TOTAL,j}$ is the total annual emissions of pollutant *j* from pneumatic devices [ton/yr]
$E_{pneumatic,j}$ is the pneumatic device emissions of pollutant *j* for a single typical well [ton/yr/well]
N_{well} is the total number of active wells in the basin [wells]

2.2.2.8 Pneumatic Pumps

To estimate emissions from pneumatic pumps, literature data indicating the average rate of gas consumption per gallon of chemical injected and the annual chemical throughput for a single pump was applied. Emissions per well from pneumatic pumps were estimated as shown in Equation 43:

$$E_{pump,i} = \frac{N_{CIP} \times V_{vented,gas} \times t_{pump} \times MW_i \times R \times Y_i}{2000} \quad \text{Equation (43)}$$

where:

$E_{pump,\,i}$ is the pneumatic pump emissions for pollutant i per well [ton/yr-well]
$V_{vented,TOTAL}$ is the average gas venting rate per pump [SCF/pump/hr]
N_{CIP} is the number of gas-actuated pneumatic pumps per well [pump/well]
t_{pump} is the annual hours of operation of a pump [hrs/yr]
MW_i is the molecular weight of pollutant i [lb/lb-mol]
R is the universal gas constant [lb-mol/391.9scf]
Y_i is the molar fraction of pollutant i in pneumatic pump vented gas
2000 is the mass unit conversion [lb/ton]

2.2.2.8.1 Area-Wide Annual Emissions from Source Category

To estimate area-wide annual emissions from pneumatic pumps the scaling surrogate, active wells, was used according to Equation 44

$$E_{pneumaticpumps,\,i} = E_{pump,\,i} \times S_{well\ count} \quad \text{Equation (44)}$$

where:

$E_{pneumaticpumps,\,i}$ are the annual emissions for pollutant i from pneumatic pumps [ton/yr]
$E_{pump,\,i}$ is the emissions from all pneumatic pumps per well [ton/yr-well]
$S_{well\ count}$ is the number of active wells for a particular year [wells]

2.2.2.9 Water Injection Pumps

This category refers to exhaust emissions associated with diesel combustion in water injection pump engines. Detailed data for each engine type such as horsepower rating, hours of operation, fuel type, engine technology and load factors was derived from the literature. The EPA NONROAD2008a model (USEPA, 2009b) was used to compile emission factors. The N_2O emissions factor was obtained from the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009).

Emissions on a per well basis for a water injection pump were estimated according to Equation 45:

$$E_{engine,i} = \frac{EF_i \times HP \times LF \times t_{event} \times n}{907{,}185} \quad \text{Equation (45)}$$

where:

E_{engine} are per-well emissions of pollutant *i* from water injection pumps [ton/well]
EF_i is the emissions factor of pollutant *i* [g/hp-hr]
HP is the horsepower of the pump [hp]
LF is the load factor of the pump
t_{event} is the number of hours the engine is used annually [hrs/unit]
907,185 is the mass unit conversion [g/ton]
n is the number of water injection pumps per well [units/well]

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2.2.2.9.1 Area-Wide Annual Emissions from Source Category

Annual emissions from water injection pumps for pollutant i were estimated according to Equation 46:

$$E_{water\ pumps,\ i} = E_{engine,\ i} \times S_{well} \quad \text{Equation (46)}$$

where:

$E_{well\ pad\ equip}$ are annual emissions of pollutant i from water injection pumps [ton/yr]
$E_{engine,\ i}$ is engine emissions per well [ton/well]
S_{well} is the scaling surrogate for water injection pumps [active wells/yr]

2.2.2.10 Miscellaneous Engines

This category refers to exhaust emissions associated with miscellaneous engines at well sites. Detailed data for miscellaneous engines such as horsepower rating, hours of operation, fuel type, engine technology and load factors was derived from the literature. The EPA NONROAD2008a model (USEPA, 2009b) was used to compile emission factors. The N_2O emissions factor was obtained from the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009).

Emissions on a per well basis for miscellaneous engines were estimated according to Equation 47:

$$E_{engine,i} = \frac{EF_i \times HP \times LF \times t_{event} \times n}{907{,}185} \times f \quad \text{Equation (47)}$$

where:

E_{engine} are per-well emissions of pollutant *i* from miscellaneous engines [ton/well]
EF_i is the emissions factor of pollutant *i* [g/hp-hr]
HP is the horsepower of the pump [hp]
LF is the load factor of the pump
t_{event} is the number of hours the engine is used [hrs/unit]

f is the fraction of wells served by a miscellaneous engine
907,185 is the mass unit conversion [g/ton]
n is the number of engines per well [units/well]

2.2.2.10.1 Area-Wide Annual Emissions from Source Category

Annual emissions from miscellaneous engines for pollutant i were estimated according to Equation 48:

$$E_{water\ pumps,\ i} = E_{engine,\ i} \times S_{well} \qquad \text{Equation (48)}$$

where:

$E_{well\ pad\ equip}$ are annual emissions of pollutant i from miscellaneous engines [ton/yr]
$E_{engine,\ i}$ is engine emissions per well [ton/well]
S_{well} is the scaling surrogate for miscellaneous engines [active wells/yr]

2.2.2.11 Compressor Station Maintenance Traffic Exhaust

This section describes the estimation of exhaust emissions from light-duty vehicles (pickup trucks) used for compressor maintenance at compressor stations. Emission factors were developed using the MOVES2010a model (USEPA, 2010) as described in Section 2.2.1.2. The total vehicle miles travelled annually from maintenance visits to a single compressor station were obtained from the literature.

Exhaust emissions for this fleet were estimated as shown in Equation 49.

$$E_{fleet,traffic,\ i} = \frac{EF_i \times VMT_{CS}}{907185} \qquad \text{Equation (49)}$$

where:

$E_{fleet,traffic,\ i}$ is the fleet's traffic emissions for pollutant i per well [tons/station]
EF_i is the average emission factor for light duty vehicles of pollutant i [g/mile]
VMT_{CS} is the annual miles travelled for maintenance compressor station [miles/station]
907185 is the mass unit conversion [g/ton]

2.2.2.11.1 Area-Wide Annual Emissions from Source Category

Annual emissions for the compressor maintenance fleet were propagated with the scaling surrogate "total count of active compressor stations" according to Equation 50:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,,\ i} \times S_{CS} \qquad \text{Equation (50)}$$

where:

$E_{fleet,TOTAL,\ i}$ are annual emissions of pollutant i from compressor station maintenance traffic [ton/yr]
$E_{fleet,traffic,\ i}$ is the emissions of pollutant i per station for the fleet [ton/station]
S_{CS} is the scaling surrogate for the source category [number of active compressor stations per year]

2.2.2.12 Fugitive Dust Emissions from Compressor Station Maintenance Traffic

Road dust emission factors for light duty vehicles traveling on unpaved surfaces to and from compressor stations were estimated with the same methodology as in Section 2.2.1.2.6 using Equations 28 and 29. Fugitive dust road emissions per station (visited) were calculated using the mitigated emissions factor ($EF_{mitigated}$) from Equation 29, along with the annual vehicle miles traveled per compressor station. This is shown in Equation 51.

$$E_{fleet,traffic,\ i} = \frac{EF_{mitigated} \times VMT}{2000} \qquad \text{Equation (51)}$$

where:

$E_{fleet,traffic,\ i}$ is the traffic fugitive dust emissions for pollutant i per station [ton/station]

$EF_{mitigated}$ is the average emission factor of pollutant i for fugitive dust emissions [lb/mile]

VMT is the annual miles travelled for maintenance compressor station [miles/station]

2000 is the mass conversion [lb/ton]

2.2.2.12.1 Area-Wide Annual Emissions from Source Category

Annual fugitive dust emissions for compressor station maintenance traffic were propagated with the "total number of compressor stations" according to Equation 52:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,\ i} \times S_{CS} \qquad \text{Equation (52)}$$

where:

$E_{fleet,TOTAL,\ i}$ are annual fugitive dust emissions of pollutant i from compressor station maintenance traffic [ton/yr]

$E_{fleet,traffic,\ i}$ is the emissions of pollutant i per station for the fleet [ton/station]

S_{CS} is the scaling surrogate for the source category [number of active compressor stations per year]

2.2.2.13 Condensate Tanks Flashing

Condensate tank emissions were calculated differently for conventional oil and gas developments and for shale gas developments.

An uncontrolled VOC emissions factor applicable to Garfield, Mesa, Rio Blanco, and Moffat Counties (CDPHE, 2011) was used to estimate emissions for condensate tanks in conventional gas, shale gas and coalbed natural gas developments on a per barrel basis. The published emissions factor was 10 lbs VOC/bbl [0.005 tons/bbl]; for planning areas outside of those counties the emission factor of 11.3 lbs VOC/bbl [0.008 tons/bbl] can be used (CDPHE, 2011). For conventional oil developments, the emissions factor of 1.6 lbs VOC/bbl was used based on BLM (2013). The VOC emissions factor was multiplied by the annual condensate production from each type of well to propagate VOC emissions to the Planning Area level for each year.

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Similar to the methodology for conventional oil and gas sources, CO_2 and CH_4 total emissions were then calculated using the weight fraction ratios from local flash gas composition analyses using Equations 53 and 54.

$$E_{tanks,CH4} = E_{tanks,VOC} \times \frac{weight\ fraction_{CH4}}{weight\ fraction_{VOC}} \quad \text{Equation (53)}$$

$$E_{tanks,CO2} = E_{tanks,VOC} \times \frac{weight\ fraction_{CO2}}{weight\ fraction_{VOC}} \quad \text{Equation (54)}$$

where:

$E_{tanks,VOC}$ is the total annual condensate tanks emissions from APENS database [tons/yr]
$E_{tanks,CO2}$ is the total condensate tank CO_2 emissions [tons/yr]
$E_{tanks,CH4}$ is the total condensate CH_4 emissions [tons/yr]
Weight fractions of each pollutant in flash gas

2.2.2.14 Loading Emissions from Condensate or Oil Tanks

This section describes emissions from truck loading of condensate or crude oil from tanks. The loading loss rate is estimated following Equation 55:

$$L = 12.46 \times \left(\frac{S \times V \times M}{T} \right) \quad \text{Equation (55)}$$

where:

L is the loading loss rate [lb/1000gal]
S is the saturation factor taken from AP-42 default values based on operating mode. The operating mode for loading assumed was submerged loading: dedicated normal service.
V is the true vapor pressure of the liquid loaded [psia]
M is the molecular weight of the vapor [lb/lb-mole]
T is the temperature of the bulk liquid [°R], T=540 R

VOC tank loading emissions are then estimated by Equation 56:

$$E_{loading,\ VOC} = L \times Y_{voc} \times \frac{42}{2000} \quad \text{Equation (56)}$$

where:

$E_{loading}$ are the VOC tank loading emissions [ton/bbl]
L is the loading loss rate [lb/1000gal]
Y_{VOC} is the weight fraction of VOC in the vapor in the liquid loaded
42 is a unit conversion [gal/bbl]
2000 is a unit conversion [lbs/ton]

CO_2 and CH_4 emissions are calculated based on Equations 57-58:

$$E_{loading,CH4} = E_{loading,VOC} \times \frac{weight\ fraction_{CH4}}{weight\ fraction_{VOC}} \quad \text{Equation (57)}$$

$$E_{loading,CO2} = E_{loading,VOC} \times \frac{weight\ fraction_{CO2}}{weight\ fraction_{VOC}}$$ Equation (58)

where:

$E_{loading,CO2}$ is the total loading CO_2 emissions per barrel of liquid [ton/bbl]
$E_{loadingCH4}$ is the total loading CH_4 emissions per barrel of liquid [ton/bbl]
Weight fractions of each pollutant in the vapor losses from the liquid loaded

2.2.2.14.1 Area-Wide Annual Emissions from Source Category

Annual emissions per pollutant i from condensate loading were scaled by annual condensate production per Equation 59:

$$E_{tank\ loadout,\ i} = E_{loading,\ i} \times S_{bbl\ condensate}$$ Equation (59)

where:

$E_{tank\ loadout,\ i}$ is the total condensate loading emissions for pollutant i from tank load-out [ton/yr]
$E_{loading,\ i}$ is the condensate loading emissions for pollutant i from per barrel [ton/bbl]
$S_{bbl\ condensate}$ is the total annual of barrels condensate [bbl/yr]

2.2.2.15 Condensate, Crude Oil and Produced Water Hauling Traffic Exhaust

This section describes the estimation of exhaust emissions from heavy-duty vehicles (haul trucks) used for produced condensate hauling from the well site. Emission factors were developed using the MOVES2010a model (EPA, 2010) as described in Section 2.2.1.2. The total round trip distance for each hauling trip was derived from the literature. A hauling volume of per truck of 200 barrels of condensate or crude oil, hence the number of round trips per barrel was estimated (1/200).

Exhaust emissions for condensate and crude oil hauling fleet were estimated as shown in Equation 60a.

$$E_{fleet,traffic,\ i} = \frac{EF_i \times N_{trips} \times D}{907185}$$ Equation (60a)

where:

$E_{fleet,traffic,\ i}$ is the hauling traffic exhaust emissions for pollutant i per barrel [ton/bbl]
EF_i is the average emission factor of pollutant i for heavy duty vehicles [g/mile]
N_{trips} is the annual number of round trips per barrel [trips/bbl]. N=1/200
D is the round trip distance [miles/trip]
907185 is the mass conversion [g/ton]

2.2.2.15.1 Area-Wide Annual Emissions from Condensate or Crude Oil Hauling

Annual emissions for the condensate and crude oil hauling fleet were propagated with the annual condensate or crude oil production according to Equation 61a:

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$$E_{fleet,TOTAL,i} = E_{fleet,traffic,\ i} \times S_{bbl,condensate}$$ Equation (61a)

where:

$E_{fleet,TOTAL,\ i}$ are annual emissions of pollutant i from condensate hauling traffic [ton/yr]
$E_{fleet,traffic,\ i}$ is the emissions of pollutant i per barrel for the hauling fleet [ton/bbl]
$S_{bbl,condensate}$ is the scaling surrogate for the source category [barrels of condensate produced per year]

2.2.2.15.2 Produced water hauling exhaust emissions

Produced water refers to the water produced with the gas once the well has been completed and is under operation. This water is typically hauled from the well site storage tanks with water trucks or sent via pipeline to injection wells. Annual produced water rates will vary by the type of well. It was assumed that the annual rate of water production for conventional oil, conventional gas and shale gas wells was 18,250 bbl/well (URS, 2012a); this value can be updated for a given area based on Colorado Oil and Gas Conservation Commission water production data. It was assumed that produced water truck capacity is 130 bbl and that 50 percent of the water is hauled out.

The annual water production per CBNG well was assumed to be 97,900 bbl/well (BLM, 2012); this value can be updated for a given area based on Colorado Oil and Gas Conservation Commission water production data.

Exhaust emissions for produced water hauling fleet were estimated as shown in Equation 60b:

$$E_{fleet,traffic,\ i} = \frac{EF_i \times N_{trips} \times D}{907185}$$ Equation (60b)

where:

$E_{fleet,traffic,\ i}$ is the produced water hauling exhaust emissions for pollutant i per well [ton/well]
EF_i is the average emission factor of pollutant i for heavy duty vehicles [g/mile]
N_{trips} is the annual number of round trips per well [trips/well]
D is the round trip distance [miles/trip]
907185 is the mass conversion [g/ton]

2.2.2.15.2.1 Area-Wide Annual Emissions from Produced Water Hauling

Annual emissions for the produced water hauling fleet were propagated to the planning area according to Equation 61b:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,\ i} \times S_{active\ wells}$$ Equation (61b)

where:

$E_{fleet,TOTAL,\ i}$ are annual emissions of pollutant i from produced water hauling traffic [ton/yr]
$E_{fleet,traffic,\ i}$ is the emissions of pollutant i per well for the hauling fleet [ton/well]
$S_{active\ wells}$ is the scaling surrogate for the source category, active wells per year [wells/yr]

2.2.2.15.3 Fugitive Dust Emissions from Condensate and Produced Water Hauling Traffic

Road dust emission factors for heavy duty vehicles traveling on unpaved surfaces for condensate hauling and produced water hauling were estimated with the same methodology as in Section 2.2.1.2.6 using Equations 28 and 29. Because the number of trips for both of these activities is based on different surrogates - per barrel for condensate hauling and per well for produced water hauling - as shown in Section 2.2.1.2.15, fugitive dust road emissions of each fleet were calculated using the mitigated emissions factor ($EF_{mitigated}$) from Equation 29. This is shown in Equation 62.

$$E_{fleet,traffic,\ i} = \frac{EF_{mitigated} \times D \times N_{trips}}{2000} \qquad \text{Equation (62)}$$

where:

$E_{fleet,traffic,\ i}$ is the traffic fugitive dust emissions for pollutant i per (1) barrel of condensate [ton/bbl] for condensate hauling or (2) well [ton/well] for produced water hauling

$EF_{mitigated}$ is the average emission factor of pollutant i for fugitive dust emissions [lb/mile]

N_{trips} is the annual number of round trips per (1) barrel of condensate hauled [trips/bbl] for condensate hauling or (2) well [trips/well] for produced water hauling

D is the round trip distance per hauling trip [miles/trip]

2000 is the mass conversion [lb/ton]

2.2.2.15.3.1 Area-Wide Annual Emissions from Condensate and Produced Water Hauling Traffic

Annual fugitive dust emissions for condensate hauling were propagated with the annual condensate production according to Equation 63:

$$E_{fleet,TOTAL,i} = E_{fleet,traffic,,\ i} \times S_{bbl,condensate\ or\ active\ wells} \qquad \text{Equation (63)}$$

where:

$E_{fleet,TOTAL,\ i}$ are annual fugitive dust emissions of pollutant i from condensate hauling traffic [ton/yr]

$E_{fleet,traffic,\ i}$ is the dust emissions of pollutant i per barrel for the hauling fleet [ton/surrogate]

$S_{bbl,condensate\ or\ active\ wells}$ is the scaling surrogate for the source category: (1) [barrels of condensate produced per year] for condensate hauling or (2) [active wells per year] for produced water hauling

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2.2.2.16 Heaters

This section describes the methodology for estimating emissions from heaters and reboilers. Heater emissions are a function of the properties of the local produced gas used as a fuel. Emissions factors for external combustion of natural gas were obtained from AP-42 Section 1.4 Natural Gas Combustion (USEPA, 1995a). Emissions per well from heaters and reboilers can be estimated individually using Equation 64.

$$E_{heater,i} = N_{heaters} \times \frac{EF_i \times Q_{heater} \times t_{annual}}{(HV_{local} \times 2000)}$$ Equation (64)

where:

$E_{heater,i}$ is the per well emissions for pollutant from a given heater [ton/well-yr]
EF_i is the heater emission factor for a given pollutant i [lb/MM SCF]
Q_{heater} is the heater MMBTU/hr rating [$MMBTU_{rated}$/hr]
HV_{local} is the local natural gas heating value [BTU_{local}/SCF]
t_{annual} is the annual hours of operation [hr/yr]
$N_{heaters}$ is the number of heaters per well

2.2.2.16.1 Area-Wide Annual Emissions from heaters

Annual emissions for heaters and reboilers are estimated with Equation 65 using the scaling surrogate active wells.

$$E_{heater,TOTAL,i} = E_{heater,i} \times W_{TOTAL}$$ Equation (65)

where:

$E_{heater,TOTAL}$ is the total emissions of pollutant i for a given heater type in the Project [ton/yr]
E_{heater} is the per well annual emissions from a given heater type for pollutant i [ton/well-yr]
W_{TOTAL} is the total number of wells for a particular year [wells]

2.2.2.17 Dehydrator Emissions

This section describes the methodology to estimate emissions from dehydrator still vents. Uncontrolled emission factors per unit of gas production for emissions of VOC, CH_4 and CO_2 were derived from the literature for the various well types. Total emissions were propagated using the gas production by well type, assuming 100 percent of the gas undergoes well site dehydration. This was done applying Equation 66.

$$E_{dehyTOTAL,i,j} = EF_{dehy,i} \times S_{gas\ production,j}$$ Equation (66)

where:

$E_{dehy,TOTAL,,i,j}$ are the total area-wide emissions from dehydrators still vents for pollutant i in year j [tons/yr]
$EF_{dehy,i}$ is the dehydrator still vent emissions rate [tons/MCF]
$S_{gas\ production}$ is the annual gas production in year j [MCF/yr]

2.2.3 Midstream sources

Midstream sources include gathering and treating emissions associated with facilities such as compressor stations and gas plants. Midstream emissions are taken from the 2011 APEN (Air Pollutant Emission Notice) emissions database provided by CDPHE (CDPHE, 2013). CDPHE

provided APEN emissions for all oil and gas related emission sources covered by the following SCC and SIC codes:

- All of the SCCs 202002*, 310*, 404003* (where * indicates all sub-SCCs for the SCC)
- And only those with the following SICs: 13*, 492*, 4612

BLM field office planning area designation was assigned according to the latitude and longitude of each source. The APEN oil and gas emissions database includes both well site and midstream sources. Midstream sources were identified for inclusion in the calculator based on the facility name and the suite of equipment included at a given facility. Appendix C-2 includes a table of emissions by facility for each field office area.

Emissions were available in the APEN emissions database for the pollutants VOCs, CO, NO_X, PM_{10} and SO_2 in tons per year. Emissions for CH_4 and CO_2 were calculated using the vented gas speciation according to Equations 67 and 68 for the following sources.

- Glycol Dehydrator
- Natural Gas Processing Facilities, Gas Sweeting: Amine Process
- Condensate Tanks
- Natural Gas Processing Facilities, Flanges and Connections

$$E_{source,CH4} = E_{tanks,VOC} \times \frac{weight\ fraction_{CH4}}{weight\ fraction_{VOC}} \qquad \text{Equation (67)}$$

$$E_{sourceCO2} = E_{tanks,VOC} \times \frac{weight\ fraction_{CO2}}{weight\ fraction_{VOC}} \qquad \text{Equation (68)}$$

where:

$E_{source,VOC}$ is the total annual emissions from APENS database *a source* [tons/yr]
$E_{source,CO2}$ is the total CO_2 emissions from *a source* [tons/yr]
$E_{source,CH4}$ is the total CH_4 emissions from *a source* [tons/yr]
Weight fractions of each pollutant in the vented gas

For combustion sources such as compressor engines, process heaters and flares, emissions for CH_4, N_2O and CO_2 were estimated using the ratios of each greenhouse gas to NOx of emissions factors from AP-42.

Emissions in future years were estimated by multiplying 2011 emissions by the ratio of gas production in a given future year to gas production in 2011.

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APPENDIX C-1

Conventional Gas Well
Calculator Inputs by Source Category

Note: Yellow highlights indicate that inputs were obtained from the Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012. All inputs taken from other sources are noted.

Gas Analysis & Venting	Speciated Sales Gas Analysis
Gas Component	Mole Fraction (%)
Methane C1	81.012
Ethane C2	4.334
Nitrogen	6.718
Water	0.000
Carbon Dioxide	5.380
Nitrous Oxide	0.000
Hydrogen Sulfide	0.000
Propane C3	1.437
i-Butane i-C4	0.288
n-Butane n-C4	0.329
i-Pentane iC5	0.154
n-Pentane nC5	0.104
Hexanes C6	0.111
Heptanes C7	0.037
Octanes+	0.017
Benzene	0.004
Ethylbenzene	0.000
n-Hexane n-C6	0.068
Toluene	0.003
2,2,4-Trimethylpentane	0.001
Xylenes	0.002

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Cn_HEq_Exh Construction/Drilling/Completion Equipment

Construction Equipment

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/Well Pad	Equipment Category	HP Range
Well Pad	Construction Equipment	250	4	42	10	13	Other Construction Equipment	300
Well Pad Access Road	Construction Equipment	250	4	42	10	10	Other Construction Equipment	300
Pipeline	Construction Equipment	250	2	42	10	2	Other Construction Equipment	300

Construction Site	Equipment Type	2011 Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Well Pad	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Well Pad Access Road	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Pipeline	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Drilling

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range for Efs
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	2469	2	40	24	17	2270010010	Tier 2	>1200

Construction Site	Equipment Type	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O[a]
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Source: EPA Federal Tier Standards

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Completion/Fracing

Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range
Completion Equipment	1230	1	40	7	1	2270010010	Tier 2	>1200
Fracing Equipment	12000	1	85	24	1	2270010010	Tier 2	>1200
Refracing Equipment	1500	4	97	1	3	2270010010	Tier 2	>1200

Grand Junction Field Office Air Quality Technical Support Document, ENVIRON, 2012
Data updated from White River Air Quality Technical Support Document, URS, 2012 (Fracing Equipment), and from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012 (Completion)

Equipment Type	Capacity (hp)	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Completion Equipment	1230	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Fracing Equipment	12000	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Refracing Equipment	1500	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002

Source: EPA Federal Tier Standards
[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Fracing frequency per spud	1
Refracing Frequency per Year per Well	0.05

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Cn_CV_Exh Construction Traffic Exhaust

Well Pad and Access Road Construction Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well Pad/ Year
	Type	Class		
Well Pad and Access Road Construction Traffic	Semi Trucks	HDDV	4	80
	Pickup Trucks	LDDT	4	30
Pipeline Construction	Semi Trucks	HDDV	5	16
	Pickup Trucks	LDDT	5	18

Drilling/Completion/Fracing Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/activity/ Year
	Type	Class		
Drilling Traffic	Semi Trucks	HDDV	4	136
	Pickup Trucks	LDDT	5	136
Rig Hauling	Semi Trucks	HDDV	5	1
Rig Move Drilling Traffic	Semi Trucks	HDDV	5	90
	Pickup Trucks	LDDT	5	42
Well Completion & Testing	Semi Trucks	HDDV	5	84
	Pickup Trucks	LDDT	5	74

Ops_Well WO Workovers

Construction Equipment

Activity	Equipment Type	Capacity (hp)	# of Operating Hours/Day	# of Operating Days/Well	Load Factor	Well Workover Frequency per Year	NONROAD SCC
Well Workover	Workover Equipment	638	9	6	43	0.08	2270010010

Tier Level	HP Range for Efs	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O[a]
Tier 2	600-750	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Traffic

Activity	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well/ Year
	Type	Class		
Well Workover	WO Rig	HDDV	4	4
	Haul Truck	HDDV	4	12
	Pickup Truck	LDDT	4	20

blowdown	Blowdown Venting		
Type	Control Efficiency (%)	Volume of gas vented per blowdown Uncontrolled (MCF)	Frequency of Blowdown per well per year
Blowdown	0%	0.75	3.0

Data updated from White River Air Quality Technical Support Document, URS, 2012

well completion	Completion Venting
Type	Total volume of gas during completion (mcf)
All completions	1,000

Data updated from White River Air Quality Technical Support Document, URS, 2012

Recompletion	Recompletion Venting		
Type	Control Efficiency (%)	Volume of gas vented per well per recompletion Uncontrolled (MCF)	No. of recompletion per well per year
Recompletion	0%	1000	1%

Data updated from White River Air Quality Technical Support Document, URS, 2012

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Compressor_Venting Compressor Venting

Type	Control Efficiency (%)	Volume of gas vented per start-up or shutdown Uncontrolled (MCF)	Frequency of Start-up per well per year	Frequency of Shutdown per well per year
Compressor Shutdown	0%	10	1	1

Wellhead Fugitives Wellhead Fugitive Devices, Pneumatic Devices, and Pneumatic Pumps

Fugitive Devices

component	Ave. # in Gas Service	Ave. # in Liquid service	Ave. # in High Oil service	Ave. # in Water/Oil Service
valves	49	14	0	3
pump seals	2	1	0	0
others	46	0	0	0
connectors	0	0	0	0
flanges	13	8	0	1
open-ended lines	6	2	0	0

Pneumatic Pumps

Type	Gallons/yr/pump	SCF/Gallon	Number of Pump
Pneumatic Pumps	91	118	1

Pneumatic Devices

Device	Number of Devices / well	Lo-Bleed Rate (cfh)
Liquid level controller	2	6
Pressure controller	1	6
Valve controllers	2.0	6
Liquid level controller	0.1	6

Data updated from Colorado River Valley Air Quality Technical Support Document, URS, 2012

WaterInjection_ Pumps_Exh	Water Injection Pumps

Type	Capacity (hp)	# of Units per well	Avg. Load Factor (%)	# of Operating Hours	Equipment Category	2011 Emission Factors (g/hp-hr)								
						VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Water Injection Pumps	347	0.06	47	2920	Pumps	0.13	0.59	2.14	0.10	0.10	0.00	227.95	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Misc_Engines_Exh	Miscellaneous Engines

Construction Site	Capacity (hp)	# of Units per Well	Fraction of wells to be served by Miscellaneous engine	Avg. Load Factor (%)	# of Operating Hours/Well	Equipment Category
Misc. Engines	118	1	1	50	4380	Misc. Engines

HP Range	2011 Emission Factors (g/hp-hr)								
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
175	0.12	0.41	1.59	0.10	0.10	0.00	227.98	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

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Condensate Tanks & Traffic	Condensate Tanks
Type	***Base Year Assumptions***
Condensate	1. All Condensate Throughput Sent Tanks
	2. Average Condensate Truck Haulout of 200 bbl/load
Produced Water	3. All Water Throughput Sent Tanks
	4. Average Water Truck Haulout of 100 bbl/load
	5. Based on COGCC data from 2008 to 2011, assumed that about 16 times as much produced water from active wells relative to condensate

Uncontrolled VOC Emission Factors for Condensate Tanks

Applicable to Garfield, Mesa, Rio Blanco, Moffat Counties*	10	lb/bbl

**The uncontrolled VOC emissions factor from Oil and Gas Exploration and Regulation Requirement Fact Sheet, Colorado Department of Public Health and Environment, Air Pollution Control Division, January, 2009.*
http://www.cdphe.state.co.us/ap/sbap/SBAPoilgastankguidance.pdf

Flash Gas Weight Fractions

CO2 Fraction in Flash Gas	%wt	2
CH4 Fraction in Flash Gas	%wt	9
VOC Fraction in Flash Gas	%wt	58
VOC Molecular weight in Flash gas	lb/lb-mol	36

Condensate Truck Load-out

True vapor pressure of liquid loaded, pounds per square inch absolute (psia)	5.2
Mode of Operation	submerged loading: dedicated normal service

Produced Water and Condensate Truck Traffic

Construction Site Destination	Vehicle		Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/BBL OR Round Trips/Year/well
	Type	Class			
Produced Condensate Hauling	Haul Truck (200 bbl)	HDDV	15	4	0.005
Water Hauling	Haul Truck (130 bbl)	HDDV	35	20	70.19

Based on 50% of the water production being hauled. BLM Coalbed Methane Emissions Calculator. Received from BLM March 2012

Ops_RoadMaint Maintenance Traffic

Activity	Vehicle		Total Miles Traveled Per Well	Avg. Vehicle Speed (mph)
	Type	Class		
Road Maintenance	Pickup Truck	LDDV	18	15

Compressor_Engines Compressor Engines

Type of Compressors / Pumps	Rate (Hp)	# Units per Well	Annual Compression (Hp)	Operating Hours/Year
Wellhead Compressor Engines	45	0.1	4	6,778
Lateral Compressor Engines	212	0.02	5	8,760

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comp_main_Traffic — Compressor Station Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Compressor Station
Compressor Maintenance	Pickup Truck	13	855

Reclaim-RdsWells — Well Pad Reclamation

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Well
Road and Well Pad Reclamation	Pickup Truck	13	1,110

Others Traffic — Other Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/Year/well
Fuel Hauling	HDDV	15	7	0.6

Heaters and Flaring — Heaters

Wellsite Heaters	Heater Rating (MMBtu/hr)	Fraction of the year heating	hr/yr	No.of Units per Well
Heaters	0.83	0.57	4964	1
Reboilers	0.67	0.53	4599	1

Ops Dehy	Dehydrators	
Uncontrolled VOC Emissions (tons/mscf)	**Uncontrolled CH4 Emissions (tons/mscf)**	**Uncontrolled CO2 Emissions (tons/mscf)**
2.51E-06	4.03E-06	3.15E-07

Data updated from White River Air Quality Technical Support Document, URS, 2012

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APPENDIX C-2

Shale Gas Well
Calculator Inputs by Source Category

Note: Yellow highlights indicate that inputs were obtained from the Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012. All inputs except those from the Bull Mountain Emission Inventory are noted. Green highlights indicate that inputs were obtained from the data from Bull Mountain Emission Inventory Aug, 2013

Gas Analysis & Venting	Speciated Sales Gas Analysis
Gas Component	Mole Fraction (%)
Methane C1	90.150
Ethane C2	1.960
Nitrogen	0.160
Water	0.000
Carbon Dioxide	6.660
Nitrous Oxide	0.000
Hydrogen Sulfide	0.000
Propane C3	0.520
i-Butane i-C4	0.120
n-Butane n-C4	0.100
i-Pentane iC5	0.060
n-Pentane nC5	0.030
Hexanes+ C6+	0.128
Heptanes C7	0.000
Octanes+	0.000
Benzene	0.036
Ethylbenzene	0.002
n-Hexane n-C6	0.000
Toluene	0.047
2,2,4-Trimethylpentane	0.000
Xylenes	0.017
Helium	0.010
O2	0.000

*The full gas composition did not include BTEX and n-hexane components. These were included by adding separately provided BTEX and n-hexane mole fractions to the composition above and subtracting the corresponding mole fractions from the hexanes+ component.

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Cn_HEq_Exh Construction/Drilling/Completion Equipment

Construction Equipment

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/Well Pad**	HP Range
Well Pad	Haul Truck	250	3	40	8	13	300
	Trackhoe	250	1	40	8	13	300
	Dozer	250	2	40	8	13	300
	Grader	250	1	40	8	13	300
	Compactor	250	1	40	8	13	300
	Water Truck	250	1	40	8	13	300
Well Pad Access Road	Dozer	250	2	40	8	10	300
	Grader	250	1	40	8	10	300
	Trackhoe	250	1	40	8	10	300
	Haul Truck	250	3	40	8	10	300
Pipeline	Dozer	250	1	40	10	10	300
	Grader	250	1	40	10	10	300
	Trackhoe	250	1	40	10	10	300
	Bending Mach	250	1	40	10	10	300
	Sideboom	250	1	40	10	10	300
	Utility Tractor	250	1	40	10	10	300

**Includes pad reclamation associated activity

Construction Site	Equipment Type	2011 Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Well Pad	For all Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Well Pad Access Road	For all Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Pipeline	For all Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00

Source: EPA NONROADS 2008a
[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Drilling

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range for Efs
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	1200	1	40	24	35	2270010010	Tier 2	>1200

Construction Site	Equipment Type	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Source: EPA Federal Tier Standards
[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Completion/Fracing

Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range
Completion Equipment	1230	1	40	7	1	2270010010	Tier 2	>1200
Fracing Equipment	12000	1	85	24	1	2270010010	Tier 2	>1200
Refracing Equipment	1500	4	97	1	3	2270010010	Tier 2	>1200

Grand Junction Field Office Air Quality Technical Support Document, ENVIRON, 2012
Data updated from White River Air Quality Technical Support Document, URS, 2012 (Fracing Equipment), and from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012 (Completion)

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Equipment Type	Capacity (hp)	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Completion Equipment	1230	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Fracing Equipment	12000	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Refracing Equipment	1500	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002

Source: EPA Federal Tier Standards

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Fracing frequency per spud	1
Refracing Frequency per Year per Well	0.25

Cn_CV_Exh Construction Traffic Exhaust

Well Pad and Access Road Construction Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well Pad/ Year
	Type	Class		
Well Pad and Access Road Construction Traffic	Semi Trucks	HDDV	16	164
	Pickup Trucks	LDDT	16	40
Pipeline Construction	Semi Trucks	HDDV	16	35
	Pickup Trucks	LDDT	16	48

Drilling/Completion/Fracing Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/activity/ Year
	Type	Class		
Drilling Traffic	Semi Trucks	HDDV	16	917
	Pickup Trucks	LDDT	16	274
Rig Hauling	Semi Trucks	HDDV	16	1
Rig Move Drilling Traffic	Semi Trucks	HDDV	16	90
	Pickup Trucks	LDDT	16	42
Well Completion & Testing	Semi Trucks	HDDV	16	84
	Pickup Trucks	LDDT	16	74

Cn_HEq_FDust Construction Traffic Dust

Area Disturbed for Oil Wells	Avg. Disturbed Acres per wellpad	Construction Days
Well Pad	3.75	15
Well Pad Access Road and Pipeline Construction	1.8	8

Road and Pipeline Construction, (Pipeline Percentage of Acreage)	6%

Ops_Well WO Workovers

Construction Equipment

Activity	Equipment Type	Capacity (hp)	# of Operating Hours/Day	# of Operating Days/Well	Load Factor	Well Workover Frequency per Year	NONROAD SCC
Well Workover	Workover Equipment	500	10	7	43	0.5	2270010010

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Tier Level	HP Range for Efs	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O[a]
Tier 2	600-750	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Traffic

Activity	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well/ Year
	Type	Class		
Well Workover	WO Rig	HDDV	4.1	0.6
	Haul Truck	HDDV	4.1	1.3
	Pickup Truck	LDDT	4.1	6.4

blowdown	Blowdown Venting		
Type	Control Efficiency (%)	Volume of gas vented per blowdown Uncontrolled (MCF)	Frequency of Blowdown per well per year
Blowdown	0%	0.81	3.4

Data updated from White River Air Quality Technical Support Document, URS, 2012

well completion	Completion Venting
Type	Total volume of gas during completion (mcf)
All completions	1,000

Recompletion	Recompletion Venting		
Type	Control Efficiency (%)	Volume of gas vented per well per recompletion Uncontrolled (MCF)	No. of recompletion per well per year
Recompletion	0%	30	50%

Compressor_Venting	Compressor Venting			
Type	**Control Efficiency (%)**	**Volume of gas vented per start-up or shutdown Uncontrolled (MCF)**	**Frequency of Start-up per well per year**	**Frequency of Shutdown per well per year**
Compressor Shutdown	0%	10	1	1

Wellhead Fugitives	Wellhead Fugitive Devices, Pneumatic Devices, and Pneumatic Pumps

Fugitive Devices

component	Ave. # in Gas Service	Ave. # in Liquid service	Ave. # in High Oil service	Ave. # in Water/Oil Service
valves	49	14	0	3
pump seals	2	1	0	0
others	46	0	0	0
connectors	0	0	0	0
flanges	13	8	0	1
open-ended lines	6	2	0	0

Pneumatic Pumps

Type	Gallons/yr/pump	SCF/Gallon	Number of Pump
Pneumatic Pumps	91	118	1

Pneumatic Devices

Device	Number of Devices / well	Lo-Bleed Rate (cfh)
Liquid level controller	2	6
Pressure controller	1	6
Valve controllers	2.0	6
Liquid level controller	0.1	6

Data updated from Colorado River Valley Air Quality Technical Support Document, URS, 2012

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WaterInjection_ Pumps_Exh	Water Injection Pumps

Type	Capacity (hp)	# of Units per well	Avg. Load Factor (%)	# of Operating Hours	Equipment Category	2011 Emission Factors (g/hp-hr)								
						VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Water Injection Pumps	347	0.09	47	2920	Pumps	0.13	0.59	2.14	0.10	0.10	0.00	227.95	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Misc_Engines_Exh	Miscellaneous Engines

Construction Site	Capacity (hp)	# of Units per Well	Fraction of wells to be served by Miscellaneous engine	Avg. Load Factor (%)	# of Operating Hours/Well	Equipment Category
Misc. Engines (wellsite water pumps)	19	1	1	47%	8760	Misc. Engines

HP Range	2011 Emission Factors (g/hp-hr)								
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
25	0.27	1.68	8.16	0.04	0.04	0.00	557.28	0.01	0.00

Source: Emission factors for NOx and VOC from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine. Emission factors for CO, PM10 and PM2.5 and HAPs from AP-42, Volume I, Fifth Edition, Table 3.2-1.

Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

Condensate Tanks & Traffic	Condensate Tanks
Type	***Base Year Assumptions***
Condensate	1. All Condensate Throughput Sent Tanks
	2. Average Condensate Truck Haulout of 200 bbl/load
Produced Water	3. All Water Throughput Sent Tanks
	4. Average Water Truck Haulout of 100 bbl/load
	5. Based on COGCC data from 2008 to 2011, assumed that about 16 times as much produced water from active wells relative to condensate

Uncontrolled VOC Emission Factors for Condensate Tanks

Applicable to Garfield, Mesa, Rio Blanco, Moffat Counties*	10	lb/bbl

**The uncontrolled VOC emissions factor from Oil and Gas Exploration and Regulation Requirement Fact Sheet, Colorado Department of Public Health and Environment, Air Pollution Control Division, January, 2009.*
http://www.cdphe.state.co.us/ap/sbap/SBAPoilgastankguidance.pdf

Flash Gas Weight Fractions

CO2 Fraction in Flash Gas	%wt	2
CH4 Fraction in Flash Gas	%wt	9
VOC Fraction in Flash Gas	%wt	58
VOC Molecular weight in Flash gas	lb/lb-mol	36

Condensate Truck Load-out

True vapor pressure of liquid loaded, pounds per square inch absolute (psia)	5.2
Mode of Operation	submerged loading: dedicated normal service

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Produced Water and Condensate Truck Traffic

Construction Site Destination	Vehicle		Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/BBL OR Round Trips/Year/well
	Type	Class			
Produced Condensate Hauling	Haul Truck (200 bbl)	HDDV	15	4	0.005
Water Hauling	Haul Truck (130 bbl)	HDDV	15	4	70.19

Based on 50% of the water production being hauled. BLM Coalbed Methane Emissions Calculator. Received from BLM March 2012

Ops_RoadMaint Maintenance Traffic

Activity	Vehicle		Total Miles Traveled Per Well	Avg. Vehicle Speed (mph)
	Type	Class		
Road Maintenance	Pickup Truck	LDDV	18	15

Compressor_Engines Compressor Engines

Type of Compressors / Pumps	Rate (Hp)	# Units per Well	Annual Compression (Hp)	Operating Hours/Year
Wellhead Compressor Engines	45	0.1	4	6,778
Lateral Compressor Engines	212	0.02	5	8,760

comp_main_Traffic — Compressor Station Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Compressor Station
Compressor Maintenance	Pickup Truck	13	107

Reclaim-RdsWells — Well Pad Reclamation

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Well
Road and Well Pad Reclamation	Pickup Truck	15	416

Others Traffic — Other Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/Year/well
Fuel Hauling	HDDV	15	7	7

Heaters and Flaring — Heaters

Wellsite Heaters	Heater Rating (MMBtu/hr)	Fraction of the year heating	hr/yr	No.of Units per Well
Heaters	0.23	0.17	1460	3
Reboilers	0.25	0.50	4380	1

The Bull Mountain Emission Inventory estimated emissions from one separator heater with 0.125 mmbtu/hr heater rating,4380 hours /year and 4 tank heaters with 0.25 mmbtu/hr heater rating and 730 hours/year. For this project, weighted average of separator heater and tank heaters data were used to estimate heater emissions.

Ops Dehy — Dehydrators

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Uncontrolled VOC Emissions (tons/mscf)	Uncontrolled CH4 Emissions (tons/mscf)	Uncontrolled CO2 Emissions (tons/mscf)
1.72E-06	2.24E-06	2.91E-06

APPENDIX C-3

Coalbed Natural Gas Well
Calculator Inputs by Source Category

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Note: Yellow highlights indicate that inputs were obtained from theBLM Coalbed Methane Emissions Calculator. Received from BLM March 2012. All inputs taken from other sources are noted.

Gas Analysis & Venting	Speciated Sales Gas Analysis
Gas Component	Mole Fraction (%)
Methane C1	97.913
Ethane C2	0.000
Nitrogen	1.173
Water	0.000
Carbon Dioxide	0.851
Nitrous Oxide	0.000
Hydrogen Sulfide	0.000
Propane C3	0.063
i-Butane i-C4	0.000
n-Butane n-C4	0.000
i-Pentane iC5	0.000
n-Pentane nC5	0.000
Hexanes C6	0.000
Heptanes C7	0.000
Octanes+	0.000
Benzene	0.000
Ethylbenzene	0.000
n-Hexane n-C6	0.000
Toluene	0.000
2,2,4-Trimethylpentane	0.000
Xylenes	0.000

Cn_HEq_Exh Construction/Drilling/Completion Equipment

Construction Equipment

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/Well Pad	Equipment Category	HP Range
Well Pad	Construction Equipment	200	2	80	12	3	Other Construction Equipment	300
Well Pad Access Road	Construction Equipment	200	1	80	4	1	Other Construction Equipment	300
Pipeline	Construction Equipment	200	2	80	10	2	Other Construction Equipment	300

Construction Site	Equipment Type	2011 Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Well Pad	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Well Pad Access Road	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Pipeline	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Drilling

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range for Efs
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	400	3	77	24	3	2270010010	Tier 2	300-600

Construction Site	Equipment Type	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O[a]
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Source: EPA Federal Tier Standards

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

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Completion/Fracing

Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range
Completion Equipment	400	1	50	10	5	2270010010	Tier 2	300-600
Fracing Equipment	-	-	-	-	-	-	-	-
Refracing Equipment	-	-	-	-	-	-	-	-

Equipment Type	Capacity (hp)	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Completion Equipment	400	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Fracing Equipment	-	-	-	-	-	-	-	-	-	-
Refracing Equipment	-	-	-	-	-	-	-	-	-	-

Source: EPA Federal Tier Standards

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Fracing frequency per spud	-
Refracing Frequency per Year per Well	-

Cn_CV_Exh	Construction Traffic Exhaust

Well Pad and Access Road Construction Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well Pad/ Year
	Type	Class		
Well Pad and Access Road Construction Traffic	Semi Trucks	HDDV	20	3
	Pickup Trucks	LDDT	20	3
Pipeline Construction	Semi Trucks	HDDV	20	8
	Pickup Trucks	LDDT	20	8

Drilling/Completion/Fracing Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/activity/ Year
	Type	Class		
Drilling Traffic	Semi Trucks	HDDV	20	2
	Pickup Trucks	LDDT	20	20
Rig Hauling	Semi Trucks	HDDV	20	12
Rig Move Drilling Traffic	Semi Trucks	HDDV	20	1
	Pickup Trucks	LDDT	20	16
Well Completion & Testing	Semi Trucks	HDDV	20	36
	Pickup Trucks	LDDT	20	12

Cn_HEq_FDust	Construction Traffic Dust

Area Disturbed for Oil Wells	Avg. Disturbed Acres per wellpad	Construction Days
Well Pad	6.00	2.50
Well Pad Access Road and Pipeline Construction	4.9	2.17

Road and Pipeline Construction, (Pipeline Percentage of Acreage)	6%

Data from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012

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Ops_Well WO Workovers

Construction Equipment

Activity	Equipment Type	Capacity (hp)	# of Operating Hours/Day	# of Operating Days/Well	Load Factor	Well Workover Frequency per Year	NONROAD SCC
Well Workover	Workover Equipment	400	10	2	43	0.08	2270010010

Data from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012

Tier Level	HP Range for Efs	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	$N2O^a$
Tier 2	600-750	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Traffic

Activity	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well/ Year
	Type	Class		
Well Workover	WO Rig	HDDV	20	1
	Haul Truck	HDDV	20	1
	Pickup Truck	LDDT	20	2

blowdown Blowdown Venting

Type	Control Efficiency (%)	Volume of gas vented per blowdown Uncontrolled (MCF)	Frequency of Blowdown per well per year
Blowdown	0%	200	2.0

Data updated from White River Air Quality Technical Support Document, URS, 2012

well completion Completion Venting

Type	Total volume of gas during completion (mcf)
All completions	1,000

Data updated from White River Air Quality Technical Support Document, URS, 2012

Recompletion | Recompletion Venting

Type	Control Efficiency (%)	Volume of gas vented per well per recompletion Uncontrolled (MCF)	No. of recompletion per well per year
Recompletion	0%	1000	1%

Data updated from White River Air Quality Technical Support Document, URS, 2012

Compressor_Venting | Compressor Venting

Type	Control Efficiency (%)	Volume of gas vented per start-up or shutdown Uncontrolled (MCF)	Frequency of Start-up per well per year	Frequency of Shutdown per well per year
Compressor Shutdown	0%	10	1	1

Data from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012

Wellhead Fugitives | Wellhead Fugitive Devices, Pneumatic Devices, and Pneumatic Pumps

Fugitive Devices

component	Ave. # in Gas Service	Ave. # in Liquid service	Ave. # in High Oil service	Ave. # in Water/Oil Service
valves	49	14	0	3
pump seals	2	1	0	0
others	46	0	0	0
connectors	0	0	0	0
flanges	13	8	0	1
open-ended lines	6	2	0	0

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Pneumatic Pumps

Type	Gallons/yr/pump	SCF/Gallon	Number of Pump
Pneumatic Pumps	-	-	-

Pneumatic Devices

Device	Number of Devices / well	Lo-Bleed Rate (cfh)
Liquid level controller	5	6
Transducer	5	6

WaterInjection_Pumps_Exh Water Injection Pumps

Type	Capacity (hp)	# of Units per well	Avg. Load Factor (%)	# of Operating Hours	Equipment Category	2011 Emission Factors (g/hp-hr)								
						NOxa	PM10b	SO2b	COa	VOCa	PM2.5b	CO2c	CH4c	N2Oc
Water Injection Pumps	34	1	47	8760	Pumps	2.14	0.10	0.0045	0.59	0.13	0.10	227.95	0.002	0.002

a Source: assume compressors will comply with NSPS 40 CFR part 60 subpart JJJJ (same rates as Colorado Regulation 7)
b Source: EPA, AP-42 Section 3.2 Natural Gas Fired Reciprocating Engines
c EPA Mandatory GHG Reporting, Part 98, Subpart C, Tables C-1 and C-2.

Condensate Tanks & Traffic	Condensate Tanks
Type	***Base Year Assumptions***
Condensate	1. All Condensate Throughput Sent Tanks
	2. Average Condensate Truck Haulout of 200 bbl/load
Produced Water	3. All Water Throughput Sent Tanks
	4. Average Water Truck Haulout of 100 bbl/load
	5. Based on COGCC data from 2008 to 2011, assumed that about 16 times as much produced water from active wells relative to condensate

Uncontrolled VOC Emission Factors for Condensate Tanks

Applicable to Garfield, Mesa, Rio Blanco, Moffat Counties*	10	lb/bbl

**The uncontrolled VOC emissions factor from Oil and Gas Exploration and Regulation Requirement Fact Sheet, Colorado Department of Public Health and Environment, Air Pollution Control Division, January, 2009.*
http://www.cdphe.state.co.us/ap/sbap/SBAPoilgastankguidance.pdf

Flash Gas Weight Fractions

CO2 Fraction in Flash Gas	%wt	2
CH4 Fraction in Flash Gas	%wt	9
VOC Fraction in Flash Gas	%wt	58
VOC Molecular weight in Flash gas	lb/lb-mol	36

Condensate Truck Load-out

True vapor pressure of liquid loaded, pounds per square inch absolute (psia)	5.2
Mode of Operation	submerged loading: dedicated normal service

Produced Water and Condensate Truck Traffic

Construction Site Destination	Vehicle		Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/BBL OR Round Trips/Year/well
	Type	Class			
Produced Condensate Hauling	Haul Truck (200 bbl)	HDDV	30	20	0.0
Water Hauling	Haul Truck (130 bbl)	HDDV	35	20	70

Assumed 50% of the water production is hauled.

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Ops_RoadMaint Maintenance Traffic

Activity	Vehicle		Total Miles Traveled Per Well	Avg. Vehicle Speed (mph)
	Type	Class		
Road Maintenance	Pickup Truck	LDDV	1	15

comp_main_Traffic Compressor Station Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Compressor Station
Compressor Maintenance	Pickup Truck	35	2,920

Reclaim-RdsWells Well Pad Reclamation

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Well
Road and Well Pad Reclamation	Pickup Truck	30	28

Others Traffic Other Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/Year/well
Fuel Hauling	HDDV	15	14	1.0

Heaters and Flaring Heaters

Wellsite Heaters	Heater Rating (MMBtu/hr)	Fraction of the year heating	hr/yr	No.of Units per Well
Heaters	0.50	0.30	8760	1
Reboilers	3.00	0.30	8760	0.002

Data from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012

Ops Dehy Dehydrators

Uncontrolled VOC Emissions (tons/mscf)	Uncontrolled CH4 Emissions (tons/mscf)	Uncontrolled CO2 Emissions (tons/mscf)
1.26E-07	1.60E-05	0.00E+00

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APPENDIX C-4

Conventional Oil Well
Calculator Inputs by Source Category

Note: Yellow highlights indicate that inputs were obtained from the Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012. All inputs taken from other sources are noted.

Gas Analysis & Venting	Speciated Sales Gas Analysis
Gas Component	Mole Fraction (%)
Methane C1	81.012
Ethane C2	4.334
Nitrogen	6.718
Water	0.000
Carbon Dioxide	5.380
Nitrous Oxide	0.000
Hydrogen Sulfide	0.000
Propane C3	1.437
i-Butane i-C4	0.288
n-Butane n-C4	0.329
i-Pentane iC5	0.154
n-Pentane nC5	0.104
Hexanes C6	0.111
Heptanes C7	0.037
Octanes+	0.017
Benzene	0.004
Ethylbenzene	0.000
n-Hexane n-C6	0.068
Toluene	0.003
2,2,4-Trimethylpentane	0.001
Xylenes	0.002

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Cn_HEq_Exh Construction/Drilling/Completion Equipment

Construction Equipment

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/Well Pad	Equipment Category	HP Range
Well Pad	Construction Equipment	250	4	42	10	13	Other Construction Equipment	300
Well Pad Access Road	Construction Equipment	250	4	42	10	10	Other Construction Equipment	300
Pipeline	Construction Equipment	250	2	42	10	2	Other Construction Equipment	300

Construction Site	Equipment Type	2011 Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Well Pad	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Well Pad Access Road	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00
Pipeline	Construction Equipment	0.18	0.78	2.32	0.15	0.15	0.01	316.19	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Drilling

Construction Site	Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range for Efs
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	2469	2	40	24	17	2270010010	Tier 2	>1200

Construction Site	Equipment Type	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N2O[a]
Rig-up, Drilling, and Rig-down	Drilling Equipment - Avg	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Source: EPA Federal Tier Standards

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Completion/Fracing

Equipment Type	Capacity (hp)	# of Units	Avg. Load Factor (%)	# of Operating Hours/Day	# of Operating Days/activity	NONROAD SCC	Tier Level	HP Range
Completion Equipment	1230	1	40	7	1	2270010010	Tier 2	>1200
Fracing Equipment	12000	1	85	24	1	2270010010	Tier 2	>1200
Refracing Equipment	1500	4	97	1	3	2270010010	Tier 2	>1200

Grand Junction Field Office Air Quality Technical Support Document, ENVIRON, 2012
Data updated from White River Air Quality Technical Support Document, URS, 2012 (Fracing Equipment), and from Uncompahgre Field Office Air Quality Technical Support Document, ENVIRON, 2012 (Completion)

Equipment Type	Capacity (hp)	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Completion Equipment	1230	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Fracing Equipment	12000	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002
Refracing Equipment	1500	0.26	2.61	4.53	0.15	0.15	0.11	523	0.004	0.002

Source: EPA Federal Tier Standards
[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Fracing frequency per spud	1
Refracing Frequency per Year per Well	0.05

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Cn_CV_Exh Construction Traffic Exhaust

Well Pad and Access Road Construction Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well Pad/ Year
	Type	Class		
Well Pad and Access Road Construction Traffic	Semi Trucks	HDDV	4	80
	Pickup Trucks	LDDT	4	30
Pipeline Construction	Semi Trucks	HDDV	5	16
	Pickup Trucks	LDDT	5	18

Drilling/Completion/Fracing Traffic

Construction Site Destination	Vehicle		Round Trip Distance (miles)	# of Round Trips/activity/ Year
	Type	Class		
Drilling Traffic	Semi Trucks	HDDV	4	136
	Pickup Trucks	LDDT	5	136
Rig Hauling	Semi Trucks	HDDV	5	1
Rig Move Drilling Traffic	Semi Trucks	HDDV	5	90
	Pickup Trucks	LDDT	5	42
Well Completion & Testing	Semi Trucks	HDDV	5	84
	Pickup Trucks	LDDT	5	74

Cn_HEq_FDust Construction Traffic Dust

Area Disturbed for Oil Wells	Avg. Disturbed Acres per wellpad	Construction Days
Well Pad	4.88	13
Well Pad Access Road and Pipeline Construction	9	10

Road and Pipeline Construction, (Pipeline Percentage of Acreage)	6%

Ops_Well WO Workovers

Construction Equipment

Activity	Equipment Type	Capacity (hp)	# of Operating Hours/Day	# of Operating Days/Well	Load Factor	Well Workover Frequency per Year	NONROAD SCC
Well Workover	Workover Equipment	638	9	6	43	0.08	2270010010

Tier Level	HP Range for Efs	Tier Emission Factors (g/hp-hr)								
		VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	$N2O^a$
Tier 2	600-750	0.26	2.61	4.53	0.15	0.15	0.11	530	0.004	0.002

Traffic

Activity	Vehicle		Round Trip Distance (miles)	# of Round Trips/Well/ Year
	Type	Class		
Well Workover	WO Rig	HDDV	4	4
	Haul Truck	HDDV	4	12
	Pickup Truck	LDDT	4	20

blowdown Blowdown Venting

Type	Control Efficiency (%)	Volume of gas vented per blowdown Uncontrolled (MCF)	Frequency of Blowdown per well per year
Blowdown	0%	0.75	3.0

Data updated from White River Air Quality Technical Support Document, URS, 2012

well completion Completion Venting

Type	Total volume of gas during completion (mcf)
All completions	1,000

Data updated from White River Air Quality Technical Support Document, URS, 2012

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Recompletion | Recompletion Venting

Type	Control Efficiency (%)	Volume of gas vented per well per recompletion Uncontrolled (MCF)	No. of recompletion per well per year
Recompletion	0%	1000	1%

Data updated from White River Air Quality Technical Support Document, URS, 2012

Compressor_Venting | Compressor Venting

Type	Control Efficiency (%)	Volume of gas vented per start-up or shutdown Uncontrolled (MCF)	Frequency of Start-up per well per year	Frequency of Shutdown per well per year
Compressor Shutdown	0%	10	1	1

Wellhead Fugitives | Wellhead Fugitive Devices, Pneumatic Devices, and Pneumatic Pumps

Fugitive Devices

component	Ave. # in Gas Service	Ave. # in Liquid service	Ave. # in High Oil service	Ave. # in Water/Oil Service
valves	49	14	0	3
pump seals	2	1	0	0
others	46	0	0	0
connectors	0	0	0	0
flanges	13	8	0	1
open-ended lines	6	2	0	0

Pneumatic Pumps

Type	Gallons/yr/pump	SCF/Gallon	Number of Pump
Pneumatic Pumps	91	118	1

Pneumatic Devices

Device	Number of Devices / well	Lo-Bleed Rate (cfh)
Liquid level controller	2	6
Pressure controller	1	6

Valve controllers	2.0	6
Liquid level controller	0.1	6
	Data updated from Colorado River Valley Air Quality Technical Support Document, URS, 2012	

WaterInjection_Pumps_Exh — Water Injection Pumps

Type	Capacity (hp)	# of Units per well	Avg. Load Factor (%)	# of Operating Hours	Equipment Category	2011 Emission Factors (g/hp-hr)								
						VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
Water Injection Pumps	347	0.06	47	2920	Pumps	0.13	0.59	2.14	0.10	0.10	0.00	227.95	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Misc_Engines_Exh — Miscellaneous Engines

Construction Site	Capacity (hp)	# of Units per Well	Fraction of wells to be served by Miscellaneous engine	Avg. Load Factor (%)	# of Operating Hours/Well	Equipment Category
Misc. Engines	118	1	1	50	4380	Misc. Engines

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HP Range	2011 Emission Factors (g/hp-hr)								
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O[a]
175	0.12	0.41	1.59	0.10	0.10	0.00	227.98	0.00	0.00

Source: EPA NONROADS 2008a

[a]N2O factor source: 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17. 130,500 Btu/gallon, 2545 Btu/hp-hr.

Condensate Tanks & Traffic	Condensate Tanks
Type	***Base Year Assumptions***
Condensate	1. All Condensate Throughput Sent Tanks
	2. Average Condensate Truck Haulout of 200 bbl/load
Produced Water	3. All Water Throughput Sent Tanks
	4. Average Water Truck Haulout of 100 bbl/load
	5. Based on COGCC data from 2008 to 2011, assumed that about 16 times as much produced water from active wells relative to condensate

Uncontrolled VOC Emission Factors for Condensate Tanks

Applicable to Garfield, Mesa, Rio Blanco, Moffat Counties*	1.6	lb/bbl

**The uncontrolled VOC emissions factor from the BLM crude oil emission calculator*

Flash Gas Weight Fractions

CO2 Fraction in Flash Gas	%wt	2
CH4 Fraction in Flash Gas	%wt	9
VOC Fraction in Flash Gas	%wt	58
VOC Molecular weight in Flash gas	lb/lb-mol	36

Condensate Truck Load-out

True vapor pressure of liquid loaded, pounds per square inch absolute (psia)	5.2
Mode of Operation	submerged loading: dedicated normal service

Produced Water and Condensate Truck Traffic

Construction Site Destination	Vehicle		Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/BBL OR Round Trips/Year/well
	Type	Class			

Produced Condensate Hauling	Haul Truck (200 bbl)	HDDV	15	4	0.005
Water Hauling	Haul Truck (130 bbl)	HDDV	35	20	70.19

Based on 50% of the water production being hauled. BLM Coalbed Methane Emissions Calculator. Received from BLM March 2012

Ops_RoadMaint Maintenance Traffic

Activity	Vehicle		Total Miles Traveled Per Well	Avg. Vehicle Speed (mph)
	Type	Class		
Road Maintenance	Pickup Truck	LDDV	18	15

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Compressor_Engines Compressor Engines

Type of Compressors / Pumps	Rate (Hp)	# Units per Well	Annual Compression (Hp)	Operating Hours/Year
Wellhead Compressor Engines	45	0.1	4	6,778
Lateral Compressor Engines	212	0.02	5	8,760

comp_main_Traffic Compressor Station Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Compressor Station
Compressor Maintenance	Pickup Truck	13	855

Reclaim-RdsWells — Well Pad Reclamation

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Total Miles Traveled per Well
Road and Well Pad Reclamation	Pickup Truck	13	1,110

Others Traffic — Other Traffic

Activity	Vehicle Type	Avg. Vehicle Speed (mph)	Round Trip Distance (miles)	# of Round Trips/Year/well
Fuel Hauling	HDDV	15	7	0.6

Heaters and Flaring — Heaters

Wellsite Heaters	Heater Rating (MMBtu/hr)	Fraction of the year heating	hr/yr	No.of Units per Well
Heaters	0.83	0.57	4964	1
Reboilers	0.67	0.53	4599	1

Ops Dehy — Dehydrators

Uncontrolled VOC Emissions (tons/mscf)	Uncontrolled CH4 Emissions (tons/mscf)	Uncontrolled CO2 Emissions (tons/mscf)
2.51E-06	4.03E-06	3.15E-07

Data updated from White River Air Quality Technical Support Document, URS, 2012

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APPENDIX C-5

Midstream Emissions by Field Office and Facility

Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
Grand Junction	Garfield	BARGATH LLC - CRAWFORD TRAIL	208.02	71.50	80.14	6.262	6.262	0.430
Grand Junction	Garfield	CHEVRON USA INC - PICEANCE BASIN CENTRAL	91.80	58.22	52.00	1.938	1.938	0.174
Grand Junction	Garfield	ENCANA (WEST) - HAY CANYON	0.00	23.74	0.00	0.000	0.000	0.000
Grand Junction	Garfield	NATIONAL FUEL CORP. - BAXTER FACILITY	18.50	2.90	4.40	0.081	0.081	0.005
Grand Junction	Garfield	OXY USA WTP LP - CONN CREEK GAS	132.80	35.28	19.13	0.010	0.010	1.760
Grand Junction	Garfield	PUBLIC SERVICE CO BAXTER STATION	58.04	7.56	67.23	0.230	0.230	0.028
Grand Junction	Garfield	SOURCEGAS DBA ROCKY MTN -DEBEQUE C S	28.48	7.97	65.49	0.591	0.591	0.013
Grand Junction	Garfield	TRANSCOLORADO GAS - CONN CREEK	2.10	0.32	0.28	0.040	0.040	0.000
Grand Junction	Garfield	WPX ENERGY RKY MTN, LLC - TRAIL RIDGE CS	31.70	8.00	5.85	0.073	0.073	0.004
Grand Junction	Mesa	ASPEN OPERATING, LLC - SINK CREEK C.S.	49.15	2.81	2.72	0.052	0.000	0.003
Grand Junction	Mesa	AXIA ENERGY - TAYLOR COMPRESSOR STATION	32.75	54.32	72.48	0.000	0.000	0.000
Grand Junction	Mesa	BADGER MIDSTREAM SERVICES - BADGER WGP	50.02	31.39	54.43	1.074	1.074	0.075
Grand Junction	Mesa	BLACK HILLS MIDSTREAM - HORSESHOE CANYON	35.30	66.14	26.50	0.570	0.570	0.035
Grand Junction	Mesa	COLLBRAN VALLEY GAS - ANDERSON GULCH	127.63	68.11	60.97	4.369	4.366	0.120
Grand Junction	Mesa	COLLBRAN VALLEY GAS GATHERING- CVG #2	192.66	112.89	49.33	0.000	0.000	0.000
Grand Junction	Mesa	COLORADO FUEL MANUFACTURERS, INC.	33.20	87.51	21.75	0.975	0.975	1.077
Grand Junction	Mesa	DELTA PETROLEUM CORP - MVS CS AND HCPWRF	4.70	61.90	22.10	0.000	0.000	0.000
Grand Junction	Mesa	ENCANA - PLATEAU CREEK	19.74	11.24	12.78	0.800	0.800	0.008
Grand Junction	Mesa	ETC CANYON PIPELINE - BAR X C.S.	12.20	20.48	14.20	0.376	0.376	0.023
Grand Junction	Mesa	ETC CANYON PIPELINE - PREMIER BAR X	73.32	7.82	5.09	1.340	1.340	0.020
Grand Junction	Mesa	ETC CANYON PIPELINE -PREMIER DEBEQUE	76.04	43.37	55.85	0.998	0.998	0.060
Grand Junction	Mesa	FRAM OPERATING - REEDER MESA CS	74.46	48.70	100.70	0.011	0.011	0.081
Grand Junction	Mesa	NATL FUEL CORP	22.07	7.55	8.85	0.307	0.307	0.015
Grand Junction	Mesa	OXY USA - BRUSH CREEK COMPRESSOR	86.20	61.31	57.57	0.443	0.443	0.027

Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
		STATION						
Grand Junction	Mesa	OXY USA INC. - East Plateau CS	77.67	32.42	48.93	1.772	1.772	0.106
Grand Junction	Mesa	PICEANCE ENERGY - BRUTON C.S.	12.13	11.03	17.19	0.640	0.640	0.000
Grand Junction	Mesa	PICEANCE ENERGY LLC - HAWXHURST RANCH	8.64	23.32	17.26	0.000	0.000	0.000
Grand Junction	Mesa	PUBLIC SERVICE CO ASBURY STATION	26.78	10.67	43.32	0.110	0.110	0.007
Grand Junction	Mesa	PUBLIC SERVICE CO HUNTER CANYON STA	16.37	0.62	1.99	0.200	0.200	0.003
Grand Junction	Mesa	SOURCEGAS DBA ROCKY MTN NG - COLLBRAN	22.82	12.50	19.72	0.460	0.260	0.010
Grand Junction	Mesa	TRANSCOLORADO GAS TR CO - WHITEWATER CS	12.37	5.73	4.65	0.360	0.360	0.020
Kremmling	Grand	PUBLIC SERVICE CO WILLIAMS FORK STATION	12.40	0.40	0.75	0.006	0.006	0.001
Little Snake	Moffat	AGAVE ENERGY - BIL HOL GULCH TREATING	8.58	32.79	17.16	0.040	0.040	0.000
Little Snake	Moffat	ARGALI EXPLORATION COMPANY	45.59	0.98	3.27	0.080	0.080	0.005
Little Snake	Moffat	CUSTOM ENERGY CONSTRUCTION INC BUCK PEAK	4.73	3.47	1.92	0.008	0.008	0.001
Little Snake	Moffat	J W OPERATING CO - GREAT DIVIDE C.S.	10.80	7.79	4.84	0.000	0.000	0.000
Little Snake	Moffat	J-W OPERATING COMPANY -SAND HILLS	28.40	13.25	2.10	0.000	0.000	0.000
Little Snake	Moffat	MERIT ENERGY - SANDWASH C.S.	19.34	7.96	12.90	0.000	0.000	0.000
Little Snake	Moffat	MERRION OIL & GAS - BLUE GRAVEL	34.41	0.11	35.37	0.070	0.070	0.000
Little Snake	Moffat	OVERLAND PASS - MIDPOINT STATION	0.00	8.60	0.00	0.000	0.000	0.000
Little Snake	Moffat	QEP FIELD SERVICES - EAST HIAWATHA CS	58.72	31.42	51.98	0.602	0.592	0.036
Little Snake	Moffat	QEP FIELD SERVICES - LION C.S.	14.30	7.63	14.30	0.475	0.475	0.029
Little Snake	Moffat	QEP FIELD SERVICES - W HIAWATHA C. S.	32.76	31.87	15.09	0.380	0.380	0.000
Little Snake	Moffat	QUESTAR - SKULL CREEK DEW POINT PLANT	56.46	87.10	41.61	0.364	0.359	0.022
Little Snake	Moffat	QUESTAR PIPELINE CO STATE LINE COMP STA	13.41	0.10	1.69	0.320	0.320	0.012
Little Snake	Moffat	QUESTAR PIPELINE PWFC SOUTHSIDE 2/MUSSER	38.54	2.15	1.91	0.070	0.070	0.004
Little Snake	Moffat	ROCKIES EXPRESS PIPELINE - BIG HOLE CS	12.60	4.01	9.96	0.690	0.690	1.290
Little Snake	Moffat	SAMSON RESOURCES - SHELL CREEK GAS COND	31.29	1.03	12.70	0.227	0.170	0.003

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Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
Little Snake	Moffat	WYOMING INTERSTATE - SNAKE RIVER C.S.	64.97	7.58	77.43	4.489	4.489	2.177
Little Snake	Rio Blanco	CHEVRON USA - WILSON CREEK GAS PLT	4.94	90.10	10.32	0.008	0.007	1.000
Tres Rios	Archuleta	PUBLIC SERVICE CO - PAGOSA SPRINGS STA	0.10	0.03	0.10	0.000	0.000	0.000
Tres Rios	Dolores	MID-AMERICA PIPELINE CO DOVE CR STA	28.22	2.46	34.37	0.460	0.460	0.010
Tres Rios	Dolores	QEP ENERGY CO - SPARGO NO 2	36.60	0.30	32.70	0.049	0.049	0.003
Tres Rios	Dolores	TRANSCOLORADO GAS TRANS - DOLORES C.S.	17.49	17.58	10.71	0.580	0.580	0.030
Tres Rios	Dolores	WILLIAMS FIELD SERV- JOHNSON AC #1 FACIL	21.20	30.90	13.48	0.413	0.413	0.025
Tres Rios	La Plata	BP AMERICA - PINON COMPRESSOR FACILITY	85.00	24.40	79.60	1.460	1.460	0.088
Tres Rios	Montezuma	KINDER MORGAN CO2 CO. -YELLOW JACKET H10	9.00	2.13	1.96	0.422	0.162	17.000
Tres Rios	Montezuma	MID-AMERICA PIPELINE CO DOLORES STA	25.27	2.20	30.77	0.460	0.460	0.010
Tres Rios	Montezuma	NORTHWEST PIPELINE CORP PLEASANT VIEW	94.73	0.51	7.52	1.142	1.142	1.535
Tres Rios	Montezuma	TRANSCOLORADO GAS TRANS - MANCOS CS	5.97	1.50	2.88	0.150	0.150	0.000
Tres Rios	Montezuma	WILLIAMS FIELD SERVICES- KOSKIE-BRUMLEY	19.41	21.95	6.47	0.443	0.443	0.027
Tres Rios	San Miguel	PATARA MIDSTREAM - ANDY'S MESA	117.46	68.20	43.64	1.963	1.963	0.118
Tres Rios	San Miguel	PATARA MIDSTREAM - HAMILTON CREEK CS	50.86	24.21	27.75	0.426	0.415	0.036
Tres Rios	San Miguel	PATARA OIL & GAS - DOUBLE EAGLE PLANT	57.03	10.35	18.44	0.081	0.081	0.005
Uncompahgre	Gunnison	GUNNISON ENERGY-RAGGED MOUNTAIN C.S.	64.44	55.32	135.60	0.689	0.687	0.053
Uncompahgre	Montrose	TRANSCOLORADO GAS - OLATHE C.S.	12.37	0.51	12.37	0.320	0.320	0.150
Uncompahgre	Montrose	TRANSCOLORADO GAS TRANS - REDVALE CS	17.23	9.42	5.78	0.680	0.680	0.030
Uncompahgre	San Miguel	ROCKY MOUNTAIN NATURAL GAS - NORWOOD C.S	12.20	7.30	25.20	0.213	0.213	0.013
CRV (in Roan Plt.)	Garfield	BARGATH - RABBIT BRUSH C.S.	177.82	64.32	35.31	5.53	5.53	0.30
CRV (in Roan Plt.)	Garfield	BARGATH LLC - ANVIL POINTS CS	131.00	52.60	40.00	2.77	2.77	0.17
CRV (in Roan Plt.)	Garfield	BARGATH LLC - CLOUGH CS	100.80	82.90	40.80	1.98	1.98	0.12
CRV (in Roan Plt.)	Garfield	BARGATH LLC - COTTONWOOD POINT CS	132.60	86.40	132.60	2.27	2.27	0.14
CRV (in Roan Plt.)	Garfield	BARGATH LLC - HAYBARN	54.80	20.30	33.92	2.12	2.12	0.09
CRV (in Roan Plt.)	Garfield	BARGATH LLC - HAYES GULCH	115.80	58.05	34.20	2.35	2.35	0.14

Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
CRV (in Roan Plt.)	Garfield	BARGATH LLC - HEATH CS	220.13	83.88	64.88	4.51	4.51	0.28
CRV (in Roan Plt.)	Garfield	BARGATH LLC - PARACHUTE	299.21	146.32	161.67	9.68	9.68	0.39
CRV (in Roan Plt.)	Garfield	BARGATH LLC - RIFLE STATION	2.80	33.90	2.40	0.00	0.00	0.00
CRV (in Roan Plt.)	Garfield	BARGATH LLC - RILEY CS	115.80	62.40	34.05	2.35	2.35	0.14
CRV (in Roan Plt.)	Garfield	BARGATH LLC - ROAN CLIFFS GAS PLANT	94.60	47.60	66.70	1.80	1.80	0.10
CRV (in Roan Plt.)	Garfield	BARGATH LLC - RULISON CS	116.72	63.71	34.91	0.00	0.00	0.00
CRV (in Roan Plt.)	Garfield	BARGATH LLC - SHARRARD CS	131.84	60.94	64.95	2.98	2.98	0.16
CRV (in Roan Plt.)	Garfield	BARGATH LLC - WEBSTER HILL	172.95	82.59	61.67	5.29	5.29	0.29
CRV (in Roan Plt.)	Garfield	BARGATH LLC - WHEELER GULCH CS	96.50	49.20	28.50	1.90	1.90	0.07
CRV (in Roan Plt.)	Garfield	BARGATH, LLC - WASATCH COMPRESSOR YARD	86.00	82.19	35.60	1.56	1.56	0.09
CRV (in Roan Plt.)	Garfield	ENCANA - RIFLE BOOSTER STATION	43.52	41.73	48.75	1.33	1.32	0.00
CRV (in Roan Plt.)	Garfield	ENCANA (WEST) - MIDDLE FORK C.S.	0.00	422.07	20.10	0.00	0.00	0.00
CRV (in Roan Plt.)	Garfield	ETC CANYON PIPELINE - RIFLE C.S.	238.88	92.78	137.93	4.73	4.73	0.26
CRV (in Roan Plt.)	Garfield	HALLIBURTON ENERGY SVCS	2.66	0.21	0.57	0.18	0.18	0.18
CRV (in Roan Plt.)	Garfield	PUBLIC SERVICE CO - RIFLE GAS PLANT	16.99	18.29	3.33	0.55	0.55	0.01
CRV (in Roan Plt.)	Garfield	WILLIAMS PRODUCTION RMT CO - WEBSTER CS	10.46	2.10	10.46	0.00	0.00	0.00
CRV (in Roan Plt.)	Garfield	WILLIAMS RMT CO - DOE COMPRESSOR STATION	33.10	12.90	3.70	0.09	0.09	0.01
CRV (not in Roan Plt.)	Garfield	ANTERO RES - CASTLE SPRINGS CENTRAL	18.30	6.11	18.30	0.25	0.25	0.02
CRV (not in Roan Plt.)	Garfield	ANTERO RESOURCES - HUNTER MESA COMP STAT	26.14	38.03	31.97	0.00	0.00	0.00
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - CALLAHAN C.S.	102.00	64.45	34.20	2.35	2.35	0.14
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - GRAND VALLEY	94.61	68.70	92.70	1.48	1.41	0.56
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - HOOVER EXPRESS	132.00	71.69	39.00	2.70	2.28	0.18
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - JANGLES	68.00	43.55	22.80	1.55	1.55	0.09
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - STARKEY GULCH CS	132.00	50.95	39.00	2.69	2.69	0.16
CRV (not in Roan Plt.)	Garfield	BARGATH LLC - UNA COMPRESSOR STATION	155.05	65.53	51.83	3.60	3.18	0.45

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Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
CRV (not in Roan Plt.)	Garfield	BARGATH, LLC - HYRUP PROD FACILITY	237.62	124.37	82.05	5.77	5.69	0.92
CRV (not in Roan Plt.)	Garfield	BILL BARRETT - BAILEY COMPRESSOR STATION	166.37	193.20	69.30	7.77	7.77	0.44
CRV (not in Roan Plt.)	Garfield	BILL BARRETT CORP - MAMM CREEK CS	292.06	78.37	227.95	15.53	4.44	0.71
CRV (not in Roan Plt.)	Garfield	ENCANA OIL & GAS - HIGH MESA COMP STATIO	99.45	262.57	16.69	1.99	1.99	0.12
CRV (not in Roan Plt.)	Garfield	ENTERPRISE PRODUCTS OP- JACKRABBIT CS	194.08	141.91	134.34	0.01	0.01	0.00
CRV (not in Roan Plt.)	Garfield	ETC CANYON PIPELINE - HOLMES MESA CS	123.73	101.83	82.67	0.00	0.00	0.00
CRV (not in Roan Plt.)	Garfield	ETC CANYON PIPELINE - WALLACE CREEK CS	0.00	18.00	0.00	0.00	0.00	0.00
CRV (not in Roan Plt.)	Garfield	GRAND RIVER GATH - EAST MAMM CREEK CS	138.21	162.64	80.27	3.86	3.86	0.23
CRV (not in Roan Plt.)	Garfield	GRAND RIVER GATHERING - HUNTER MESA CS	148.32	181.24	87.43	0.00	0.00	0.00
CRV (not in Roan Plt.)	Garfield	GRAND RIVER GATHERING - ORCHARD CS	63.20	34.61	20.90	1.07	1.07	0.06
CRV (not in Roan Plt.)	Garfield	GRAND RIVER GATHERING - PUMBA CS	98.35	122.76	140.49	3.56	3.56	0.21
CRV (not in Roan Plt.)	Garfield	NOBLE ENERGY - RULISON STATION	38.84	4.01	14.68	0.84	0.84	0.05
CRV (not in Roan Plt.)	Garfield	PETROLEUM DEVELOPMENT - GARDEN GULCH	26.20	42.03	39.14	1.49	1.49	0.09
CRV (not in Roan Plt.)	Mesa	OXY USA - ALKALI CREEK C.S.	71.56	64.13	56.49	0.04	0.04	0.00
CRV (not in Roan Plt.)	Mesa	SG INTERESTS I - DIVIDE CREEK TREATMENT	39.91	24.14	33.43	1.48	1.48	0.11
White River Valley	Garfield	HUNTER RIDGE - CDP K22 496	29.57	31.78	56.86	0.00	0.00	0.00
White River Valley	Garfield	HUNTER RIDGE ENERGY - STORY GULCH C.S.	155.07	236.41	96.81	0.00	0.00	0.01
White River Valley	Rio Blanco	BARGATH LLC - BLACK SULPHUR CREEK	31.90	0.35	52.20	0.13	0.13	0.01
White River Valley	Rio Blanco	BARGATH LLC - GREASEWOOD CS	96.28	45.82	28.38	1.96	1.96	0.12
White River Valley	Rio Blanco	BARGATH LLC - RYAN GULCH GAS	192.00	127.15	27.30	5.64	5.64	0.34
White River Valley	Rio Blanco	BARGATH LLC - SAGEBRUSH GAS PROCESSING	157.28	44.81	117.04	3.46	3.04	0.20
White River Valley	Rio Blanco	CCES PICEANCE - BUCKSKIN MESA CFS-2	84.70	30.80	21.80	2.70	2.40	0.00
White River Valley	Rio Blanco	ENCANA OIL - EAST DRAGON TRAIL CS	34.66	22.93	41.55	0.53	0.53	0.03
White River Valley	Rio Blanco	ENCANA OIL & GAS - DRAGON TRAIL	431.04	99.33	174.57	13.91	13.89	0.23
White River Valley	Rio Blanco	ENCANA OIL & GAS - PARK CANYON WEST	48.83	40.99	31.73	0.43	0.43	0.03
White River Valley	Rio Blanco	ENCANA OIL & GAS (USA) INC - BULL FORK	39.53	56.80	12.12	0.00	0.00	0.00
White River Valley	Rio Blanco	ENCANA OIL & GAS (USA), INC. - CR 109 CS	2.81	1.03	2.53	0.04	0.04	0.00

Field Office	County	Facility Name	2011 Emissions (tons/year)					
			NOx	VOC	CO	PM10	PM2.5	SO2
White River Valley	Rio Blanco	ENCANA OIL & GAS (USA), INC. - HORSE DRA	10.23	5.93	5.73	0.22	0.22	0.01
White River Valley	Rio Blanco	ENCANA OIL & GAS (USA), INC.- W DRAGON T	60.19	37.96	48.30	0.54	0.54	0.03
White River Valley	Rio Blanco	ENCANA OIL & GAS (USA), INC-W DOUGLAS CR	32.20	97.11	32.20	3.34	3.34	0.07
White River Valley	Rio Blanco	ENTERPRISE GAS PROC - MEEKER GAS PLANT	138.73	317.66	254.06	26.40	26.40	205.27
White River Valley	Rio Blanco	ENTERPRISE GAS-PICEANCE DEV. PROJECT	93.18	208.64	112.70	4.54	4.54	21.83
White River Valley	Rio Blanco	ETC CANYON PIPELINE - N. DOUGLAS CREEK	72.17	54.12	83.19	1.82	0.45	0.10
White River Valley	Rio Blanco	ETC CANYON PIPELINE- CATHEDRAL C.S.	10.77	0.63	1.04	0.02	0.02	0.00
White River Valley	Rio Blanco	ETC CANYON PIPELINE-FOUNDATION CREEK	73.05	69.47	49.87	0.58	0.58	0.03
White River Valley	Rio Blanco	KINDER MORGAN TREATING - MEEKER PLANT	44.96	26.30	43.77	1.56	1.40	0.13
White River Valley	Rio Blanco	NORTHWEST PIPELINE CORP RANGELY STA	382.05	11.61	53.51	2.67	2.67	0.04
White River Valley	Rio Blanco	PICEANCE BASIN GAS GATH - FLETCHER PLANT	45.56	60.67	75.59	1.15	1.15	0.07
White River Valley	Rio Blanco	PUBLIC SERVICE CO GREASEWOOD STATION	24.41	0.17	21.51	0.05	0.05	0.00
White River Valley	Rio Blanco	QUESTAR PIPELINE CO - GREASEWOOD GULCH	51.56	22.50	9.20	2.32	2.32	0.13
White River Valley	Rio Blanco	ROCKY MOUNTAIN NAT GAS - PICEANCE	28.29	31.86	36.01	0.92	0.29	0.02
White River Valley	Rio Blanco	SOUTH-TEX - BASS YELLOW CREEK	14.59	54.91	12.26	0.00	0.00	0.00
White River Valley	Rio Blanco	WEST TEXAS - PICEANCE CREEK GP	61.67	52.39	52.63	1.04	1.03	0.06
White River Valley	Rio Blanco	WHITING OIL & GAS CORP-BOIES RANCH	32.04	37.48	23.06	1.47	1.47	0.09
White River Valley	Rio Blanco	WHITING OIL & GAS -JIMMY GULCH STATION	23.28	19.25	10.03	0.52	0.52	0.03
White River Valley	Rio Blanco	WILLIAMS FIELD - WILLOW CREEK GAS PLANT	199.84	109.89	218.90	37.61	36.90	71.75
White River Valley	Rio Blanco	XTO ENERGY, INC. - PICEANCE CREEK	89.96	91.71	90.02	7.12	6.79	7.85
White River Valley	Mesa	PIONEER NATURAL RES - CSP-3	24.40	5.50	23.09	0.42	0.42	0.02
Canyon Of The Ancients Nm	Montezuma	KINDER MORGAN CO2 CO. -HOVENWEEP CENTRAL	8.60	2.13	1.96	0.422	0.325	16.844

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APPENDIX C-6

EPA MOVES Emissions Factor by Field Office, County, and Year

Table F1. Field Office to Representative County On-road Emission Factor Cross-reference.

Field Office	County
Colorado River Valley	Garfield County
Kremmling Field Office	Grand County
Tres Rios Field Office	La Plata County
Grand Junction Field Office	Mesa County
Little Snake Field Office	Moffat County
Uncompahgre Field Office	Montrose County
White River Field Offices	Rio Blanco County

Table F2. On-road Light Duty and Heavy Duty Truck Emisison Factors by Representative County and by Project Year.

County	Year	Vehicle Type	Emission Rates (grams/mile)								
			VOC	CO	NOx	PM10	PM2.5	SO2	CO2	CH4	N2O
Garfield County	2011	Light Duty	1.02	12.80	1.49	0.05	0.03	0.01	491	0.05	0.03
Garfield County	2011	Heavy Duty	0.71	3.94	14.41	1.09	0.93	0.02	2403	0.03	0.00
Grand County	2011	Light Duty	1.04	13.58	1.50	0.06	0.04	0.01	495	0.06	0.03
Grand County	2011	Heavy Duty	0.73	4.04	14.69	1.09	0.93	0.02	2404	0.04	0.00
La Plata County	2011	Light Duty	0.99	12.58	1.48	0.05	0.03	0.01	490	0.05	0.03
La Plata County	2011	Heavy Duty	0.72	4.07	14.57	1.09	0.93	0.02	2404	0.04	0.00
Mesa County	2011	Light Duty	0.98	11.99	1.45	0.05	0.02	0.01	488	0.05	0.03
Mesa County	2011	Heavy Duty	0.71	3.99	14.28	1.09	0.93	0.02	2403	0.03	0.00
Moffat County	2011	Light Duty	1.00	12.78	1.47	0.05	0.03	0.01	492	0.05	0.03
Moffat County	2011	Heavy Duty	0.73	4.06	14.54	1.09	0.93	0.02	2404	0.04	0.00
Montrose County	2011	Light Duty	0.97	12.22	1.46	0.05	0.03	0.01	489	0.05	0.03
Montrose County	2011	Heavy Duty	0.72	4.07	14.44	1.09	0.93	0.02	2404	0.04	0.00
Rio Blanco County	2011	Light Duty	1.00	12.68	1.47	0.05	0.03	0.01	491	0.05	0.03
Rio Blanco County	2011	Heavy Duty	0.72	4.03	14.51	1.09	0.93	0.02	2404	0.04	0.00
Garfield County	2012	Light Duty	0.95	12.06	1.39	0.05	0.03	0.01	485	0.05	0.03
Garfield County	2012	Heavy Duty	0.64	3.54	12.74	0.98	0.83	0.02	2402	0.04	0.00
Grand County	2012	Light Duty	0.97	12.83	1.40	0.06	0.03	0.01	489	0.06	0.03
Grand County	2012	Heavy Duty	0.65	3.63	13.00	0.98	0.83	0.02	2404	0.04	0.00
La Plata County	2012	Light Duty	0.92	11.86	1.38	0.05	0.03	0.01	484	0.05	0.03
La Plata County	2012	Heavy Duty	0.65	3.65	12.89	0.98	0.83	0.02	2404	0.04	0.00
Mesa County	2012	Light Duty	0.91	11.28	1.35	0.05	0.02	0.01	481	0.04	0.03
Mesa County	2012	Heavy Duty	0.64	3.58	12.63	0.98	0.83	0.02	2403	0.04	0.00
Moffat County	2012	Light Duty	0.93	12.05	1.37	0.05	0.03	0.01	485	0.05	0.034

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County	Year	Vehicle Type	Emission Rates (grams/mile)								
			VOC	CO	NOx	PM10	PM2.5	SO2	CO2	CH4	N2O
Moffat County	2012	Heavy Duty	0.65	3.65	12.86	0.98	0.83	0.02	2404	0.04	0.003
Montrose County	2012	Light Duty	0.91	11.51	1.36	0.05	0.03	0.01	482	0.05	0.033
Montrose County	2012	Heavy Duty	0.65	3.66	12.77	0.98	0.83	0.02	2404	0.04	0.003
Rio Blanco County	2012	Light Duty	0.93	11.95	1.37	0.05	0.03	0.01	484	0.05	0.033
Rio Blanco County	2012	Heavy Duty	0.64	3.62	12.84	0.98	0.83	0.02	2404	0.04	0.004
Garfield County	2013	Light Duty	0.89	11.40	1.29	0.05	0.03	0.01	477	0.05	0.033
Garfield County	2013	Heavy Duty	0.56	3.15	11.19	0.87	0.72	0.02	2402	0.05	0.003
Grand County	2013	Light Duty	0.91	12.18	1.30	0.06	0.03	0.01	481	0.05	0.032
Grand County	2013	Heavy Duty	0.57	3.24	11.41	0.87	0.72	0.02	2404	0.05	0.004
La Plata County	2013	Light Duty	0.86	11.22	1.28	0.05	0.03	0.01	476	0.05	0.033
La Plata County	2013	Heavy Duty	0.57	3.26	11.32	0.87	0.72	0.02	2404	0.05	0.004
Mesa County	2013	Light Duty	0.85	10.66	1.26	0.05	0.02	0.01	473	0.04	0.033
Mesa County	2013	Heavy Duty	0.56	3.19	11.09	0.87	0.72	0.02	2403	0.05	0.003
Moffat County	2013	Light Duty	0.87	11.41	1.27	0.05	0.03	0.01	477	0.05	0.032
Moffat County	2013	Heavy Duty	0.57	3.25	11.30	0.87	0.72	0.02	2404	0.05	0.003
Montrose County	2013	Light Duty	0.84	10.88	1.26	0.05	0.03	0.01	474	0.04	0.030
Montrose County	2013	Heavy Duty	0.57	3.27	11.22	0.87	0.72	0.02	2404	0.05	0.003
Rio Blanco County	2013	Light Duty	0.87	11.31	1.27	0.05	0.03	0.01	477	0.05	0.030
Rio Blanco County	2013	Heavy Duty	0.57	3.23	11.27	0.87	0.72	0.02	2404	0.05	0.004
Garfield County	2014	Light Duty	0.83	10.78	1.19	0.05	0.03	0.01	468	0.05	0.031
Garfield County	2014	Heavy Duty	0.49	2.78	9.83	0.78	0.63	0.02	2402	0.05	0.003
Grand County	2014	Light Duty	0.85	11.55	1.20	0.06	0.03	0.01	472	0.05	0.030
Grand County	2014	Heavy Duty	0.50	2.86	10.03	0.78	0.63	0.02	2404	0.06	0.004
La Plata County	2014	Light Duty	0.80	10.61	1.18	0.05	0.03	0.01	468	0.04	0.030
La Plata County	2014	Heavy Duty	0.50	2.89	9.95	0.78	0.63	0.02	2404	0.06	0.004
Mesa County	2014	Light Duty	0.79	10.06	1.16	0.05	0.02	0.01	465	0.04	0.030
Mesa County	2014	Heavy Duty	0.49	2.82	9.75	0.78	0.63	0.02	2403	0.05	0.003
Moffat County	2014	Light Duty	0.81	10.80	1.18	0.05	0.03	0.01	469	0.05	0.029
Moffat County	2014	Heavy Duty	0.50	2.88	9.93	0.78	0.63	0.02	2404	0.06	0.003
Montrose County	2014	Light Duty	0.79	10.28	1.17	0.05	0.02	0.01	466	0.04	0.028
Montrose County	2014	Heavy Duty	0.50	2.89	9.86	0.78	0.63	0.02	2404	0.05	0.003
Rio Blanco County	2014	Light Duty	0.81	10.70	1.18	0.05	0.03	0.01	468	0.05	0.028
Rio Blanco County	2014	Heavy Duty	0.50	2.86	9.91	0.78	0.63	0.02	2404	0.05	0.004
Garfield County	2015	Light Duty	0.77	10.17	1.10	0.05	0.03	0.01	460	0.04	0.028
Garfield County	2015	Heavy Duty	0.43	2.44	8.61	0.69	0.55	0.02	2402	0.06	0.003
Grand County	2015	Light Duty	0.79	10.95	1.11	0.06	0.03	0.01	463	0.05	0.027
Grand County	2015	Heavy Duty	0.44	2.53	8.79	0.69	0.55	0.02	2404	0.06	0.004
La Plata County	2015	Light Duty	0.75	10.02	1.09	0.05	0.03	0.01	459	0.04	0.027

County	Year	Vehicle Type	Emission Rates (grams/mile)								
			VOC	CO	NOx	PM10	PM2.5	SO2	CO2	CH4	N2O
La Plata County	2015	Heavy Duty	0.44	2.55	8.72	0.69	0.55	0.02	2404	0.06	0.004
Mesa County	2015	Light Duty	0.74	9.49	1.07	0.05	0.02	0.01	456	0.04	0.027
Mesa County	2015	Heavy Duty	0.43	2.48	8.54	0.69	0.55	0.02	2403	0.06	0.003
Moffat County	2015	Light Duty	0.76	10.21	1.09	0.05	0.03	0.01	460	0.04	0.026
Moffat County	2015	Heavy Duty	0.44	2.54	8.70	0.69	0.55	0.02	2404	0.06	0.003
Montrose County	2015	Light Duty	0.74	9.70	1.07	0.05	0.02	0.01	457	0.04	0.025
Montrose County	2015	Heavy Duty	0.44	2.55	8.64	0.69	0.55	0.02	2404	0.06	0.003
Rio Blanco County	2015	Light Duty	0.76	10.11	1.08	0.05	0.03	0.01	459	0.04	0.025
Rio Blanco County	2015	Heavy Duty	0.44	2.52	8.68	0.69	0.55	0.02	2404	0.06	0.004
Garfield County	2016	Light Duty	0.71	9.52	1.01	0.05	0.02	0.01	450	0.04	0.026
Garfield County	2016	Heavy Duty	0.37	2.14	7.54	0.62	0.47	0.02	2402	0.06	0.003
Grand County	2016	Light Duty	0.73	10.29	1.02	0.06	0.03	0.01	453	0.05	0.025
Grand County	2016	Heavy Duty	0.38	2.22	7.70	0.62	0.47	0.02	2404	0.06	0.003
La Plata County	2016	Light Duty	0.69	9.38	1.00	0.05	0.03	0.01	449	0.04	0.025
La Plata County	2016	Heavy Duty	0.38	2.24	7.63	0.62	0.47	0.02	2404	0.06	0.004
Mesa County	2016	Light Duty	0.68	8.86	0.98	0.05	0.02	0.01	446	0.04	0.025
Mesa County	2016	Heavy Duty	0.37	2.18	7.47	0.62	0.47	0.02	2403	0.06	0.003
Moffat County	2016	Light Duty	0.70	9.57	1.00	0.05	0.03	0.01	450	0.04	0.024
Moffat County	2016	Heavy Duty	0.38	2.24	7.62	0.62	0.47	0.02	2404	0.06	0.003
Montrose County	2016	Light Duty	0.68	9.08	0.99	0.05	0.02	0.01	448	0.04	0.023
Montrose County	2016	Heavy Duty	0.38	2.25	7.56	0.62	0.47	0.02	2404	0.06	0.003
Rio Blanco County	2016	Light Duty	0.70	9.47	1.00	0.05	0.03	0.01	450	0.04	0.023
Rio Blanco County	2016	Heavy Duty	0.38	2.21	7.60	0.62	0.47	0.02	2404	0.06	0.004
Garfield County	2017	Light Duty	0.67	9.10	0.93	0.05	0.02	0.01	441	0.04	0.024
Garfield County	2017	Heavy Duty	0.32	1.87	6.58	0.55	0.41	0.02	2402	0.06	0.003
Grand County	2017	Light Duty	0.68	9.87	0.94	0.06	0.03	0.01	444	0.04	0.023
Grand County	2017	Heavy Duty	0.33	1.96	6.72	0.55	0.41	0.02	2404	0.06	0.003
La Plata County	2017	Light Duty	0.64	8.97	0.92	0.05	0.03	0.01	440	0.04	0.023
La Plata County	2017	Heavy Duty	0.33	1.98	6.67	0.55	0.41	0.02	2404	0.06	0.004
Mesa County	2017	Light Duty	0.64	8.46	0.90	0.04	0.02	0.01	437	0.04	0.023
Mesa County	2017	Heavy Duty	0.32	1.92	6.52	0.55	0.41	0.02	2403	0.06	0.003
Moffat County	2017	Light Duty	0.65	9.16	0.92	0.05	0.03	0.01	441	0.04	0.022
Moffat County	2017	Heavy Duty	0.33	1.97	6.65	0.55	0.41	0.02	2404	0.06	0.003
Montrose County	2017	Light Duty	0.63	8.67	0.91	0.05	0.02	0.01	438	0.04	0.021
Montrose County	2017	Heavy Duty	0.33	1.98	6.60	0.55	0.41	0.02	2404	0.06	0.003
Rio Blanco County	2017	Light Duty	0.65	9.06	0.92	0.05	0.03	0.01	440	0.04	0.021
Rio Blanco County	2017	Heavy Duty	0.33	1.95	6.64	0.55	0.41	0.02	2403	0.06	0.003
Garfield County	2018	Light Duty	0.62	8.72	0.86	0.05	0.02	0.01	432	0.04	0.022

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County	Year	Vehicle Type	Emission Rates (grams/mile)								
			VOC	CO	NOx	PM10	PM2.5	SO2	CO2	CH4	N2O
Garfield County	2018	Heavy Duty	0.28	1.64	5.75	0.49	0.35	0.02	2402	0.06	0.003
Grand County	2018	Light Duty	0.64	9.49	0.87	0.05	0.03	0.01	436	0.04	0.021
Grand County	2018	Heavy Duty	0.28	1.72	5.88	0.49	0.35	0.02	2404	0.07	0.003
La Plata County	2018	Light Duty	0.60	8.60	0.85	0.05	0.02	0.01	431	0.04	0.021
La Plata County	2018	Heavy Duty	0.28	1.74	5.83	0.49	0.35	0.02	2404	0.07	0.004
Mesa County	2018	Light Duty	0.60	8.09	0.83	0.04	0.02	0.01	429	0.04	0.021
Mesa County	2018	Heavy Duty	0.28	1.68	5.70	0.49	0.35	0.02	2403	0.06	0.003
Moffat County	2018	Light Duty	0.61	8.79	0.85	0.05	0.03	0.01	432	0.04	0.021
Moffat County	2018	Heavy Duty	0.28	1.73	5.82	0.49	0.35	0.02	2404	0.07	0.003
Montrose County	2018	Light Duty	0.59	8.30	0.84	0.05	0.02	0.01	430	0.04	0.020
Montrose County	2018	Heavy Duty	0.28	1.74	5.77	0.49	0.35	0.02	2404	0.07	0.003
Rio Blanco County	2018	Light Duty	0.61	8.69	0.85	0.05	0.03	0.01	432	0.04	0.020
Rio Blanco County	2018	Heavy Duty	0.28	1.71	5.80	0.49	0.35	0.02	2403	0.07	0.003
Garfield County	2019	Light Duty	0.58	8.37	0.79	0.05	0.02	0.01	424	0.04	0.020
Garfield County	2019	Heavy Duty	0.24	1.43	5.04	0.44	0.30	0.02	2402	0.06	0.003
Grand County	2019	Light Duty	0.59	9.14	0.80	0.05	0.03	0.01	427	0.04	0.019
Grand County	2019	Heavy Duty	0.24	1.51	5.15	0.44	0.30	0.02	2404	0.07	0.003
La Plata County	2019	Light Duty	0.56	8.26	0.78	0.05	0.02	0.01	423	0.04	0.020
La Plata County	2019	Heavy Duty	0.24	1.53	5.11	0.44	0.30	0.02	2404	0.07	0.004
Mesa County	2019	Light Duty	0.56	7.76	0.77	0.04	0.02	0.01	421	0.03	0.020
Mesa County	2019	Heavy Duty	0.24	1.47	5.00	0.44	0.30	0.02	2403	0.07	0.003
Moffat County	2019	Light Duty	0.57	8.45	0.78	0.05	0.03	0.01	424	0.04	0.019
Moffat County	2019	Heavy Duty	0.24	1.52	5.10	0.44	0.30	0.02	2404	0.07	0.003
Montrose County	2019	Light Duty	0.56	7.97	0.77	0.05	0.02	0.01	422	0.03	0.018
Montrose County	2019	Heavy Duty	0.24	1.53	5.06	0.44	0.30	0.02	2404	0.07	0.003
Rio Blanco County	2019	Light Duty	0.57	8.35	0.78	0.05	0.03	0.01	424	0.04	0.018
Rio Blanco County	2019	Heavy Duty	0.24	1.50	5.09	0.44	0.30	0.02	2403	0.07	0.003
Garfield County	2020	Light Duty	0.55	8.06	0.73	0.05	0.02	0.01	416	0.04	0.018
Garfield County	2020	Heavy Duty	0.20	1.26	4.43	0.40	0.26	0.02	2402	0.07	0.003
Grand County	2020	Light Duty	0.56	8.84	0.74	0.05	0.03	0.01	420	0.04	0.018
Grand County	2020	Heavy Duty	0.21	1.34	4.54	0.40	0.26	0.02	2403	0.07	0.003
La Plata County	2020	Light Duty	0.53	7.96	0.73	0.05	0.02	0.01	416	0.04	0.018
La Plata County	2020	Heavy Duty	0.21	1.36	4.50	0.40	0.26	0.02	2404	0.07	0.003
Mesa County	2020	Light Duty	0.53	7.47	0.71	0.04	0.02	0.01	413	0.03	0.018
Mesa County	2020	Heavy Duty	0.20	1.30	4.40	0.40	0.26	0.02	2403	0.07	0.003
Moffat County	2020	Light Duty	0.54	8.15	0.73	0.05	0.03	0.01	417	0.04	0.018
Moffat County	2020	Heavy Duty	0.21	1.35	4.49	0.40	0.26	0.02	2404	0.07	0.003
Montrose County	2020	Light Duty	0.52	7.67	0.72	0.05	0.02	0.01	414	0.03	0.017

County	Year	Vehicle Type	Emission Rates (grams/mile)								
			VOC	CO	NOx	PM10	PM2.5	SO2	CO2	CH4	N2O
Montrose County	2020	Heavy Duty	0.21	1.36	4.46	0.40	0.26	0.02	2404	0.07	0.003
Rio Blanco County	2020	Light Duty	0.54	8.05	0.72	0.05	0.03	0.01	416	0.04	0.017
Rio Blanco County	2020	Heavy Duty	0.21	1.33	4.48	0.40	0.26	0.02	2403	0.07	0.003
Garfield County	2021	Light Duty	0.52	7.80	0.68	0.05	0.02	0.01	409	0.04	0.017
Garfield County	2021	Heavy Duty	0.17	1.12	3.94	0.36	0.23	0.02	2402	0.07	0.003
Grand County	2021	Light Duty	0.53	8.57	0.69	0.05	0.03	0.01	413	0.04	0.017
Grand County	2021	Heavy Duty	0.18	1.19	4.04	0.36	0.23	0.02	2403	0.07	0.003
La Plata County	2021	Light Duty	0.50	7.70	0.67	0.05	0.02	0.01	409	0.03	0.017
La Plata County	2021	Heavy Duty	0.18	1.21	4.00	0.36	0.23	0.02	2404	0.07	0.003
Mesa County	2021	Light Duty	0.50	7.22	0.66	0.04	0.02	0.01	406	0.03	0.017
Mesa County	2021	Heavy Duty	0.18	1.16	3.91	0.36	0.23	0.02	2403	0.07	0.003
Moffat County	2021	Light Duty	0.51	7.89	0.67	0.05	0.03	0.01	410	0.03	0.016
Moffat County	2021	Heavy Duty	0.18	1.21	3.99	0.36	0.23	0.02	2404	0.07	0.003
Montrose County	2021	Light Duty	0.49	7.42	0.66	0.05	0.02	0.01	407	0.03	0.016
Montrose County	2021	Heavy Duty	0.18	1.21	3.96	0.36	0.23	0.02	2404	0.07	0.003
Rio Blanco County	2021	Light Duty	0.51	7.79	0.67	0.05	0.02	0.01	409	0.03	0.016
Rio Blanco County	2021	Heavy Duty	0.18	1.19	3.98	0.36	0.23	0.02	2403	0.07	0.003

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APPENDIX D

CARMMS Technical Memorandum
Draft CARMMS Coal and Uranium/Vanadium Mining Emissions
June 21, 2013

ENVIRON

June 21, 2013

MEMORANDUM

To: Chad Meister and Forrest Cook, BLM Colorado State Office
From: John Grant ENVIRON, Jim Zapert Carter Lake Consulting, Ralph Morris ENVIRON
Subject: Draft CARMMS Coal and Uranium/Vanadium Mining Emissions

INTRODUCTION

The purpose of this document is to explain the sources of emissions and methodology used to compile Western Colorado coal and uranium/vanadium mining emissions. Emissions from coal and uranium/vanadium mines under federal jurisdiction have been developed for the Western Colorado Air Resource Management Modeling Study (West-CARMMS). The primary sources used to compile these emissions are Environmental Assessments and Environmental Impact Statements developed for individual mines as well as 2011 reported emissions from Colorado Department of Public Health (CDPHE) Air Pollutant Emission Notices (APENs).

These mining emissions will be used in baseline and future-year emissions inventories as estimates of coal and uranium mining emissions under Task 2 for the Western Colorado Bureau of Land Management (BLM) planning areas (see Figure 1-1).

Emissions were not estimated for mines not under federal jurisdiction; emissions from these mines in the West-CARMMS will be taken from existing inventory estimates. To avoid double counting in air quality modeling, emissions were not estimated for on-road or off-road mobile sources.

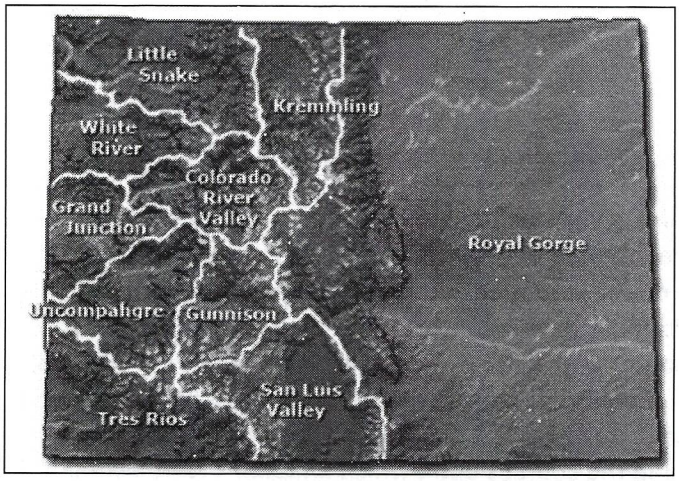

Figure 1-1. Colorado Field Office Planning Areas.

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Pollutants

The emissions include estimates of criteria air pollutants (CAPs), greenhouse gases (GHGs), and hazardous air pollutants (HAPs) as follows:

- Criteria Pollutants
  - Carbon monoxide (CO)
  - Nitrogen oxides (NO_X)
  - Particulate matter less than or equal to 10 microns in diameter (PM_{10})
  - Particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$)
  - Sulfur dioxide (SO_2)
  - Volatile Organic Compounds (VOCs)
- Greenhouse Gases
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
- Hazardous Air Pollutants (HAPs)

While lead (pb) is a criteria pollutant, emissions of lead in the BLM western Colorado planning areas are expected to be extremely low and are therefore not included in this analysis.

HAP emissions were estimated for each emissions source.

Anthropogenic greenhouse gas emission inventories typically include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Fluorinated gases are not expected to be emitted in appreciable quantities by any category considered in this emission inventory and were therefore not included in this analysis.

Temporal

The calculators estimate annual emissions associated coal and uranium/vanadium mining. Per the West-CARMMS scope of work, base year emissions are estimated for 2011 with annual emission forecasts to 2021.

EMISSIONS ESTIMATION

Coal Mining

Annual base year emissions from coal mining were estimated for the coal mines in Western Colorado under federal jurisdiction. As mentioned above, the mining emission estimates are not inclusive of mobile sources to avoid double counting with the mobile sources emissions in the air quality modeling inventory. Additionally, lacking any data upon which to base emission estimates, we have not accounted for potential growth in Kremmling Field Office surface coal mining in Jackson County where the U.S..Geological Survey (USGS) has defined the McCallum area as a known recoverable coal resource area. Table 1 provides a listing of the Western Colorado mines under BLM jurisdiction and the sources upon which emissions were estimated for those mines. Appendix D-1 provides emission estimates by year and mine.

Table 1. Coal mine emissions estimation methodology.

Mine Name (Field Office)	Emission Estimation Methodology
Book Cliffs Area (Grand Junction)	**Base Year 2011:** Non-operational, zero emissions. **Future Years 2012-2021:** Per the Grand Junction Field Office Draft Regional Management Plant Air Quality Technical Support document (ENVIRON, 2012a), the Book Cliffs area is assumed to have three additional new mines with estimated annual production of 2,000,000 tons/year in the future. Mines are assumed to come online in 2017, 2019, and 2021. Emissions for each mine are assumed to be similar to the Red Cliff Mine Environmental Impact Statement estimates (BLM, 2009) with a scalar of 25% to account for smaller production.
McClane (Grand Junction)	**Base Year 2011:** Non-operational, zero emissions. **Future Years 2012-2021:** Per the Grand Junction Field Office Draft Regional Management Plant Air Quality Technical Support document (ENVIRON, 2012a), the McClane mine is assumed operational from 2015 to 2021. Emissions are assumed to be at pre-December 2010 levels (BLM, 2012a).
Oak Mesa Area (Uncompahgre)	**Base Year 2011:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2012-2021:** Assume emissions are at levels estimated in the following Environmental Assessment documents: Bowie #2 (BLM, 2012c), West Elk (BLM, 2012d), and Elk Creek (BLM, 2012f) and that emissions remain constant in the 2012-2021 period. The Uncompahgre Coal Resource and Development Potential Report (BLM, 2010), indicated that Somerset Coal Field production is likely to remain stable at recent levels into the future (ENVIRON, 2012b).
King (Tres Rios)	**Base Year 2011:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2012-2021:** Assume emissions at permitted levels in future years (CDPHE, 2011).
Foidel (Kremmling)	**Base Year 2011, Future Year 2012:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2013-2021:** Assume emissions are at levels estimated in the draft Environment Assessment (BLM 2013a).
Deserado (White River)	**Base Year 2011:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2012-2021:** Assume emissions are at levels estimated in the draft Environment Assessment (BLM 2013b).
Trapper (Little Snake)	**Base Year 2011:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2012-2021:** Assume emissions remain constant at CDPHE 2011 APEN levels.
Colowyo (Little Snake)	**Base Year 2011:** CDPHE APEN emissions (CDPHE, 2013). **Future Years 2012-2021:** Assume emissions remain constant at CDPHE 2011 APEN levels.
Sage Creek (Little Snake)	**Base Year 2011:** Non-operational, zero emissions. **Future Years 2012-2021:** Assume mining begins in 2013 with constant emissions to 2021 at levels estimated in the draft Environment Assessment (BLM 2013c).

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Uranium/Vanadium Mining

Annual emissions from uranium/vanadium mining were estimated according to the number of mines constructed and producing in a given year combined with estimates of emissions per mine from discrete emission producing activities: wind erosion, fugitive dust, and stationary engines. Activity inputs such as the equipment operation, tons of material processed, and disturbed area were taken primarily from the Whirlwind Mine EA (BLM, 2008). The estimated number of future uranium mines in operation in the Grand Junction Field Office and Uncompahgre Field Office were taken from ENVIRON (2012a) and ENVIRON (2012b) and are shown in Table 2. Emissions results are presented in Appendix D-2.

Table 2. Schedule of uranium/vanadium mines in production.

Year	Uranium Mining Facilities, GJFO (source: ENVIRON, 2012a)	Uranium Mining Facilities, UFO (source: ENVIRON, 2012b)
2011-2012	0	0
2013	1	1
2014	3	3
2015	5	5
2016	7	7
2017	9	9
2018	10	10
2019	11	11
2020	12	12
2021	13	13
2022	14	14
2023	15	15
2024	16	16
2025	17	17
2026	18	18
2027	19	19
2028	20	20
2029	20	20
2030	20	20

Wind Erosion

Wind erosion dust emissions were estimated based on AP-42 guidance for the estimation of emissions from industrial wind erosion (USEPA, 2006b) based on Equation 1:

$$E_{dust,i} = \frac{k \times P \times M \times N}{907{,}185} \qquad \text{Equation (1)}$$

where:

$E_{dust,i}$ are dust emissions for pollutant i from construction wind erosion [ton/mine]
k is the particle size multiplies [0.5 for PM_{10} and 0.075 from $PM_{2.5}$]
P is the erosion potential [g/m^2]
M is the number of disturbed acres [m^2/pad]
N is the number of disturbances
907,185 is a mass unit conversion [g/ton]

The erosions potential is a function of the wind friction velocity, as shown in Equation 2 and 3:

$$P = 58 \times (u^* - u_t)^2 + 25(u^* - u_t) \qquad \text{Equation (2)}$$

where:

u^* is the friction velocity (m/s)

u_t is the threshold friction velocity (m/s)

$$P = 0 \quad for \quad (u^* \leq u_t) \qquad \text{Equation (3)}$$

Friction velocity estimates (u*) were made by multiplying the average annual fastest wind speed from Uncompahgre, Colorado from 1947 to 1979 by 0.053 per AP-42 guidance (USEPA, 2006b).

Fugitive Dust

Fugitive dust emissions from ventilation and surface facilities were taken from Whirlwind Mine Environmental Assessment (BLM, 2008) permit not-to-exceed values.

Stationary Engines

This category refers to emissions associated with stationary internal combustion engines used in uranium mining. Emission estimates for NOx were taken from the Whirlwind Mine Environmental Assessment permit not-to-exceed values (BLM, 2008). Emission estimates were not available in the Whirlwind Mine Environmental Assessment (BLM, 2008) for other pollutants. Emissions of other pollutants were estimated based on the EPA NONROAD2008a model (USEPA, 2009b) except for N_2O which was estimated based on the 2009 API O&G GHG Methodologies Compendium, Tables 4-13 and 4-17 (API, 2009).

Emissions on per piece of equipment were estimated according to Equation 74:

$$E_{engine,i} = \frac{EF_i \times HP \times LF \times t_{event} \times n}{907{,}185} \qquad \text{Equation (4)}$$

where:

E_{engine} are emissions of pollutant *i* [ton/equipment]

EF_i is the emissions factor of pollutant *i* [g/hp-hr]

HP is the horsepower [hp]

LF is the load factor

t_{event} is the number of hours the engine is used [hr/pad]

907,185 is the mass unit conversion [g/ton]

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APPENDIX D-1

Coal Mining Emissions

Table A1. 2011 to 2021 Coal Mine Emissions for mines in Western Colorado under federal jurisdiction (tons/year).

Year	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/year)
Book Cliffs (Grand Junction Field Office)												
2011	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	1	3	20	6	2	0	2,616	21,278	0	0	449,496	407,891
2018	1	3	20	6	2	0	2,616	21,278	0	0	449,496	407,891
2019	2	5	40	12	4	0	5,231	42,556	0	0	898,992	815,783
2020	2	5	40	12	4	0	5,231	42,556	0	0	898,992	815,783
2021	3	8	60	18	5	0	7,847	63,833	0	0	1,348,489	1,223,674
McClane (Grand Junction Field Office)												
2011	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2016	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2017	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2018	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2019	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2020	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757
2021	0	0	0	13	0.3	0	0	3,818	0	0	80,178	72,757

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Year	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/year)
Oak Mesa Area (Uncompahgre Field Office)												
2011	2	15	14	291	81	0.2	44,671	80,619	0.8	0.2	1,737,918	1,577,058
2012	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2013	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2014	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2015	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2016	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2017	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2018	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2019	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2020	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
2021	13	41	55	513	190	0.8	53,176	140,290	0.9	1.3	2,999,549	2,721,914
King (Tres Rios Field Office)												
2011	0	0	0	15	14	0	0	0	0	0	0	0
2012	0	0	0	25	24	0	0	0	0	0	0	0
2013	0	0	0	25	24	0	0	0	0	0	0	0
2014	0	0	0	25	24	0	0	0	0	0	0	0
2015	0	0	0	25	24	0	0	0	0	0	0	0
2016	0	0	0	25	24	0	0	0	0	0	0	0
2017	0	0	0	25	24	0	0	0	0	0	0	0
2018	0	0	0	25	24	0	0	0	0	0	0	0
2019	0	0	0	25	24	0	0	0	0	0	0	0
2020	0	0	0	25	24	0	0	0	0	0	0	0
2021	0	0	0	25	24	0	0	0	0	0	0	0

Year	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/year)
Foidel (Kremmling Field Office)												
2011	0	1	4	259	54	0	*	*	*	0	*	*
2012	0	1	4	259	54	0	*	*	*	0	*	*
2013	5	6	11	161	33	0	36,878	1,257	0	0	63,298	57,439
2014	5	6	11	161	33	0	36,878	1,257	0	0	63,298	57,439
2015	5	6	11	161	33	0	36,878	1,257	0	0	63,298	57,439
2016	5	6	11	161	33	0	36,878	1,257	0	0	63,298	57,439
2017	5	6	11	161	33	0	36,878	1,257	0	0	63,298	57,439
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0
Deserado (White River Field Office)												
2011	0	0	0	119	13	0	*	*	*	0	*	*
2012	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2013	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2014	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2015	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2016	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2017	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2018	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2019	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2020	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383
2021	5	6	11	126	15	0	29,498	923	0	0	48,910	44,383

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Year	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/year)
Trapper (Little Snake Field Office)												
2011	0	452	115	852	251	0	*	*	*	0	*	*
2012	0	452	115	852	251	0	*	*	*	0	*	*
2013	0	452	115	852	251	0	*	*	*	0	*	*
2014	0	452	115	852	251	0	*	*	*	0	*	*
2015	0	452	115	852	251	0	*	*	*	0	*	*
2016	0	452	115	852	251	0	*	*	*	0	*	*
2017	0	452	115	852	251	0	*	*	*	0	*	*
2018	0	452	115	852	251	0	*	*	*	0	*	*
2019	0	452	115	852	251	0	*	*	*	0	*	*
2020	0	452	115	852	251	0	*	*	*	0	*	*
2021	0	452	115	852	251	0	*	*	*	0	*	*
Colowyo (Little Snake Field Office)												
2011	0	0	0	1,700	252	0	*	*	*	0	*	*
2012	0	0	0	1,700	252	0	*	*	*	0	*	*
2013	0	0	0	1,700	252	0	*	*	*	0	*	*
2014	0	0	0	1,700	252	0	*	*	*	0	*	*
2015	0	0	0	1,700	252	0	*	*	*	0	*	*
2016	0	0	0	1,700	252	0	*	*	*	0	*	*
2017	0	0	0	1,700	252	0	*	*	*	0	*	*
2018	0	0	0	1,700	252	0	*	*	*	0	*	*
2019	0	0	0	1,700	252	0	*	*	*	0	*	*
2020	0	0	0	1,700	252	0	*	*	*	0	*	*
2021	0	0	0	1,700	252	0	*	*	*	0	*	*

Year	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/year)
Sage Creek (Little Snake Field Office)												
2011	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2014	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2015	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2016	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2017	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2018	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2019	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2020	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480
2021	4	3	4	112	15	0	4,178	298	0	0	10,447	9,480

* Greenhouse gas emissions not available for all years for the Trapper and Colowyo mines, in 2011 for the Deserado mine, and in 2011 and 2012 for the Foidel mine.

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APPENDIX D-2

Uranium/Vanadium Mining Emissions

Table B1. Grand Junction Field Office Uranium/Vanadium Mine Emissions (tons/year).

Year	Mines	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/ year)
2011	0	0	0	0	0	0	0.0	0	0.0	0.0	0.0	0	0
2012	0	0	0	0	0	0	0.0	0	0.0	0.0	0.0	0	0
2013	1	1	4	12	14	13	0.2	1,077	0.0	0.0	0.1	1,080	980
2014	3	3	13	37	42	39	0.7	3,231	0.0	0.0	0.3	3,240	2,940
2015	5	5	22	62	69	66	1.2	5,386	0.1	0.0	0.5	5,401	4,901
2016	7	7	31	86	97	92	1.6	7,540	0.1	0.1	0.7	7,561	6,861
2017	9	9	40	111	125	118	2.1	9,694	0.1	0.1	0.9	9,721	8,821
2018	10	10	44	123	139	131	2.3	10,771	0.2	0.1	1.0	10,801	9,801
2019	11	11	49	135	153	145	2.6	11,848	0.2	0.1	1.1	11,881	10,782
2020	12	12	53	148	167	158	2.8	12,925	0.2	0.1	1.2	12,961	11,762
2021	13	13	57	160	181	171	3.0	14,003	0.2	0.1	1.3	14,041	12,742
2022	14	14	62	172	194	184	3.3	15,080	0.2	0.1	1.4	15,122	13,722
2023	15	15	66	185	208	197	3.5	16,157	0.2	0.1	1.5	16,202	14,702
2024	16	16	71	197	222	210	3.7	17,234	0.2	0.1	1.6	17,282	15,682
2025	17	17	75	209	236	223	4.0	18,311	0.3	0.1	1.7	18,362	16,662
2026	18	18	79	221	250	236	4.2	19,388	0.3	0.2	1.8	19,442	17,642
2027	19	19	84	234	264	250	4.5	20,465	0.3	0.2	1.9	20,522	18,623
2028	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603
2029	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603
2030	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603

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Table B2. Uncompahgre Field Office Uranium/Vanadium Mine Emissions (tons/year).

Year	Mines	VOC (short tons/year)	CO (short tons/year)	NOx (short tons/year)	PM10 (short tons/year)	PM2.5 (short tons/year)	SO2 (short tons/year)	CO2 (short tons/year)	CH4 (short tons/year)	N2O (short tons/year)	HAPs (short tons/year)	CO2eq (short tons/year)	CO2eq (metric tonnes/ year)
2011	0	0	0	0	0	0	0.0	0	0.0	0.0	0.0	0	0
2012	0	0	0	0	0	0	0.0	0	0.0	0.0	0.0	0	0
2013	1	1	4	12	14	13	0.2	1,077	0.0	0.0	0.1	1,080	980
2014	3	3	13	37	42	39	0.7	3,231	0.0	0.0	0.3	3,240	2,940
2015	5	5	22	62	69	66	1.2	5,386	0.1	0.0	0.5	5,401	4,901
2016	7	7	31	86	97	92	1.6	7,540	0.1	0.1	0.7	7,561	6,861
2017	9	9	40	111	125	118	2.1	9,694	0.1	0.1	0.9	9,721	8,821
2018	10	10	44	123	139	131	2.3	10,771	0.2	0.1	1.0	10,801	9,801
2019	11	11	49	135	153	145	2.6	11,848	0.2	0.1	1.1	11,881	10,782
2020	12	12	53	148	167	158	2.8	12,925	0.2	0.1	1.2	12,961	11,762
2021	13	13	57	160	181	171	3.0	14,003	0.2	0.1	1.3	14,041	12,742
2022	14	14	62	172	194	184	3.3	15,080	0.2	0.1	1.4	15,122	13,722
2023	15	15	66	185	208	197	3.5	16,157	0.2	0.1	1.5	16,202	14,702
2024	16	16	71	197	222	210	3.7	17,234	0.2	0.1	1.6	17,282	15,682
2025	17	17	75	209	236	223	4.0	18,311	0.3	0.1	1.7	18,362	16,662
2026	18	18	79	221	250	236	4.2	19,388	0.3	0.2	1.8	19,442	17,642
2027	19	19	84	234	264	250	4.5	20,465	0.3	0.2	1.9	20,522	18,623
2028	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603
2029	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603
2030	20	20	88	246	278	263	4.7	21,542	0.3	0.2	2.0	21,602	19,603

Exhibit 5

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United States Department of the Interior
Bureau of Land Management

Environmental Assessment
DOI-BLM-CO-S010-2012-0036-EA

July 2013

D.J. Simmons, Inc.
Two Pinto Wells Project
Pinto 1-7 and Pinto 3-17 Oil Wells
Dolores County, Colorado

Location: The two-well project area is located in the Papoose Canyon Oil Field about 15.5 kilometers (9.6 miles) south-southwest of Dove Creek, Colorado in the vicinity of the intersection of Dolores County Roads 4 and T, and on County Road 4 on the point of land between Squaw and Cross Canyons.

Pinto 1-7: Lot 11 (SE NW) Sec 7, T39N, R19W
Pinto 3-17: SE NW Sec 17, T39N, R19W

Applicant/Address: D.J. Simmons, Inc.
1009 Ridgeway Place, Suite 200
Farmington, NM 87401

Tres Rios Field Office
29211
Dolores, CO 81323
970-882-7296
970-882-6841

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Two Pinto-Wells Project - Pinto 1-7 and Pinto 3-17
DOI-BLM-CO-S010-2012-0036-EA

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Two Pinto-Wells Project - Pinto 1-7 and Pinto 3-17
DOI-BLM-CO-S010-2012-0036-EA

CHAPTER 1
INTRODUCTION AND NEED FOR THE PROPOSED ACTION

INTRODUCTION

D.J. Simmons, Inc. (D.J. Simmons) is proposing to vertically drill the Pinto 1-7 and Pinto 3-17 oil wells and to construct associated access roads and pipelines. The proposed project would be located on privately-owned surface with the subsurface minerals owned by the federal government and administered by the Bureau of Land Management (BLM) Tres Rios Field Office (TRFO). D.J. Simmons has submitted Colorado Oil and Gas Conservation Commission (COGCC) applications and Applications for Permits to Drill (APDs) the two oil wells and associated well tie pipelines. The proposed wells would be located in Dolores County, Colorado as shown on Figure 1. Legal coordinates of the proposed wells and lease information are given in Table 1. The southwest corner of the proposed Pinto 1-7 well pad would be located approximately 50 feet outside the boundary of the Canyon of the Ancients National Monument (CANM) (Figure 2). The proposed pipeline for Pinto 3-17 terminates at the existing Santa Fe Canyon 42-18 well site that is located on private land about 130-feet east of the CANM boundary (Figure 3).

Table 1. Lease Summaries and Legal Descriptions for Proposed Well Pad Locations.

Well Name	Mineral Lease	Surface Location (Ownership)	Bottom Hole Location (Mineral Ownership)	Proposed Vertical Depth (Feet)
Pinto 1-7	COC 38420	2,832 feet from the south line (FSL) and 2,841 feet from the east line (FEL); Lot 11, Section 7, Township 39 North, Range 19 West (Fee)	2,832 feet FSL and 2,841 feet FEL; SE NW, Section 7, Township 39 North, Range 19 West (BLM)	6,325
Pinto 3-17	COC 36140	2,498 feet from the north line (FNL) and 2,523 feet from the west line (FWL); SE NW Section 17, Township 39 North, Range 19 West (Fee)	2,498 feet FNL and 2,523 feet FWL; SE NW Section 17, Township 39 North, Range 19 West (BLM)	6,350

This Environmental Assessment (EA) has been prepared to assess the site-specific environmental effects of the proposed development of two oil wells, and associated access roads and pipelines as proposed by D.J. Simmons. The EA would be used to assist the BLM TRFO in project planning and ensuring compliance with the National Environmental Policy Act (NEPA) of 1969, as amended (Public Law [Pub. L.] 91-90, 42 United States Code [USC] 4321 et seq.).

PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to allow the applicant to exercise valid existing fluid-mineral rights by developing the mineral estate from Federal Leases COC 38420 and COC 36140. The need for the action is established by the BLM's responsibility under the Mineral Leasing Act, the Mining and Minerals Policy Act of 1970 (30 USC 21 et seq.), the Federal Land Policy and Management Act, the National Materials and Minerals Policy, Research, and Development Act of 1980 (30 USC 1601 et seq.), and the Federal Onshore Oil and Gas Leasing Reform Act of 1987 (30 USC 181 et seq.; 43 Code of Federal Regulations [CFR] 3160) to consider the proposal submitted by DJ Simmons. The BLM will decide whether or not to approve the APDs, and if so, under what terms and conditions.

CONFORMANCE WITH BLM LAND USE PLAN(S)

Pursuant to 40 CFR 1508.20 and 1502.28, this EA tiers to the analysis contained in the Record of Decision for San Juan/San Miguel Resource Management Plan and Final Environmental Impact Statement (EIS) (USDI/BLM 1985) and the Colorado Oil and Gas Leasing and Development Final EIS amendment to the Resource Management Plan (USDI/BLM 1991).

The proposed action is subject to and has been reviewed for conformance with the following land use plan (43 CFR 1610.5, BLM 1617.3):

- San Juan/San Miguel Planning Area Resource Management Plan and the Record of Decision approved September 1985 (USDI/BLM 1985).
- Colorado Oil and Gas Leasing and Development Final Environmental Impact Statement Record of Decision, approved October 1991 (USDI/BLM 1991b).

BLM actively encourages and facilitates the development by private industry of public land mineral resources so that national and local needs are satisfied and economically and environmentally sound exploration, extraction, and reclamation practices are provided (USDI/BLM 1985; page 17).

RELATIONSHIPS TO STATUTES, REGULATIONS AND OTHER PLANS

The Proposed Action is consistent with the terms, conditions of other Federal Laws, statutes, regulations, and other plans including:

- The Endangered Species Act of 1973 (USC 4321 et seq.)
- The Migratory Bird Treaty Act of 1918, as amended (16 USC 703-712)
- The Bald and Golden Eagle Protection Act of 1940, as amended (16 USC 668-668d)
- The Federal Water Pollution Control Act of 1948, as amended (33 USC 26)
- The Clean Air Act of 1963, as amended (42 USC 7401 et seq.)
- Clean Water Act of 1972, amended 1977 (33 USC 1251 et seq.)
- The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 USC 103)
- The Antiquities Act of 1906, as amended (16 USC 431–433)

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- The National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.)
- The Archaeological and Historic Preservation Act of 1974 (16 USC 469-469c)
- The Archaeological Resources Protection Act of 1979, as amended (16 USC 470aa-mm)
- The American Indian Religious Freedom Act of 1978, as amended (42 USC 1996)
- The Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 et seq.)
- Executive Order 12898 of 1994 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"
- Code of Federal Regulations, Title 43, part 3101 section1-2, Surface Use Rights.

This EA considers the requirements of these laws and implementing regulations, as applicable, as part of the proposed action. The proposed action, including associated applicant-committed mitigation measures, complies with the laws and implementing regulations indicated above.

SCOPING AND PUBLIC INVOLVEMENT AND ISSUES

An on-site inspection was conducted on June 4, 2012 at each of the proposed well sites. Present were the landowners, representatives from D.J. Simmons, the BLM project manager, a BLM archaeologist, wildlife biologists from Colorado Parks and Wildlife, consultants from Ecosphere Environmental Services (Ecosphere) and Woods Canyon Archaeological Consultants (Woods Canyon); and surveyors from Basin Surveying. A follow-up on-site inspection was conducted by the BLM project manager and a BLM wildlife biologist on June 5, 2013. A second follow-up on-site inspection was conducted on July 19, 2012, by the BLM project manage and a COGCC representative. The on-site discussions were used as the initial scoping for the project, to develop the design features for the project, and to shape the content of the APD.

In addition, two public hearings were held in Dove Creek about the project. A Dolores County Planning Commission public hearing was held on March 13, 2013 and a Dolores County Board of County Commissioners public hearing was held on May 6, 2013. Public notice was published in the Dove Creek Press for two consecutive weeks prior to both of these hearings and certified letters were sent to all adjacent land owners notifying them of the project and the up-coming hearings. A third certified project notification letter was sent to all adjacent landowners to meet COGCC requirements.

The environmental resources were examined by an interdisciplinary team (ID-Team) of BLM specialists to determine which resources were present at the project area and which of those had a potential to be impacted by the proposed project. Those resources that were determined to be present with the potential for relevant impacts were evaluated by the ID-team and are documented in the Interdisciplinary Team Checklist (Appendix A) and in this EA. Concerns were expressed that the proposed action may affect the following the resources:

- Air Quality.
- Cultural Resources

- Fish and Wildlife
- Threatened or Endangered Species
- Lands and Access
- Soils
- Water Resources and Water Quality
- Visual Resources

Resources that were considered but not analyzed in the EA are listed in the ID-Team Checklist (Appendix A) with brief explanations for why these resources were not analyzed further.

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CHAPTER 2
DESCRIPTION OF ALTERNATIVES

INTRODUCTION

D.J. Simmons has filed APDs for the proposed wells, which would be located on split-estate lands, where the surface is privately owned and the federal government owns the subsurface minerals. The proposed action would allow for development of the mineral resources present in the area, while minimizing environmental effects to surface resources.

Potential sites were evaluated for archaeological, biological, and hydrologic resource concerns and landowners were consulted. Based upon this screening, the proposed project locations were chosen as those that would least impact resources, while allowing for efficient and economical development of the mineral resources and consideration of landowner needs. In choosing the well pad and access road/pipeline locations, a number of factors were considered including the potential for the occurrence of cultural resources on the site, impacts to wildlife, consideration of topography and the presence of drainage channels, and the proximity to existing access routes.

The proposed action is described in detail below. The no action alternative is considered and analyzed to provide a baseline for comparison of the impacts of the proposed action. The site locations represent the result of a screening process that accounted for landowner needs and environmental concerns. Based on this screening process, other potential locations were excluded from consideration.

PROPOSED ACTION ALTERNATIVE

D.J. Simmons filed APDs with the BLM TRFO and the COGCC to vertically drill and develop the proposed Pinto 1-7 and the Pinto 3-17 oil wells on private land in Dolores County, Colorado (Table 1 and Figure 1). The wells would be drilled to the Upper Ismay/Desert Creek zone of the Paradox Formation. The proposed action would extract oil (liquid hydrocarbons) and natural gas from the formation. The APDs were submitted in November 2012.

The two wells are proposed to be drilled in July through fall of 2013. Drilling, testing, and well completion would take approximately 45 days at each well - for a total of about 3 months to drill and complete both wells. Well pad construction would take approximately an additional 2 weeks. Gas pipelines, as described below and in Table 2, would be constructed after testing and completion of the wells and upon determination that the pipeline is necessary to transport produced natural gas. Construction of the pipeline at Pinto 3-17 would take about 1 week. The pipeline at Pinto 1-7 is much shorter and could be completed in about 2 days. If the wells are successful, the production period could last up to about 30 years. Given successful wells, interim reclamation of the well pads would begin immediately after well and pipeline completion as described below and in Appendix B.

A summary of the proposed surface disturbance is provided in Table 2 and details of construction and reclamation of the sites are described below.

Construction activities associated with the proposed action include drilling the two proposed wells, building a new access road and pipeline right-of-way (ROW) to Pinto 1-7 (Figure 2),

improving the existing access road to Pinto 3-17, constructing a new buried pipeline from Pinto 3-17 to the tie-in at the Santa Fe Canyon 42-18 well site (Figure 3), and installing surface equipment necessary for production. All construction, drilling, access roads, and pipelines would be located on private lands.

Surface disturbance for the proposed Pinto 1-7 well pad would include a 300-foot by 225-foot well pad with a 50-foot wide construction buffer zone around the perimeter, plus a 105-foot long access road and pipeline ROW, for a total maximum disturbance of 2.98 acres (Table 2). The 50-ft. construction buffer is available for construction activities such as top-soil storage and equipment movement. Therefore, the minimum disturbance would consist of the working well pad and the access-pipeline ROW, a total of 1.65 acres and the maximum disturbance will be 2.98 acres. The proposed Pinto 1-7 well project is shown on Figure 2.

The proposed Pinto 3-17 well pad would include a 225-foot by 300-foot area, with a construction buffer zone of 50 feet wide on the north and west sides, 25 feet wide on the south side, and 9.4 feet wide on the east side for a maximum total well-pad disturbance of 2.48 acres (Table 2). The access road would be an improved farm two-track that would be 2,645-feet long and 40-feet wide - a total of 2.43 acres. The pipeline corridor, if needed, would be completely separate from the access road and would be 2,484-feet long and 40-feet wide - a total of 3.29 acres. Therefore the total maximum disturbance for Pinto 3-17 would be 8.2 acres (2.48 + 2.43 + 3.29). The proposed Pinto 3-17 well project is shown on Figure 3.

The well pad locations would be leveled and graded to provide a work area for the drilling activities. Stripped topsoil would be segregated outside of the well pad work area, but within the construction buffer zone that defines the construction boundary limit. The stripped topsoil would be utilized for interim reclamation activities and excavated materials from cuts would be used on the fill portion of the location to level the pad. The drill rigs would be assembled on each well pad. Associated drilling facilities and equipment may include a drill rig, generators, diesel engines, water tanks, mud tanks, safety stations, equipment and material storage units, blowout preventer, an accumulator station, and gas buster. Produced water and cuttings on each well pad would be contained in a lined 70-foot by 110-foot temporary pit.

Each well location would require construction of a new or improved access road. The proposed roads would spur from county roads (Figures 1, 2, and 3) and would be constructed according to specifications outlined in the Surface Use Plan. Roads would be constructed within a 40-foot wide corridor, which would be reclaimed back to a 25-foot width. Refer to Table 2 for the amount of disturbance associated with proposed access roads.

Table 2. Summary of Proposed Surface Disturbance, in acres.

Well Name	Access Road Length/Disturbance[1]	Pipeline Length/Disturbance	Well Pad Area (Acres)	Total Affected Surface Area (Acres)
Pinto 1-7	105 feet/0.10 acre	105 feet/0.10 acre [2]	2.98	3.08
Pinto 3-17	2,645 feet/2.43 acre	2,484 feet/3.29 acres	2.48	8.2
			Total	**11.28**

[1] Access road construction width would be 40 feet wide and reclaimed to 25 feet wide.

[2] No additional disturbance associated with pipeline; constructed within the access road corridor.

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Following well completion and successful production, two or three storage tanks with 400- to 500-barrel capacities would be located on each well pad. Produced liquids would be stored on site in the tanks and trucked out as needed. One to two truck trips per week are anticipated.

Subsurface natural gas pipelines may or may not be needed as part of the proposed action because it is unknown how much gas, if any, would be produced from the wells. The pipeline associated with the Pinto 1-7 well would be constructed completely within the access road corridor, resulting in no additional surface disturbance. The Pinto 3-17 pipeline would result in additional disturbance of 3.29 acres of disturbance along its 2,484 foot length. Typically, pipeline construction consists of clearing the corridor, trenching a ditch 5 to 6 feet deep, stringing and welding pipe, placing pipe in the trench, backfilling the trench, and reclaiming disturbed areas of the corridor. Reclamation of the Pinto 3-17 pipeline corridor should result in 100-percent of the disturbed area reclaimed to its pre-construction land use.

Interim reclamation of the unused areas of the well pad, the reserve pit, and pipeline route would be implemented after construction, drilling, and well completion activities are completed. Interim and final reclamation activities would be completed as described in Appendix B - Surface Use Design Features, Conditions of Approval (COAs), and Proposed Mitigation Measures. In summary, disturbed areas would be re-contoured to original topography, re-seeded with a seed mix as specified by the landowner, and weeds would be controlled at least to the specifications outlined in the Dolores County Development and Land Use Regulations.

Additional details regarding construction activities and interim and final reclamation are provided in the Design Features section of this EA, below, and in Appendix B.

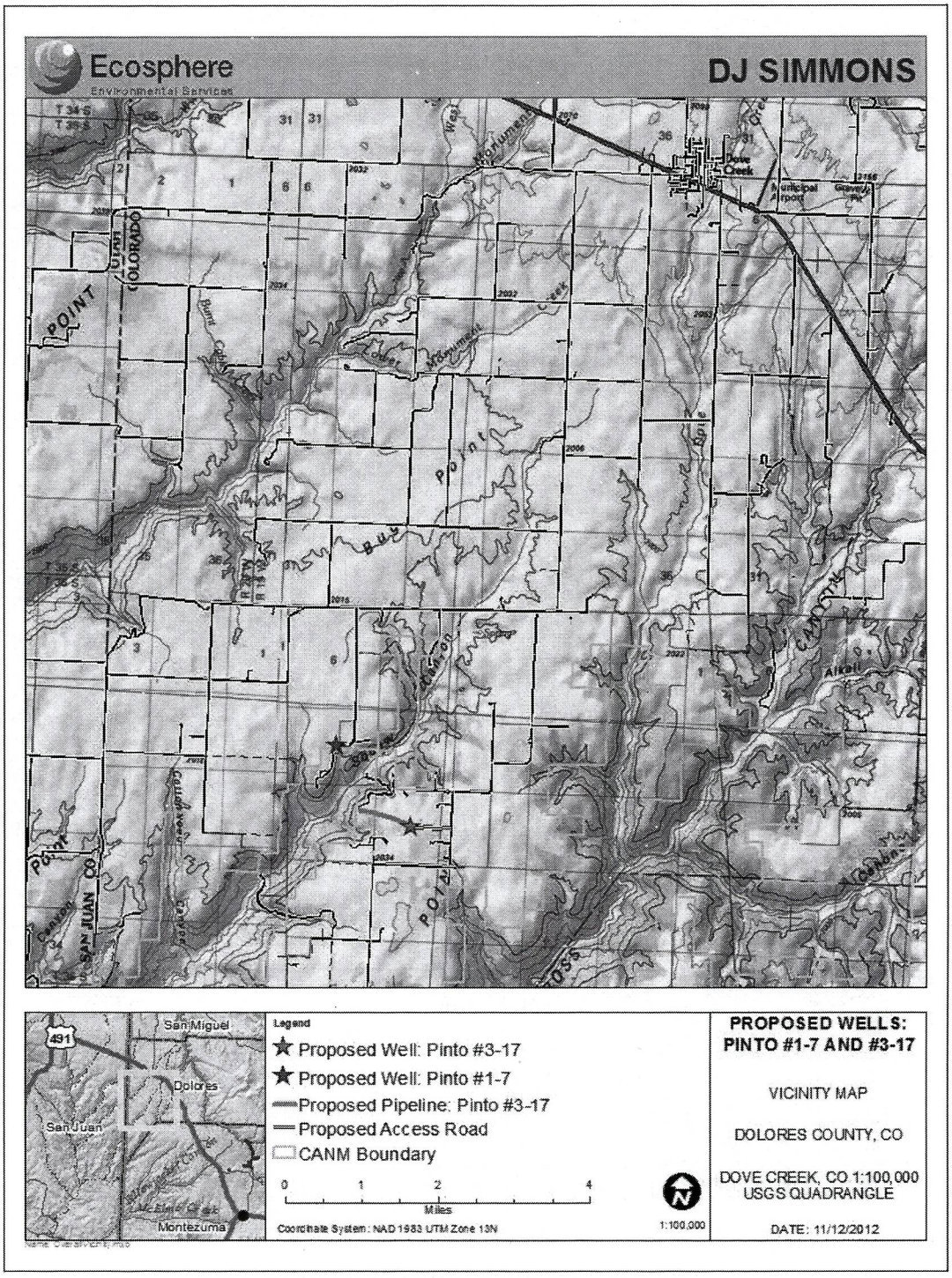

Figure 1: Vicinity of the proposed Pinto 1-7 and Pinto 3-17

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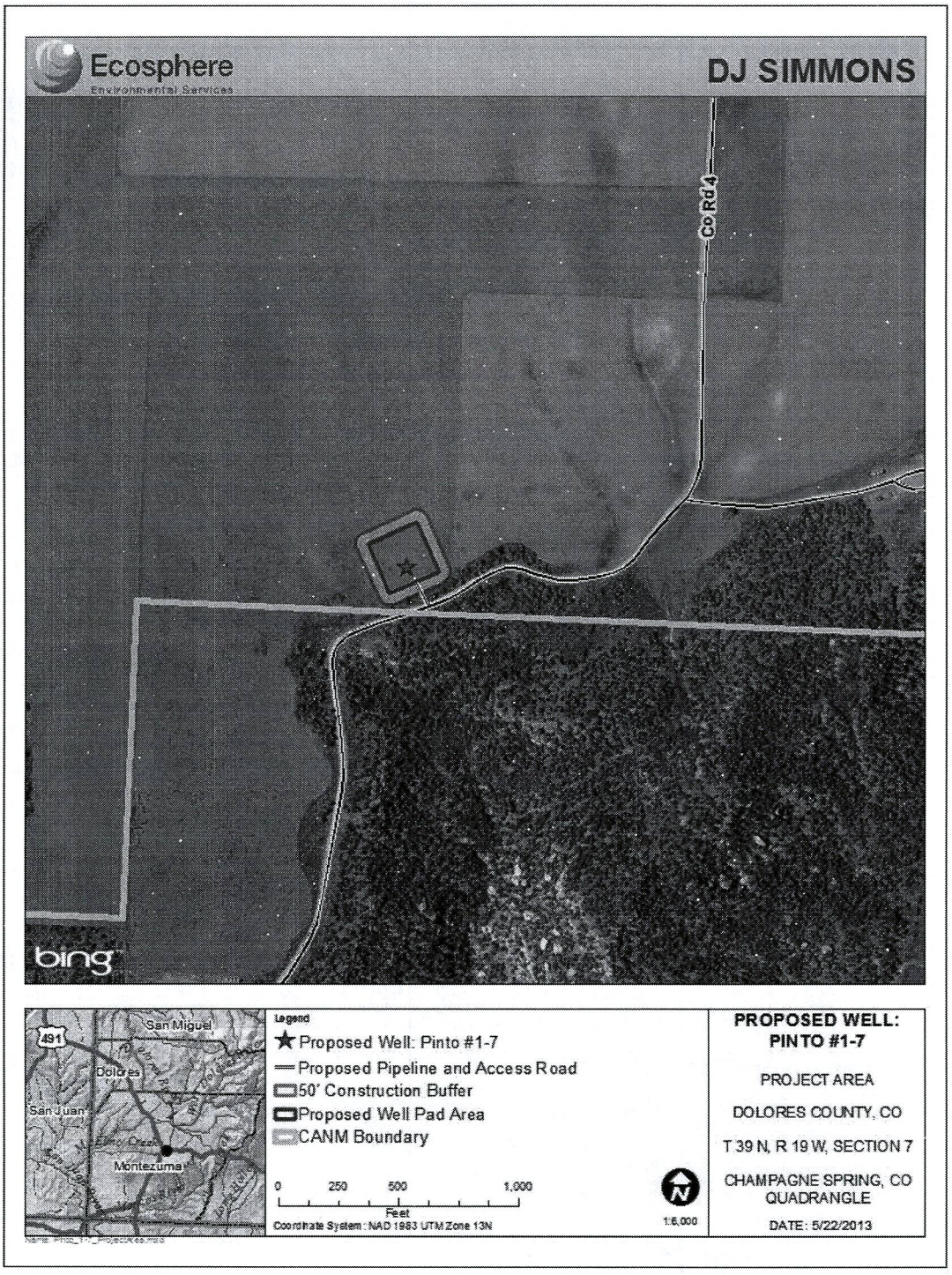

Figure 2: Proposed Pinto #1-7 Project Area

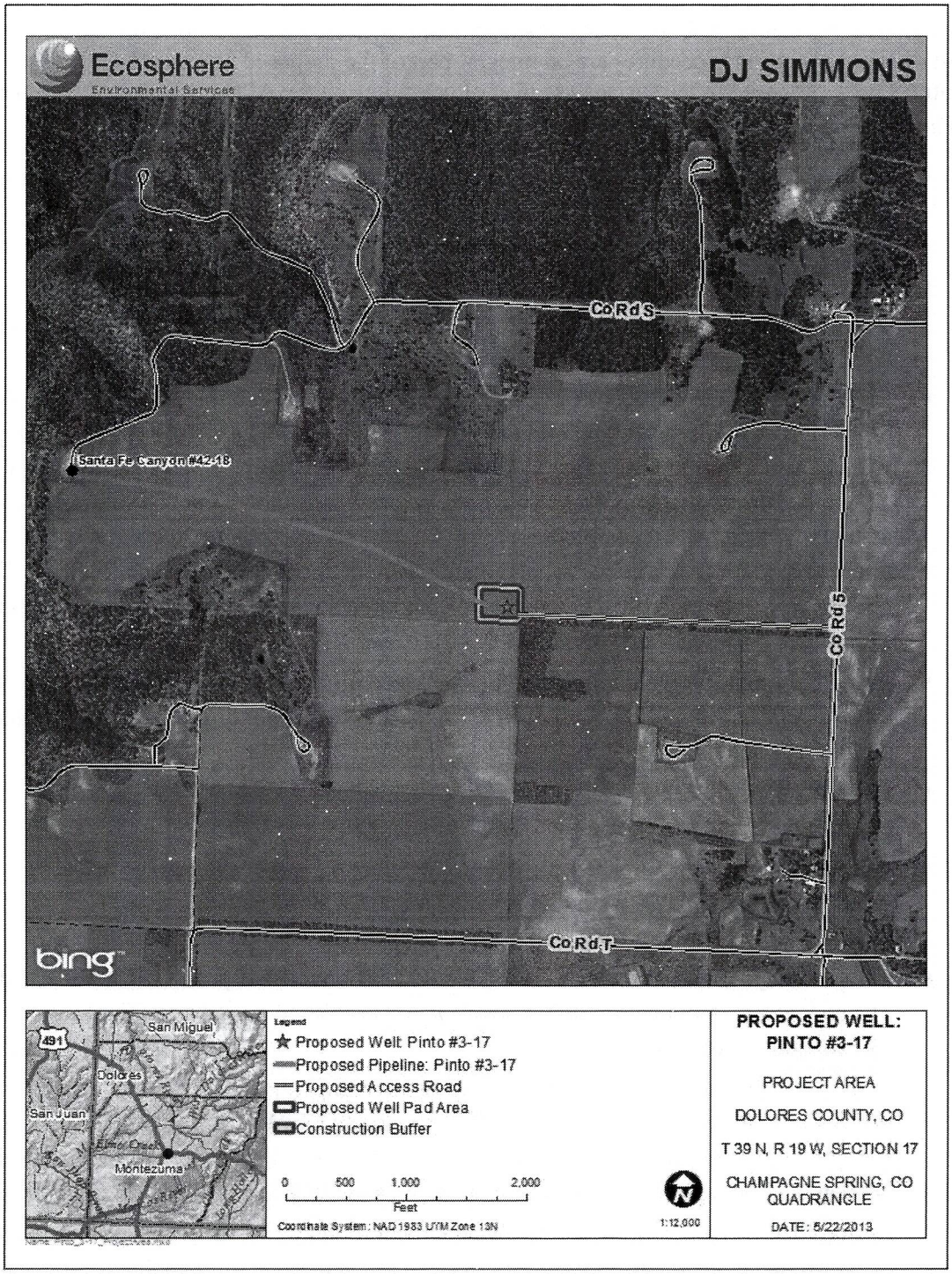

Figure 3: Proposed Pinto 3-17 Project Area

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Design Features

Design features that include use of best management practices, adherence to lease stipulations, and standard operating procedures are an integral part of the proposed action. These design features were proposed in the surface use plan of operations in the APD package and would be implemented to minimize or eliminate potential impacts to resources.

- Stripped topsoil would be segregated outside of the well pad work area, but within the construction boundary limit. 100-percent of the stripped topsoil would be utilized for interim reclamation activities (see Appendix B, #1).
- Water for drilling and completion would be hauled by truck from a permitted water source. The drill cuttings, fluids, and completion fluids would be placed in a reserve pit, which would be lined according to COGCC Rule 904 (see Appendix B, #2).
- Drilling mud will consist of fresh water and will not be salt-saturated or oil-based. The drill cuttings, fluids, and completion fluids will be placed in the reserve pit. Reserve pits will be lined according to Colorado Oil and Gas Conservation Commission Rule 904 and all will be constructed to prevent leakage from occurring and will not be located on a natural drainage. Upon completion of drilling, testing, and completion of the well, the reserve pit will be allowed to dry, and materials remaining in the reserve pit buried. The reserve pit will be backfilled, leveled, and contoured so as to prevent any materials being carried into the watershed (Appendix B, #3).
- All garbage and trash material would be contained on location in an industry-approved trash container and would be removed from the site for proper disposal (see Appendix B, #4 for more details).
- Industry approved chemical toilets will be provided and maintained during drilling, testing, and completion operations (Appendix B, #5.
- Following drilling and completion, interim reclamation, as per the surface use plan submitted with the APD, would reduce the amount of surface disturbance to approximately 1 acre per each well pad (see Appendix B, #6 for more details).
- The reserve pit closure and reclamation would be conducted as per COGCC Rule 1003.d. The reserve pit would be backfilled, leveled, and contoured as part of the interim reclamation (Appendix B, #7).
- Weed control measures would be implemented in compliance with Colorado Noxious Weed Act, C.R.S. §35-5.5-115 and, at a minimum, to the Dolores County Development and Land Use Regulations, (Amended Nov. 2012), Article IV - Performance Standards, Section 2, Paragraph C - Noxious Weeds, page 14 (see Appendix B, #8 for more details).
- During final reclamation, following abandonment of the wells, the locations and access roads would be reclaimed and restored as close to the original topographic contours as possible and reseeded. The access road at Pinto 3-17 would be reclaimed at the

discretion and direction of the land owner who may want the road left, in some form, for access to fields (see Appendix B, #9 for more details).

NO ACTION ALTERNATIVE

The No Action Alternative would be to deny the APDs. This alternative would not approve the APDs for the proposed Pinto 1-7 and Pinto 3-17 wells, as well as the associated access roads and pipelines. The BLM's authority to implement the no action alternative may be limited because oil and gas leases allow drilling in the lease area subject to the stipulations of the specific lease agreement, 40 CFR 3160, and conditions that may result as part of an environmental analysis.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

No other alternatives are needed to address any unresolved resource conflicts.

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CHAPTER 3
AFFECTED ENVIRONMENT

INTRODUCTION AND GENERAL SETTING

Chapter 3 describes the environment that would be affected by implementation of the proposed action described in Chapter 2 and is organized by environmental resource. Descriptive information was obtained from a range of sources, including the BLM and other federal and state agencies.

The affected environment was considered and analyzed by an interdisciplinary team as documented in the Interdisciplinary Team Checklist (Appendix A). The checklist indicates which resources of concern are either not present in the project area or would not be impacted to a degree that requires detailed analysis. Environmental resources that would not be affected or that are not present in the project area include the following: Forests and Rangeland health, Migratory birds, Native American Religious Concerns, Wastes (Hazardous or Solid), Wild and Scenic Rivers, Wilderness, Environmental Justice, Floodplains, Wetlands-Riparian Zones, Farmlands (Prime or Unique), and Lands with Wilderness Characteristics. Resources that could be affected to a level requiring further analysis are described in Chapter 3, below, and effects on these resources are analyzed in Chapter 4.

The project area is located in southwestern Dolores County, Colorado approximately 9.6 miles south-southwest of the town of Dove Creek. This area is a high-desert plateau of mesas covered by eolian (wind -deposited) soil, and incised by deep, sandstone-walled canyons. The proposed action would be located on two mesas known as Bug Point and Squaw Point on the northwest and southeast sides of Squaw Canyon, respectively. The Abajo Mountains are visible to the west and the La Plata Mountains and San Juan Mountains are visible to the east and northeast, respectively. The eolian soils are underlain by the Dakota Sandstone and Burro Canyon Formation that generally comprise the cliff-forming cap rock at the top of the canyon walls in the area.

The eolian soils are deep and fertile so agriculture is a primary land use of most of the mesa tops in the area.

Pinto 1-7

The proposed Pinto 1-7 well pad would be located within 100 feet of the Canyons of the Ancients National Monument boundary (Figure 2). The elevation at the site is approximately 6,325 feet, with slopes ranging from zero to 5 degrees. The proposed Pinto 1-7 well pad lies northwest of the upper end of Squaw Canyon and would be located on previously cultivated land that has been enrolled in the Conservation Resource Program (CRP). Lands are enrolled in the CRP at the request of the land owner and may be taken out of CRP when needed by the landowner.

The existing vegetation at the proposed Pinto 1-7 well pad consists of a mixed shrub/grass community. Shrubs in the area include big sagebrush (*Artemesia tridentata*), broom snakeweed (*Guterrezia sarothrae*) Russian thistle (*Salsola tragus*), and the subshrub hairy false goldenaster (*Heterotheca villosa*). Grasses include crested wheatgrass (*Agropyron cristatum*), western wheatgrass (*Pascopyrum smithii*), smooth brome (*Bromus inermus*), purple three-awn (*Aristida*

purpurea), and alfalfa (*Medicago sativa*). Adjacent land to the east consists of open-canopy, piñon-juniper woodland that occupies the steep, southeast-facing slopes of an unnamed tributary to Squaw Canyon.

Pinto 3-17

The proposed Pinto 3-17 access road would follow an existing two-track farm road west from County Road 5, along the north side of a fence line (Figure 3). The access would enter the well pad from the southeast and the pad would be located on tilled, dry-land farm land. The proposed Pinto 3-17 project lies on Squaw Point between Squaw canyon to the northwest and Cross Canyon to the southeast. The elevation at the well pad is approximately 6,500 feet, with slopes ranging from zero to 5 degrees. The proposed pipeline would exit the western side of the well pad and cross a tilled field before tying into a pipeline at the existing Santa Fe Canyon 42-18 well site. This well pad is located about 130-feet east of the CANM boundary. No natural vegetation occurs within the proposed area of disturbance as it is actively farmed.

AIR QUALITY

The project study area lies within the Southwestern Colorado Air Quality Control Region, as defined by the Colorado Air Quality Control Commission Report to the Public 2010-2011, (CDPHE 2011). On-going state air quality monitoring and sources of air quality impairment in the area are summarized in the annual air quality report. Currently, air quality concerns in the Southwestern region are from impacts from energy development including direct emissions, support services, and associated growth. Coal-fired Power plants in New Mexico, motor vehicles, and wildfires are also emission sources in this region (CDPHE 2011).

The Air Quality Division of the Colorado Department of Public Health and Environment (CDPHE) regulates air quality impacts from oil and gas activities and develops mitigation measures on a case-by-case basis. Impacts are evaluated to see if they are allowable or unacceptable. Air quality permits are required for emission sources on well pads if established emission thresholds for designated pollutants are exceeded. Currently, the area is in attainment for all criteria pollutants as defined under the Clean Air Act.

CULTURAL RESOURCES

Generally, the project area is known to be culturally rich with numerous surface and subsurface cultural resources, as evidenced by the close proximity to the Canyons of the Ancients National Monument. Woods Canyon Archaeological Consultants conducted a Class III cultural resource inventory on a total of approximately 22 acres consisting of two, 10-acre areas around the proposed well pads and along approximately 5,234 feet of proposed access roads and pipeline corridors—all within private lands (Fetterman 2012). The cultural surveys located one archaeological site along the Pinto 3-17 pipeline corridor. Composed of eight artifacts, this site is recommended as "not eligible" to the National Register of Historic Places. However, the proposed pipeline corridor for Pinto 3-17 was re-designed/re-routed to avoid the site.

FISH AND WILDLIFE

The region surrounding the proposed projects is composed of a patchwork of agricultural lands, native and re-vegetated mixed grasses and shrub habitat, and piñon-juniper woodland habitat.

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These combine to provide cover and forage for a wide range of terrestrial wildlife. Several common mammalian species are likely to be found throughout the project area including the cougar (*Puma concolor*), coyote (*Canis latrans*), black bear (Ursus americanus), fox (*Vulpes* sp.), skunk (*Mephitis* sp.), and porcupine (*Erethizon dorsatum*). Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) are year-round residents on public and private land. Both big-game species tend to migrate between forested lands at higher elevations in the spring and summer, to agricultural lands and woodlands at lower elevations in the fall and winter. Migration between winter and summer ranges may exceed 50 miles in this region (USDI/BLM 1991).

Sage-grouse (*Centrocercus urophasianus*), chukar partridge (*Alectoris chukar*), quail (*Callipepla gambelii*), wild turkey (*Meleagris gallopavo*), and pheasant (*Phasianus colchicus*) are present in small numbers and scattered throughout the San Juan/San Miguel Resource Area. Pheasants are mainly dependent on agricultural land, while the other species are associated with native rangeland and forest-type habitats (USDI/BLM 1991). Raptors potentially occurring in the area include golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), sharp-shinned hawk *(Accipiter striatus*), Cooper's hawk *(Accipiter cooperii)*, and American kestrel *(Falco sparverius)*.

THREATENED OR ENDANGERED SPECIES

Gunnison sage-grouse *(Centrocercus minimus)*: Critical habitat for Gunnison sage-grouse has been proposed by the U.S. Fish and Wildlife Service (USFWS) for a large area of Dolores County, including much of the agricultural lands on which the proposed Pinto Wells are located. This proposed critical habitat is mapped by the USFWS as unoccupied in the project area. Habitat around each of the proposed well pads does not meet the constituent elements listed in the proposed rule for critical habitat for Gunnison sage-grouse. Well locations were buffered by 1.5 km and sagebrush in unoccupied critical habitat was less than 25% for each of the proposed well locations. In the proposed rule, only areas that meet primary constituent element 1 are considered as critical habitat.

Table 3 – Constituent Element Analysis for Proposed Critical Habitat

Well Name	Acres of unoccupied critical habitat w/in 1.5 km	Acres of sagebrush	% sagebrush
Pinto 1-7	995	20	2.0%
Pinto 3-17	1196	50	4.2%

LANDS/ACCESS

All well pads, access roads, and pipelines are located on private lands. Surface Access Agreements typically describe how construction, drilling, production and maintenance of the oil wells and the associated pads and facilities will be conducted. In addition, the agreements include information about construction and/or improvement of access roads and their

maintenance over the life of the wells, and interim and final reclamation of the well pads, access roads, and pipeline corridors.

SOILS

Soils in the proposed Pinto 1-7 well pad and approximately 20 feet of the proposed access road/pipeline corridor are Wetherill loam, 3 to 6 percent slopes. This soil is considered prime farmland, if irrigated, but it is not irrigated in the project area. The Wetherill loam is very deep, well drained, and has high available water capacity. The soil is comprised of eolian (wind-blown) deposits derived from sandstone. Major uses of this soil type include cropland and livestock grazing. The remainder of the proposed access road/pipeline corridor would cross the Gladel-Pulpit complex, 3 to 9 percent slopes. This soil is comprised of eolian deposits over residuum weathered from sandstone. This soil complex is shallow to moderately deep, well drained, has moderate to very low available water capacity, and is not considered prime farmland (USDA/NRCS 2013). Major uses of this soil unit are livestock grazing and wildlife habitat.

Soils in the proposed Pinto 3-17 well pad site, pipeline, and approximately 1,000 feet of the proposed access road/pipeline corridor are Wetherill loam, 3 to 6 percent slopes. A small portion of the proposed Pinto 3-17 pipeline (approximately 200 feet) runs through the Sharps-Cahona complex, 6 to 12 percent slopes. This soil is well drained and is not considered prime farmland. The eastern portion of the proposed Pinto 3-17 access road (approximately 1,650 feet) is within the Cahona-Sharps-Wetherill complex, 2 to 6 percent slopes. This soil is deep, well drained, has a high available water capacity and is not considered prime farmland (USDA/NRCS 2013).

WATER RESOURCES/WATER QUALITY

Surface drainage in the vicinity of both proposed well pads flows to Squaw Canyon creek via intermittent and/or ephemeral streams in steep, tributary canyon drainages. Squaw Canyon creek flows south to Cross Canyon creek which, in turn, is a tributary to Montezuma Creek with the confluence near the northeastern corner of the Navajo Indian Reservation. Montezuma Creek flows south-southwest across the Navajo Indian Reservation to the San Juan River at Montezuma Creek, Utah.

No perennial waters, wetlands, or riparian habitats are located within a ½-mile radius of the proposed well pads or access/pipeline route locations. The hydrologic regime in the vicinity of the project area is such that surface water flows only on an intermittent basis in conjunction with sizable precipitation events. Thunderstorms are the primary source of flow in these ephemeral drainages, which are also fed by snowmelt. Key factors that influence the surface-water quality in the project area include agricultural practices, sparse vegetative cover, highly erosive soils, rapid runoff, existing roads, oil and gas well pads and facilities, and livestock grazing.

An ephemeral stock pond is located to the southeast of the proposed Pinto 1-7 well pad. This pond is approximately 0.4 acre in size and was dry during the on-site and the biological survey. One water well is located within a one-mile radius of the proposed well site. This domestic/stock well (permit # 83355) is located about 2,000 feet west of the proposed well site and, according to Colorado Division of Water Resources (DWR), the well is 18-feet deep and has a yield of 3 gallons per minute (gpm). Another water well (permit # 93488) is located about

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6,300-feet southwest of the proposed well location. According to DWR, the well is 185-feet deep, has a yield of 0.8 gallons per minute and is used for domestic water supply and stock watering.

One un-named spring is located about 2,000 feet southwest of the proposed Pinto 3-17 well location at the head of an un-named tributary canyon to Squaw Canyon creek. The proposed well pad is upstream about 2,300 feet and immediately adjacent to the same drainage that contains this spring. Seven water wells are located within one mile of the proposed Pinto 3-17 well location (Water Well Table, below).

Table 4 - Water Wells Within One-Mile of Proposed Pinto 3-17 Location

Permit No.	Approximate Distance/Direction From Proposed Well Pad	Depth (ft.)	Yield (gpm)	Water Level below surface (ft.)	Use
93488	1,600 ft./NW	185	0.8	NA	Domestic/Stock
239006	3.300 ft./SE	100	10	48	Domestic/Stock
269710	3,600 ft./NE	142	NA	NA	Domestic
125479	3,600 ft./SE	45	15	NA	Domestic/Stock
17082	3,900 ft./SE	28	1	7	Stock
273136	4,600 ft./SE	15	15	NA	Domestic
120272A	4,900 ft./SE	100	NA	60	Domestic

Source: Colorado Division of Water Resources (DWR)

The ground-water resources in the project area are derived mostly from the Dakota -Glen Canyon aquifer system that underlies most of the Colorado Plateau in western Colorado, northwestern New Mexico, northeast Arizona, and eastern Utah. The Dakota-Glen Canyon aquifer system is composed of a series of aquifers and confining units that are interconnected enough to be considered a thick, connected aquifer system. The Dakota aquifer is the uppermost aquifer in the system and is composed of the Dakota Sandstone and the Burro Canyon Formation (Robson and Banta 1995). This is the primary ground-water-supply unit for the project area since the Dakota Sandstone is the cap rock at the top of most of the local canyon walls and is the bedrock unit that immediately underlies the agricultural soils in the area. The Brushy Basin Member of the Morrison Formation underlies the Dakota aquifer and is a local confining unit which is a poor water producer. The Salt Wash Member of the Morrison Formation is also known as the Morrison aquifer and can supply potable water to wells in the project area. However, the drilling depth to the Morrison aquifer is great enough that the cost is beginning to get prohibitive for the typical home/landowner. The Entrada and Navajo Sandstone units are two aquifers of the Dakota-Glen Canyon aquifer system lying below the Morrison aquifer. The

Entrada Sandstone, the uppermost of these two aquifers, is the unit in the Sand Canyon area and in Canyon of the Ancients National Monument that contains numerous natural alcoves where ancient Puebloan cliff dwellings were built. The Navajo Sandstone is only exposed at the surface at the Sand Canyon parking lot and vicinity in McElmo Canyon. Both of these aquifers can be good sources of ground water, but the drilling depth to reach these sandstone aquifers in the project area is prohibitive. The Glen Canyon aquifer is lowermost aquifer of the Dakota-Glen Canyon aquifer system and is composed of the Kayenta Formation and Wingate Sandstone (Robson and Banta 1995).

More localized and shallow ground-water resources are encountered within alluvial deposits that are associated with the surface water drainages within the project area. These aquifers consist of Quaternary period deposits of alluvial gravel, sand, silt, and clay or Quaternary deposits of eolian sand and silt (Robson and Banta 1995). These aquifers tend to be localized near surface water and of limited aerial extent. There are a few of these shallow wells in the project area such as the 18-ft. deep well west of the Pinto 1-7 location and the 15 -ft. and 28-ft. deep wells southeast of the Pinto 3-17 location.

VISUAL RESOURCES

Visual Resources of the area consist of dry-land, agriculture scenery in the sparsely populated section of southwestern Dolores County, Colorado.

The Pinto 1-7 well would be located about 100 feet north of the CANM boundary along Dolores County Road 4. The area surrounding the proposed well site is piñon-juniper forest, in CANM, immediately to the south and rolling hills of formerly cultivated lands that of the well pad

The proposed project area contains broad, level mesa tablelands intersected by deep canyons and numerous smaller draws. Viewsheds within the Project Area are dominated in the foreground (0 to 0.5 mile) and middle-ground (0.5 to 3 to 5 miles) by active, dry-land agricultural fields on the mesa tops. The individual fields are typically separated by windrows of deciduous trees, mature piñon-juniper (P-J) woodlands (in the canyons), and/or desert scrub shrublands. The rolling topography periodically provides background views (3 to 5 miles to 15 miles and beyond) south to Sleeping Ute Mountain, northwest to the Abajo Mountains in Utah, and east to the La Plata Mountains. Overall, existing conditions in the Project Area are moderately natural.

Visual disturbances currently exist in foreground and middle-ground views along public travel corridors and in the agricultural lands. These disturbances include: paved and gravel roadways; oil and gas well pads with storage tanks and facilities; overhead, rural-supply power lines along roadways and to residences; rural residences; and agricultural development including cultivated fields, crops, barns, hay and equipment sheds, and farm equipment stored or abandoned in fields.

Previous visual resource management (VRM) efforts at the oil and gas well pads in the area have yielded mixed results. Best management practices (BMPs) for visual resources have been implemented on all wells pads on federal lands in the area and, as such, blend into the surrounding colors and forms fairly well and do not tend to dominate the view for the casual observer. Comparatively, similar BMPs have not been utilized at some well facilities on private lands where BLM does not have jurisdiction, and the resultant VRM impacts (typified by white,

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rusting storage tanks and other facilities) become visual focal points within the near and mid-distance backgrounds.

Pinto 1-7 Proposed Location:

The Pinto 1-7 location is in a good location from a VRM perspective. It is in a relatively low location that is not visible from any middle- or back-ground viewpoints. Foreground viewpoints would be from local fields and from two points on County Road 4 (on the approach to the well site and as the road passes the south side of the well site). The view of the site from the south, southeast and east is screened by P-J forest and from the northeast, north, northwest, west and southwest by topography and/or P-J forest. The well pad is located less than 100 feet north of the Canyons of the Ancients National Monument (the Monument) boundary but, in spite of that, the well site would be visible from only a small, very local portion of the Monument - from the road immediately adjacent to the well pad and from an open field southwest of the well location in a corner of the Monument. There are no residences in direct line of site with this well location.

Pinto 3-17 Proposed Location:

The proposed Pinto 3-17 well pad is located on a gentle southeast-facing slope in a cultivated, dry-land agricultural field. The location is slightly higher than most of the surrounding foreground lands and would be visible intermittently from numerous viewpoints on surrounding private lands. The well site would be visible from various points along County Road S, County Road 5 and County Road T - all approximately 1/2 -mile from the well site. Various visibility screens such as wind-block rows of trees, stands of P-J forests, and topography would make the views of this site intermittent, depending on perspective. Degree of visibility would vary by season because the color used to paint the facilities on site would blend in better during the summer months when crops are on the fields, as opposed to snow-covered fields in the winter and brown, tilled fields in the spring.

Visibility from the Monument would be limited because nearby Monument lands tend to drop off quickly into local canyons and the view of this well location would immediately be screened by topography and P-J forest as one moved into the Monument proper. One local residence would have a direct view of the well pad to the south. The resident here is the owner of the land on which the well would be located. This location would also be visible from three or four other oil & gas well pad locations in the vicinity.

CHAPTER 4
ENVIRONMENTAL IMPACTS

DIRECT AND INDIRECT IMPACTS

This EA tiers to the information and analysis contained in the San Juan/San Miguel Resource Management Plan and EIS (USDI/BLM 1985) and the Colorado Oil and Gas Leasing and Development Final EIS amendment to the Resource Management Plan (USDI/BLM 1991). The 1991 Resource Management Plan Amendment projected that oil and gas exploration over the life of the plan would result in approximately 1,430 acres of disturbance within the planning area. Approximately 410 acres of this disturbance would be long term (USDI/BLM 1991, page 4-31). The analysis determined that the cumulative impacts of oil and gas leasing and development would not be significant (USDI/BLM 1991, page 4-27).

PROPOSED ACTION

This section analyzes the impacts of the proposed action to those potentially impacted resources described in the affected environment Chapter 3, above.

Air Quality

Air emissions associated with oil and gas development and production activities primarily occur during well pad construction and drilling phases. Air emissions during construction activities include hydrocarbons, carbon monoxide, and nitrogen oxides associated with production equipment; gas-fired drilling equipment; and vehicle exhaust. Other air quality effects associated with the construction, drilling, and operation of the proposed wells and associated access roads and pipeline routes would occur from several sources:

- Suspended particulates (dust) generated during site clearing and from vehicular traffic on unpaved roads.
- Suspended particulates (dust) from wind erosion on cleared construction areas.
- Hydrocarbon emissions from the drill rig, service/support vehicles, and operation of gasoline and diesel engines (e.g., generators).

A temporary increase in emissions and fugitive dust is anticipated due to an increase in vehicle and equipment use in the area. However, the degree to which this increase would affect the air quality is difficult to predict due to variables such as vehicle speed, distance traveled, road conditions, duration of engine idling, and the effectiveness of smog control devices on vehicles.

Air quality effects from construction and drilling operations, primarily from vehicle/equipment exhaust and increased fugitive dust, would likely be localized to the proposed project area (1/2 mile radius) and short term. Drilling and construction activities would occur over an estimated 45 day period for each well. Therefore, air quality impacts and greenhouse gas emissions should be of short duration and are not considered significant.

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Indirect effects to air quality during the production phase would occur from vehicle travel on area roads during ongoing facility and well operation inspections. The operation of the wells and pipelines are not a source of emissions of monitored parameters. No compressors or other equipment with internal combustion engines are planned for the production facilities at these sites. No permits or authorizations are required from Colorado Air Quality Control Commission for project-related activities.

Proposed Air Quality Mitigation Measures

The entire Two Pinto Well Project is located on private lands. The surface-mitigation measures here are not intended to dictate the surface management on private lands. However, the following air-quality mitigation measures are recommended, by BLM, as best management practices (BMPs) that, if implemented, would reduce effects to the natural and human environment in the vicinity of the wells.

1. Construction activities that disturb a surface area greater than 1 acre and are of a duration greater than 5 days should use effective dust-suppression materials and techniques to prevent dust from visibly transporting from the area of disturbance (e.g., well pad, access road, or pipeline ROW) or drift more than 50 feet from the road prism.

   Effective dust abatement would be used to control air-born dust. Water or other dust suppressants would be used to the extent necessary to control dust during windy conditions or when traffic/construction activities create dusty conditions. This would reduce the amount of dust in the air and maintain good construction-site visibility and air quality for worker safety.

   This recommended BMP would prevent fugitive dust from leaving the construction zones of this project and, as a result, would prevent dust accumulation at local residences, reduce or eliminate dust pollution that is often associated with construction projects, and would reduce or eliminate the visual effects of blowing dust.

2. All activities should handle, transport, and store construction materials, such as excess pit spoils and topsoil storage piles, in such a way to prevent particulate matter (dust) from visibly transporting from the storage area or area of disturbance.

   This BMP, if implemented, would serve the same purpose as stated above - to maintain the air and visual quality of the agricultural community surrounding the project area.

3. No oil, solvents, or other unacceptable contaminates will be used in dust-abatement fluids.

   This mitigation measure would protect surface- and ground-water quality as well as soil quality and health. Additionally, the use of oil or other toxic materials to control dust would fall under the same category as a spill of toxic materials and would require cleanup.

Cultural Resources

The construction of the proposed well pads and access roads/pipelines would avoid all known cultural resource sites. No effects to significant cultural resources are expected to occur. However, there is a potential to encounter buried cultural deposits despite the lack of archaeological material on the present ground surface.

As per Conditions of Approval (Appendix B, numbers 11, 12, and 13), all construction personnel would be informed that disturbance, collecting, or removal of cultural resources is a violation of federal law and that disclosure or release of information regarding the nature and location of archaeological, historic, or sacred sites without written approval of the BLM is prohibited under provisions of the Archaeological Resources Protection Act.

Fish and Wildlife

A wildlife clearance report was completed on 4/09/2013. Impacts to: Threatened, Endangered, Proposed, and Candidate species listed under the Endangered Species Act, BLM Special Status Species, Birds of Conservation Concern, and migratory birds were addressed in the report. Only BLM special status species, birds of conservation concern, or migratory birds that may be impacted as identified in the report are addressed in the EA. Species not potentially affected are not addressed in the EA.

The proposed Pinto 1-7 well pad would remove approximately 3 acres of previously cultivated land that was enrolled in the Conservation Reserve Program. Vegetation removal would result in temporary habitat modification and loss. Approximately 2.4 acres would be reclaimed following drilling and completion. There would be a long term loss of approximately 1 acre due the decrease in habitat effectiveness and avoidance by wildlife.

During construction and drilling activities at the Pinto 1-7 location, there would be short-term effects to area wildlife as a result of human and vehicular activity, increased noise, and night-lighting. Wildlife would be temporarily displaced and would avoid the project area. However, wildlife could return to the area after construction is completed. During the production period, there would be an increase of one to two tanker-truck and/or pick-up truck trips per week to the proposed well to remove stored liquids from the site and for routine maintenance. This increased traffic would not measurably impact wildlife species within the proposed project area. The current access is on existing county roads.

Construction activities could directly disturb birds, including raptor species occupying canyon habitat adjacent to the Pinto #1-7 due to increased noise, night-lighting, and human activity. Potential disturbance could cause birds to change their normal breeding, foraging, and nesting behavior. Disturbance would be highest during construction and drilling, then decreasing to intermittent disturbance during long-term operation and maintenance of the wells. The duration of construction activities for the proposed wells would be for approximately a period of four weeks, thereby limiting the severity of potential impacts to a short time period for any specific area.

Bat roosting habitat in the project area is comprised of rock crevices and piñon and juniper trees.

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No snags or rock crevices are proposed to be disturbed during construction; however the disturbance may preclude the use of the area during construction for any tree roosting species. Bats may be drawn to the area during drilling operations due to increased insects attracted to the rig lights. Long term impacts may result in the 'take' of individuals depending upon the equipment and design at the well location. Meter runs, treaters, vent pipes and other oil and gas facilities present potential roost habitat for various bat species. Exhaust stacks on oil and gas equipment have been known to trap and kill birds and bats. Exhaust stacks and vent pipes covered with screen can exclude birds and bats from nesting and roosting in potentially hazardous production equipment.

To access the proposed Pinto #3-17 well pad, an existing two-track would be upgraded. The proposed Pinto #3-17 well pad and pipeline would be located within tilled cropland. There would be no native vegetation removed. Short-term impacts to wildlife from development of the proposed Pinto #3-17 would be limited to avoidance during construction and drilling. During the production period, there would be an increase of one to two tanker-truck and/or pick-up truck trips per week to the proposed well to remove stored liquids from the site and for routine maintenance. This traffic increase is not expected to measurably impact wildlife species within the proposed project area.

Proposed Wildlife Mitigation Measures

As previously stated, the entire Two Pinto well project is located on private lands. The surface-mitigation measures listed here are not intended to dictate the surface management on private lands. However, the following wildlife mitigation measures are recommended, by BLM, as best management practices (BMPs) that, if implemented, would reduce or avoid effects to wildlife populations and the important natural human/wildlife interactions in the vicinity of the wells.

1. Drilling, Completion, Production, Emergency, or NPDES pits must be maintained to exclude wildlife at all times. The operator shall install fencing and/or other deterrents necessary to preclude access to pits by wildlife. Other deterrents to preclude pit access may include screening and/or netting. Flagging is not considered an effective deterrent and is not allowed (USFWS 2011). If netting is used to exclude wildlife it needs to be maintained so it does not become a trap for wildlife. This mitigation measure is required to meet the intent of the Migratory Bird Treaty Act, 16 U.S.C. 703.

2. BLM recommends that equipment used for production be maintained and/or modified to minimize noise impacts to wildlife. If this recommendation were implemented, it would benefit local wildlife populations by reducing noise disturbance during important phases of their reproduction cycles and would reduce noise for local human residents as well.

3. Production equipment with vent pipes, exhaust stacks, or other areas that may provide access for migratory birds and bats must be screened to exclude wildlife. Mesh screening must be no larger than ¼ inch. This mitigation measure is required to meet the intent of the Migratory Bird Treaty Act, 16 U.S.C. 703.

4. BLM recommends that when brush hogging or mowing, operators ensure that no active migratory bird nests are destroyed. Destruction of an active nest may result in a violation of the Migratory Bird Treaty Act. To ensure compliance, no activity should take place between May 15 and June 15 annually to protect nesting migratory birds. If activities must take place during this time period, pre-construction surveys should be conducted for any activities after May 15, to clear for nesting migratory birds.

5. If power lines are needed for production facilities, BLM recommends that they be buried whenever possible in the project area to protect bald eagles and other important wildlife. When it is not possible to bury them, overhead power lines should be constructed to standards identified by the Avian Power Line Interaction Committee (most recent version) to minimize raptor electrocution potential.

6. As agreed at the on-site meeting For Pinto 1-7, held on June 4, 2012, , no surface disturbing activity would be allowed within ½ mile of documented active raptor nests from February 1 through July 31, annually. The presence of an active raptor nest would be based on a raptor nest occupancy survey for the current breeding season. This timing limitation date will be adjusted for species-specific guidance. The timing limitation applies to construction, drilling, completions operations, placing of production equipment, and associated infrastructure to include roads, pipelines, power lines, etc.

7. If the proposed action is not completed by March 15, 2014, then the raptor survey requirements of #6, above would be carried through to 2014 operations prior to any activities taking place.

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Threatened or Endangered Species

Table 5 - Federally listed species for the BLM Tres Rios Field Office based on July 14th, 2010 list from the USFWS and the quarterly updates received at the Tres Rios Field Office.

Species	Status	Presence	Project Effects	Rationale
Canada lynx	Threatened	NP	NE	No habitat in project area
New Mexico jumping mouse	Candidate	NP	NE	No habitat in project area
Gunnison sage-grouse	Proposed	NP	NE	No grouse in project area
Gunnison sage-grouse critical habitat	Proposed	K	NE	Project area does not meet constituent elements.
Mexican spotted owl	Threatened	NP	NE	No habitat in project area
Southwestern willow flycatcher	Endangered	NP	NE	No habitat in project area
Yellow-billed cuckoo	Candidate	NP	NE	No habitat in project area
Bonytail	Endangered	NP	LAA	Water depletions
Colorado pikeminnow	Endangered	NP	LAA	Water depletions
Greenback cutthroat trout	Threatened	NP	NE	No habitat in project area, outside watershed
Humpback chub	Endangered	NP	LAA	Water depletions
Razorback sucker	Endangered	NP	LAA	Water depletions
Uncompahgre fritillary butterfly	Endangered	NP	NE	No habitat in project area

**Project effect determinations are: no effect (NE); may affect (MA); not likely to adversely affect (NLAA); likely to adversely affect (LAA). Presence determinations are: habitat not present (NP); habitat present species not expected to occur (NS); suspected occurrence (S); known occurrence (K)*

Site-specific evaluation of the proposed critical Gunnison sage-grouse habitat resulted in a determination that the habitat in the project area for the two wells is not suitable in its present state and does not provide habitat necessary to meet the primary constituent element in the proposed rule for critical habitat. Therefore, the impacts from the project activities will have no effect on proposed critical habitat and the Proposed Action will have no effect on Gunnison sage-grouse. No other threatened or endangered plants or animals are known to occur in the area.

Given that the proposed action would result in the depletion of approximately 1.29 acre-feet of water from within the Colorado River basin, this project falls under BLM Colorado's Programmatic Biological Assessment (PBA) for water depleting activities associated with BLM's fluid minerals program in the Colorado River basin in Colorado (BLM 2008).

In response to BLM's PBA, the U. S. Fish and Wildlife Service (USFWS) issued a Programmatic Biological Opinion (PBO) (ES/GJ-6-CO-08-F-0006) on December 19, 2008, which concurred with BLM's determination that water depletions are "Likely to Adversely Affect" the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker. Likewise, the project is also likely to adversely affect designated critical habitats for these endangered fish along the Green, Yampa, White, Colorado, and Gunnison rivers. However, the USFWS also determined that BLM water depletions from the Colorado River Basin are not likely to jeopardize the continued existence of the Colorado pikeminnow, humpback chub, bonytail, or

razorback sucker, and that BLM water depletions are not likely to destroy or adversely modify designated critical habitat.

A Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin was initiated in January 1988. The Recovery Program serves as the reasonable and prudent alternative to avoid jeopardy and aid in recovery efforts for these endangered fishes resulting from water depletions from the Colorado River Basin. The PBO addresses water depletions associated with fluid minerals development on BLM lands, including water used for well drilling, hydrostatic testing of pipelines, and dust abatement on roads. The PBO includes reasonable and prudent alternatives developed by the USFWS which allow BLM to authorize oil and gas wells that result in water depletion while avoiding the likelihood of jeopardy to the endangered fishes and avoiding destruction or adverse modification of their critical habitat. As a reasonable and prudent alternative in the PBO, USFWS authorized BLM to solicit a one-time monetary contribution to the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) in the amount equal to the average annual acre-feet depleted by fluid minerals activities on BLM lands.

This project has been entered into the Tres Rios Field Office fluid minerals water depletion log which will be submitted to the Colorado State Office at the end of the Fiscal Year.

Lands/Access

Drilling operations would increase traffic, including heavy truck traffic, on local county roads for a period of about 45 days per each well or, roughly, a total of 3 months. If the wells are economically productive, production operations may continue for up to about 30 years. During that production period, there would be an increase of one to two tanker-truck and/or pick-up truck trips per week to recover liquid resources gathered at the site and for routine maintenance. Based on the anticipated increase in vehicle traffic during construction, drilling, and production, the proposed action would measurably increase traffic impacts on area roads. Impacts would include, but are not necessarily limited to: increased noise, safety concerns attendant with increased traffic, increase in large truck traffic, potential for spills from trucks, increased wear and tear on paved county roads, and increased need for county road maintenance and repairs.

Soils

The proposed action would result in temporary displacement, compaction, and mixing of approximately 11.28 acres soils in the project area. Accidental spills or releases of hazardous substances could result in soil contamination requiring remediation. Temporary reduced capacity for plant growth due to removal and/or disturbance of the soil would be an additional direct effect. Due to the susceptibility of the project area soils to wind and water erosion, construction activities may cause loss of some upper soil layers.

The proposed action would result in the scraping and temporary removal of the topsoil as the roads and pipelines are constructed and the well pads are leveled. Topsoil will be excavated, separated, and stored inside the construction buffer. All stockpiled soils would be protected from degradation due to contamination, compaction, and erosion by wind and water during drilling and completion operations.

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Interim reclamation would replace all stockpiled topsoil to its original relative position and contoured and seeded as practicable to achieve erosion control and long-term stability and soil health.

Best management practices would be implemented to prevent noxious weed establishment (Appendix B, #23). Interim reclamation best management practices would be implemented, as per Appendix B, numbers, 33-37, to stabilize and protect soils in the project areas.

Water Resources/Water Quality

The proposed action would temporarily disturb an estimated 11.28 acres of soil that, if not mitigated, could serve as a sediment source to adjacent drainages. Disturbance of soils, particularly near washes and on slopes, would lead to a potential increase in the amount of sediment transport from the project area, particularly during and following storm events. Slight alterations in the project area drainage patterns may also lead to an increase in sediment transport. However, the storm-water-control plan for these wells contains mitigation measures designed to reduce or eliminate sediment moving off-site or into area drainage ways. In addition, the planned interim reclamation and reestablishment of healthy vegetation cover will facilitate stabilization of the disturbed areas and, once accomplished, would eliminate the potential for sediment transport from areas disturbed by project activities.

As in any drilling operation, there is a potential for contamination of aquifers through co-mingling in the wellbore. However, placing sealed surface casing in the wellbore to protect ground-water resources is a required standard procedure. The surface casing is set to a depth well below the potential ground-water aquifer system and the casing is sealed with concrete along the entire length to prevent water movement along the well bore hole.

The operator's proposed drilling plans were reviewed by a BLM geologist and a BLM petroleum engineer as part of the BLM's APD approval process. It was determined that D.J. Simmons's drilling plan included procedures adequate to protect ground water aquifers. Design features and conditions of approval related to lining pits and immediate spill clean-up (Appendix B, numbers 3, 7, 17, and 21) are designed to protect surface-water and shallow ground-water resources and other resources.

Additional requirements were agreed upon at the on-site inspection, requiring drainage protection for any water that may leave the site during storm events. D.J. Simmons would provide adequate storm-water protection as required by Colorado law.

Visual Resources

Both proposed well pads would be constructed on private lands. Drill rigs, trailer and equipment storage, and vehicle use would occur at the well pad locations during drilling activities. The 132-foot high drill rig derricks and nighttime lighting on the derricks would be visible above surrounding vegetation for three to four weeks at each well site during well drilling activities.

The completed well pads and their associated storage tanks would be visible from various local points along county roads and from local agricultural fields. However, interim reclamation to reduce the size of the well pad to a small, tear-drop shape, re-vegetation of reclaimed areas, and painting the facilities with a flat, earth-tone color as recommended in Appendix B, # 38, would

make the well pad facilities blend into the surrounding colors and forms fairly well. As such, the facilities would not tend to dominate the view for the casual observer.

The proposed Pinto 1-7 well pad would be located on previously cultivated land adjacent to County Road 4 that has been enrolled in the Conservation Resource Program. Drilling and production activities on Pinto 1-7 would be readily visible from the approach on County Road 4 and where the road passes the proposed well site. Changes to existing landform, vegetation, and structures from project activities would result in a weak to moderate degree of contrast in form, line, texture, and color.

The proposed Pinto 3-17 well pad would be located on active, tilled, dry-land farm land. Drilling and production activities on Pinto 3-17 would be visible from various points along County Road S, County Road 5 and County Road T - all approximately 1/2 -mile from the well site - and from various points in the surrounding agricultural fields. Various visibility screens such as wind-block rows of trees, stands of P-J forests, and topography would make the views of this site intermittent, depending on perspective. Degree of visibility would vary by season because the color used to paint the facilities on site would blend in better during the summer months when crops are on the fields, as opposed to snow-covered fields in the winter and brown, tilled fields in the spring. Changes to existing landform, vegetation, and structures from project activities would result in a weak to moderate degree of contrast in form, line, texture, and color.

NO ACTION ALTERNATIVE

The no-action alternative would not meet the purpose and need for the proposed action. Under the no action alternative, the proposed natural gas well pads, access roads, and well-tie pipelines would not be constructed nor the wells drilled. The no-action alternative would result in the continuation of the current land and resource uses in the project area. There would be no environmental impacts from the no-action alternative as described above to Air Quality; Cultural Resources, Fish and Wildlife species, Threatened or Endangered Species, Lands and Access, Soils, Water Resources and Water Quality, and Visual Resources. Therefore, the environment would remain as described in Chapter 3.

CUMULATIVE IMPACTS

This section analyzes the environmental consequences of the proposed action to those potentially impacted resources described in the Chapter 3: Affected Environment.

The proposed action would result in approximately 11.28 acres of short-term disturbance. Following interim reclamation, the proposed action would contribute approximately 2.4 acres of long-term disturbance for operation and access in the planning area.

The proposed action is not expected to cumulatively impact cultural resources, land ownership, or access as these resources are not expected to be directly or indirectly affected. The proposed action would result in cumulative impacts to air quality, wildlife habitat, soils, and water resources.

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Air Quality

The cumulative impacts analysis area for air quality is the San Juan airshed. Past, present and reasonably foreseeable development that has and would affect air quality include: coal-fired power plants operated in the Four Corners area; windblown dust from exposed soils, dirt and gravel roads, and soil erosion; vehicle emissions; agricultural practices such as burning irrigation ditches and tilling soils; emissions from oil and gas and mineral development construction and operation activities including vehicle operations. Farming and livestock herding activities have and would continue to impact local air quality primarily from fugitive dust and vehicle emissions. The proposed action would contribute a small incremental increase in overall hydrocarbon emissions, including greenhouse gases (GHGs), NO_X, and volatile Organic Compounds (VOCs). When combined with impacts from past, present, and reasonably foreseeable development, the proposed action would result in synergistic and long-term additive impacts to air quality in the San Juan airshed.

Fish and Wildlife

The cumulative impacts analysis area for general wildlife is the San Juan/San Miguel planning area. The 1991 Resource Management Plan Amendment projected that oil and gas exploration over the life of the plan would result in approximately 1,430 acres of disturbance within the planning area. Approximately 410 acres of this disturbance would be long term (USDI/BLM 1991, page 4-31). In the analysis area, impacts to wildlife and habitat have resulted from residential, commercial, and community development; agricultural and grazing land use; industrial development including oil and gas development; and land management activities such as prescribed burning. The proposed action would contribute approximately 2.4 acres of long-term disturbance to wildlife habitat within the analysis area. The cumulative impact of the proposed action on wildlife—when considered with past, present and reasonably foreseeable activities in the analysis area—is expected to be additive and long term.

Soils

The cumulative impacts analysis area for soils and water resources is the San Juan/San Miguel planning area. Past, present, and future developments are expected to result in a range of short- and long-term impacts to soils including disturbance, temporarily increasing erosion prior to reclamation, and reducing soil loss to erosion where reclamation and re-vegetation occurs. A maximum of 11.28 acres of soil would be disturbed by the proposed action and all but about 2.4 of that area would be interim-reclaimed to its original land use. Also, the soil types affected by this project are abundant in the San Juan River Watershed. Therefore, any impact from the proposed action is not expected to contribute appreciably to cumulative impacts to soils when added to past, present, and reasonably foreseeable actions. Cumulative impacts on approximately 2.4 acres of soils affected by the proposed action would be long term (approximately 30 years) and additive.

Water Resources

Past activities that have contributed to water quality impacts in the analysis area include sedimentation resulting from surface disturbance associated with residential, commercial,

agricultural, and industrial development as well as land management activities (e.g., prescribed fires). Given the minimal amount of surface disturbance (coupled with design features and conditions of approval), the cumulative impacts of the proposed action on surface and groundwater resources are expected to be short to long term, and additive when added to past, present and reasonably foreseeable development.

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CHAPTER 5
PERSONS, GROUPS, AND AGENCIES CONSULTED

Table 6. List of Persons, Agencies and Organizations Consulted

Name	Purpose and Authorities for Consultation or Coordination	Findings Conclusions
Brian Magee, Colorado Parks and Wildlife	Information on special status species.	The proposed action requires mitigation measures for protection of raptors.
Chris Lopez and Craig Starkey, D.J. Simmons	Information regarding the proposed action.	
Cindy Crist, Soil Conservationist, USDA/ NRCS	Information regarding Soils and Prime Farmlands	

Table 7. List of Preparers

Name	Title	Responsible for the Following Section(s) of this Document
Robert Garrigues	BLM Natural Resource Specialist	Project Manager, technical coordination and quality control, impact analyses for water resources/water quality, and soils.
Nate West	BLM Wildlife Biologist	Impact analyses for wildlife and TES
Julie Bell	BLM Archaeologist	Impact analysis for cultural resources
Kelly Palmer	San Juan Nat'l Forest Hydrologist	Impact analyses for air quality, water resources/water quality, and soils.
Jeff Christenson	BLM Outdoor Recreation Planner	Impact analysis for Visual Resources
Gina Jones	BLM NEPA coordinator	Review
Tracy Perfors	BLM Natural Resource Specialist	Review

Table 8. List of Non-BLM Preparers

Name	Title	Responsible for the Following Section(s) of this Document
Elizabeth Burak	Project Manager, Ecosphere	Chapters 1 and 2, technical review
Lucas Phipps	GIS Analyst/Biologist, Ecosphere	Chapters 1-5, biological resources and impacts analysis.
Joey Herring	Senior Project Manager, Ecosphere	Chapters 1-5, quality control and

		coordination.
Jerry Fetterman	Woods Canyon Archaeological Consultants	Archaeological surveys and report

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CHAPTER 6
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APPENDICES

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APPENDIX A
INTERDISCIPLINARY TEAM CHECKLIST

Project Title: Two Pinto Wells Project

NEPA Log Number: DOI-BLM-CO-S010-2012-0035-E

Project Leader: Robert Garrigues

DETERMINATION OF STAFF: ***(Choose one of the following abbreviated options for the left column)***

NP = not present in the area impacted by the proposed or alternative actions
NI = present, but not affected to a degree that detailed analysis is required
PI = present with potential for relevant impact that need to be analyzed in detail in the EA
NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section D of the DNA form. The Rationale column may include NI and NP discussions.

Determination	Resource	Rationale for Determination*	Signature	Date
RESOURCES AND ISSUES CONSIDERED (INCLUDES SUPPLEMENTAL AUTHORITIES APPENDIX 1 H-1790-1)				
PI	**Air Quality**	**Local air quality would be directly impacted by the proposed action.**		
NP	Areas of Critical Environmental Concern	No ACECs in or in close proximity to the proposed project areas	R.S. Garrigues	7/7/13
NP	BLM Natural Areas	No BLM Natural Areas in or in close proximity to the proposed project areas.	R.S. Garrigues	7/7/13
PI	**Cultural Resources**	**Cultural resources occur within the Class III archeological survey area.**	[signature]	5/22/13
NI	Greenhouse Gas Emissions	The proposed action will not result in substantial greenhouse gas emissions		
NI	Environmental Justice	No adverse effects to low-income or minority populations would occur.	R. Garrigues	7/7/13
NI	Farmlands (Prime or Unique)	The project areas are located within Prime Farmlands if irrigated. However; current land use does not employ irrigation.	R. Garrigues	7/7/13
PI	**Fish and Wildlife Excluding USFW Designated Species**	**The proposed actions could affect general wildlife.**	[signature]	5/22/2013
NP	Floodplains	No floodplains located within the proposed project areas.		
NP	Fuels/Fire Management	Proposed actions are located on private lands.	R. Garrigues	7/7/13
NI	Geology / Mineral Resources/Energy Production	The proposed actions would affect mineral resources and energy production. These impacts are not expected to be significant.	R. Garrigues	7/7/13
NI	Invasive Species/Noxious Weeds	No invasive species or noxious weeds were found within the proposed project areas.	R. Garrigues	7/7/13
PI	**Lands/Access**	**The proposed actions would construct/improve two roads on private property to access the sites. Traffic increases would occur on local county roads.**	R. Garrigues	7/7/13
NP	Livestock Grazing	The proposed actions are located on private lands that are not used for livestock grazing.	R. Garrigues	7/7/13
NI	Migratory Birds.	The proposed actions would impact migratory bird habitats; however, these impacts would not be significant.	[signature]	5/22/2013
NP	Native American Religious Concerns	No known Native American religious concerns (traditional cultural properties) within the proposed project areas.	[signature]	5/22/13

Determination	Resource	Rationale for Determination*	Signature	Date
NP	Paleontology	There are no known paleontology resources within the proposed project areas.	R. Garrigues	7/7/13
NP	Rangeland Health Standards	The proposed actions would be located on private lands and there are no effects on rangelands	R Garrigues	7/7/13
NP	Recreation	The proposed actions would be located on private lands and would not affect recreation resources		5/22/13
NI	Socio-Economics	No negative effects to socioeconomic conditions anticipated. Positive economic effects to county.	R. Garrigues	7/7/13
PI	**Soils**	**The proposed actions would impacts soils.**		
NP	Threatened. Endangered or Candidate Plant Species	No suitable habitat for any federally listed threatened, endangered, or candidate plant species.	R. Garrigues (as per personal comm. 7/8/13)	7/8/13
PI	**Threatened, Endangered or Candidate Animal Species**	**The project is likely to adversely affect fish species associated with the Colorado River System.**		5/22/2013
NI	Wastes (hazardous or solid)	No chemicals subject to the Superfund Amendments and Reauthorization Act Title III in amounts greater than 10.000 pounds will be used during project activities. No extremely hazardous substances as defined in 40 CFR 355 in threshold planning quantities will be used.	R. Garrigues	7/7/13
PI	**Water Resources/Water Quality**	**The proposed actions could impact surface and ground-water resources primarily from increased sedimentation or accidental spills.**		
NP	Wetlands/Riparian Zones	No wetlands or riparian zones are within the proposed project areas.		
NP	Wild and Scenic Rivers	No Wild and Scenic Rivers are within the proposed project areas.	R. Garrigues	7/7/13
NP	Wilderness/WSA	No Wilderness or Wilderness Study Areas are located within the proposed project areas.		5/22/13
NP	Woodland / Forestry	No saleable forestry products are within the proposed project areas. The proposed actions would be located on private lands.		
NI	Vegetation Excluding USFW Designated Species	Vegetation and cropland would be impacted by the proposed actions. These impacts would not be significant and would occur on private lands.	R. Garrigues	7/7/13
PI	**Visual Resources**	**Visual impacts would occur during construction and drilling. There would be long-term impacts from aboveground facilities. Visual resource BMPs will be implemented to mitigate visual impacts.**		5/22/13
NP	Wild Horses and Burros	No wild horses or burros are within the proposed project areas.	R. Garrigues	7/7/13
NP	Areas with Wilderness Characteristics**	No areas with Wilderness characteristics fall within the proposed project areas.		5/22/13

FINAL REVIEW:

Environmental Coordinator	Gina Jones	5/21/13	Gina Jones
Authorized Officer			

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APPENDIX A
INTERDISCIPLINARY TEAM CHECKLIST

Project Title: Two Pinto Wells Project

NEPA Log Number: DOI-BLM-CO-S010-2012-0035-E

Project Leader: Robert Garrigues

DETERMINATION OF STAFF: ***(Choose one of the following abbreviated options for the left column)***

NP = not present in the area impacted by the proposed or alternative actio
NI = present, but not affected to a degree that detailed analysis is required
PI = present with potential for relevant impact that need to be analyzed in detail in the EA
NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section D of the DNA form. The Rationale column may include NI a NP discussions.

Determination	Resource	Rationale for Determination*		Signature	Date
RESOURCES AND ISSUES CONSIDERED (INCLUDES SUPPLEMENTAL UTHORITIES APPENDIX 1 H-1790-1)					
PI	**Air Quality**	**Local air quality would be directly impacte**	**y the**	Kerry Pam	6/21/13
NP	Areas of Critical Environmental Concern	No ACECs in or in close proximity to the proj	ed project areas		
NP	BLM Natural Areas	No BLM Natural Areas in or in close proximi	to the proposed project areas.		
PI	**Cultural Resources**	**Cultural resources occur within the Class I archeological survey area.**		Del Bell	5/22/13
NI	Greenhouse Gas Emissions	The proposed action will not result in substan	greenhouse gas emissions	Kerry Pam	6/21/13
NI	Environmental Justice	No adverse effects to low-income or minority	populations would occur.		
NI	Farmlands (Prime or Unique)	The project areas are located within Prime Fa	lands if irrigated. However, current land use does not employ irrigation.		
PI	**Fish and Wildlife Including USFW Designated Species**	**The proposed actions could affect general**	**dlife.**	Matthew Blakeman	5/22/2013
NP	Floodplains	No floodplains located within the proposed p	ect areas.	Kerry Pam	6/21/13
NP	Fuels/Fire Management	Proposed actions are located on private lands			
NI	Geology / Mineral Resources/Energy Production	The proposed actions would affect mineral re	urces and energy production. These impacts are not exp ted to be significant.		
NI	Invasive Species Noxious Weeds	No invasive species or noxious weeds were f	nd within the proposed project areas.		
PI	**Lands/Access**	**The proposed actions would construct/imp**	**ve two roads on private property to access the sit Traffic increases would occur on local county roa**		
NP	Livestock Grazing	The proposed actions are located on private l	ds that are not used for livestock grazing.		
NI	Migratory Birds.	The proposed actions would impact migrato	bird habitats; however, these impacts would not b significant.	Matthew Blakeman	5/22/2013
NP	Native American Religious Concerns	No known Native American religious concer	(traditional cultural properties) within the proposed proj areas.	Del Bell	5/22/13

Determination	Resource	Rationale for Determination*		Signature	Date
NP	Paleontology	There are no known paleontology resources w	lin the proposed project areas.		
NP	Rangeland Health Standards	The proposed actions would be located on pri	ıe lands and there are no effects on rangelands		
NP	Recreation	The proposed actions would be located on pri	ıe lands and would not affect recreation resources		5/22/13
NI	Socio-Economics	No negative effects to socioeconomic conditi	s anticipated. Positive economic effects to cou		
PI	**Soils**	**The proposed actions would impacts soils.**			6/21/13
NP	Threatened, Endangered or Candidate Plant Species	No suitable habitat for any federally listed thr	ıened, endangered, or candidate plant species.		
PI	**Threatened, Endangered or Candidate Animal Species**	**The project is likely to adversely affect fish**	**ıecies associated with the Colorado River System**		5/22/2013
NI	Wastes (hazardous or solid)	No chemicals subject to the Superfund Amen Reauthorization Act Title III in amounts grea 10,000 pounds will be used during project act extremely hazardous substances as defined in in threshold planning quantities will be used.	ıents and than ties. No l CFR 355		
PI	**Water Resources/Water Quality**	**The proposed actions could impact surface**	**ıd ground-water resources primarily from increased sedimentation or accidental spills.**		6/21/13
NP	Wetlands/Riparian Zones	No wetlands or riparian zones are within the p	posed project areas.		6/21/13
NP	Wild and Scenic Rivers	No Wild and Scenic Rivers are within the pro	sed project areas.		
NP	Wilderness/WSA	No Wilderness or Wilderness Study Areas ar	ocated within the proposed project areas.		5/22/13
NP	Woodland / Forestry	No saleable forestry products are within the p	posed project areas. The proposed actions would be	ated on private lands.	
NI	Vegetation Excluding USFWS Designated Species	Vegetation and cropland would be impacted l	the proposed actions. These impacts would not b	ignificant and would occur on private lands.	
PI	**Visual Resources**	**Visual impacts would occur during constru**	**ion and drilling. There would be long-term impact**	om aboveground facilities. Visual resource BM	will be **implemented to mitigate visual impacts.**		5/22/13
NP	Wild Horses and Burros	No wild horses or burros are within the propo	d project areas.		
NP	Areas with Wilderness Characteristics**	No areas with Wilderness characteristics fall	thin the proposed project areas.		5/22/13

FINAL REVIEW:

Environmental Coordinator	Gina Jones	6/21/13	Gina Jones
Authorized Officer			

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Appendix B
Surface Use Design Features, Conditions of Approval, and Proposed Mitigation Measures

D.J. Simmons, Inc.

Pinto 1-7 and Pinto 3-17 Well Pads, Access Roads,

and Pipelines

Dolores County, Colorado

The following is a compilation of all Design Features, proposed Mitigation Measures and proposed Conditions of Approval (collectively referred to as COAs) identified during the EA analyses. If approved in the Decision Record, these COAs will take precedence over any or all terms and conditions set forth in the Applications for Permits to Drill (APD). D.J. Simmons, Inc. (D.J. Simmons) and its contractors should refer to these COAs and the APD package for specific information associated with construction, drilling, production, and reclamation.

Exceptions or waivers from these COAs are only granted with written permission from the BLM Authorized Officer.

The following Design Features and COAs are required on BLM and private lands. However, some COAs may be waived by the private landowner if their written request for a waiver is approved by the BLM and the COGCC.

Design Features

The following design features were proposed by the project proponent and were included in the project proposal as best management practices designed to minimize or eliminate potential impacts to the environment.

1. Stripped topsoil would be segregated outside of the well pad work area, but within the construction boundary limit. 100-percent of the stripped topsoil would be utilized for interim reclamation activities.

2. Water for drilling and completion would be hauled by truck from a permitted water source. The drill cuttings, fluids, and completion fluids would be placed in a reserve pit, which would be lined according to COGCC Rule 904.

3. Drilling mud will consist of fresh water and will not be salt saturated or oil-based. The drill cuttings, fluids, and completion fluids will be placed in the reserve pit. Reserve pits will be lined according to Colorado Oil and Gas Conservation Commission Rule 904 and all will be constructed to prevent leakage from occurring and will not be located on a natural drainage. Upon completion of drilling, testing, and completion of the well, the reserve pit will be allowed to dry, and materials remaining in the reserve pit buried. The reserve pit will be backfilled, leveled, and contoured so as to prevent any materials being carried into the watershed.

4. All garbage and trash material would be contained on location in an industry-approved trash container and would be removed from the site for proper disposal (see #14, below for additional COAs related to this design feature).

5. Industry approved chemical toilets will be provided and maintained during drilling, testing, and completion operations.

6. Following drilling and completion, interim reclamation, as per the surface use plan submitted with the APD, would reduce the amount of surface disturbance to approximately 1 acre per each well pad (see numbers 33 - 35, below for additional COAs related to this design feature).

7. The reserve pit closure and reclamation would be conducted as per COGCC Rule 1003.d. The reserve pit would be backfilled, leveled, and contoured as part of the interim reclamation.
8. Weed control measures would be implemented in compliance with Colorado Noxious Weed Act, C.R.S. §35-5.5-115 and, at a minimum, to the Dolores County Development and Land Use Regulations, (Amended Nov. 2012), Article IV - Performance Standards, Section 2, Paragraph C - Noxious Weeds, page 14 (see #23, below for additional COAs related to this design feature).
9. During final reclamation, following abandonment of the wells, the locations and access roads would be reclaimed and restored as close to the original topographic contours as possible and reseeded. The access road at Pinto 3-17 would be reclaimed at the discretion and direction of the land owner who may want the road left, in some form, for access to fields (see numbers 36 and 37 below for additional COAs related to this design feature).

Proposed Required Conditions of Approval (COAs)

The following COAs are required by the BLM to protect various environmental resources.

10. The operator or operator's contractor will contact the BLM Authorized Officer (Robert Garrigues at 970-882-6845) at least seven (7) days before beginning any surface-disturbing activities and at least seven (7) days before beginning any reclamation.

11. Before beginning any work, it is the responsibility of the operator to inform all employees, contractors, and subcontractors of applicable cultural resource laws and regulations as well as the project-specific measures for protecting cultural resources. Disturbance to, defacement of, or collection or removal of archaeological, historical, or

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sacred material is prohibited by law. Disclosure or release of information regarding the nature and location of archaeological, historic, or sacred sites, without written approval by the Bureau of Land Management (BLM) is prohibited by law

12. Disclosure or release of information regarding the nature and location of archaeological, historic, or sacred sites, without written approval by the BLM, is prohibited under provisions of the Archaeological Resources Protection Act. Cultural resource consultants and other permitees of the BLM are allowed to use this information during the course of the project for site protection purposes only. Unauthorized use or distribution of this information (which includes site location information present in cultural resource reports) is a violation of Federal statute.

13. If cultural resources or human remains, funerary items, sacred objects, or objects of cultural patrimony are discovered during construction, activity in the vicinity of the resource will cease, the resource will be protected, and Julie Bell, BLM Archaeologist at 970-882-6832, and/or Robert Garrigues, BLM Project Manager at 970-882-8645, will be notified immediately and the following procedures will be carried out. The operator shall take any measures requested by the BLM to protect the resources until they can be evaluated and treated. The discovered resources will be documented and evaluated by a permitted archaeologist. The permitted archaeologist, in consultation with the BLM archaeologist, will make a determination of the nature and significance of the discovery, and will determine the appropriate method of treatment for it. Avoidance is the preferable treatment. However, if the resources cannot be avoided, the appropriate treatment method will be determined, and the permitted archaeologist will prepare any and all necessary treatment plans. These plans will be reviewed and approved by the BLM. Treatment activities will be conducted after all necessary consultations have been completed as required by Section 106 of the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and the Archaeological Resources Protection Act. The BLM will be responsible for conducting all necessary consultations. Construction within the area of the discovery will be allowed to proceed after the appropriate treatment has been completed.

14. Throughout the lifetime of the project, trash and debris will be collected from the location and the surrounding area and removed to an approved sanitary landfill. During construction and drilling, the operator will collect trash and debris on a regular schedule of at least once per week from the project area. This trash can be stored in an appropriate on-site trash bin that will prevent loss due to wind and which will be periodically hauled to a permitted land fill or disposal site.

15. Storm-water controls will be implemented, inspected, and maintained for the well pads, roads, pipelines, if applicable, for the life of the project. They should be sized for a 25-year storm. Any unsatisfactory storm-water controls (by evidence of wind or water erosion or cutting, or sedimentation transported off the project area) will be replaced or upgraded as needed. All storm-water controls needed during the construction phase of this project must be installed before ground disturbance begins.

16. Storm-water control measures will be designed by a specialist with proof of training in storm-water management, design, and implementation of best management practices (BMPs) for storm-water control. The specialist must be qualified to design the storm-water control systems, supervise the installation/construction of storm-water control features and, to ensure adequate storm-water management. Training certified by the Colorado Dept. of Transportation (CDOT) or Colorado Dept. of Public Health and Environment (CDPHE) or similar entities from other states would qualify as adequate training. If the operator does not have a trained storm-water specialist on staff, a storm-water specialist should be hired to do the designs and supervise the installation.

17. Spills and leaks will be cleaned up immediately, and contaminated soils will be removed to a permitted disposal site. BLM spill reporting procedures will be followed.

18. A copy of Appendix B and the operator's Surface Use Plan of Operations must be located at the well pad during construction, drilling, and completion activities.

19. For any well pad locations with any slope across the pad area, an "eyebrow ditch" shall be installed above the locations on the uphill side. The intent of the eyebrow ditch is to intercept surface water flows and disperse the water to either side of the location. The ends of the ditch or "daylight" ends should be placed in native soils, within undisturbed areas. Any natural moisture will be diverted off of the pads and away from the location. The well pads would be designed in such a manner as not to allow runoff water to enter the pads.

20. The top six-inches of topsoil will be stripped and stockpiled within the authorized area of disturbance for use in reclamation. To preserve topsoil health and viability, the topsoil stockpile should, preferably, be distributed in low berms around the sides of the well pad. These berms can be used to form the storm-water-controlling eye-brow ditches required in COA, 12, above. Topsoil storage piles shall not be more than 3-feet high (deep). If the topsoil stockpile is not used within 6 months, it will be seeded to ensure topsoil integrity and prevent erosion.

21. Degreasing of machinery or equipment is not allowed on location.

22. Water withdrawals from surface waters require notification to the State of Colorado by the company and the water rights holder if using a private water right that is not decreed for industrial use. The Colorado Division of Water Resources (WRD) requests notification 2 weeks prior to the beginning of surface waters withdrawals to determine if there is a call on or below the withdrawal point. Regardless of when or how fresh water is used, the WRD will be notified and allowed to respond before water is withdrawn from any surface waters in Colorado. The contact office for Southwestern Colorado is the Division of Water Resources in Durango, Colorado (970-247-1845), and for the Water Commissioner for the Dolores River is 970-565-0694. After the drilling operations are completed, a final estimate of the volume of water used for all activities should be submitted in writing to the State of Colorado. If required by WRD, the operator must apply and obtain water rights prior to water withdrawals. The operator will comply with all state and local water laws and regulations.

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23. The Permit Holder (Holder) shall be responsible for control of all State listed noxious weed species on all disturbed areas. The Holder is responsible for consultation with the Authorized Officer and local authorities for acceptable weed control methods and shall comply with the following:

    a. Weed control measures would be implemented in compliance with Colorado Noxious Weed Act, C.R.S. §35-5.5-115 and, at a minimum, to the Dolores County Development and Land Use Regulations, (Amended Nov. 2012), Article IV - Performance Standards, Section 2, Paragraph C - Noxious Weeds, page 14.

    b. Use of pesticides shall comply with all applicable Federal and State laws. Pesticides shall be used only in accordance with their registered uses within limitations imposed by the Secretary of the Interior. Prior to the use of pesticides, the Holder shall obtain approval from the Authorized Officer of a Pesticide Use Proposal showing the type and quantity of material to be used, pests to be controlled, method of application, locations of storage and disposal of containers, and any other information deemed necessary by the Authorized Officer.

    c. All pesticide applicators must hold a valid Colorado Qualified Supervisor license or Certified Operator license, and the license must be valid for the applicable pesticide application category. For all areas treated, Pesticide Application Records (BLM Form 3-3-94) must be submitted to the BLM Tres Rios Field Office by November 1 of each year. Pesticide Application Records must be completed no later than 14 days following the pesticide application and must be maintained for 10 years.

24. Excavated materials from cuts would be used on the fill portion of the location to level the pad. Any excess materials (non-topsoil) would be stored within the construction boundary limit (inside the 50-ft. buffer zone) and used for interim and/or final reclamation of the pits and well pad.
25. Access roads at both locations will be maintained to keep the travel surface in good working order, free of ruts, and to keep storm-water control measures operating properly.

Proposed Required Conditions of Approval Specific to Wildlife Issues

26. Observations of any threatened, endangered, proposed, or candidate species within the project area shall be reported to the BLM Tres Rios Field Office (970-882-6845 or 882-6856).

27. If any dead or injured sensitive species is located during construction or operation, the BLM Tres Rios Field Office shall be notified at (970-882-6845 or 882-6856) within 24 hours.

28. If any dead or injured threatened, endangered, proposed, or candidate species is located during construction or operation, the U.S. Fish and Wildlife Service's Colorado Ecological Services Field Office (970-243-2778) and law enforcement office (970-882-

6849) and BLM Tres Rios Field Office (970-882-6845 or 882-6856) shall be notified within 24 hours.

29. BLM shall be notified at 970-882-6845 or 882-6856 if wildlife (other than insects and other invertebrates), or livestock are discovered in a pit.

Proposed Recommended Conditions of Approval

30. The following COAs are recommended by BLM as best management practices that, if implemented, would serve to protect various environmental resources, and reduce the environmental and aesthetic impacts of the proposed project. Since the proposed wells and associated disturbance would be located on private lands, the landowners have jurisdiction over the activities that impact the land surface - so long as those activities do not violate national, state, or local laws or regulations. So, for example, the landowner cannot overrule COAs designed to protect cultural resources, threatened or endangered species, or to protect water quality but the landowner does have jurisdiction over such things as: how the site is reclaimed; what type of seed mix is used; the color of the facilities; and noise levels allowed from the facilities.

31. All work, staging, and parking of equipment will be confined to the well pads, roads and pipeline ROW. No pullouts or off-road parking will be allowed unless specifically authorized. "Keep vehicles on the road surface" signs must be installed by the operator to assist with compliance, as needed. No shortcutting by any motor vehicles operated by employees or contractors is permitted on roads not identified as access routes in the APD. Vehicular access to the pads will be strictly limited to authorized vehicles only; these vehicles are restricted to use on the drill pad only; no off-pad or off-road parking.

32. Heavy equipment will be pressure-washed to remove all dirt and vegetative materials at an offsite location prior to entering either of the two well locations in this project. This is a preventive measure for reducing noxious weed infestation at the drilling sites. If equipment is removed from the project area, used elsewhere, then brought back to the project area, pressure washing is required before the equipment can be used in the project area. Likewise, the heavy equipment should be pressure washed before moving to the other well location in this project. This COA pertains to heavy equipment such as dozers, trackhoes, backhoes, bobcats, and other earth-moving equipment. Pickup trucks, passenger vehicles, water trucks, and gravel trucks do not require pressure washing prior to entering these sites.

33. During interim reclamation, those portions of the road/pipeline ROW deemed unnecessary for production shall be shaped to conform to the natural terrain. 100-percent of the topsoil stockpiled during construction should be spread back over the re-contoured, interim reclamation areas, and the area reseeded. The brush, limbs, crushed stumps and other woody material stockpiled during construction, if any, should be spread back over reclaimed areas and associated pipelines after seeding. This reclamation shall begin within 6 months of completion of the pipeline construction.

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34. During interim reclamation, those portions of the well pads deemed unnecessary for production shall be shaped to conform to the natural terrain, using 100-percent of the stockpiled topsoil, and should be reseeded, leaving only a small teardrop for access to the wellhead during operations, and the area reseeded. The brush, limbs, crushed stumps and other woody material stockpiled during construction, if any, should be spread back over reclaimed areas after seeding. Interim reclamation shall begin within 6 months of testing and completion of the wells, regardless of the timing of putting the well into production. Notify Surface Managing Agency representative (Robert Garrigues at 970 882 6845) seven (7) days prior to seeding so that they may be present to witness reseeding activities. The seed mixture shown in Table B-1 shall be used for reseeding at the Pinto 1-7 well pad during reclamation, unless another seed mixture is specified in a landowner Surface Use Agreement. The Pinto 3-17 site is an actively cultivated field and it is assumed that the land owner will specify a crop seed mix for the reclamation of this site. The woody materials stockpiled during construction, if any, are to be spread evenly back over the reclaimed and seeded areas.

Table B-1 - Sage Flats Mix

Common Name	***Species Name***	***Variety(2)***	***PLS(1) lbs/ac****
Sand Dropseed	*Sporobolus cryptandrus*	VNS	0.05
Galleta	*Hilaria jamesii*	Viva, florets	1.6
Big Sagebrush	*Artemisia tridentata*	VNS	0.1
Winterfat	*Krasheninnikovia lanata*	VNS	0.25
Four-wing Saltbrush	*Atriplex canescens*	VNS	0.25
Indian Ricegrass	*Achnatherum hymenoides*	Paloma	2.5
Blue Grama	*Chondrosum gracile*	Alma	0.3
Squirreltail	*Elymus elymoides*	Tusas	1.4
Muttongrass	*Poa fendleriana*	CO Source ID	0.1
		Total	6.6

*This reflects the drilled seeding rate of 40 PLS /ft², it needs to be doubled if broadcast.

(1) PLS stands for Pure Live Seed. It is a number that takes into account that the germination rate of any seed lot will inevitably be less than 100% and that there is inert material in the seedlot that is not viable seed. So PLS pounds/acre = bulk pounds/acre * % germination rate - inert material.
(2) VNS=Variety Not Specified, get most local variety available.

If the seed is broadcast, application rates will be twice the drilled rate, and some means such as a rake or harrow will be used to incorporate the seed into the soil. Certified weed-free mulch may be required on locations with an inadequate supply of removed vegetation.

35. The seed mixture used must be ***certified*** weed free. There shall be NO primary or secondary noxious weeds in the seed mixture. Seed labels from each bag shall be available for inspection while seeding is being accomplished. The seeding contractor shall keep a record of the dates seeding was accomplished for each site and shall send that information along with the seed labels from each bag to the Authorized Officer.

36. Upon final reclamation, all compacted areas and areas devoid of vegetation on location shall be ripped, along the contour, to a minimum of 6 inches in depth before the re-spread of topsoil and subsequent reseeding according to the seed mix in Table B-1, or as per land-owner specified seed mix, for the Pinto 1-7 location. All access roads will be shaped to conform to the natural terrain and left as rough as possible to deter vehicle travel. Access will be ripped, along the contour when possible, to a minimum depth of 6 inches, water barred, and reseeded according to the seed mix in Table B-1 (Pinto 1-7). All erosion problems created by the development must be corrected prior to acceptance of release.

37. Reclamation (whether interim or final) will be considered successful when the desired vegetative species are established at 70% cover or higher, as compared to reference sites with undisturbed vegetation. In addition, erosion must be controlled, weeds considered a minimal threat, there must be evidence of vegetation reproduction, either spreading by rhizomatous species or seed production, and it is deemed likely that ground cover will return to a desirable condition. The operator will be required to continue re-vegetation efforts, at the direction of BLM, until these standards are met.

38. All surface production equipment constructed or installed at the two well sites (onsite for 6 months or longer), should be painted with the flat, non-reflective earth-tone color Shale Green (Munsell 5Y 4/2) from the BLM's Standard Environmental Color Chart CC-001 (June 2008) to minimize contrast with the existing environment unless the land owner specifically demands a different color, in writing.

Proposed Air Quality Mitigation Measures

39. Construction activities that disturb a surface area greater than 1 acre and are of a duration greater than 5 days should use effective dust-suppression materials and techniques to prevent dust from visibly transporting from the area of disturbance (e.g., well pad, access road, or pipeline ROW) or drift more than 50 feet from the road prism.

40. All activities should handle, transport, and store material in such a way to prevent particulate matter (dust) from visibly transporting from the storage area or area of disturbance.

41. No oil, solvents, or other unacceptable contaminates will be used in dust-abatement fluids.

Proposed Wildlife Mitigation Measures

42. Drilling, Completion, Production, Emergency, or NPDES pits must be maintained to exclude wildlife at all times. The operator shall install fencing and/or other deterrents necessary to preclude access to pits by wildlife. Other deterrents to preclude pit access may include screening and/or netting. Flagging is not considered an effective deterrent and is not allowed (USFWS 2011). If netting is used to exclude wildlife it needs to be maintained so it does not become a trap for wildlife. This mitigation measure is required to meet the intent of the Migratory Bird Treaty Act, 16 U.S.C. 703.

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43. BLM recommends that equipment used for production be maintained and/or modified to minimize noise impacts to wildlife. If this recommendation were implemented, it would benefit local wildlife populations by reducing noise disturbance during important phases of their reproduction cycles and would reduce noise for local human residents as well.

44. Production equipment with vent pipes, exhaust stacks, or other areas that may provide access for migratory birds and bats must be screened to exclude wildlife. Mesh screening must be no larger than ¼ inch. This mitigation measure is required to meet the intent of the Migratory Bird Treaty Act, 16 U.S.C. 703.

45. BLM recommends that when brush hogging or mowing, operators ensure that no active migratory bird nests are destroyed. Destruction of an active nest may result in a violation of the Migratory Bird Treaty Act. To ensure compliance, no activity should take place between May 15 and June 15 annually to protect nesting migratory birds. If activities must take place during this time period, pre-construction surveys should be conducted for any activities after May 15, to clear for nesting migratory birds.

46. If power lines are needed for production facilities, BLM recommends that they be buried whenever possible in the project area to protect bald eagles and other important wildlife. When it is not possible to bury them, overhead power lines should be constructed to standards identified by the Avian Power Line Interaction Committee (most recent version) to minimize raptor electrocution potential.

47. As agreed at the on-site meeting For Pinto 1-7, held on June 4, 2012, , no surface disturbing activity would be allowed within ½ mile of documented active raptor nests from February 1 through July 31, annually. The presence of an active raptor nest would be based on a raptor nest occupancy survey for the current breeding season. This timing limitation date will be adjusted for species-specific guidance. The timing limitation applies to construction, drilling, completions operations, placing of production equipment, and associated infrastructure to include roads, pipelines, power lines, etc.

48. If the proposed action is not completed by March 15, 2014, then the raptor survey requirements of #47, above would be carried through to 2014 operations prior to any activities taking place.

Exhibit 6

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THE COST OF DELAYING ACTION TO STEM CLIMATE CHANGE

July 2014

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Executive Summary

The signs of climate change are all around us. The average temperature in the United States during the past decade was 0.8° Celsius (1.5° Fahrenheit) warmer than the 1901-1960 average, and the last decade was the warmest on record both in the United States and globally. Global sea levels are currently rising at approximately 1.25 inches per decade, and the rate of increase appears to be accelerating. Climate change is having different impacts across regions within the United States. In the West, heat waves have become more frequent and more intense, while heavy downpours are increasing throughout the lower 48 States and Alaska, especially in the Midwest and Northeast.[1] The scientific consensus is that these changes, and many others, are largely consequences of anthropogenic emissions of greenhouse gases.[2]

The emission of greenhouse gases such as carbon dioxide (CO_2) harms others in a way that is not reflected in the price of carbon-based energy, that is, CO_2 emissions create a negative externality. Because the price of carbon-based energy does not reflect the full costs, or economic damages, of CO_2 emissions, market forces result in a level of CO_2 emissions that is too high. Because of this market failure, public policies are needed to reduce CO_2 emissions and thereby to limit the damage to economies and the natural world from further climate change.

There is a vigorous public debate over whether to act now to stem climate change or instead to delay implementing mitigation policies until a future date. This report examines the economic consequences of delaying implementing such policies and reaches two main conclusions, both of which point to the benefits of implementing mitigation policies now and to the net costs of delaying taking such actions.

First, although delaying action can reduce costs in the short run, on net, delaying action to limit the effects of climate change is costly. Because CO_2 accumulates in the atmosphere, delaying action increases CO_2 concentrations. Thus, if a policy delay leads to higher ultimate CO_2 concentrations, that delay produces persistent economic damages that arise from higher temperatures and higher CO_2 concentrations. Alternatively, if a delayed policy still aims to hit a given climate target, such as limiting CO_2 concentration to given level, then that delay means that the policy, when implemented, must be more stringent and thus more costly in subsequent years. In either case, delay is costly.

These costs will take the form of either greater damages from climate change or higher costs associated with implementing more rapid reductions in greenhouse gas emissions. In practice, delay could result in both types of costs. These costs can be large:

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[1] For a fuller treatment of the current and projected consequences of climate change for U.S. regions and sectors, see the Third National Climate Assessment (United States Global Change Research Program (USGCRP) 2014).

[2] See for example the Summary for Policymakers in Working Group I contribution to the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC WG I AR5 2013).

- Based on a leading aggregate damage estimate in the climate economics literature, a delay that results in warming of 3° Celsius above preindustrial levels, instead of 2°, could increase economic damages by approximately 0.9 percent of global output. To put this percentage in perspective, 0.9 percent of estimated 2014 U.S. Gross Domestic Product (GDP) is approximately $150 billion. The incremental cost of an additional degree of warming beyond 3° Celsius would be even greater. Moreover, these costs are not one-time, but are rather incurred year after year because of the permanent damage caused by increased climate change resulting from the delay.

- An analysis of research on the cost of delay for hitting a specified climate target (typically, a given concentration of greenhouse gases) suggests that net mitigation costs increase, on average, by approximately 40 percent for each decade of delay. These costs are higher for more aggressive climate goals: each year of delay means more CO_2 emissions, so it becomes increasingly difficult, or even infeasible, to hit a climate target that is likely to yield only moderate temperature increases.

Second, climate policy can be thought of as "climate insurance" taken out against the most severe and irreversible potential consequences of climate change. Events such as the rapid melting of ice sheets and the consequent increase of global sea levels, or temperature increases on the higher end of the range of scientific uncertainty, could pose such severe economic consequences as reasonably to be thought of as climate catastrophes. Confronting the possibility of climate catastrophes means taking prudent steps now to reduce the future chances of the most severe consequences of climate change. The longer that action is postponed, the greater will be the concentration of CO_2 in the atmosphere and the greater is the risk. Just as businesses and individuals guard against severe financial risks by purchasing various forms of insurance, policymakers can take actions now that reduce the chances of triggering the most severe climate events. And, unlike conventional insurance policies, climate policy that serves as climate insurance is an investment that also leads to cleaner air, energy security, and benefits that are difficult to monetize like biological diversity.

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I. Introduction

The changing climate and increasing atmospheric greenhouse gas (GHG) concentrations are projected to accelerate multiple threats, including more severe storms, droughts, and heat waves, further sea level rise, more frequent and severe storm surge damage, and acidification of the oceans (USGCRP 2014). Beyond the sorts of gradual changes we have already experienced, global warming raises additional threats of large-scale changes, either changes to the global climate system, such as the disappearance of late-summer Arctic sea ice and the melting of large glacial ice sheets, or ecosystem impacts of climate change, such as critical endangerment or extinction of a large number of species.

Emissions of GHGs such as carbon dioxide (CO_2) generate a cost that is borne by present and future generations, that is, by people other than those generating the emissions. These costs, or economic damages, include costs to health, costs from sea level rise, and damage from increasingly severe storms, droughts, and wildfires. These costs are not reflected in the price of those emissions. In economists' jargon, emitting CO_2 generates a negative externality and thus a market failure. Because the price of CO_2 emissions does not reflect its true costs, market forces alone are not able to solve the problem of climate change. As a result, without policy action, there will be more emissions and less investment in emissions-reducing technology than there would be if the price of emissions reflected their true costs.

This report examines the cost of delaying policy actions to stem climate change, and reaches two main conclusions. First, delaying action is costly. If a policy delay leads to higher ultimate CO_2 concentrations, then that delay produces persistent additional economic damages caused by higher temperatures, more acidic oceans, and other consequences of higher CO_2 concentrations. Moreover, if delay means that the policy, when implemented, must be more stringent to meet a given target, then it will be more costly.

Second, uncertainty about the most severe, irreversible consequences of climate change adds urgency to implementing climate policies *now* that reduce GHG emissions. In fact, climate policy can be seen as climate insurance taken out against the most damaging potential consequences of climate change—consequences so severe that these events are sometimes referred to as climate catastrophes. The possibility of climate catastrophes leads to taking prudent steps now to sharply reduce the chances that they occur.

The costs of inaction underscore the importance of taking meaningful steps today towards reducing carbon emissions. An example of such a step is the Environmental Protection Agency's (EPA) proposed rule (2014) to regulate carbon pollution from existing power plants. By adopting economically efficient mechanisms to reduce emissions over the coming years, this proposed rule would generate large positive net benefits, which EPA estimates to be in the range of $27 - 50 billion annually in 2020 and $49 - 84 billion in 2030. These benefits include benefits to health from reducing particulate emissions as well as benefits from reducing CO_2 emissions.

Delaying Climate Policies Increases Costs

Delaying climate policies avoids or reduces expenditures on new pollution control technologies in the near term. But this short-term advantage must be set against the disadvantages, which are the costs of delay. The costs of delay are driven by fundamental elements of climate science and economics. Because the lifetime of CO_2 in the atmosphere is very long, if a mitigation policy is delayed, it must take as its starting point a higher atmospheric concentration of CO_2. As a result, delayed mitigation can result in two types of cost, which we would experience in different proportions depending on subsequent policy choices.

First, if delay means an increase in the ultimate end-point concentration of CO_2, then delay will result in additional warming and additional economic damages resulting from climate change. As is discussed in Section II, economists who have studied the costs of climate change find that temperature increases of 2° Celsius above preindustrial levels or less are likely to result in aggregate economic damages that are a small fraction of GDP. This small net effect masks important differences in which some regions could benefit somewhat from this warming while other regions could experience net costs. But global temperatures have *already* risen nearly 1° above preindustrial levels, and it will require concerted effort to hold temperature increases to within the narrow range consistent with small costs.[3] For temperature increases of 3° Celsius or more above preindustrial levels, the aggregate economic damages from climate change are expected to increase sharply.

Delay that causes a climate target to be missed creates large estimated economic damages. For example, a calculation in Section II of this report, based on a leading climate model (the DICE model as reported in Nordhaus 2013), shows that if a delay causes the mean global temperature increase to stabilize at 3° Celsius above preindustrial levels, instead of 2°, that delay will induce annual additional damages of approximately 0.9 percent of global output, as shown in Figure 1.[4] To put this percentage in perspective, 0.9 percent of estimated 2014 U.S. GDP is approximately $150 billion.[5] The next degree increase, from 3° to 4°, would incur greater *additional* annual costs of approximately 1.2 percent of global output. These costs are not one-time: they are incurred year after year because of the permanent damage caused by additional climate change resulting from the delay.

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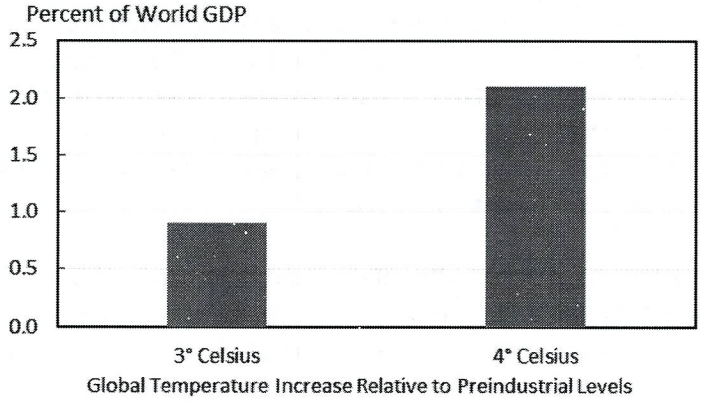
[3] The Working Group III contribution to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC WG III AR5 2014) does not analyze scenarios producing temperatures in 2100 less than 1.5 Celsius above preindustrial, because this is considered so difficult to achieve.

[4] Nordhaus (2013) stresses that these estimates "are subject to large uncertainties...because of the difficulty of estimating impacts in areas such as the value of lost species and damage to ecosystems." (pp. 139-140).

[5] These percentages apply to gross world output and the application of them to U.S. GDP is illustrative.

Figure 1: Economic Damage from Temperature Increase Beyond 2° Celsius



Source: Nordhaus (2013) and CEA calculations

The second type of cost of delay is the increased cost of reducing emissions more sharply if, instead, the delayed policy is to achieve the same climate target as the non-delayed policy. Taking meaningful steps now sends a signal to the market that reduces long-run costs of meeting the target. Part of this signal is that new carbon-intensive polluting facilities will be seen as bad investments; this reduces the amount of locked-in high-carbon infrastructure that is expensive to replace. Second, taking steps now to reduce CO_2 emissions signals the value of developing new low- and zero-emissions technologies, so additional steps towards a zero-carbon future can be taken as policy action incentivizes the development of new technologies. For both reasons, the least-cost mitigation path to achieve a given concentration target typically starts with a relatively low price of carbon to send these signals to the market, and subsequently increases as new low-carbon technology becomes available.[6]

The research discussed in Section II of this report shows that any short run gains from delay tend to be outweighed by the additional costs arising from the need to adopt a more abrupt and stringent policy later.[7] An analysis of the collective results from that research, described in more detail in Section II, suggests that the cost of hitting a specific climate target increases, on average, by approximately 40 percent for each decade of delay. These costs are higher for more aggressive climate goals: the longer the delay, the more difficult it becomes to hit a climate target. Furthermore, the research also finds that delay substantially decreases the chances that even concerted efforts in the future will hit the most aggressive climate targets.

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[6] The 2010 National Research Council, *Limiting the Magnitude of Future Climate Change*, also stressed the importance of acting now to implement mitigation policies as a way to reduce costs. The NRC emphasized the importance of technology development in holding down costs, including by providing clear signals to the private sector through predictable policies that support development of and investment in low-carbon technologies.

[7] The IPCC WG III AR5 (2014) includes an extensive discussion of mitigation, including sectoral detail, potential for technological progress, and the timing of mitigation policies.

Although global action is essential to meet climate targets, unilateral steps both encourage broader action and benefit the United States. Climate change is a global problem, and it will require strong international leadership to secure cooperation among both developed and developing countries to solve it. America must help forge a truly global solution to this global challenge by galvanizing international action to significantly reduce emissions. By taking credible steps toward mitigation, the United States will also reap the benefits of early action, such as investing in low-carbon infrastructure now that will reduce the costs of reaching climate targets in the future.

Climate Policy as Climate Insurance

Individuals and businesses routinely purchase insurance to guard against various forms of risk such as fire, theft, or other loss. This logic of self-protection also applies to climate change. Much is known about the basic science of climate change: there is a scientific consensus that, because of anthropogenic emissions of CO_2 and other GHGs, global temperatures are increasing, sea levels are rising, and the world's oceans are becoming more acidic. These and other climate changes are expected to be harmful, on balance, to the world's natural and economic systems. Nevertheless, uncertainty remains about the magnitude and timing of these and other aspects of climate change, even if we assume that future climate policies are known in advance. For example, the Working Group I contribution to the IPCC's Fifth Assessment Report (IPCC WG I AR5 2013) provides a likely range of 1.5° to 4.5° Celsius for the equilibrium climate sensitivity, which is the long-run increase in global mean surface temperature that is caused by a sustained doubling of atmospheric CO_2 concentrations. The upper end of that range would imply severe climate impacts under current emissions trajectories, and current scientific knowledge indicates that values in excess of this range are also possible.[8]

An additional, related source of climate uncertainty is the possibility of irreversible, large-scale changes that have wide-ranging and severe consequences. These are sometimes called abrupt changes because they could occur extremely rapidly as measured in geologic time, and are also sometimes called climate catastrophes. We are already witnessing one of these events—the rapid trend towards disappearance of late-summer Arctic sea ice. A recent study from the National Research Council (NRC 2013) found that this strong trend toward decreasing sea-ice cover could have large effects on a variety of components of the Arctic ecosystem and could potentially alter large-scale atmospheric circulation and its variability. The NRC also found that another large-scale change has been occurring, which is the critical endangerment or loss of a significant percentage of marine and terrestrial species. Other events judged by the NRC to be likely in the more distant future (after 2100) include, for example, the possible rapid melting of the Western Antarctic ice and Greenland ice sheets and the potential thawing of Arctic permafrost and the consequent release of the potent GHG methane, which would accelerate global warming. These and other potential large-scale changes are irreversible on relevant time

[8] It is important to note that, as a global average, the equilibrium climate sensitivity masks the expectation that temperature change will be higher over land than the oceans, and that there will be substantial regional variations in temperature increases. The equilibrium climate sensitivity describes a long-term effect and is only one component of determining near term warming due to the buildup of GHGs in the atmosphere.

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scales—if an ice sheet melts, it cannot be reconstituted—and they could potentially have massive global consequences and costs. For many of these events, there is thought to be a "tipping point," for example a temperature threshold, beyond which the transition to the new state becomes inevitable, but the values or locations of these tipping points are typically unknown.

Section III of this report examines the implications of these possible climate-related catastrophes for climate policy. Research on the economic and policy implications of such threats is relatively recent. As detailed in Section III, a conclusion that clearly emerges from this young but active literature is that the threat of a climate catastrophe, potentially triggered by crossing an unknown tipping point, implies erring on the side of prudence today. Accordingly, in a phrase used by Weitzman (2009, 2012), Pindyck (2011), and others, climate policy can be thought of as "climate insurance." The logic here is that of risk management, in which one acts now to reduce the chances of worst-case outcomes in the future. Here, too, there is a cost to delay: the longer emission reductions are postponed, the greater are atmospheric concentrations of GHGs, and the greater is the risk arising from delay.

Other Costs of Delay and Benefits of Acting Now

An additional benefit of adopting meaningful mitigation policies now is that doing so sends a strong signal to the market to spur the investments that will reduce mitigation costs in the future. An argument sometimes made is that mitigation policies should be postponed until new low-carbon technologies become available. Indeed, ongoing technological progress has dramatically improved productivity and welfare in the United States because of vast inventions and process improvements in the private sector (see for example CEA 2014, Chapter 6). The private sector invests in research and development, and especially in process improvements, because those technological advances reap private rewards. But low-carbon technologies, and environmental technologies more generally, face a unique barrier: their benefits – the reduction in global impacts of climate change – accrue to everyone and not just to the developer or adopter of such technologies.[9] Thus private sector investment in low-carbon technologies requires confidence that those investments, if successful, will pay off, that is, the private sector needs to have confidence that there will be a market for low-carbon technologies now and in the future. Public policies that set out a clear and ongoing mitigation path provide that confidence. Simply waiting for a technological solution, but not providing any reason for the private sector to create that solution, is not an effective policy. Although public financing of basic research is warranted because many of the benefits of basic research cannot be privately appropriated, many of the productivity improvements and cost reductions seen in new technologies come from incremental advances and process improvements that only arise through private-sector experience producing the product and learning-by-doing. These advances are protected through the patent system and as trade secrets, but those advances will only transpire if it is clear that they will have current and

[9] Popp, Newell, and Jaffe (2010) provide a thorough review of the literature regarding technological change and the environment.

future value. In other words, policy action induces technological change.[10] Although a full treatment of the literature on technological change is beyond the scope of this report, providing the private sector with the certainty needed to invest in low-carbon technologies and produce such technological change is a benefit of adopting meaningful mitigation policies now.

Finally, because this report examines the economic costs of delay, it focuses on actions or consequences that have a market price. But the total costs of climate change include much that does not trade in the market and to which it is difficult to assign a monetary value, such as the loss of habitat preservation, decreased value of ecosystem goods and services, and mass extinctions. Although some studies have attempted to quantify these costs, including all relevant climate impacts is infeasible. Accordingly, the monetized economic costs of delay analyzed in this report understate the true total cost of delaying action to mitigate climate change.

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[10] For example, Popp (2003) provides empirical evidence that Title IV of the 1990 Clean Air Act Amendments (CAAA) led to innovations that reduced the cost of the environmental technologies that reduced SO_2 emissions from coal-fired power plants. Other literature shows evidence linking environmental regulation more broadly to innovation (e.g., Popp 2006, Jaffe and Palmer 1997, Lanjouw and Mody 1996).

II. Costs from Delaying Policy Action

Delaying action on climate change can increase economic costs in two ways. First, if the delayed policy is no more stringent, it will miss the climate target of the original, non-delayed policy, resulting in atmospheric GHG concentrations that are permanently higher, thereby increasing the economic damages from climate change. Second, suppose a delayed policy alternatively strove to achieve the original climate target; if so, it would require a more stringent path to achieve that target. But this delayed, more stringent policy typically will result in additional mitigation costs by requiring more rapid adjustment later. In reality, delay might result in a mix of these two types of costs. The estimates of the costs of delay in this section draw on large bodies of research on these two types of costs. We first examine the economic damages from higher temperatures, then turn to the increased mitigation costs arising from delay.

Our focus here is on targets that limit GHG concentrations, both because this is what most of the "delay" literature considers and because concentration limits have been the focus of other assessments. These concentration targets are typically expressed as concentrations of CO_2-equivalent (CO_2e) GHGs, so they incorporate not just CO_2 concentrations but also methane and other GHGs. The CO_2e targets translate roughly into ranges of temperature changes as estimated by climate models and into the cumulative GHG emissions budgets discussed in some other climate literature. More stringent concentration targets decrease the odds that global average temperature exceeds 2°C above preindustrial levels by 2100. According to the IPCC WG III AR5 (2014), meeting a concentration target of 450 parts per million (ppm) CO_2e makes it "likely" (probability between 66 and 100 percent) that the temperature increase will be at most 2°C, relative to preindustrial levels, whereas stabilizing at a concentration level of 550 ppm CO_2e makes it "more unlikely than likely" (less than a 50 percent probability) that the temperature increase by 2100 will be limited to 2°C (IPCC WG III AR5 2014).[11]

Increasing Damages if Delay Means Missing Climate Targets

If delay means that a climate target slips, then the ultimate GHG concentrations, temperatures, and other changes in global climate would be greater than without the delay.[12]

A growing body of work examines the costs that climate change imposes on specific aspects of economic activity. The IPCC WG II AR5 (2014) surveys this growing literature and summarizes the impacts of projected climate change by sector. Impacts include decreased agricultural production; coastal flooding, erosion, and submergence; increases in heat-related illness and other stresses due to extreme weather events; reduction in water availability and quality;

[11] IPCC WG III AR5 (2014, ch. 6) provides a further refinement of these probabilities, associating a concentration target of 450 ppm of CO_2e with an approximate 70-85 percent probability of maintaining temperature change below 2°C, and a concentration level of 550 CO_2e with an approximate 30-45 percent probability of maintaining temperature change below 2°C.

[12] For information on the impacts of climate change at various levels of warming see *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia* (NRC 2011).

displacement of people and increased risk of violent conflict; and species extinction and biodiversity loss. Although these impacts vary by region, and some impacts are not well-understood, evidence of these impacts has grown in recent years.[13]

A new class of empirical studies draw similar conclusions. Dell, Jones, and Olken (2013) review academic research that draws on historical variation in weather patterns to infer the effects of climate change on productivity, health, crime, political instability, and other social and economic outcomes. This approach complements physical science research by estimating the economic impacts of historical weather events that can be used to extrapolate to those expected in the future climate. The research finds evidence of economically meaningful impacts of climate change on a variety of outcomes. For example, when the temperature is greater than 100° Fahrenheit in the United States, labor supply in outdoor industries declines up to one hour per day relative to temperatures in the 76°-80° Fahrenheit range (Graff Zivin and Neidell 2014). Also in the United States, each additional day of extreme heat (exceeding 90° Fahrenheit) relative to a moderate day (50° to 59° Fahrenheit) increases the annual age-adjusted mortality rate by roughly 0.11 percent (Deschênes and Greenstone 2011).

These studies provide insights into the response of specific sectors or aspects of the economy to climate change. But because they focus on specific aspects of climate change, use different data sources, and use a variety of outcome measures, they do not provide direct estimates of the aggregate, or total, cost of climate change. Because estimating the total cost of climate change requires specifying future baseline economic and population trajectories, efforts to estimate the total cost of climate change typically rely on integrated assessment models (IAMs). IAMs are a class of economic and climate models that incorporate both climate and economic dynamics so that the climate responds to anthropogenic emissions and economic activity responds to the climate. In addition to projecting future climate variables and other economic variables, the IAMs estimate the total economic damages (and, in some cases, benefits) of climate change which includes impacts on agriculture, health, ecosystems services, productivity, heating and cooling demand, sea level rise, and adaptation.

Overall costs of climate change are substantial, according to IAMs. Nordhaus (2013) estimates global costs that increase with the rise in global average temperature, and Tol (2009, 2014) surveys various estimates. Two themes are common among these damage estimates. First, damage estimates remain uncertain, especially for large temperature increases. Second, the costs of climate change increase nonlinearly with the temperature change. Based on Nordhaus's (2013, Figure 22) net damage estimates, a 3° Celsius temperature increase above preindustrial levels, instead of 2°, results in additional damages of 0.9 percent of global output.[14] To put this

[13] The EPA's Climate Change Impacts and Risk Analysis project collects new research that estimates the potential damages of inaction and the benefits of GHG mitigation at national and regional scales for many important sectors, including human health, infrastructure, water resources, electricity demand and supply, ecosystems, agriculture, and forestry (Waldhoff et al. 2014).

[14] Some studies estimate that small temperature increases have a net economic *benefit*, for instance due to increased agricultural production in regions with colder climates. However, projected temperature increases even

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percentage in perspective, 0.9 percent of estimated 2014 U.S. GDP is approximately $150 billion. The next degree increase, from 3° to 4°, would incur additional costs of 1.2 percent of global output. Moreover, these costs are not one-time, rather they recur year after year because of the permanent damage caused by increased climate change resulting from the delay. It should be stressed that these illustrative estimates are based on a single (albeit leading) model, and there is uncertainty associated with the aggregate monetized damage estimates from climate change; see for example the discussion in IPCC WG II AR5 (2014).

Increased Mitigation Costs from Delay

The second type of cost of delay arises if policy is delayed but still hits the climate target, for example stabilizing CO_2e concentrations at 550 ppm. Because a delay results in additional near-term accumulation of GHGs in the atmosphere, delay means that the policy, when implemented, must be more stringent to achieve the given long-term climate target. This additional stringency increases mitigation costs, relative to those that would be incurred under the least-cost path starting today.

This section reviews the recent literature on the additional mitigation costs of delay, under the assumption that both the original and delayed policy achieve a given climate target. We review 16 studies that compare 106 pairs of policy simulations based on integrated climate mitigation models (the studies are listed and briefly described in the Appendix). The simulations comprising each pair implement similar policies that lead to the same climate target (typically a concentration target but in some cases a temperature target) but differ in the timing of the policy implementation, nuanced in some cases by variation in when different countries adopt the policy. Because the climate target is the same for each scenario in the pair, the environmental and economic damages from climate change are approximately the same for each scenario. The additional cost of delaying implementation thus equals the difference in the mitigation costs in the two scenarios in each paired comparison. The studies reflect a broad array of climate targets, delayed timing scenarios, and modeling assumptions as discussed below. We focus on studies published in 2007 or later, including recent unpublished manuscripts.

In each case, a model computes the path of cost-effective mitigation policies, mitigation costs, and climate outcomes over time, constraining the emissions path so that the climate target is hit. Each path weighs technological progress in mitigation technology and other factors that encourage starting out slowly against the costs that arise if mitigation, delayed too long, must be undertaken rapidly. Because the models typically compute the policy in terms of a carbon price, the carbon price path computed by the model starts out relatively low and increases over the course of the policy. Thus a policy started today typically has a steadily increasing carbon price, whereas a delayed policy typically has a carbon price of zero until the start date, at which point it jumps to a higher initial level then increases more rapidly than the optimal immediate policy.

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under immediate action fall in a range with a strong consensus that the costs of climate change exceed such benefits. The cost estimates presented here are net of any benefits expected to accrue.

The higher carbon prices after a delay typically lead to higher total costs than a policy that would impose the carbon price today.[15]

The IPCC WG III AR5 (2014) includes an overview of the literature on the cost of delayed action on climate change. They cite simulation studies showing that delay is costly, both when all countries delay action and when there is partial delay, with some countries delaying acting alone until there is a more coordinated international effort. The present report expands on that overview by further analyzing the findings of the studies considered by the IPCC report as well as additional studies. Like the IPCC report, we find broad agreement across the scenario pairs examined that delayed policy action is more costly compared to immediate action conditional on a particular climate target. This finding is consistent across a range of climate targets, policy participants, and modeling assumptions. The vast majority of studies estimate that delayed action incurs greater mitigation costs compared to immediate action. Furthermore, some models used in the research predict that the most stringent climate targets are feasible only if immediate action is taken under full participation. One implication is that considering only comparisons with numerical cost estimates may understate the true costs of delay, as failing to reach a climate target means incurring the costs from the associated climate change.

The costs of delay in these studies depend on a number of factors, including the length of delay, the climate target, modeling assumptions, future baseline emissions, future mitigation technology, delay scenarios, the participants implementing the policy, and geographic location. More aggressive targets are more costly to achieve, and meeting them is predicted to be particularly costly, if not infeasible, if action is delayed. Similarly, international coordination in policy action reduces mitigation costs, and the cost of delay depends on which countries participate in the policy, as well as the length of delay.

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[15] Some models explicitly identify the carbon price path that minimizes total social costs. These optimization models always find equal or greater costs for scenarios with a delay constraint. Other models forecast carbon prices that result in the climate target but do not demand that the path results in minimal cost. These latter models can predict that delay reduces costs, and a small number of comparisons we review report negative delay costs.

The Role of Technological Progress in Cost Estimates

Assumptions about energy technology play an important role in estimating mitigation costs. For example, many models assume that carbon capture and storage (CCS) will enable point sources of emission to capture the bulk of carbon emissions and store them with minimal leakage into the atmosphere over a long period. Some comparisons also assume that CCS will combine with large-scale bio-energy ("bio-CCS"), effectively generating "negative emissions" since biological fuels extract atmospheric carbon during growth. Such technology could facilitate reaching a long-term atmospheric concentration target despite relatively modest near-term mitigation efforts. However, the IPCC warns that "There is only limited evidence on the potential for large-scale deployment of [bio-CCS], large-scale afforestation, and other [CO_2 removal] technologies and methods" (IPCC WG III AR5 2014). In addition, models must also specify the cost and timing of availability of such technology, potentially creating further variation in mitigation cost estimates.

The potential importance of technology, especially bio-CCS, is manifested in differences across models. Clarke et al. (2009) present delay cost estimates for 10 models simulating a 550 ppm CO_2 equivalent target by 2100 allowing for overshoot. The three models that assume bio-CCS availability estimate global present values of the cost of delay ranging from $1.4 trillion to $4.7 trillion. Among the seven models without bio-CCS, four predict higher delay costs, one predicts that the concentration target was infeasible under a delay, and two predict lower delay costs. The importance of bio-CCS is even clearer with a more stringent target. For example, two of the three models with bio-CCS find that a 450 ppm CO_2 equivalent target is feasible under a delay scenario, while none of the seven models without bio-CCS find the stringent target to be feasible.

The Department of Energy sponsors ongoing research on CCS for coal-fired power plants. As part of its nearly $6 billion commitment to clean coal technology, the Administration, partnered with industry, has already invested in four commercial-scale and 24 industrial-scale CCS projects that together will store more than 15 million metric tons of CO_2 per year.

An important determinant of costs is the role of technological progress and the availability of mitigation technologies (see the box). The models typically assume technological progress in mitigation technology, which means that the cost of reducing emissions declines over time as energy technologies improve. As a result, it is cost-effective to start with a relatively less stringent policy, then increase stringency over time, and the models typically build in this cost-effective tradeoff. However, most models still find that immediate initiation of a less stringent policy followed by increasing stringency incurs lower costs than delaying policy entirely and then increasing stringency more rapidly.

We begin by characterizing the primary findings in the literature broadly, discussing the estimates of delay costs and how the costs vary based on key parameters of the policy scenarios; additional details can be found in the Appendix. We then turn to a statistical analysis of all the available

delay cost estimates that we could gather in a standardized form, that is, we conduct a meta-analysis of the literature on delay cost estimates.

Effect on Costs of Climate Targets, Length of Delay, and International Coordination

Climate Targets

Researchers estimate a range of climate and economic impacts from a given concentration of GHGs and find that delaying action is much costlier for more stringent targets. Two recent major modeling simulation projects conducted by the Energy Modeling Forum (Clarke et al. 2009) and by AMPERE (Riahi et al. 2014) consider the economic costs of delaying policies to reach a range of CO_2e concentration targets from 450 to 650 ppm in 2100. In the Energy Modeling Forum simulations in Clarke et al. (2009), the median additional cost (global present value) for a 20-year delay is estimated to be $0.7 trillion for 650 ppm CO_2e but a substantially greater $4.7 trillion for 550 ppm CO_2e. Many of the models in these studies suggest that delay causes a target of 450 ppm CO_2e to be much more costly to achieve, or possibly even infeasible.

Length of Delay

The longer the delay, the greater the cumulative emissions before action begins and the shorter the available time to meet a given target. Several recent studies examine the cost implications of delayed climate action and find that even a short delay can add substantial costs to meeting a stringent concentration target, or even make the target impossible to meet. For example, Luderer et al. (2012) find that delay from 2010 to 2020 to stabilize CO_2 concentration levels at 450 ppm by 2100 raises mitigation cost by 50 to 700 percent.[16] Furthermore, Luderer et al. find that delay until 2030 renders the 450 ppm target infeasible. Edmonds et al. (2008) find that additional mitigation costs of delay by newly developed and developing countries are substantial. In fact, they find that stabilizing CO_2 concentrations at 450 ppm even for a relatively short delay from 2012 to 2020 increases costs by 28 percent over the idealized case, and a delay to 2035 increased costs by more than 250 percent.

International Coordination

Meeting stringent climate targets with action from only one country or a small group of countries is difficult or impossible, making international coordination of policies essential. Recent research shows, however, that even if a delay in international mitigation efforts occurs, unilateral or fragmented action reduces the costs of delay: although immediate coordinated international action is the least costly approach, unilateral action is less costly than doing nothing.[17] More specifically, Jakob et al. (2012) consider a 10-year delay of mitigation efforts to reach a 450 ppm CO_2 target by 2100 and find that global mitigation costs increase by 43 to 700 percent if all countries begin mitigation efforts in 2020 rather than 2010. However, early action in 2010 by more developed countries reduces this increase to 29 to 300 percent. In a similar scenario,

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[16] We present a range of cost estimates which comes from the three IAMs – ReMIND-R, WITCH and IMACLIM-R – used by Luderer et al. (2012). These scenarios also allow temporary overshoot of the target.

[17] Waldhoff and Fawcett (2011) find that early mitigation action by industrialized economies significantly reduces the likelihood of large temperature changes in 2100 while also increasing the likelihood of lower temperature changes, relative to a no policy scenario.

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Luderer et al. (2012) find that costs increase by 50 to 700 percent with global delay from 2010 to 2020, however if the industrialized countries begin mitigation efforts unilaterally in 2010 (and are joined by all countries in 2020), the estimated cost increases range from zero to about 200 percent. Luderer et al. (2013) and Riahi et al. (2014) find that costs of delay are smaller when fewer countries delay mitigation efforts, or when short-term actions during the delay are more aggressive.

Jakob et al. (2012) find it is in the best interest of the European Union to begin climate action in 2010 rather than delaying action with all other countries until 2020. They also estimate that the cost increase to the United States from delaying climate action with all other countries until 2020 is from 28 to 225 percent, relative to acting early along with other industrialized economies.[18] McKibbin, Morris, and Wilcoxen (2014) consider the impact that a delay in imposing a unilateral price of carbon would have on economic outcomes in the United States including GDP, investment, consumption and employment. They find that although unilateral mitigation efforts do incur costs, delay is costlier.

Summary: Quantifying Patterns across the Studies

We now turn to a quantitative summary and assessment, or meta-analysis, of the studies discussed above.[19] The data set for this analysis consists of the results on all available numerical estimates of the average or total cost of delayed action from our literature search. Each estimate is a paired comparison of a delay scenario and its companion scenario without delay. To make results comparable across studies, we convert the delay cost estimates (presented in the original studies variously as present values of dollars, percent of consumption, or percent of GDP) to percent change in costs as a result of delay.[20] We capture variation across study and experimental designs using variables that encode the length of the delay in years; the target CO_2e concentration; whether only the relatively more-developed countries act immediately (partial delay); the discount rate used to calculate costs; and the model used for the simulation.[21] All comparisons consider policies and outcomes measured approximately through the end of the century. To reduce the effect of outliers, the primary regression analysis only uses results with less than a 400 percent increase in costs (alternative methods of handling the outliers are

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[18] Note that the IMACLIM model finds that U.S. mitigation declines to the point in which they are slightly negative (i.e. net gains compared to business-as-usual).

[19] A study of the results of other studies is referred to as a meta-analysis, and there is a rich body of statistical tools for meta-analysis, see for example Borenstein et al. (2009).

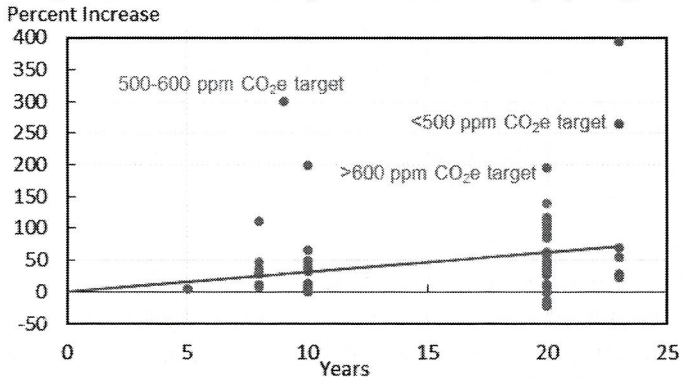
[20] For example, if in some paired comparison delay increased mitigation costs from 0.20 percent of GDP to 0.30 percent of GDP, the cost increase would be 50 percent. Comparisons for which the studies provided insufficient information to calculate the percentage increase in costs (including all comparisons from Riahi et al. 2014) are excluded. Also excluded are comparisons that report only the market price of carbon emissions at the end of the simulation, which is not necessarily proportional to total mitigation costs.

[21] When measuring delay length for policies with multiple stages of implementation, we count the delay as ending at the start of any new participation in mitigation by any party after the start of the simulation. We also exclude scenarios with delays exceeding 30 years. When other climate targets were provided (e.g., CO_2 concentration or global average temperature increase), the corresponding CO_2e concentration levels are estimated using conversions from IPCC WG III AR5 (2014).

discussed below as sensitivity checks), and only includes paired comparisons for which both the primary and delayed policies are feasible (i.e. the model was able to solve for both cases).[22] The dataset contains a total of 106 observations (paired comparisons), with 58 included in the primary analysis. All observations in the data set are weighted equally.

Analysis of these data suggests two main conclusions, both consistent with findings from specific papers in the underlying literature. The first is that, looking across studies, costs increase with the length of the delay. Figure 2 shows the delay costs as a function of the delay time. Although there is considerable variability in costs for a given delay length because of variations across models and experiments, there is an overall pattern of costs increasing with delay.

Figure 2: Additional Mitigation Costs of Delay by Length



Notes: Data points are percentage increase in mitigation costs from delay and the associated length of delay for a given paired simulation. The scatterplot presents a total of 58 paired delay simulations. The solid line is the regression fit to these data, restricted to pass through the origin.
Source: CEA calculations.

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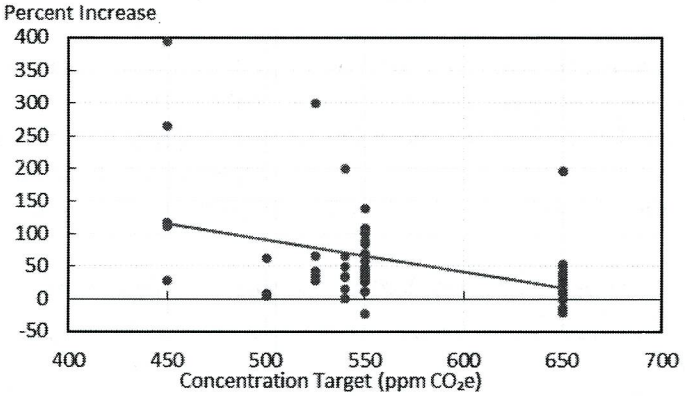
For example, of the 14 paired simulations with 10 years of delay (these are represented by the points in Figure 2 with 10 years of delay), the average delay cost is 39 percent. The regression line shown in Figure 2 estimates an average cost of delay per year using all 58 paired experiments under the assumption of a constant increasing delay cost per year (and, by definition, no cost if there is no delay), and this estimate is 37 percent per decade. This analysis ignores possible confounding factors, such as longer delays being associated with less stringent targets, and the multiple regression analysis presented below controls for such confounding factors.

The second conclusion is that the more ambitious the climate target, the greater are the costs of delay. This can be seen in Figure 3, in which the lowest (most stringent) concentration targets tend to have the highest cost estimates. In fact, close inspection of Figure 2 reveals a related pattern: the relationship between delay length and additional costs is steeper for the points representing CO_2e targets of 500 ppm or less than for those in the other two ranges. That is, costs

[22] In the event that a model estimates a cost for a first-best scenario but determines the corresponding delay scenario to be infeasible, the comparison is coded as having costs exceeding 400 percent. In addition, one comparison from Clarke et al. (2009) is excluded because a negative baseline cost precludes the calculation of a percent increase.

of delay are particularly high for scenarios with the most stringent target and the longest delay lengths.

Figure 3: Additional Mitigation Costs by CO_2 Concentration



Notes: Data points are percentage increase in mitigation costs from delay and the associated CO_2 concetration target for a given paired simulation. The scatterplot presents a total of 58 paired delay simulations. The solid line is the regression line fit to these data.

Table 1 presents the results of multiple regression analysis that summarizes how various factors affect predictions from the included studies, holding constant the other variables included in the regression. The dependent variable is the cost of delay, measured as the percentage increase relative to the comparable no-delay scenario, and the length of delay is measured in decades. Specifications (1) and (2) correspond to Figures 2 and 3, respectively. Each subsequent specification includes the length of the delay in years, an indicator variable for a partial delay scenario, and the target CO_2e concentration. In addition to the coefficients shown, specification (4) includes model fixed effects, which control for systematic differences across models, and each specification other than column (1) includes an intercept.

The results in Table 1 quantify the two main findings mentioned above. The coefficients in column (3) indicate that, looking across these studies, a one decade increase in delay length is on average associated with a 41 percent increase in mitigation cost relative to the no-delay scenario. This regression does not control for possible differences in baseline costs across the different models, however, so column (4) reports a variant that includes an additional set of binary variables indicating the model used ("model fixed effects"). Including model fixed effects increases the delay cost to 56 percent per decade. When the cost of a delay is estimated separately for different concentration target bins (column (5)), delay is more costly the more ambitious is the concentration target. But even for the least ambitious target – a CO_2e concentration exceeding 600 ppm – delay is estimated to increase costs by approximately 24 percent per decade. Because of the relatively small number of cases (58 paired comparisons), which are further reduced when delay is estimated within target bins, the standard errors are large, especially for the least ambitious scenarios, so for an overall estimate of the delay cost we do not differentiate between the different targets. While the regression in column (4) desirably controls for differences across models, other (unreported) specifications that handle

the outliers in different ways and include other control variables give per-decade delay estimates both larger and smaller than the regression in column (3).[23] We therefore adopt the estimate in regression (3) of 41 percent per decade as the overall annual estimate of delay costs.

One caveat concerning this analysis is that it only considers cases in which model solutions exist. The omitted, infeasible cases tend to be ones with ambitious targets that cannot be met when there is long delay, given the model's technology assumptions. For this reason, omitting these cases arguably understates the costs of delay reported in Table 1.[24] Additionally, we note that estimates of the effect of a partial delay (when some developed nations act now and other nations delay action) are imprecisely estimated, perhaps reflecting the heterogeneity of partial delay scenarios examined in the studies.

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[23] The results in Table 1 are generally robust to using a variety of other specifications and regression methods, including: using the percent decrease from the delay case, instead of the percent increase from the no-delay case, as the dependent variable as an alternative way to handle outliers; using median regression, also as an alternative way to handle outliers; and including the discount factor as additional explanation of variation in the cost of delay, but this coefficient is never statistically significant. These regressions use linear compounding, not exponential, because the focus is on the per-decade delay cost not the annual delay cost. An alternative approach is to specify the dependent variable in logarithms (although this eliminates the negative estimates), and doing so yields generally similar results after compounding to those in Table 1.

[24] An alternative approach to omitting the infeasible-solution observations is to treat their values as censored at some level. Accordingly, the regressions in Table 1 were re-estimated using tobit regression, for which values exceeding 400 percent (including the non-solution cases) are treated as censored. As expected, the estimated costs of delay per year estimated by tobit regression exceed the ordinary least squares estimates. A linear probability model (not shown) indicates that scenarios with longer delay and more stringent targets are more likely to have delay cost increases exceeding 400 percent (including non-solution cases). The assumption of bio-CCS technology has no statistically significant correlation with delay cost increase in a censored regression but is associated with a significantly lower probability of delay cost increases exceeding 400 percent.

Table 1: Increased Mitigation Costs Resulting from a Delay, Given a Specified Climate Target: Regression Results

	(1)	(2)	(3)	(4)	(5)
Delay (decades)	37.3***		41.1**	56.3***	
	(5.9)		(17.0)	(18.2)	
Delay (decades) x ppm CO_2e≤500					66.7**
					(27.1)
Delay (decades) x 500<ppm CO_2e≤600					24.9
					(18.5)
Delay (decades) x ppm CO_2e>600					24.1
					(33.9)
Partial delay			8.3	-20.0	14.8
			(26.0)	(27.8)	(25.7)
Target CO_2e concentration		-0.49***	-0.61***	-0.61***	-0.30
		(0.16)	(0.16)	(0.15)	(0.49)
Model fixed effects?	No	No	No	Yes	No
Observations	58	58	58	58	58
R-squared	0.41	0.15	0.24	0.53	0.30

Notes: The table presents ordinary least squares regression coefficients, with each column representing a different regression. For each, the dependent variable is the percent increase in cost from a scenario involving no delay to a scenario involving a delay. Each observation is a comparison of a pair of scenarios with the same climate target, for a total of 58 observations. The regressors represent some of the variables that characterize each paired comparison: the simulated delay, the delay interacted with the concentration target (binned), whether only some countries delayed (partial delay), and the target concentration. The appendix lists all studies from which the data were drawn. The specification in column (1) does not include a constant.

Significant at the: *10% **5% ***1% significance level.

Source: CEA calculations on results from studies listed in appendix.

III. Climate Policy as Climate Insurance

As discussed in the 2013 NRC report, *Abrupt Impacts of Climate Change: Anticipating Surprises*, the Earth's climate history suggests the existence of "tipping points," that is, thresholds beyond which major changes occur that may be self-reinforcing and are likely to be irreversible over relevant time scales. Some of these changes, such as the rapid decline in late-summer Arctic sea ice, are already under way. Others represent potential events for which a tipping point likely exists, but cannot at the present be located. For example, there is new evidence that we might already have crossed a previously unrecognized tipping point concerning the destabilization of the West Antarctic Ice Sheet (Joughin, Smith, and Medley 2014 and Rignot et. al. 2014). A tipping point that is unknown, but thought unlikely to be reached in this century, is the release of methane from thawing Arctic permafrost, which could reinforce the greenhouse effect and spur additional warming and exacerbate climate change. Tipping points can also be crossed by slower climate changes that exceed a threshold at which there is a large-scale change in a biological system, such as the rapid extinction of species. Such impacts could pose such severe consequences for societies and economies that they are sometimes called potential climate catastrophes.

This section examines the implications of these potentially severe outcomes for climate policy, a topic that has been the focus of considerable recent research in the economics literature. The main conclusion emerging from this growing body of work is that the potential of these events to have large-scale impacts has important implications for climate policy. Because the probability of a climate catastrophe increases as GHG emissions rise, missing climate targets because of postponed policies increases risks. Uncertainty about the likelihood and consequences of potential climate catastrophes adds further urgency to implementing policies now to reduce GHG emissions.

Tail Risk Uncertainty and Possible Large-Scale Changes

Were some of these large-scale events to occur, they would have severe consequences and would effectively be irreversible. Because these events are thought to be relatively unlikely, at least in the near term – that is, they occur in the "tail" of the distribution – but would have severe consequences, they are sometimes referred to as "tail risk" events. Because these tail risk events are outside the range of modern human experience, uncertainty surrounds both the science of their dynamics and the economics of their consequences.

Because many of these events are triggered by warming, their likelihood depends in part on the equilibrium climate sensitivity. The IPCC WG I AR5 (2013) provides a likely range of 1.5° to 4.5° Celsius for the equilibrium climate sensitivity. However, considerably larger values cannot be ruled out and are more likely than lower values (i.e. the probability distribution is skewed towards higher values). Combinations of high climate sensitivity and high GHG emissions can result in extremely large end-of-century temperature changes. For example, the IPCC WG III AR5 (2014) cites a high-end projected warming of 7.8° Celsius by 2100, relative to 1900-1950.

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A second way to express this risk is to focus on specific large-scale changes in Earth or biological systems that could be triggered and locked in by GHG concentrations rising beyond a certain point. At higher climate sensitivities, the larger temperature response to atmospheric GHG concentrations would make it even more likely that we would cross temperature-related tipping points in the climate system. The potential for additional releases of methane, a potent GHG, from thawing permafrost, thus creating a positive feedback to further increase temperatures, is an example of such a tail risk event. Higher carbon dioxide concentrations in the atmosphere, by increasing the acidity of the oceans, could also trigger and lock in permanent changes to ocean ecosystems, such as diminished coral reef-building, which decreases biodiversity supported on reefs and decreases the breakwater effects that protect shorelines. The probability of significant negative effects from ocean acidification can be increased by other stressors such as higher temperatures and overfishing.

The box summarizes some of these potential large-scale events, which are sometimes also referred to as "abrupt" because they occur in a very brief period of geological time. These events are sufficiently large-scale they have the potential for severely disrupting ecosystems and human societies, and thus are sometimes referred to as catastrophic outcomes.

Abrupt Impacts of Climate Change: Anticipating Surprises

The National Research Council's 2013 report, *Abrupt Impacts of Climate Change: Anticipating Surprises*, discusses a number of abrupt climate changes with potentially severe consequences. These events include:

- **Late-summer Arctic sea ice disappearance:** Strong trends of accelerating late-summer sea ice loss have been observed in the Arctic. The melting of Arctic sea ice comprises a positive feedback loop, as less ice means more sunlight will be absorbed into the dark ocean, causing further warming.
- **Sea level rise (SLR) from destabilization of West Antarctic ice sheets (WAIS):** The WAIS represents a potential SLR of 3-4 meters as well as coastal inundation and stronger storm surges. Much remains unknown of the physical processes at the ice-ocean frontier. However, two recent studies (Joughin, Smith, and Medley 2014, Rignot et. al. 2014) report evidence that irreversible WAIS destabilization has already started.
- **Sea level rise from other ice sheets melting:** Losing all other ice sheets, including Greenland, may cause SLR of up to 60 meters as well as coastal inundation and stronger storm surges. Melting of the Greenland ice sheet alone may induce SLR of 7m, but it is not expected to destabilize rapidly within this century.
- **Disruption to Atlantic Meridional Overturning Circulation (AMOC):** Potential disruptions to the AMOC may disrupt local marine ecosystems and shift tropical rain belts southward. Although current models do not indicate that an abrupt shift in the AMOC is likely within the century, the deep ocean remains understudied with respect to measures necessary for AMOC calculations.
- **Decrease in ocean oxygen:** As the solubility of gases decrease with rising temperature, a warming of the ocean will decrease the oxygen content in the surface ocean and expand existing Oxygen Minimum Zones. This will pose a threat to aerobic marine life as well as release nitrous oxide—a potent GHG—as a byproduct of microbial processes. The NRC study assesses a moderate likelihood of an abrupt increase in oxygen minimum zones in this century.
- **Increasing release of carbon stores in soils and permafrost:** Northern permafrost contains enough carbon to trigger a positive feedback response to warming temperatures. With an estimated stock of 1700-1800 Gt, the permafrost carbon stock could amplify considerably human-induced climate change. Small trends in soil carbon releases have been already observed.
- **Increasing release of methane from ocean methane hydrates:** This is a particularly potent long-term risk due to hydrate deposits through changes in ocean water temperature; the likely timescale for the physical processes involved spans centuries, however, and there is low risk this century.

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- **Rapid state changes in ecosystems, species range shifts, and species boundary changes:** Research shows that climate change is an important component of abrupt ecosystem state-changes, with a prominent example being the Sahel region of Africa. Such state-changes from forests to savanna, from savanna to grassland, et cetera, will cause extensive habitat loss to animal species and threaten food and water supplies. The NRC study assesses moderate risk during this century and high risk afterwards.
- **Increases in extinctions of marine and terrestrial species:** Abrupt climate impacts include extensive extinctions of marine and terrestrial species; examples such as the destruction of coral reef ecosystems are already underway. Numerous land mammal, bird, and amphibian species are expected to become extinct with a high probability within the next one or two centuries.

Implications of Tail Risk

An implication of the theory of decision-making under uncertainty is that the risks posed by irreversible catastrophic events can be substantial enough to influence or even dominate decisions.

Weitzman's Dismal Theorem

Over the past few years, economists have examined the implications of decision-making under uncertainty for climate change policy. In a particularly influential treatment, Weitzman (2009) proposes his so-called "Dismal Theorem," which provides a set of assumptions under which the current generation would be willing to bear very large (in fact, arbitrarily large) costs to avoid a future event with widespread, large-scale costs. The intuition behind Weitzman's mathematical result rests with the basic insight that because individuals are risk-averse, they prefer to buy health, home, and auto insurance than to take their chances of a major financial loss. Similarly, if major climate events have the potential to reduce aggregate consumption by a large amount, society will be better off if it can take out "climate insurance" by paying mitigation costs now that will reduce the odds of a large-scale—in Weitzman's (2009) word, catastrophic—drop in consumption later.[25]

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[25] This logic has its basis in expected utility theory. Because individuals are risk averse, each additional dollar of consumption provides less value, or utility, to individuals than the previous dollar. To avoid this major loss, an individual will buy home insurance. That insurance is provided by the market because an insurance company can offer home insurance to many homeowners in different regions of the country, and through diversification the company will on average have many homeowners paying premiums and a few collecting insurance, so diversification allows the company to run a relatively low-risk business. But risks from severe climate change are not diversifiable because their enormous costs would impact the global economy. Consequently, as long as there is a non-negligible probability of a large drop in consumption, and therefore a very large drop in utility, arising from a large-scale loss in consumption, society today should be willing to pay a substantial amount if doing so would avoid that loss.

Weitzman's (2009) dismal theorem has spurred a substantial amount of research on the economics of what this literature often refers to as climate catastrophes. A number of authors (e.g. Newbold and Daigneault 2009, Ackerman et al. 2010, Pindyck 2011, 2013, Nordhaus 2011, 2012, Litterman 2013, Millner 2013), including Weitzman (2011, 2014), stress that although the strong version of Weitzman's (2009) result—that society would be willing to pay an arbitrarily large amount to avoid future large-scale economic losses—depends on specific mathematical assumptions, the general principle of taking action to prevent such events does not. The basic insight is that, just as the sufficiently high threat of a fire justifies purchasing homeowners insurance, the threat of large-scale losses from climate change justifies purchasing "climate insurance" in the form of mitigation policies now (Pindyck 2011), and that taking actions today could help to avoid worst-case outcomes (Hwang, Tol, and Hofkes 2013). According to this line of thinking, the difficulty of assessing the probabilities of such large-scale losses or the location of tipping points does not change the basic conclusion that, because their potential costs are so overwhelming, the threat of very large losses due to climate change warrants implementing mitigation policies now.

Several recent studies have started down the road of quantifying the implications of the precautionary motive for climate policy. One approach is to build the effects of large-scale changes into IAMs, either by modeling the different risks explicitly or by simulation using heavy-tailed distributions for key parameters such as the equilibrium climate sensitivity or parameters of the economic damage function. Research along these lines includes Ackerman, Stanton, and Bueno (2013), Pycroft et al. (2011), Dietz (2011), Ceronsky et al. (2011), and Link and Tol (2011). Another approach is to focus on valuation of the extreme risks themselves outside an IAM, for example as examined by Pindyck (2012) and van der Ploeg and de Zeeuw (2013). Kopits, Marten, and Wolverton (2013) review some of the tail risk literature and literature on large-scale Earth system changes, and suggest steps forward for incorporating such events in IAMs, identifying ways in which the modeling could be improved even within current IAM frameworks and where additional work is needed. One of the challenges in assessing these large-scale events is that some of the most extreme events could occur in the distant future, and valuing consumption losses beyond this century raises additional uncertainty about intervening economic growth rates and questions about how to discount the distant future.[26] The literature is robust in showing that the potential for such events could have important climate policy implications, however, the scientific community has yet to derive robust quantitative policy recommendations based on a detailed analyses of the link between possible large-scale Earth system changes and their economic consequences.

Implications of Uncertainty about Tipping Points

Although research that embeds tipping points into climate models is young, one qualitative conclusion is that the prospect of a potential tipping point with unknown location enhances the precautionary motive for climate policy (Baranzini, Chesney, and Morisset 2003, Brozovic and Schlenker 2011, Cai, Judd, and Lontzek 2013, Lemoine and Traeger 2012, Barro 2013, van der

[26] For various perspectives on the challenges of evaluating long-term climate risks, see Dasgupta (2008), Barro (2013), Ackerman, Stanton, and Bueno (2013), Roe and Bauman (2013), and Weitzman (2013).

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Ploeg 2014). To develop the intuition, first suppose that the tipping point is a known temperature increase, say 3° Celsius above preindustrial levels, and that the economic consequences of crossing the tipping point are severe, and temporarily put aside other reasons for reducing carbon emissions. Under these assumptions climate policy would allow temperature to rise, stopping just short of the 3° increase. In contrast, now suppose that the tipping point is unknown and that its estimated mean is 3°, but that it could be less or more with equal probability. In this case, the policy that stops just short of 3° warming runs a large risk of crossing the true tipping point. Because that mistake would be very costly, the uncertainty about the tipping point generally leads to a policy that is more stringent today than it would be absent uncertainty. To the extent that delayed implementation means higher long-run CO_2 concentrations, then the risks of hitting a tipping point increase with delay.

As a simplification, the above description assumes away other costs of climate change that increase smoothly with temperature, as well as the reality that important tipping points in biological systems could be crossed by small gradual changes in temperatures, so as to focus on the consequences of uncertainty about large-scale temperature changes. When the two sets of costs are combined, the presence of potential large-scale changes increases the benefits of mitigation policies, and the presence of uncertainty about tipping points that would produce abrupt changes increases those benefits further.[27] Cai, Judd, and Lontzek (2013) use a dynamic stochastic general equilibrium version of DICE model that is modified to include multiple tipping points with unknown (random) locations. To avoid the Weitzman "infinities" problem, they focus on tipping events with economic consequences that are large (5 or 10 percent of global GDP) but fall short of global economic collapses. They conclude that the possibility of future tipping points increases the optimal carbon price today: in their benchmark case, the optimal pre-tipping carbon price more than doubles, relative to having no tipping point dynamics. Similarly, Lemoine and Traeger (2012) embed unknown tipping points in the DICE model and estimate that the optimal carbon price increases by 45 percent as a result. In complementary work, Barro (2013) considers a simplified model in which the only benefits of reducing carbon emissions come from reducing the probability of potential climate catastrophes, and finds that this channel alone can justify investment in reducing GHG pollution of one percent of GDP or more, beyond what would normally occur in the market absent climate policy.

[27] Cai, Judd, and Lontzek (2013) provide a stark example of this dynamic. Their analysis, which is undertaken using a modified version of Nordhaus's (2008) DICE-2007 model, includes both the usual reasons for emissions mitigation (damages that increase smoothly with temperature) and the possibility of a tipping point at an uncertain future temperature which results in a jump in damages.

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Appendix: Literature on Delay Costs

This appendix lists the studies reviewed Section II and used in the meta-analysis, and briefly describes the scenarios they analyzed.

The EMF22 project engaged ten leading integrated assessment models to analyze the climate and economic consequences of delay scenarios. The EMF22 studies consist of Loulou, Labriet, and Kanudia (2009), Tol (2009), Gurney, Ahammad, and Ford (2009), van Vliet, den Elzen, and van Vuuren (2009), Blanford, Richels, and Rutherford (2009), Krey and Riahi (2009), Calvin et al. (2009a, 2009b), Russ and van Ierland (2009), and Bosetti, Carraro, and Tavoni (2009), with Clarke et al. (2009) providing an overview of the project.[28] Among other objectives, each study estimates the mitigation costs associated with five climate targets under both an immediate action scenario and a harmonized delay scenario. The targets are 450, 550, and 650 ppm CO_2e in 2100, and the models consider the first two targets alternatively allowing or prohibiting an overshoot before 2100.[29] In the delay scenario, only more developed countries (minus Russia) begin mitigation immediately in 2012 in a coordinated fashion (i.e., with the same carbon pricing), with some countries delaying action until 2030, and remaining countries delay action until 2050. These scenarios enable calculating the additional mitigation costs associated with delay for each concentration target.

The AMPERE project engaged nine modeling teams to analyze the climate and economic consequences of global emissions following the proposed policy stringency of the national pledges from the Copenhagen Accord and Cancún Agreements to 2030. (The AMPERE scenarios were not included in the meta-analysis in Section II because Riahi et al. (2014) did not provide sufficient information to calculate the percent increase in mitigation costs for each delay scenario.) One of the questions addressed by this project is the economic costs of delaying policies to reach CO2e concentration targets of 450 and 550 ppm in 2100 (Riahi et al. 2014). Eight models simulate pairs of policy scenarios reaching each target. One simulation in each pair assumes that all countries act immediately in a coordinated fashion (i.e., with the same carbon pricing), while the other simulation assumes that all countries follow the less stringent emissions commitments made during the Copenhagen Accord and Cancun Agreements until 2030, when coordinated international action begins.

The meta-analysis includes the following studies not associated with either AMPERE or EMF22: Jakob et al. (2012); Luderer et al. (2012, 2013); Edmonds et al. (2008); Richels et al. (2007), and Bosetti et al. (2009). Jakob et al. (2012) consider a 10-year delay of mitigation efforts to reach a 450 ppm CO_2 target by 2100, including variations where more developed countries implement mitigation immediately. Luderer et al. (2012) consider a similar 10-year delay and the same 450 ppm CO_2 target by 2100, with a scenario where Europe and all other industrialized countries

[28] Russ and van Ierland (2009) did not present estimates of total delay costs, so this paper is not included in the meta-analysis in Section II.

[29] We included three additional scenarios in van Vliet, den Elzen, and van Vuuren (2009) with alternate targets and models that were not reported in Clarke et al. (2009).

begin mitigation efforts in 2010. Luderer et al. (2013) analyze a scenario where countries implement fragmented policies before coordinating efforts in 2015, 2020, or 2030 to meet a target of 2°C above preindustrial levels by 2100, allowing for overshooting. Edmonds et al. (2008) consider targets of 450, 550, and 660 ppm CO_2, with newly developed and developing countries delaying climate action from a start date of 2012 to 2020, 2035 and 2050. Richels et al. (2007) estimate the additional cost of delay by newly developing countries until 2050 for a 450 and 550 ppm CO_2 target. Finally, Bosetti et al. (2009) estimate the additional cost when all countries delay climate action for 20 years with a goal of reaching a 550 ppm and 650 ppm CO_2e target by 2100.

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Exhibit 7

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Edited by David Leonhardt

CLIMATE CHANGE

There's a Formula for Deciding When to Extract Fossil Fuels

"Drill, Baby, Drill" became a popular campaign mantra back in the 2008 election cycle. But now we're hearing the opposite call: "Leave It in the Ground."

These calls come from environmentalists who see the end of drilling and mining as the way to avoid disruptive climate change. They direct these calls toward the federal government because it is estimated that about half of the carbon in technologically recoverable fossil fuels in the United States is on public lands.

Is there a middle ground that can supply the energy we need without causing significant climate damages? Yes. And it doesn't involve exploiting all available resources, nor banning their use.

What if we continued to lease the rights to access fossil fuels on federal land but required the leases and royalty payments to reflect the full climate damages from these fuels? Doing so would put the market to work by unlocking fossil fuels that have the highest value in relation to their impact on the climate. The bonus: It provides money to pay for some of the damage of climate change.

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We've seen the benefits of using our domestic resources over the last decade as the amount of our energy coming from domestic oil and gas resources increased 54 percent. Chiefly, we have lower fuel prices. We now pay 74 percent less for natural gas and 25 percent less for petroleum, compared with 2005. Further, net imports will account for just 23 percent of American liquid fuel supplies this year — down from 60 percent in 2005 — with important energy security benefits. Our carbon emissions are also below 2005 levels, with cheap natural gas having taken significant market share from coal, which is more carbon intensive.

At the same time, the combustion of fossil fuels causes climate change that is projected to impose myriad costs around the world. But in this regard, not all fossil fuels are created equal. The value per unit of energy, measured by the market price, is greater for some (like petroleum) than others (like coal). Further, some contain more carbon or result in the release of more emissions because of other factors like the extraction and transportation process, and inflict greater climate damages. Knowing the monetary value of climate damages associated with a ton of carbon emissions is therefore the key to this whole problem.

Luckily, there is a way to determine this. It is called the Social Cost of Carbon (S.C.C.), and the federal government sets it at $40 per metric ton of CO_2 emissions. The S.C.C. is used to inform a wide variety of regulations that limit the use of fossil fuels, including emissions standards for vehicles, appliances and power plants. But the S.C.C. has not been used to guide extraction policies. (I was co-leader of an interagency group that set the S.C.C. when I worked in the Obama administration from 2009 to 2010.)

If the S.C.C. were applied as a part of leasing and royalty rates on federal lands, we would unlock resources with the greatest net benefits. To illustrate the consequences of such a shift, I did some calculations based on the spot prices for coal, petroleum and natural gas and their respective energy and carbon contents. The addition of a charge based on the S.C.C. is unlikely to

have a substantial effect on domestic production of petroleum: The spot price per million British thermal units (B.T.U.s) this year has been $8.81, and the associated climate damages are $2.98. If the federal government collected a charge of $2.98 for each million B.T.U.s of petroleum extracted on federal lands, the revenue could be refunded directly to taxpayers or used to help the nation adapt to climate damages. The story is similar for natural gas; its value today exceeds the expected climate damages.

The case of coal is different, especially coal from the federal land in the Powder River Basin in Wyoming and Montana. The climate damages from coal mined from this region are five to six times greater than its market value ($0.66 at market value versus $3.89 of climate damages). Thus, a climate charge linked to the S.C.C. would probably make at least some of the coal mining in this region unprofitable. There is currently an opportunity for policy overhaul: The Department of the Interior is considering how to restructure lease terms for fossil fuels on federal lands. Further, a federal judge ruled last year that the government should take into account climate impacts when making decisions about mining on federal lands.

The application of an S.C.C.-related fee would meet many goals. Environmentalists would naturally like it, and so should fiscal conservatives who recognize that the federal government will be increasingly on the hook for climate damages (recall the more than $50 billion of federal tax dollars appropriated in response to Hurricane Sandy). At the same time, this fee would not stop the development of economically attractive fossil fuels.

Such a change in policy would have challenges. There would inevitably be some shifting of fossil fuel production to private lands in the United States, as well as to other countries; but it would also reduce the long-run global supply of fossil fuels. Further, there would be a strong case for harmonizing S.C.C. charges with existing domestic climate regulations to ensure that the carbon policies operate as efficiently as possible. There is also a strong case for providing support to communities that experience meaningful declines in

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economic activity because of an extraction fee linked to the S.C.C.

An efficient climate policy would price carbon throughout the global economy so that users of all fossil fuels recognized their climate costs. It does not appear likely that the current Paris climate negotiations will produce such a system. In the absence of such a policy, the solution doesn't need to be to use all fossil fuels, or to ban their usage. Common sense suggests that we use the ones that provide more value than harm and that we leave the others in the ground.

For a detailed analysis of the calculations, the technical document is available here.

Michael Greenstone, the Milton Friedman professor of economics at the University of Chicago, runs the Energy Policy Institute there. He was the chief economist of President Obama's Council of Economic Advisers from 2009 to 2010.

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