BLM AIR RESOURCES TECHNICAL REPORT FOR OIL AND GAS DEVELOPMENT IN NEW MEXICO, OKLAHOMA, TEXAS, AND KANSAS

2023

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1. INTRODUCTION

The purpose of this document is to present, discuss, and summarize technical information regarding air quality, air quality–related values, greenhouse gas (GHG) emissions, and climate change relative to air resources with the Bureau of Land Management (BLM) New Mexico State Office (NMSO) Planning Areas (New Mexico, Oklahoma, Texas, and Kansas). Much of the information contained in this document is directly related to air quality in the context of oil and gas development; other information is generalized air quality data that can be applied to other development scenarios and assessments. This information can then be incorporated by reference into National Environmental Policy Act (NEPA) documents, such as leasing-level documents, and site-specific documents, such as Applications for Permit to Drill (APDs), as necessary.

Because the BLM manages extensive land holdings in New Mexico, more of its activities are centered there than in other areas. The BLM has jurisdiction over mineral rights on federal lands managed by other agencies and on split estate lands in Kansas, Texas, and Oklahoma. Wherever possible, information for those states is included.

1.1 UPDATES, ADDITIONS, AND CHANGES FROM THE PREVIOUS REPORT

This section provides a list of updates, additions, and changes to the air resources technical report since the previous report.

- Fixed/edited minor grammar, spelling, formatting, and typographical errors.

- Added 2024 Waste Prevention Rule discussion (Section 2.5).

- Added new federal and state regulatory discussion, including 40 Code of Federal Regulations (C.F.R.) § 60 Subpart OOOOb and Subpart OOOOc (Section 2.5).

- Added a figure showing Class I areas (Figure 1).

- Updated the annual primary National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) smaller than 2.5 micrometers in diameter ($PM_{2.5}$) (Table 1).

- Expanded upon the health effects of certain pollutants (Section 3).

- Added most recent design values for 2023 (Sections 3.1 through 3.9).

- Removed discussion on the 2013 Comprehensive Air Resources Technical Support Document (ARTSD) by URS Corporation (URS).

- Added 2024 Carlsbad Field Office (CFO) and 2024 Pecos District Office (PDO) HAPS modeling discussion (Section 5.3).

- Added discussion of the 2032 BLM Regional Criteria Air Pollutant Photochemical Modeling Study (Section 6.3).

- Adjusted discussion of 2017 Colorado Air Resources Management Modeling Study (CARMMS) 2.0 northern New Mexico modeling study (Section 6.2).

- Updated PDO single-well emission factors (Section 7.1.2).

- Added spud data for available field offices for 2016-2023 (Section 7.2).

- Added New Mexico EMIT soil and climate data(Section 7.3)

- Modified the GHG section, updating language and incorporating the *2023 BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends* (https://www.blm.gov/content/ghg/) (BLM Specialist Report) (BLM 2024a) and removing any outdated or redundant information.

- Added GHG NEPA discussion consistent with Council on Environmental Quality (CEQ) (Sections 11.2 and 11.3)

- Added Methane Emissions Reduction Program to discussion (Section 18).

1.2   AIR RESOURCES

Air quality, GHGs, and climate are components of air resources that may be affected by BLM applications, activities, and resource management. Therefore, the BLM must consider and analyze the potential effects of BLM and BLM-authorized activities on air resources as part of the planning and decision-making process. In particular, the activities surrounding oil and gas development are likely to have impacts related to air resources.

2   AIR QUALITY REGULATORY ANALYSIS

The Clean Air Act (CAA), as amended, is the primary authority for the regulation and protection of air quality in the United States. The Federal Land Policy and Management Act (FLPMA) also charges the BLM with the responsibility to protect air and atmospheric values. Additionally, each state, tribal, or local government holds additional authority for regulating air quality within their unique jurisdiction.

2.1   CLASS I, II, AND III AREAS AND THE CLEAN AIR ACT

All areas of the United States not specifically classified as Class I by the CAA are considered Class II for air quality. Class I areas are afforded the highest level of protection by the CAA and include all international parks, national wilderness areas and national memorial parks greater than 5,000 acres, and national parks greater than 6,000 acres that were in existence on August 7, 1977. Moderate amounts of air quality degradation are allowed in Class II areas. Although the CAA allows for designation of Class III areas where greater amounts of degradation would be allowed, no areas have been designated as such by the U.S. Environmental Protection Agency (EPA). Figure 1 shows the Class I areas located in New Mexico and the surrounding states. Air quality in a given area is determined by comparing monitored air pollution levels using air monitoring equipment operated in accordance with federal regulatory standards with NAAQS for six regulated air pollutants defined in the CAA. In some cases, states have set their own ambient air quality standards in accordance with provisions of the CAA.
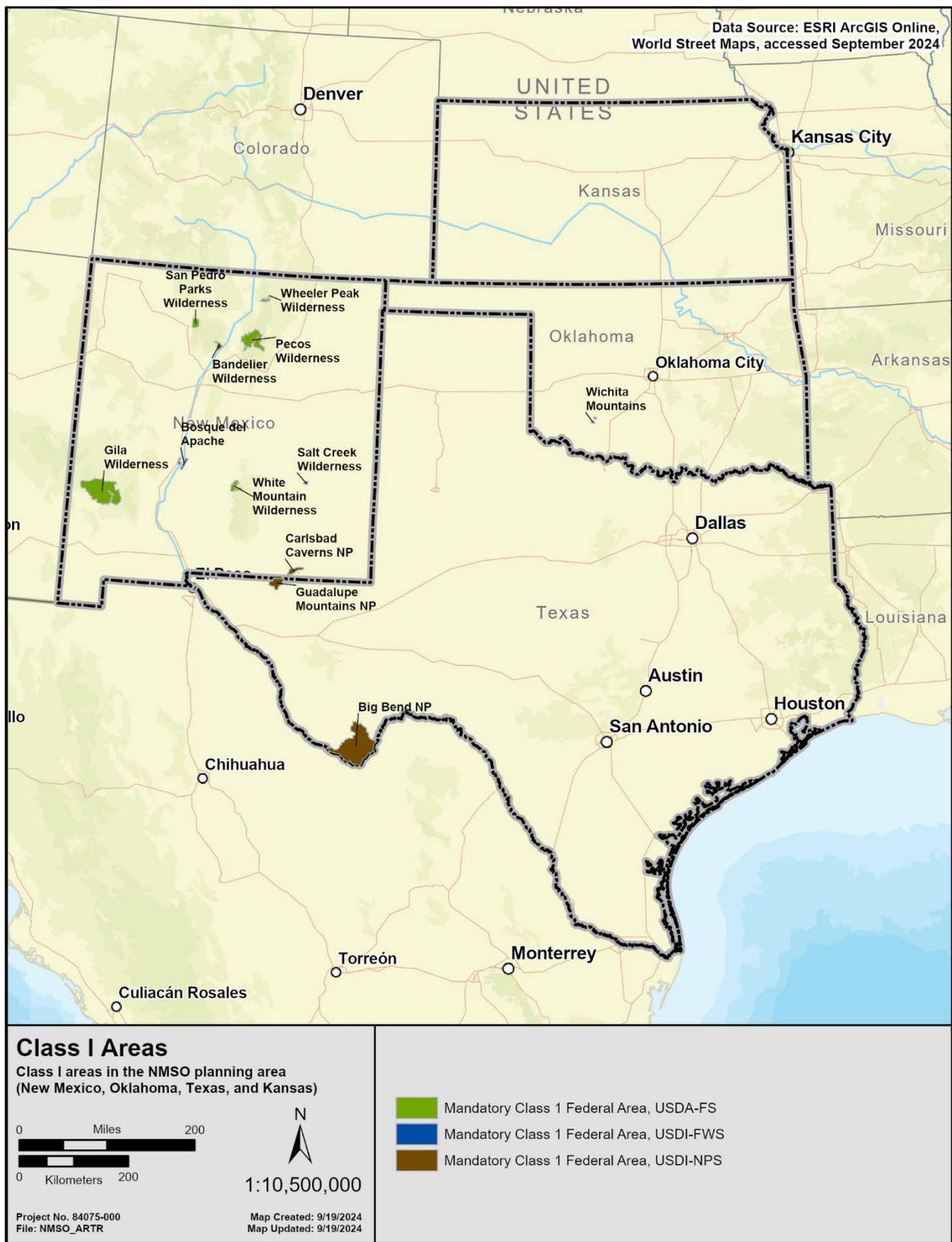
Figure 1. Class 1 areas.

2.2 FEDERAL LAND POLICY AND MANAGEMENT ACT

The FLPMA of 1976 (43 United States Code [U.S.C.] §§ 1701–1785), often referred to as the BLM "Organic Act," provides most of the BLM legislated authority, direction policy, and basic management guidance. This Act outlines the BLM role as a multiple-use land management agency and provides for management of the public lands under principles of multiple-use and sustained yield. The Organic Act directs public lands to be managed "in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values" (Section 102 [43 U.S.C. § 1701] (a) (8)). To fulfill this responsibility, BLM land use plans ensure "compliance with applicable pollution control laws, including state and federal air, water, noise, or other pollution standards or implementation plans" (Section 202 [43 U.S.C. § 1712] (a)(8)). Accordingly, BLM leases and operating permits for fossil fuels require compliance with all state and federal air pollution standards. FLPMA also gives the BLM authority to revoke or suspend any BLM-authorized activity that is found to be in violation of regulations applicable to public lands and/or in noncompliance with applicable state or federal air quality standards or implementation plans, thus ensuring that the BLM can provide for compliance with applicable air quality standards, regulations, and implementation plans (Section 302(c) [43 U.S.C. § 1732]). When authorizing activities, the BLM assumes full compliance with applicable state and federal air quality requirements and emissions standards, and related equipment and performance standards in effect at the time.

2.3 NATIONAL ENVIRONMENTAL POLICY ACT

The NEPA of 1969 (42 U.S.C. § 4321 et seq.) ensures that information on the potential environmental and human impact of federal actions is available to public officials and citizens before decisions are made and before actions are taken. One of the purposes of NEPA is to "promote efforts which will prevent or eliminate damage to the environment and biosphere" and to promote human health and welfare. NEPA requires that agencies prepare a detailed statement on the environmental impact of the proposed action for major federal actions expected to significantly affect the quality of the human environment (Section 102(C) [42 U.S.C. § 4321]). In addition, agencies are required, to the fullest extent possible, to use a "systematic, interdisciplinary approach" in planning and decision-making processes that may have an impact on the environment (Section 102(A) [43 U.S.C. § 4321]).

2.4 ADDITIONAL GUIDANCE

Other guidance and policies are useful for the BLM in managing air resources, although not required by law. Such guidance includes:

- Council on Environmental Quality (CEQ) guidance on NEPA analysis,
- CEQ NEPA guidance on consideration of GHG emissions and climate change from January 2023,
- The 2010 Federal Land Managers Air Quality Related Values Work Group (FLAG),
- 2023 BLM Specialist Report (BLM 2024a),
- The Mineral Leasing Act (MLA) of 1920 (30 U.S.C. § 181 et seq.),
- Executive Orders (EOs) 13990 and 14008,
- The Global Change Research Act of 1990 (Public Law 101–606; 104 Statute 3096–3104),

- BLM guidance for conducting air quality general conformity determinations (Instruction Memorandum No. 2013-025 – *Guidance for Conducting Air Quality General Conformity Determinations* [BLM 2012] and BLM Information Bulletin 2014-084 – *Issuance of the Bureau of Land Management Fact Sheet on the Air Quality General Conformity Rule* [BLM 2014a]).

For detailed information on many of these laws and policies and their relationship to mitigation of climate change, refer to Section 2.0 of the BLM Specialist Report (BLM 2024a).

2.5 FEDERAL RULES

The EPA has the primary responsibility for regulating atmospheric emissions, including six nationally regulated air pollutants defined in the CAA. These pollutants, referred to as "criteria pollutants," are carbon monoxide (CO), nitrogen dioxide (NO_2) (and nitrogen oxides[1] [NO_x]), ozone (O_3), particulate matter smaller than 2.5 micrometers in diameter ($PM_{2.5}$), particulate matter smaller than 10 micrometers in diameter (PM_{10}), sulfur dioxide (SO_2) (and sulfur oxides [SO_x]), and lead (Pb).

The EPA New Source Performance Standards (NSPS) rules (under 40 C.F.R. § 60) are designed to regulate criteria air pollutant and O_3 precursor emissions, as well as greenhouse gas (GHG) emissions. The EPA NSPS regulations that are most likely to have applicability to oil and gas operations are as follows:

- Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

- Subpart Kb – Standards of Performance for Volatile Organic Liquid Storage Vessels (including Petroleum Liquid Storage Vessels) for which Construction, Reconstruction, or Modification Commenced After July 23, 1984

- Subpart OOOO (amended) – Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced After August 23, 2011, and on or Before September 18, 2015.

- Subpart OOOOa – Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after September 18, 2015 and on or before December 6, 2022: NSPS – Originally this rule and its draft was promulgated to regulate volatile organic compounds (VOCs) and GHG emissions (methane [CH_4]) from specific sources within the oil and natural gas industry which would have included new, modified, and reconstructed compressors, pneumatic controllers, pneumatic pumps, storage vessels, well completions, fugitive emissions from well sites and compressor stations, and equipment leaks at natural gas processing plants. In September 2018 and August 2019, the EPA proposed changes to the rule to modify, amend and/or rescind requirements for the 2012 and 2016 NSPS for the Oil and Gas Industry, which have been incorporated into the final rule as of September 14, 2020.

- Subpart OOOOb – Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After December 6, 2022: NSPS – that will sharply reduce emissions of methane and other harmful air pollution from oil and natural gas operations — including, for the first time, from existing sources nationwide. It also includes emissions guidelines, which set procedures for states to follow as they develop plans to limit methane from existing sources (Subpart OOOOc). In May 2024, EPA notified petitioners that it is granting reconsideration on two aspects of its final NSPS OOOOb in response to petitions from

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[1] The nitrogen oxide family of compounds includes nitric oxide (NO), NO_2, nitrous acid (HNO_2), and nitric acid (HNO_3).

industry. The reconsideration will address narrow technical issues raised by industry petitioners related to monitoring and emergency operations for flares that were included in the final rule, which was published March 8, 2024. Through the reconsideration process, EPA intends to propose and take public comment on minor changes to the final rule in response to these petitions.

- Subpart OOOOc—Emissions Guidelines for Greenhouse Gas Emissions from Existing Crude Oil and Natural Gas Facilities Constructed on or before December 6, 2022 - This subpart establishes emission guidelines and compliance schedules for the control of GHG emissions from designated facilities in the crude oil and natural gas source category as defined in the Model Rule at §60.5430c of this subpart.

Other relevant NSPS requirements under 40 C.F.R. § 60 include:

- Subpart GG – Standards of Performance for Stationary Gas Turbines

- Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

- Subpart K – Standards of Performance for Storage Vessels for Petroleum Liquids for which Construction, Reconstruction, or Modification Commenced after June 11, 1973, and prior to May 19, 1978

- Subpart Ka – Standards of Performance for Storage Vessels for Petroleum Liquids for which Construction, Reconstruction, or Modification Commenced after May 18, 1978, and prior to July 23, 1984

- Subpart KKK – Standards of Performance for Equipment Leaks of VOCs from Onshore Natural Gas Processing Plants for Which Construction, Reconstruction, or Modification Commenced after January 20, 1984, and on or before August 23, 2011

- Subpart KKKK – Standards of Performance for Stationary Combustion Turbines

- Subpart TTTT – Standards of Performance for Greenhouse Gas Emissions for Electric Generating Units

- Subpart TTTTa - Standards of Performance for Greenhouse Gas Emissions for Modified Coal-Fired Steam Electric Generating Units and New Construction and Reconstruction Stationary Combustion Turbine Electric Generating Units

The BLM finalized the Waste Prevention, Production Subject to Royalties, and Resource Conservation Rule, also known as the Waste Prevention Rule, which went into effect on June 10, 2024. The rule is distinct from the EPA's Methane Rule, discussed above. This rule updates Onshore O&G Operations and Production Rules 43 C.F.R. 3160 and 43 C.F.R. 3170. The rule is expected to conserve billions of cubic feet of gas that might have otherwise been vented, flared, or leaked from operators. This rule will replace the BLM's current requirements governing venting and flaring, which are more than four decades old. BLM is phasing in the new requirements to allow operators ample time to appropriately adjust. Operators will have 18 months to submit leak detection and repair plans to BLM state offices (BLM 2024b). The primary components of the rule update are to:

- Require operators to take reasonable measures to prevent waste as conditions of approval of an APD.

- Require operators to submit either a Waste Minimization Plan or a self-certification statement. Waste Minimization Plans will include anticipated oil and associated-gas production and anticipated 3-year decline curves; certification that the operator has an executed, valid gas sales contract; and any other steps the operator commits to take to reduce or eliminate gas losses. Self-certification statements commit the operator to capturing 100% of the associated gas produced from an oil well and would obligate the operator to pay royalties on all lost gas except for gas lost through emergencies. This applies to all APDs submitted after June 10, 2024.

- Clarify definition of "unavoidably lost" (i.e., royalty free). For unavoidably lost gas, the rule establishes a volumetric loss threshold based on oil production on royalty-free flaring due to pipeline capacity constraints, midstream processing failures, or other similar events that may prevent produced gas from being transported to market.

- All operators on federal or Indian leases are required to submit a BLM administrative statewide Leak Detection and Repair (LDAR) plan to the NMSO. For leases in effect on June 10, 2024, the operator must submit a statewide LDAR program to the state office no later than December 10, 2025.

2.6   STATE RULES

Regulation and enforcement of the NAAQS has been delegated to the states by the EPA. Both the NAAQS and the New Mexico Ambient Air Quality Standards (NMAAQS) are shown in Table 1. Texas has state property line standards for SO_2 and certain non-criteria pollutants. Other than the addition of a 30-minute SO_2 state property line standard, which varies based on which county a project is in, there are no other differences between state standards and NAAQS in Texas. Oklahoma and Kansas do not have state standards that differ from the NAAQS.

The regulatory authority for air quality in New Mexico is the New Mexico Environment Department (NMED) Air Quality Bureau (NMED 2024a), except in Bernalillo County and on tribal lands. The City of Albuquerque/Bernalillo Air Quality Division has authority over air quality in Bernalillo County.
The regulatory authority for air quality in Kansas is the Kansas Department of Health and Environment, Bureau of Air (Kansas Department of Health and Environment 2024). The regulatory authority for air quality in Oklahoma is the Oklahoma Department of Environmental Quality (ODEQ), Air Quality Division (AQD) (ODEQ 2024). The regulatory authority for air quality in Texas is the Texas Commission on Environmental Quality (TCEQ), Air Division (TCEQ 2024a).

Table 1. NAAQS and NMAAQS

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards		NMAAQS Level (Averaging Time)
	Level	Averaging Time	Level	Averaging Time	
CO	9 ppm (10 mg/m^3)	8-hour[1]	None	(n/a)	8.7 ppm (n/a)
	35 ppm (40 mg/m^3)	1-hour[1]	None	(n/a)	13.1 ppm (n/a)

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards		NMAAQS Level (Averaging Time)
	Level	Averaging Time	Level	Averaging Time	
Pb	0.15 µg/m^3	Rolling 3-month average[2]	0.15 µg/m^3	Rolling 3-month average[2]	None (n/a)
NO$_2$ (or NO$_x$)	53 ppb (100 µg/m^3)	Annual (arithmetic average)	53 ppb (100 µg/m^3)	Annual (arithmetic average)	50 ppb (n/a)
	100 ppb (188 µg/m^3)	1-hour[3]	None	n/a	100 ppb (24-hour)
PM$_{10}$	150 µg/m^3	24-hour[4]	150 µg/m^3	24-hour[4]	*
PM$_{2.5}$	9.0 µg/m^3	Annual[5] (arithmetic average)	15.0 ug/m^3	Annual[5] (arithmetic average)	*
	35 µg/m^3	24-hour[6]	35 µg/m^3	24-hour[6]	*
O$_3$	0.070 ppm (137 µg/m^3)	8-hour[7]	0.070 ppm (137 µg/m^3)	8-hour[7]	None (n/a)
SO$_2$ (or SO$_x$)	75 ppb (196 µg/m^3)	1-hour[8]	0.5 ppm[1] (1,300 µg/m^3)	3-hour	0.02 ppm (annual)** 0.10 ppm (24-hour)**

Source: EPA (2024a); New Mexico Administrative Code (N.M.A.C.) 20.2.3.

Notes:

n/a = not applicable.

µg/m3 = micrograms/ cubic meter.

mg/m3 = milligrams/cubic meter.

ppb = parts per billion.

ppm = parts per million.

*The New Mexico Environmental Improvement Board repealed the total suspended particle NMAAQS in N.M.A.C. 20.2.3, Ambient Air Quality Standards effective November 30, 2018, and therefore, total suspended particles will no longer be reported. A determination was made that the current state and federal air quality standards for PM$_{10}$ and PM$_{2.5}$ are sufficiently protective of public health and that that the repeal of the total suspended particles standard will not result in deterioration of air quality.

** For additional standards of air quality related to sulfur compounds in specific areas such as Chino Mines Company smelter furnace stack at Hurley and the Pecos-Permian basin intrastate air quality control region, see N.M.A.C. 20.2.3.

[1] Not to be exceeded more than once per year.

[2] Not to be exceeded.

[3] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

[4] Not to be exceeded more than once per year on average over 3 years.

[5] To attain this standard, the 3-year average of the weighted annual mean PM$_{2.5}$ concentrations from single or multiple community-oriented monitors must not be exceeded.

[6] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).

[7] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O$_3$ concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm.

[8] To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

On May 25, 2021, in accordance with Governor Michelle Lujan Grisham's EO 2019-003 (January 29, 2019), the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) announced the release of the New Mexico Oil Conservation Division (NMOCD) Statewide Natural Gas Capture Requirements (Waste Prevention Rule), New Mexico Administrative Code (N.M.A.C.) 19.15.27.9, as part of the New Mexico statewide enforceable regulatory framework to secure reductions in oil and gas sector emissions and to prevent natural gas waste from new and existing sources. Key provisions include prohibition of unnecessary venting and flaring of waste natural gas where it is technically feasible to route the gas to pipeline or to use this gas for some other beneficial purpose (such as on-site fuel consumption). In all cases, operators must flare rather than vent natural gas except where this is technically infeasible or would pose a safety risk. These provisions will reduce VOC emissions due to stringent limitations on natural gas venting which results in uncombusted VOC emissions. Additionally, it proposes that natural gas be recovered and reused rather than flared, which would result in reductions of VOCs, NO_x, CO, SO_2, GHGs, and PM emissions.

The NMED has developed the "Oil and Natural Gas Regulation for Ozone Precursors" (N.M.A.C. 20.2.50.1), which was published on July 26, 2022, with an effective date of August 5, 2022. Approximately 50,000 wells and associated equipment will be subject to this regulation. It is anticipated that the regulation will annually reduce VOC emissions by 106,420 tons, nitrogen oxide (NO) emissions by 23,148 tons, and CH_4 emissions by 200,000 to 425,000 tons. The regulation includes emissions reduction requirements for compressors, engines and turbines, liquids unloading, dehydrators, heaters, pneumatics, storage tanks, and pipeline inspection gauge launching and receiving. The regulation also encourages operators to stop venting and flaring and use fuel cells technology to convert CH_4 to electricity at the well site and incentivizes new technology for leak detection and repair.

3 CRITERIA AIR POLLUTANTS

The EPA has the primary responsibility for regulating criteria air pollutants (CO, NO_2 (or NO_X), O_3, $PM_{2.5}$, PM_{10}, SO_2 (or SO_X), and Pb). The CAA charges the EPA with establishing and periodically reviewing NAAQS for each criteria pollutant. Table 1 shows the current primary and secondary NAAQS and averaging time for each pollutant, as well as the New Mexico–specific NMAAQS for select pollutants. Primary standards are set to protect the public health with a margin of safety, and secondary standards are meant to protect environmental concerns such as air quality related values (AQRVs) (visibility, vegetation injury, etc.).

3.1 MONITORING DATA AND DESIGN VALUES

Criteria pollutants are monitored throughout various parts of the country. Monitors measure concentrations of pollutant in the atmosphere, and the results are often presented in parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). EPA and states periodically analyze and review monitor locations, discontinuing monitoring at locations where pollutant concentrations have been well below the standards and adding monitors in areas where pollutant concentrations may be approaching air quality standards. *Instantaneous on-demand* monitored outdoor air quality data collected from state, local, and tribal monitoring agencies can be obtained from the EPA Air Data webpage and interactive tool (EPA 2024b). Most air monitors are situated to measure air quality in both neighborhoods and industrial areas. A few stations are situated in rural areas by various federal agencies to monitor air quality conditions and trends at national parks and other public lands and to identify background concentrations away from major emission sources.

Another type of monitoring data is *annual average concentration(s)* measured at air monitors, which is then translated to annual design values to be consistent with the individual NAAQS (as shown in Table 1). A design value is a statistic representing the monitored concentration of a given pollutant in a given location, expressed in the manner of its standard, which can be compared with the NAAQS. Design values are normally updated annually and posted to the EPA Air Quality Design Value website. These design values are intended for informational use only and does not constitute a regulatory determination by EPA as to whether an area has attained an NAAQS.

3.2   OZONE AND VOLATILE ORGANIC COMPOUNDS

Ground-level O_3 is not emitted directly into the air but is created by chemical reactions between precursors—NO_x and VOCs—in the presence of sunlight (Figure 2). Whereas O_3 and NO_2 are criteria air pollutants, VOCs are not. Figure 1 uses a graphical representation to show how O_3 is created in the atmosphere.
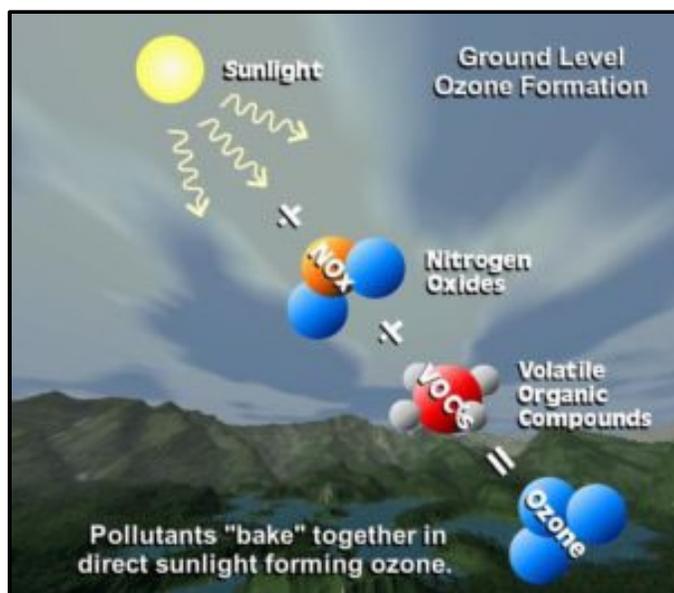
Figure 2. O_3 formation, courtesy of NASA.

VOCs are organic chemical compounds whose composition makes it possible for them to evaporate under normal atmospheric conditions of temperature and pressure (EPA 2024c). Although there is no NAAQS for VOCs, these are regulated by the EPA to prevent the formation of O_3, a constituent of photochemical smog. Many VOCs are also HAPs. Inhalation of VOCs can cause difficulty breathing, nausea, and damage to the central nervous system and other organs. Some VOCs are also air toxins that can be carcinogenic. VOCs are components of natural gas and may be emitted from well drilling, operations, and equipment leaks, valves, pipes, and pneumatic devices. Additionally, VOCs are emitted from a variety of sources, such as refineries, oil and gas production equipment, consumer products, and natural (biogenic) sources, such as trees and plants.

Specifically, VOCs are emitted during well drilling and operations as exhaust from internal combustion engines. VOCs may be emitted from hydraulically fractured oil and gas wells during fracturing and refracturing of the wells. In the hydraulic fracturing process, a mixture of water, chemicals, and proppant is pumped into a well at extremely high pressures to fracture rock and allow oil and gas to flow

from the geological formation. During one stage of well completion, fracturing fluids, water, and reservoir gas come to the surface at high velocity and volume (flowback). This flowback mixture contains VOCs, CH_4, benzene, ethylbenzene, and n-hexane; some or all the flowback mixture may be vented, flared, or captured. The typical flowback process lasts from 3 to 10 days, so there is potential for significant VOC emissions from this stage of the well completion process. Most new oil and gas wells drilled today use the hydraulic fracturing process.

O_3 is most likely to reach unhealthy levels on hot, sunny days but can still reach high levels during colder months. O_3 can also be transported long distances by wind (EPA 2024d).

People most at risk from breathing air containing O_3 include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from O_3 exposure (EPA 2024e). Deficiencies of vitamin E, a fat-soluble nutrient, is uncommon in developed countries but do occur in those individuals with conditions that prevent the body from adequately absorbing fats (e.g., chronic pancreatitis, cholestasis, cystic fibrosis, primary biliary, cirrhosis, Crohn's disease, or short bowel syndrome). Vitamin C deficiency and scurvy are rare in developed countries, as overt deficiency symptoms occur only if vitamin C intake falls below approximately 10 milligrams /day for many weeks; however, vitamin C deficiency can still occur in people with limited food variety or those with intestinal problems such as ulcerative colitis or Crohn's disease. Children are at greatest risk from exposure to O_3 because their lungs are still developing and they are more likely to be active outdoors when O_3 levels are high, which increases their exposure. Children are also more likely than adults to have asthma (EPA 2024e).

Depending on the level of exposure, breathing O_3 can trigger a variety of health problems. Effects of O_3 inhalation can include coughing and sore or scratchy throat; difficulty breathing deeply and vigorously and pain when taking deep breaths; inflammation and damage the airways; increased susceptibility to lung infections; aggravation of lung diseases such as asthma, emphysema, and chronic bronchitis; and an increase in the frequency of asthma attacks. Some of these effects have been found even in healthy people, but effects are more serious in people with lung diseases such as asthma. O_3 exposure may lead to increased school absences, medication use, visits to doctors and emergency rooms, and hospital admissions. Long-term exposure to O_3 is linked to aggravation of asthma and is likely to be one of many causes of asthma development. Studies in locations with elevated concentrations also report associations of O_3 with deaths from respiratory causes (EPA 2024e). Asthma often starts during childhood when the immune system is still developing. Multiple factors may work together to cause asthma, such as allergens in the environment that affect babies or young children, including cigarette smoke and certain germs; viral infections that affect breathing; and family history, such as a parent (in particular, a mother) who has asthma. Common triggers for asthma include indoor allergens, such as dust mites, mold, and pet dander or fur; outdoor allergens, such as pollens and mold; emotional stress; physical activity (although with treatment, most individuals can still be active); infections, such as colds, influenza (flu), or COVID-19; certain medicines, such as aspirin, which may cause serious breathing problems in people with severe asthma; poor air quality (such as high levels of O_3); or very cold air (National Heart, Lung, and Blood Institute 2024).

The environmental effects of O_3 include damaging sensitive vegetation and ecosystems. In particular, O_3 harms sensitive vegetation during the growing season (EPA 2023a). Plant species that are sensitive to the O_3 in terms of growth effects include trees found in many areas of the United States, such as black cherry (*Prunus serotina*), quaking aspen (*Populus tremuloides*), tulip poplar (*Liriodendron tulipifera*), white pine (*Pinus strobus*), ponderosa pine (*Pinus ponderosa*) and red alder (*Alnus rubra*). When

sufficient O_3 enters the leaves of a sensitive plant, it can reduce photosynthesis, which is the process by which plants convert sunlight to energy to live and grow. O_3 can also slow a plant's growth and increase its risk of disease, damage from insects, effects of other pollutants, and damage from severe weather. The effects of O_3 on individual plants can then have negative impacts on ecosystems, including loss of species diversity, changes to the specific assortment of plants present in a forest, changes to habitat quality, and changes to water and nutrient cycles (EPA 2023a).

3.2.1 OZONE TRENDS

Nationally, O_3 concentrations at urban and rural sites have decreased 26% from 1980 to 2023 (EPA 2023b) and 12% from 2000 to 2023 (EPA 2023c). The increase of O_3-depleting substance (ODS) concentrations caused the large O_3 decline observed from 1980 to the mid-1990s. Since the late 1990s, concentrations of ODS have been declining due to the successful implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer (National Oceanic and Atmospheric Administration [NOAA] 2018). The long-term decrease is also likely driven by reductions in global emissions of substances that lead to the formation of O_3, such as O_3 precursors VOCs and NO_x. In correlation, from 1980 to 2023, anthropogenic emissions of VOCs and NO_x have decreased by 58% and 75%, respectively (EPA 2023c). From 2000 to 2023, anthropogenic emissions of VOCs and NOx have decreased by 26% and 69%, respectively (EPA 2023c). Nevertheless, some areas still experience O_3 exceedances as discussed in Section 3.9. Weather conditions have a significant role in the formation of O_3, which is most readily formed on warm summer days when there is stagnation. Conversely, O_3 production is more limited when it is cloudy, cool, rainy, or windy. EPA uses a statistical model to adjust for the variability in seasonal O_3 concentrations due to weather to provide a more accurate assessment of the underlying trend in O_3 caused by emissions, however often long periods are required to distinguish between weather effects and the effect of changes in pollutant emissions. Table 2 shows the O_3 trends for all the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas). Only those counties with monitoring completed in the last 10 years are included in Table 2. Of the eight New Mexico counties in the major oil and gas basin (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties), O_3 trend data are not available for Chaves, McKinley, or Roosevelt Counties. Table 2 shows that O_3 trends vary depending on state and county.

Table 2. Local O$_3$ Trends – 8 hour

State/County/ *City*	Site ID	2012–2014 Design Value (ppm)	2013–2015 Design Value (ppm)	2014–2016 Design Value (ppm)	2015–2017 Design Value (ppm)	2016–2018 Design Value (ppm)	2017–2019 Design Value (ppm)	2018–2020 Design Value (ppm)	2019–2021 Design Value (ppm)	2020–2022 Design Value (ppm)	2021–2023 Design Value (ppm)
New Mexico											
Bernalillo	350011012	0.067	0.064	0.064	0.067	0.069	0.071	0.071	0.072	0.073	0.072
	350010023	0.068	0.066	0.065	0.067	0.070	0.070	0.070	0.068	0.069	0.069
	350010029	0.067	0.066	0.065	0.065	0.066	0.067	0.067	0.066	0.067	0.066
Doña Ana	350130021	0.072	0.072	0.072	0.072	0.074	0.077	0.078	0.080	0.081	0.079
	350130008	0.067	0.066	0.066	0.068	0.068	0.070	0.070	0.072	0.076	0.076
	350130020	0.068	0.067	0.066	0.068	0.071	0.073	0.072	0.070	0.071	0.070
	350130022	0.074	0.072	0.068	0.072	0.074	0.076	0.074	0.075	0.075	0.072
	350130023	0.065	0.065	0.065	0.066	0.067	0.070	0.070	0.070	0.066	0.067
Eddy	350151005	0.071	0.069	0.067	0.068	0.074	0.079	0.078	0.077	0.077	0.078
	350150010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.074	0.077	0.078
Grant	350171003	0.062	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	350250008	0.065	0.067	0.066	0.067	0.070	0.071	0.068	0.066	0.066	0.071
Luna	350290003	0.066	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rio Arriba	350390026	n/a	n/a	0.064	0.065	0.067	0.067	0.065	0.064	0.064	0.063
Sandoval	350431001	0.063	0.065	0.064	0.065	0.068	0.068	0.070	0.068	0.070	0.067
San Juan	350450018	0.068	0.067	0.066	0.068	0.070	0.069	0.068	0.068	0.070	0.070
	350450020	n/a	n/a	n/a	n/a	n/a	n/a	0.067	0.068	0.068	0.067
	350451005	0.066	0.063	0.062	0.064	0.069	0.069	0.069	0.068	0.067	0.067
	350450009	0.067	0.064	0.062	0.064	0.069	0.068	0.066	0.063	0.064	0.065
Santa Fe	350490021	0.066	0.064	0.063	0.063	0.066	0.066	0.068	0.066	0.067	0.065
Valencia	350610008	0.069	0.066	0.064	0.065	0.067	0.068	0.069	0.066	0.066	0.063

State/County/City	Site ID	2012–2014 Design Value (ppm)	2013–2015 Design Value (ppm)	2014–2016 Design Value (ppm)	2015–2017 Design Value (ppm)	2016–2018 Design Value (ppm)	2017–2019 Design Value (ppm)	2018–2020 Design Value (ppm)	2019–2021 Design Value (ppm)	2020–2022 Design Value (ppm)	2021–2023 Design Value (ppm)
Oklahoma											
Tulsa-Muskogee-Bartlesville, OK	401430178	0.071	0.065	0.063	0.064	0.065	0.066	0.065	0.064	0.066	0.073
Oklahoma City-Shawnee, OK	401091037	0.074	0.069	0.068	0.069	0.070	0.069	0.069	0.068	0.070	0.071
Kansas											
Wichita-Arkansas City-Winfield, KS	201730010	0.073	0.068	0.065	0.063	0.063	0.063	0.061	0.060	0.064	0.066
Texas											
El Paso-Las Cruces, TX	481410044	0.068	0.068	0.067	0.069	0.071	0.074	0.074	0.071	0.069	0.068
Longview-Marshall, TX	481830001	0.071	0.068	0.066	0.065	0.065	0.065	0.063	0.062	0.061	0.065
Dallas-Fort Worth-Arlington, TX	481210034	0.081	0.083	0.080	0.079	0.075	0.073	0.072	0.074	0.076	0.079
Austin-Round Rock, TX	484530020	0.069	0.068	0.066	0.067	0.066	0.066	0.065	0.063	0.064	0.067

Source: EPA (2024f).

Note: n/a = Data not available due to lack of monitoring data.

3.3   NITROGEN DIOXIDE

NO_2 is both a criteria pollutant and an indicator for the NO_x family of NO compounds that are ground-level O_3 precursors. The NO family of compounds, a group of highly reactive gases, includes NO, NO_2, nitrous acid (HNO_2), and nitric acid (HNO_3). The primary sources of NO_x nationally are from the burning of fuel. The excess air required for complete combustion of fuels introduces atmospheric nitrogen into the combustion reactions at high temperatures and produces NO_x. Breathing air with a high concentration of NO_2 can cause adverse respiratory impacts in both healthy people and those with asthma (EPA 2023d). High concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma and lung cancer, as well as children and the elderly are generally at greater risk for the health effects of NO_2. NO_2 exposure has also been strongly associated with heart and lung harm, affected pregnancy and birth outcomes, and were likely associated with increased risk of kidney and neurological harm, autoimmune issues, and cancer (American Lung Association 2023). NO_2 and other NO_x interact with water, oxygen, and other chemicals in the atmosphere to produce acid rain. High levels of NO_2 are also harmful to vegetation, damaging foliage, decreasing growth, and reducing crop yields (Rowland et al. 1985).

3.3.1   NITROGEN DIOXIDE TRENDS

Nationally, NO_2 concentrations have decreased substantially (66% reduction) from 1980 to 2023 due to improvements in motor vehicle emissions controls, with a 40% decrease occurring from 2000 to 2023. In the southwest (Arizona, New Mexico, Colorado, and Utah), NO_2 concentrations have decreased 17% between 2010 and 2023; in the south (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi), NO_2 concentrations have decreased 23% between 2010 and 2023. EPA expects NO_2 concentrations will continue to decrease (EPA 2023e). Table 3 and Table 4 show the NO_2 trends for all the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas). Only those counties with monitoring completed in the last 10 years are included in Table 3 and Table 4. Of the eight New Mexico counties in the major oil and gas basin (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties), NO_2 trend data are available only for Eddy, Lea, and San Juan Counties. Table 3 and Table 4 show that NO_2 trends vary depending on state and county.

Table 3. Local NO₂ Trends – Annual

State/County/ *City*	Site ID	2014 Design Value (ppb)	2015 Design Value (ppb)	2016 Design Value (ppb)	2017 Design Value (ppb)	2018 Design Value (ppb)	2019 Design Value (ppb)	2020 Design Value (ppb)	2021 Design Value (ppb)	2022 Design Value (ppb)	2023 Design Value (ppb)
New Mexico											
Bernalillo	350011023	12	11	10	10	10	9	8	8	9	8
	350010029	n/a	n/a	n/a	n/a	n/a	9	8	8	7	7
Doña Ana	350130021	6	7	7	6	7	7	8	8	8	8
	350130022	5	4	5	4	5	5	6	7	6	7
Eddy	350151005	3	2	2	3	5	5	5	5	5	5
Lea	350250008	n/a	5	4	4	5	5	5	4	4	5
Luna	350290003	3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	350450009	11	11	10	10	10	10	10	9	9	9
	350450018	7	6	6	6	6	5	6	6	6	6
	350450020	n/a	n/a	n/a	1	1	1	1	1	1	1
	350451005	5	5	5		3	3	3	3	3	2
Oklahoma											
Tulsa, OK	401431127	7	8	7	7	7	7	6	7	7	6
Oklahoma City, OK	401090097	n/a	n/a	17	16	13	12	11	13	13	12
Kansas											
Wichita, KS	201730010	8	7	7	7	8	6	6	7	6	6
Texas											
El Paso-Las Cruces, TX	481410055	12	11	11	n/a	n/a	10	13	14	13	15
Longview, TX	481830001	4	4	4	3	4	3	3	3	3	2

State/County/City	Site ID	2014 Design Value (ppb)	2015 Design Value (ppb)	2016 Design Value (ppb)	2017 Design Value (ppb)	2018 Design Value (ppb)	2019 Design Value (ppb)	2020 Design Value (ppb)	2021 Design Value (ppb)	2022 Design Value (ppb)	2023 Design Value (ppb)
Dallas-Fort Worth-Arlington, TX	481210034	7	6	5	5	6	6	5	6	7	5
Austin-Round Rock, TX	484530014	5	4	4	5	5	5	n/a	3	3	4

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

Table 4. Local NO$_2$ Trends – 1 hour

State/County/*City*	Site ID	2012–2014 Design Value (ppb)	2013–2015 Design Value (ppb)	2014–2016 Design Value (ppb)	2015–2017 Design Value (ppb)	2016–2018 Design Value (ppb)	2017–2019 Design Value (ppb)	2018–2020 Design Value (ppb)	2019–2021 Design Value (ppb)	2020–2022 Design Value (ppb)	2021–2023 Design Value (ppb)
New Mexico											
Bernalillo	350010023	45	44	43	44	45	45	43	43	43	43
	350010029	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37	36	36
Doña Ana	350130021	44	44	46	45	45	45	47	47	48	48
	350130022	41	40	40	40	40	41	43	45	46	46
Eddy	350151005	18	19	19	20	23	27	29	29	31	31
Lea	350250008	n/a	n/a	n/a	n/a	34	35	35	32	31	31
Luna	350290003	30	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	350450009	37	36	35	35	34	34	33	32	31	33
	350450018	35	33	28	n/a	n/a	n/a	23	23	24	22
	350450020	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	4
	350451005	36	34	33	n/a	n/a	n/a	24	23	22	20
Oklahoma											
Tulsa, OK	401431127	39	39	39	38	37	37	n/a	n/a	n/a	37
Oklahoma City, OK	401091037	37	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37	34
Kansas											
Wichita, KS	201730010	55	39	38	n/a	n/a	n/a	36	36	36	36
Texas											
El Paso-Las Cruces, TX	481410055	57	55	53	n/a	n/a	n/a	n/a	55	56	56
Longview, TX	481830001	24	23	23	21	20	18	18	16	16	18

State/County/City	Site ID	2012–2014 Design Value (ppb)	2013–2015 Design Value (ppb)	2014–2016 Design Value (ppb)	2015–2017 Design Value (ppb)	2016–2018 Design Value (ppb)	2017–2019 Design Value (ppb)	2018–2020 Design Value (ppb)	2019–2021 Design Value (ppb)	2020–2022 Design Value (ppb)	2021–2023 Design Value (ppb)
Dallas-Fort Worth-Arlington, TX	481210034	38	35	32	31	32	33	34	33	34	n/a
Austin-Round Rock, TX	484530014	n/a	32	31	30	30	31	n/a	n/a	n/a	n/a

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

3.4   CARBON MONOXIDE

CO, a colorless and odorless gas, is produced from the incomplete burning of carbon-containing compounds such as fossil fuels; it forms when there is not enough oxygen to produce carbon dioxide (CO_2). The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels.

Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain. This can cause specific complications in people who have some types of heart disease as they are especially vulnerable to the effects of CO when exercising or under increased stress. For these individuals, short-term exposure to elevated CO may be accompanied by angina, a type of chest pain caused by reduced blood flow to the heart. Other symptoms of carbon monoxide exposure include headache, nausea, rapid breathing, weakness, exhaustion, dizziness, and confusion. At extremely high levels, CO can cause hypoxia (severe oxygen deficiency) that can lead to brain damage and death due to asphyxiation. Very high levels of CO are not likely to occur outdoors (EPA 2024g).

3.4.1   CARBON MONOXIDE TRENDS

Nationally, CO concentrations have decreased 88% from 1980 to 2023 due to improvements in motor vehicle emissions controls, with a 65% decrease from 2000 to 2023. Monitored CO concentrations in the southwest region (New Mexico, Arizona, Colorado, and Utah) have decreased 34% between 2010 and 2023. Monitored CO concentrations in the south region (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi) have decreased 19% between 2010 and 2023 (EPA 2023f). Table 5 and Table 6 show the CO trends for all the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas). Only those counties with monitoring completed in the last 10 years are included in Table 5 and Table 6. CO trend data are not available for any of the eight New Mexico counties in the major oil and gas basin (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties). Table 5 and Table 6 show that CO trends vary depending on state and county.

Table 5. Local CO Trends – 8 hour

State/County/City	Site ID	2013–2014 Design Value (ppm)	2014–2015 Design Value (ppm)	2015–2016 Design Value (ppm)	2016–2017 Design Value (ppm)	2017–2018 Design Value (ppm)	2018–2019 Design Value (ppm)	2019–2020 Design Value (ppm)	2020–2021 Design Value (ppm)	2021–2022 Design Value (ppm)	2022–2023 Design Value (ppm)
New Mexico											
Bernalillo	350010023	1.2	1.4	1.4	1.2	1.0	1.0	1.0	0.9	0.9	0.9
	350010029	1.2	1.2	1.9	1.9	1.0	0.9	0.9	1.0	1.7	1.7
Oklahoma											
Tulsa, OK	401431127	1.0	1.1	1.6	1.6	1.0	1.0	0.9	0.9	0.8	1.0
Oklahoma City, OK	401091037	0.8	0.9	0.9	0.9	0.8	0.8	1.4	1.4	1.1	0.9
Kansas											
Kansas City-Overland Park-Kansas City, MO-KS	202090021	1.7	1.2	1.2	1.4	1.4	1.1	1.1	1.1	1.1	0.8
Texas											
El Paso-Las Cruces, TX	481410044	2.4	2.4	2.4	2.6	2.6	2.4	2.4	2.6	2.6	2.0
Dallas-Fort Worth-Arlington, TX	484391053	n/a	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.7
Austin-Round Rock, TX	484531068	n/a	n/a	0.6	1.3	1.3	1.8	1.8	1.6	1.4	1.5

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

Table 6. Local CO Trends – 1 hour

State/County/City	Site ID	2013–2014 Design Value (ppm)	2014–2015 Design Value (ppm)	2015–2016 Design Value (ppm)	2016–2017 Design Value (ppm)	2017–2018 Design Value (ppm)	2018–2019 Design Value (ppm)	2019–2020 Design Value (ppm)	2020–2021 Design Value (ppm)	2021–2022 Design Value (ppm)	2022–2023 Design Value (ppm)
New Mexico											
Bernalillo	350010023	1.5	1.7	1.9	1.9	1.7	1.9	1.9	1.3	1.4	1.4
	350010029	2.8	2.8	2.4	2.2	2.2	1.9	3.7	3.7	3.3	3.3
Oklahoma											
Tulsa, OK	401431127	1.6	1.6	2.4	2.4	1.4	1.4	1.4	1.4	1.2	1.5
Oklahoma City, OK	401091037	1.0	2.9	2.9	1.3	1.0	1.0	2.6	2.6	1.2	1.0
Kansas											
Kansas City-Overland Park-Kansas City, MO-KS	202090021	2.2	1.8	1.8	1.9	1.9	1.8	1.5	1.7	1.7	1.3
Texas											
El Paso-Las Cruces, TX	481410044	4.0	4.4	4.4	4.2	5.0	5.0	3.8	4.1	4.1	4.1
Dallas-Fort Worth-Arlington, TX	484391053	n/a	1.6	1.6	1.6	1.8	1.8	1.8	1.9	1.9	3.7
Austin-Round Rock, TX	484531068	n/a	n/a	0.8	2.2	2.3	2.4	2.4	2.2	2.1	2.5

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

3.5   PARTICULATE MATTER

PM, also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. PM is measured and regulated according to particle size. Sources of PM include industrial processes, power plants, vehicle exhaust, fugitive dust, construction activities, home heating, and fires. PM_{10} particles derive primarily from crushing, grinding, or abrasion of surfaces. $PM_{2.5}$ particles derive primarily from the incomplete combustion of fuel sources and secondarily formed aerosols. Smaller particles are associated with more negative health effects, including respiratory and cardiovascular problems, because they can become more deeply embedded in the lungs and some may even get into the bloodstream (EPA 2024h). Many scientific studies have linked breathing PM to serious health problems, including aggravated asthma, increased respiratory symptoms, difficult or painful breathing, chronic bronchitis, decreased lung function, nonfatal heart attacks, irregular heartbeat, and premature death. In adults, long-term particle pollution is linked to worsening of heart disease/atherosclerosis/COPD, higher risk of developing diabetes, higher risk of developing fatal lung cancer, impaired cognitive functioning, and increased risk of Parkinson's disease/Alzheimer's disease/other dementias (American Lung Association 2023). PM is a major cause of reduced visibility. It can stain and damage stone and other materials, including culturally important objects, such as monuments and statues (EPA 2023g). Airborne dust can also deposit on snow. This dust deposition accelerates snowmelt by reducing albedo through surface darkening and enhanced snow grain growth (Skiles and Painter 2016). The degree of advanced snowmelt during each water year has a linear relationship to the amount of dust loading on the snowpack, which can affect the availability of late season water in areas dependent on snowmelt to fill their watersheds.

Dust (windblown or from surface disturbance) has also been linked to health effects resulting from pathogens that live in the soil. Valley fever is an infection caused by coccidiomycosis fungus that lives in thermic, aridic soil (Dulin 2015). Thermic soil describes the temperature profile of the soil and is found in hot, arid areas with limited rainfall, high summer temperatures and few freezes. Aridic soil describes the moisture profile of the soil and can be found in areas where the soil is dry for more than half of the year and when it is wet, it is wet for less than 90 consecutive days (Pennsylvania State University 1998). Valley fever is endemic to the southwestern United States. The fungus is transmitted by the inhalation of airborne arthrospores from the soil which can be lofted by the wind after the soil is disturbed. The spores are usually found in the soil at a depth of 2 to 8 inches and has an incubation period of 1 to 4 weeks before symptoms present themselves. Most cases of valley fever are asymptomatic, but the primary symptoms are similar to influenza/tuberculosis/pneumonia and include cough, fatigue, fever, and chest pains. Patients who are over age 65, immuno-compromised, pregnant, or African American/Filipino are at a higher risk of developing a more serious form of the infection that can attack the bones, joints, skin, brain, and lymph nodes.

3.5.1   PARTICULATE MATTER TRENDS

Nationally, $PM_{2.5}$ concentrations have decreased 37% from 2000 to 2023. In that same period, PM_{10} concentrations decreased 36% nationally. In the southwest (New Mexico, Arizona, Colorado, and Utah), $PM_{2.5}$ concentrations have decreased 14% from 2010 to 2023, and PM_{10} concentrations have increased 14% during the same period. For the southern region encompassing Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi, $PM_{2.5}$ concentrations have decreased 10% and PM_{10} concentrations have increased 19% between 2010 and 2023 (EPA 2023h, 2023i).

PM$_{10}$ design values are only available and presented as average estimated exceedance values for the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas) (Table 7). Although exceedances are presented, the information listed in this PM$_{10}$ design value report is intended for informational use only and does not constitute a regulatory determination by EPA as to whether an area has attained an NAAQS. PM$_{10}$-monitored outdoor air quality data can be obtained from the EPA Air Data webpage and interactive tool (EPA 2024b). Table 8 and Table 9 show the PM$_{2.5}$ trends for all the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas). Only those counties with monitoring completed in the last 10 years are included in Table 7, Table 8, and Table 9. Of the eight New Mexico counties in the major oil and gas basin (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties), PM$_{2.5}$ trend data are available for only Lea and San Juan Counties. Table 8 and Table 9 show that PM$_{2.5}$ trends vary depending on state and county.

Table 7. Local PM$_{10}$ Exceedance Trends – 24 hour

State/ County/City	Site ID	2012–2014 Average Estimated Exceedances	2013–2015 Average Estimated Exceedances	2014–2016 Average Estimated Exceedances	2015–2017 Average Estimated Exceedances	2016–2018 Average Estimated Exceedances	2017–2019 Average Estimated Exceedances	2018–2020 Average Estimated Exceedances	2019–2021 Average Estimated Exceedances	2020–2022 Average Estimated Exceedances	2021–2023 Average Estimated Exceedances
New Mexico											
Bernalillo	350010023	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	350010026*	0.0	0.0	0.7	0.7	n/a	n/a	n/a	n/a	n/a	n/a
	350010026*	0.3	0.0	0.7	0.7	0.7	0.0	0.0	0.7	1.4	1.4
	350010029	n/a	n/a	0.0	0.0	0.0	0.0	1.0	2.3	5.4	5.7
	350011012	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.0	0.0	0.0
	350011013	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.0	0.3	0.3
Doña Ana	350130021*	8.7	7.1	5.1	1.3	n/a	n/a	n/a	n/a	n/a	n/a
	350130021*	8.7	7.1	5.1	1.3	0.4	0.7	0.3	3.7	5.1	6.9
	350130016*	0.0	n/a	n/a	n/a	0.0	0.0	0.0	0.0	0.0	n/a
	350130016*	10.4	7.7	4.3	0.3	0.0	0.0	0.0	1.4	4.4	5.8
	350130019*	6.7	4.0	1.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	350130019*	6.7	4.0	1.3	n/a	0.0	0.0	0.0	1.3	2.3	2.7
	350130020*	7.6	5.5	3.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	350130020*	7.6	5.5	3.5	n/a	n/a	0.0	0.0	2.7	4.0	4.4
	350130024*	5.2	4.1	1.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	350130024*	5.2	4.1	1.3	n/a	0.0	0.0	0.0	1.0	1.3	1.7
Luna	350290003	6.4	4.0	1.3	n/a	0.0	0.0	0.3	1.3	4.4	4.7
	350290003	6.4	4.0	1.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	350451005	n/a	n/a	n/a	n/a	n/a	n/a	0.3	0.3	3.0	3.0
	350450019	2.2	2.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

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State/County/*City*	Site ID	2012–2014 Average Estimated Exceedances	2013–2015 Average Estimated Exceedances	2014–2016 Average Estimated Exceedances	2015–2017 Average Estimated Exceedances	2016–2018 Average Estimated Exceedances	2017–2019 Average Estimated Exceedances	2018–2020 Average Estimated Exceedances	2019–2021 Average Estimated Exceedances	2020–2022 Average Estimated Exceedances	2021–2023 Average Estimated Exceedances
Santa Fe	350490020*	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	350490020*	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oklahoma											
Tulsa, OK	401431127	n/a	0.0	0.0	0.0	0.0	0.0	0.0	n/a	n/a	0.0
Oklahoma City, OK	401091037	0.0	n/a	n/a	n/a	n/a	n/a	0.3	0.3	0.3	n/a
Kansas											
Wichita, KS	201730010	0.3	0.3	0.3	0.0	0.0	0.0	0.0	n/a	n/a	n/a
Texas											
El Paso-Las Cruces, TX	481410057	6.7	6.7	0.0	0.0	0.0	0.0	2.2	4.2	0.0	0.0
Longview, TX	482030002	0.0	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a
Dallas-Fort Worth-Arlington, TX	481130061	0.0	n/a	n/a	n/a	n/a	n/a	n/a	0.0	0.0	0.0
Austin-Round Rock, TX	484530020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	n/a

Source: EPA (2024f).

The level of the 1987 24-hour PM10 NAAQS is 150 micrograms per cubic meter ($\mu g/m^3$). The NAAQS metric is the annual estimated number of exceedances (ENE), averaged over three consecutive years. Only valid average estimated exceedance values are shown.

*Co-located monitors with same Site ID

n/a = Data not available due to lack of monitoring data

Table 8. Local PM$_{2.5}$ Trends – Annual

State/County/*City*	Site ID	2012–2014 Design Value (µg/m³)	2013–2015 Design Value (µg/m³)	2014–2016 Design Value (µg/m³)	2015–2017 Design Value (µg/m³)	2016–2018 Design Value (µg/m³)	2017–2019 Design Value (µg/m³)	2018–2020 Design Value (µg/m³)	2019–2021 Design Value (µg/m³)	2020–2022 Design Value (µg/m³)	2021–2023 Design Value (µg/m³)
New Mexico											
Bernalillo	350011012	n/a	n/a	n/a	n/a	n/a	n/a	3.9	4.4	4.5	4.2
	350010023	6.5	6.2	6.1	5.8	5.3	5.2	5.2	5.4	5.5	5.2
	350010029	n/a	7.5	7.1	6.8	7.1	6.8	7.3	8.0	8.4	8.0
	350010024	6.3	n/a	n/a	n/a	n/a	n/a	n/a	0.074	0.077	0.078
	350010026	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7.3	7.7	7.4
	350011013	n/a	n/a	n/a	n/a	n/a	n/a	7.0	8.0	8.4	7.8
Doña Ana	350130021	n/a	n/a	n/a	9.0	8.3	7.6	7.9	8.4	8.9	8.6
	350130016	n/a	n/a	n/a	7.3	7.8	7.6	7.8	7.9	8.1	7.5
	350130022	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6.4	5.9	5.6
	350130025	6.2	5.6	5.0	5.2	5.2	5.2	5.2	5.5	5.5	5.0
Lea	350250008	n/a	n/a	7.1	7.5	7.6	n/a	7.0	6.5	6.3	6.6
Santa Fe	350490021	n/a	n/a	n/a	n/a	n/a	n/a	3.7	4.3	4.3	n/a
San Juan	350450019	4.5	4.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Taos	350550005	n/a	n/a	n/a	n/a	n/a	n/a	5.7	5.6	5.5	4.9
Oklahoma											
Tulsa-Muskogee-Bartlesville, OK	401431127	9.3	8.8	8.7	8.6	9.2	8.8	8.3	8.1	8.2	8.8
Oklahoma City-Shawnee, OK	401091037	9.2	8.6	8.1	7.8	8.0	8.2	8.5	8.9	8.8	n/a

State/County/ *City*	Site ID	2012–2014 Design Value (μg/m³)	2013–2015 Design Value (μg/m³)	2014–2016 Design Value (μg/m³)	2015–2017 Design Value (μg/m³)	2016–2018 Design Value (μg/m³)	2017–2019 Design Value (μg/m³)	2018–2020 Design Value (μg/m³)	2019–2021 Design Value (μg/m³)	2020–2022 Design Value (μg/m³)	2021–2023 Design Value (μg/m³)
Kansas											
Wichita-Arkansas City-Winfield, KS	201730010	8.8	8.7	8.1	n/a	n/a	n/a	n/a	n/a	n/a	9.7
Texas											
El Paso-Las Cruces, TX	481410044	11.2	9.9	9.4	8.9	9.1	8.8	8.8	8.9	9.2	9.0
Longview-Marshall, TX	481830002	9.5	9.0	8.8	8.6	8.5	8.4	8.4	n/a	9.4	9.5
Dallas-Fort Worth-Arlington, TX	481130069	9.7	9.4	8.8	8.6	8.9	9.2	8.9	8.4	8.2	8.9
Austin-Round Rock, TX	484530021	9.4	9.2	9.6	9.6	9.8	9.8	9.6	9.5	9.2	9.3

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

Table 9. Local PM$_{2.5}$ Trends – 24 hour

State/County/*City*	Site ID	2012–2014 Design Value (µg/m³)	2013–2015 Design Value (µg/m³)	2014–2016 Design Value (µg/m³)	2015–2017 Design Value (µg/m³)	2016–2018 Design Value (µg/m³)	2017–2019 Design Value (µg/m³)	2018–2020 Design Value (µg/m³)	2019–2021 Design Value (µg/m³)	2020–2022 Design Value (µg/m³)	2021–2023 Design Value (µg/m³)
New Mexico											
Bernalillo	350011012	n/a	n/a	n/a	n/a	n/a	n/a	11	13	14	11
	350010023	19	18	19	17	15	13	14	15	15	13
	350010029	n/a	18	19	18	19	19	20	21	21	19
	350010024	20	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	350010026	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20	21	19
	350011013	n/a	n/a	n/a	n/a	n/a	n/a	19	22	23	20
Doña Ana	350130021	n/a	n/a	n/a	27	27	24	19	21	22	21
	350130016	n/a	n/a	n/a	20	22	22	21	21	20	19
	350130022	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18	18	17
	350130025	14	13	11	12	12	12	12	13	14	13
Lea	350250008	21	n/a	17	15	16	16	17	17	19	20
San Juan	350450019	12	11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Santa Fe	350490021	n/a	n/a	n/a	n/a	n/a	n/a	9	11	14	n/a
Taos	350550005	n/a	n/a	n/a	n/a	n/a	n/a	16	16	16	15
Oklahoma											
Tulsa-Muskogee-Bartlesville, OK	401431127	21	20	21	20	23	22	21	22	22	23
Oklahoma City-Shawnee, OK	401091037	21	21	19	17	18	19	20	22	22	21

State/County/ *City*	Site ID	2012–2014 Design Value (µg/m³)	2013–2015 Design Value (µg/m³)	2014–2016 Design Value (µg/m³)	2015–2017 Design Value (µg/m³)	2016–2018 Design Value (µg/m³)	2017–2019 Design Value (µg/m³)	2018–2020 Design Value (µg/m³)	2019–2021 Design Value (µg/m³)	2020–2022 Design Value (µg/m³)	2021–2023 Design Value (µg/m³)
Kansas											
Wichita-Arkansas City-Winfield, KS	201910002	21	22	21	17	16	17	20	23	25	n/a
Texas											
El Paso-Las Cruces, TX	481410044	34	29	25	23	24	24	24	24	22	22
Longview-Marshall, TX	481830002	22	20	17	17	18	18	20	n/a	n/a	n/a
Dallas-Fort Worth-Arlington, TX	481130069	21	21	19	18	20	20	22	19	19	19
Austin-Round Rock, TX	484530021	24	22	19	20	22	23	22	22	22	22

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

3.6   SULFUR DIOXIDE

SO_2 is one of a group of highly reactive gases known as "oxides of sulfur," commonly referred to as SO_x. The largest sources of SO_2 emissions nationwide are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO_2 emissions include industrial processes, such as extracting metal from ore, and the burning of high sulfur-containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system, including wheezing, shortness of breath, chest tightness, and reduced lung function. People with asthma, particularly children, are sensitive to these effects of SO_2. At high concentrations, gaseous SO_x can harm trees and plants by damaging foliage and decreasing growth. SO_2 and other SO_x can contribute to acid rain, which can harm sensitive ecosystems (EPA 2024i).

3.6.1   SULFUR DIOXIDE TRENDS

Nationally, SO_2 concentrations have decreased 87% from 2000 to 2023, but substantial decreases (95% reduction) have occurred since 1980 due to implementation of federal rules requiring reductions in SO_2 emissions from power plants and other large sources of SO_2. In the southwest, SO_2 concentrations decreased 94% between 2010 and 2023. In the southern region of the United States (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi), SO_2 concentrations decreased 66% between 2010 and 2023 (EPA 2023j). Table 10 shows the SO_2 trends for all the available counties and monitoring sites in New Mexico and select monitoring stations within the BLM NMSO area of operations (Oklahoma, Kansas, and Texas). Only those counties with monitoring completed in the last 10 years are included in Table 10. Of the eight New Mexico counties in the major oil and gas basin (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties), SO_2 trend data are available for only San Juan County. Table 10 show that SO_2 trends vary depending on state and county.

Table 10. Local SO₂ Trends – 1 hour

State/County/ *City*	Site ID	2012–2014 Design Value (ppb)	2013–2015 Design Value (ppb)	2014–2016 Design Value (ppb)	2015–2017 Design Value (ppb)	2016–2018 Design Value (ppb)	2017–2019 Design Value (ppb)	2018–2020 Design Value (ppb)	2019–2021 Design Value (ppb)	2020–2022 Design Value (ppb)	2021–2023 Design Value (ppb)
New Mexico											
Bernalillo	350010023	5	5	6	5	5	4	4	3	3	2
Grant	350171003	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	350450009	7	5	3	2	2	2	1	1	1	1
	350451005	21	13	8	n/a	n/a	n/a	n/a	n/a	8	4
Oklahoma											
Tulsa, OK	401431127	14	12	6	6	4	3	3	2	3	3
Oklahoma City, OK	401091037	4	3	3	3	3	2	2	1	1	1
Kansas											
Wichita- Arkansas City- Winfield, KS	201910002	n/a	6	5	4	4	4	3	3	3	3
Texas											
El Paso-Las Cruces, TX	481410044	10	9	n/a	n/a	n/a	n/a	n/a	n/a	6	5
Longview, TX	481830001	50	46	35	30	37	41	49	45	35	23
Dallas-Fort Worth- Arlington, TX	482570005	14	13	11	9	9	8	7	7	10	13
Austin-Round Rock, TX	484530014	n/a	5	4	4	3	3	n/a	n/a	n/a	n/a

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

3.7   NATIONAL TRENDS

EPA estimates nationwide emissions of ambient air pollutants and the pollutants they are formed from (their precursors) based on actual monitored readings or engineering calculations of the amounts and types of pollutants emitted by vehicles, factories, and other sources. Table 11 shows that emissions of the common air pollutants and their precursors have been reduced substantially since 1980.

Table 11. National Percent Changes in Emissions

Pollutant	1980 vs. 2023	1990 vs. 2023	2000 vs. 2023	2010 vs. 2023
CO	−76	−71	−59	−28
Lead (Pb)	−99	−88	−78	−36
NO$_x$	−75	−73	−69	−55
VOC	−58	−46	−26	−5
Direct PM$_{10}$	−62	−27	−24	−14
Direct PM$_{2.5}$	Not available	−28	−35	−11
SO$_2$	−94	−93	−90	−76

Source: EPA (2024j).

Note: A negative percentage means that concentrations have decreased.

3.8   LEAD

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources. As a result of EPA regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector declined by 95% between 1980 and 1999, and levels of lead in the air decreased by 94% during the same period. Major sources of lead emissions to the air today are ore and metals processing and piston-engine aircraft using leaded aviation gasoline (EPA 2024k). Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. Lead can accumulate in the body over time, where it is stored in bones along with calcium. The lead effects most likely to be encountered in current populations are neurological effects in children. Infants and young children are especially sensitive to lead exposures, which may contribute to behavioral problems, learning deficits, lowered IQ, and hyperactivity. Children are also at an increased risk of slowed growth, hearing problems, and anemia. Adults exposed to lead can suffer from cardiovascular effects, decreased kidney function, and both male and female reproductive issues.

3.9   NEW MEXICO DESIGN VALUES

The most recent design values for the measured criteria pollutants from those monitoring stations in New Mexico with 2023 design values are provided in Table 12 through Table 20, and only those counties with monitoring completed in the last 10 years are included. These design values are compared with the NAAQS and NMAAQS for those New Mexico counties with available data. Rural counties, such as McKinley County, may not have existing monitors and, therefore, no data are available; other counties,

such as San Juan County, may have monitors that record only certain pollutants. Design values are typically used to designate and classify nonattainment areas, as well as to assess progress toward meeting the NAAQS. Therefore, when the design values exceed the NAAQS or NMAAQS, actions may be taken to reassess the designations of these areas.

Table 12. 2021–2023 Design Values – 8-hour O_3

County	Site ID	Design Value (ppm)[1]	NAAQS	Exceed NAAQS?
Bernalillo	350011012	0.072	0.070 ppm	Yes
	350010023	0.069	0.070 ppm	No
	350010029	0.066	0.070 ppm	No
Doña Ana	350130021	0.079	0.070 ppm	Yes
	350130008	0.076	0.070 ppm	Yes
	350130020	0.070	0.070 ppm	No
	350130022	0.072	0.070 ppm	Yes
	350130023	0.067	0.070 ppm	No
Eddy	350151005	0.078	0.070 ppm	Yes
	350150010	0.078	0.070 ppm	Yes
Lea	350250008	0.071	0.070 ppm	Yes
Rio Arriba	350390026	0.063	0.070 ppm	No
Sandoval	350431001	0.067	0.070 ppm	No
San Juan	350450018	0.070	0.070 ppm	No
	350451005	0.067	0.070 ppm	No
	350450009	0.065	0.070 ppm	No
	350450020	0.067	0.070 ppm	No
Santa Fe	350490021	0.065	0.070 ppm	No
Valencia	350610008	0.063	0.070 ppm	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years.

Table 13. 2023 Design Values – Annual NO_2

County	Site ID	Design Value (ppb)[1]	NAAQS	Exceed NAAQS?	NMAAQS	Exceed NMAAQS?
Bernalillo	350010029	7	53 ppb	No	50 ppb	No
	350010023	8	53 ppb	No	50 ppb	No
Doña Ana	350130021	8	53 ppb	No	50 ppb	No
	350130022	7	53 ppb	No	50 ppb	No

County	Site ID	Design Value (ppb)[1]	NAAQS	Exceed NAAQS?	NMAAQS	Exceed NMAAQS?
Eddy	350151005	5	53 ppb	No	50 ppb	No
Lea	350250008	5	53 ppb	No	50 ppb	No
San Juan	350450018	6	53 ppb	No	50 ppb	No
	350451005	2	53 ppb	No	50 ppb	No
	350450009	9	53 ppb	No	50 ppb	No
	350450020	1	53 ppb	No	50 ppb	No

Source: EPA (2024f).

Notes:

n/a = Data not available due to lack of monitoring data.

[1] Not to be exceeded during the year.

Table 14. 2021–2023 Design Values – 1-hour NO$_2$

County	Site ID	Design Value (ppb)[1]	NAAQS	Exceed NAAQS?
Bernalillo	350010029	36	100 ppb	No
	350010023	43	100 ppb	No
Doña Ana	350130021	48	100 ppb	No
	350130022	46	100 ppb	No
Eddy	350151005	31	100 ppb	No
Lea	350250008	31	100 ppb	No
San Juan	350450018	22	100 ppb	No
	350451005	20	100 ppb	No
	350450009	33	100 ppb	No
	350450020	4	100 ppb	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] 98th percentile, averaged over 3 years.

Table 15. 2022–2023 Design Values – 8-hour CO

County	Site ID	Design Value (ppm)[1]	NAAQS	Exceed NAAQS?
Bernalillo	350010023	0.9	9 ppm	No
	350010029	1.7	9 ppm	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] Not to be exceeded more than once per year.

Table 16. 2022-2023 Design Values – 1-hour CO

County	Site ID	Design Value (ppb)[1]	NAAQS	Exceed NAAQS?
Bernalillo	350010023	1.4	35 ppm	No
	350010029	3.3	35 ppm	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] Not to be exceeded more than once per year.

Table 17. 2021–2023 Average Estimated Exceedances – 24-hour PM$_{10}$

County	Site ID	Design Value (µg/m³)[1]	NAAQS	Exceed NAAQS?[2]
Bernalillo	350010029	5.7	150 µg/m³, Not to be exceeded more than once per year on average over 3 years.	Yes
	350010023	0.0	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
	350010026	1.4	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
	350011012	0.0	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
	350011013	0.3	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
Doña Ana	350130021	6.9	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	Yes
	350130016	5.8	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	Yes
	350130019	2.7	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
	350130020	4.4	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	Yes
	350130024	1.7	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No
Luna	350290003	4.7	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	Yes
San Juan	350451005	3.0	150 µg/m³, Not to be exceeded more than once per year on average over 3 years	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] Not to be exceeded more than once per year on average over 3 years.

[2] The NMAAQS for total suspended particulates, which was used as a comparison for PM$_{10}$ and PM$_{2.5}$, was repealed as of November 30, 2018. The NAAQS still apply.

Table 18. 2021–2023 Design Values – Annual PM$_{2.5}$

County	Site ID	Design Value (µg/m³)[1]	NAAQS	Exceed NAAQS?[2]
Bernalillo	350010029	8.0	9 µg/m³	No
	350010023	5.2	9 µg/m³	No
	350010026	7.4	9 µg/m³	No
	350011012	4.2	9 µg/m³	No
	350011013	7.8	9 µg/m³	No
Doña Ana	350130021	8.6	9 µg/m³	No
	350130022	5.6	9 µg/m³	No
	350130016	7.5	9 µg/m³	No
	350130025	5.0	9 µg/m³	No
Lea	350250008	6.6	9 µg/m³	No
Taos	350550005	4.9	9 µg/m³	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] Annual mean averaged over 3 years.

[2] The NMAAQS for total suspended particulates, which was used as a comparison for PM$_{10}$ and PM$_{2.5}$, was repealed as of November 30, 2018. The NAAQS still apply.

Table 19. 2021–2023 Design Values – 24-hour PM$_{2.5}$

County	Site ID	Design Value (µg/m³)[1]	NAAQS	Exceed NAAQS?[2]
Bernalillo	350010029	19	35 µg/m³	No
	350010023	13	35 µg/m³	No
	350010026	19	35 µg/m³	No
	350011012	11	35 µg/m³	No
	350011013	20	35 µg/m³	No
Doña Ana	350130021	21	35 µg/m³	No
	350130022	17	35 µg/m³	No
	350130016	19	35 µg/m³	No
	350130025	13	35 µg/m³	No
Lea	350250008	20	35 µg/m³	No
Taos	350550005	15	35 µg/m³	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] 98th percentile, averaged over 3 years.

[2] The NMAAQS for total suspended particulates, which was used as a comparison for PM$_{10}$ and PM$_{2.5}$, was repealed as of November 30, 2018. The NAAQS still apply.

Note: Many rural counties have no monitoring data and are assumed under the CAA to be in attainment. $PM_{2.5}$ monitor stations currently show installed locations in the planning area (San Juan County); however, the monitor status of these stations shows invalid data and cannot be used to represent design values.

Table 20. 2021–2023 Design Values – 1-hour SO$_2$

County	Site ID	Design Value (ppb)[1]	NAAQS	Exceed NAAQS?
Bernalillo	350010023	2	75 ppb	No
San Juan	350451005	4	75 ppb	No
	350450009	1	75 ppb	No

Source: EPA (2024f).

n/a = Data not available due to lack of monitoring data.

[1] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.

Note: Although there are no NAAQS for hydrogen sulfide (H_2S), New Mexico has set a 1-hour standard for H_2S at 0.010 ppm for all areas of the state outside of the area within 5 miles of the Pecos-Permian Air Quality Control Region and a 0.5-hour standard for H_2S at 0.100 ppm within the Pecos-Permian Air Quality Control Region and 0.030 ppm for municipal boundaries and within 5 miles of municipalities with populations greater than 20,000 in areas of the state outside of the area within 5 miles of the Pecos-Permian Air Quality Control Region (see Table 44).

3.10 GENERAL CONFORMITY AND NONATTAINMENT

If the concentration of one or more criteria pollutants in a geographic area is found to violate the NAAQS, the area may be classified as a **nonattainment** area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either **attainment** or unclassifiable areas. Areas for which available data are not sufficient to make an attainment status designation are listed as unclassifiable. When a state submits a request to the EPA to redesignate a nonattainment area as an attainment area, it must submit a maintenance plan that demonstrates that the area can maintain the air-quality standard for at least 10 years following the effective date of redesignation. An EPA-approved maintenance plan will allow the EPA to redesignate the area as an attainment area and in the interim is classified as a maintenance area.

To eliminate or reduce the severity and number of NAAQS violations in nonattainment areas and to achieve expeditious attainment of the NAAQS, the EPA promulgated the Conformity Rule (40 C.F.R. § 93, Subpart B). The Conformity Rule applies to federal actions and environmental analyses in nonattainment and maintenance areas completed after March 15, 1994. This rule contains a variety of substantive and procedural requirements to show conformance with both the NAAQS and state implementation plans (SIPs).

Section 176(c) of the CAA prohibits federal agencies from taking actions in nonattainment and maintenance areas unless the emissions from the actions conform to the SIP or tribal implementation plan for the area. Federal actions must be evaluated for conformity to the local SIP if the project 1) is within an EPA-designated nonattainment or maintenance area, 2) would result in emissions above the de minimis threshold quantities of criteria pollutants listed in 40 C.F.R. § 93, 3) is not a listed exempt action, and 4) has not been accounted for in an EPA-approved SIP.

The Conformity Rule requires that all federal actions in a nonattainment area must demonstrate conformity with the SIP for the pollutant in question. If the agency can demonstrate that emissions for the action will fall below certain established levels, known as de minimis, then no further analysis is necessary. To establish a de minimis claim, an emissions inventory for the project is required. In the case

of O_3, the emissions inventory would include NO_x and VOCs. If emissions are projected to be above de minimis levels, a formal Conformity Determination may be required.

Nonattainment designation is classified on six levels depending on the design value and pollutant, with the lowest level starting at marginal and increasing in severity: marginal, moderate, serious, severe-15, severe-17, and extreme. Nonattainment areas in New Mexico are as follows:

- **O_3 nonattainment area in Doña Ana County (Sunland Park, New Mexico, southwest of the CFO Planning Area, south of Las Cruces):** In 1995, the EPA declared a 42-square-mile region in the southeast corner of the county on the border of Texas and Mexico as a marginal nonattainment area for the 1-hour O_3 standard. The nonattainment area included the city of Sunland Park, Santa Teresa, and La Union, New Mexico. The 1-hour O_3 standard was revoked by EPA in 2004 with the adoption of the new 8-hour O_3 standard. Due to the revocation of the 1979 1-hour O_3 standard and based on monitoring data, Sunland Park was designated as attainment for the 1997 8-hour O_3 standard (0.080 ppm).

  In October 2015, the EPA lowered the NAAQS for O_3 to 0.070 ppm. As a result, in 2016, NMED recommended that the EPA designate a portion of Doña Ana County near Sunland Park, New Mexico, as nonattainment. Based on 2014 through 2016 O_3 monitoring data, EPA designated the Sunland Park area in southern Doña Ana County as a marginal nonattainment area for 2015 O_3 NAAQS on June 18, 2018, with an attainment deadline of August 3, 2021 (Federal Register 83:25776) (NMED 2020). On November 30, 2021 (Federal Register 86:67864), the EPA expanded the marginal nonattainment area that previously covered only the Sunland Park area in Doña Ana County to include El Paso County, Texas, and renamed the marginal nonattainment designated area as the El Paso-Las Cruces, TX-NM nonattainment area.

  On December 6, 2018 (Federal Register 83:6299), the EPA published the Nonattainment Area SIP Requirements rule that establishes the minimum elements that must be included in all nonattainment SIPs, including the requirements for New Mexico Nonattainment New Source Review (NNSR) permitting. On August 10, 2021, the NMED submitted a SIP to the New Mexico NNSR permitting program to address the requirements of the 2015 8-hour O_3 NAAQS. On November 16, 2022, the EPA approved this SIP, which updated the NNSR permitting program for the 2015 8-hour O_3 NAAQS (Federal Register 87:51041 and 86:57388).

- **O_3 Design Value Exceedance in Eddy and Lea Counties (Carlsbad, New Mexico):** In May 2023, new design values for NAAQS were published by the EPA for various counties throughout the United States. The monitor at 2811 Holland Street in Eddy County showed an 8-hour O_3 exceedance of 77 parts per billion (ppb) and the monitor at 2320 N. Jefferson St in Lea County showed an 8-hour O_3 exceedance of 71 ppb (EPA 2024f). These areas have not been formally declared nonattainment by the EPA through the State's recommendation, but it may be designated as nonattainment in the future.

  New Mexico Statutes Annotated (N.M.S.A.) 1978, § 74-2-5, directs NMED to develop plans that may include regulations more stringent than federal rules for areas of the state in which ambient monitoring shows O_3 levels at or above 95% of the NAAQS to control NO_x and VOC emissions to provide for attainment and maintenance of the standard. The NMOCD Statewide Natural Gas Capture Requirements (Waste Prevention Rule) (N.M.A.C. 19.15.27.9) and NMED Oil and Natural Gas Regulation for Ozone Precursors (N.M.A.C.20.2.50.1) are recent regulations reducing NO_x, VOC, and Ch_4 emissions. The 2015 8-hour primary NAAQS for O_3 is 0.070 ppm (70 ppb); 95% of the O_3 NAAQS is 0.067 ppm (67 ppb). This form of the standard requires averaging of 3 years of monitoring data for the fourth highest 8-hour average, using the most

recent year's data to determine the "design value." For New Mexico, six counties show 3-year averages (2021–2023) of O_3 levels at or above 95% of the NAAQS or exceeding the NAAQS (EPA 2024f):

- o Bernalillo County (72 ppb)
- o Doña Ana County (79 ppb)
- o Eddy County (78 ppb)
- o Lea County (71 ppb)
- o Sandoval County (67 ppb)
- o San Juan County (67 ppb)

The NMED participates in the Ozone Advance Program for the entirety of San Juan (northwestern New Mexico), Lea (southeastern New Mexico), and Eddy (southeastern New Mexico) Counties and for the portion of Doña Ana County that excludes the Sunland Park nonattainment area (south-central New Mexico). Since the acceptance into the Ozone Advance Program in April 2019, O_3 levels in Rio Arriba, Sandoval, Santa Fe, and Valencia Counties either currently or recently have exceeded 95% of the 2015 8-hour O_3 NAAQS (67 ppb) and could soon violate this standard. In total, the Ozone Advance Path Forward and outreach efforts includes the following nine counties: Chaves, Doña Ana, Eddy, Lea, Rio Arriba, San Juan, Santa Fe, Sandoval, and Valencia. Although Chaves County does not have O_3 monitors, the NMED includes it in the Ozone Advance Program planning effort as it is part of the Permian Basin with oil and gas emissions that contribute to high O_3 levels in Lea and Eddy Counties. The efforts under the Ozone Advance Program may benefit these areas by potentially 1) reducing air pollution in terms of O_3, as well as other air pollutants, 2) ensuring continued healthy O_3 levels, 3) maintaining the O_3 NAAQS and helping the Sunland Park nonattainment area attain the 2015 Ozone NAAQS, 4) avoiding violations of the NAAQS that could lead to a future nonattainment designation, 5) increasing public awareness about O_3 as an indirect air pollutant, and 6) targeting limited resources toward actions to address O_3 problems quickly. The NMED goal is to implement measures and programs to reduce O_3 in the near term and, ultimately, to effect changes that will protect community well-being into the future. NMED will work together and in coordination with stakeholders and the public to proactively pursue this goal (NMED 2022a).

- **PM_{10} nonattainment area in Anthony, New Mexico (west of the CFO Planning Area, south of Las Cruces):** The State of New Mexico submitted the Anthony PM_{10} SIP to the regional EPA headquarters on November 8, 1991. This area was designated nonattainment for PM_{10} by the EPA in 1991. The nonattainment area is bounded by Anthony quadrangle, Anthony, New Mexico – Texas. SE/4 La Mesa 15-minute quadrangle, N32 00 – W106 30/7.5, Sections 35 and 36, Township 26 South, Range 3 East as limited by the New Mexico–Texas state line on the south. The site is in Doña Ana County, which submitted a Natural Events Action Plan for PM_{10} exceedances to the EPA in December 2000. However, Anthony, New Mexico, still exceeds the NAAQS for PM_{10}. Therefore, the EPA has not redesignated the state PM_{10} nonattainment area at this time. The EPA has not indicated its plans to do so (NMED 2024b).

- The NMED Air Quality Bureau developed a Fugitive Dust Control Rule in conjunction with the mitigation plan to abate certain controllable sources in Doña Ana and Luna Counties. Mitigation plans are required by the EPA in areas where recurring natural events (in this case, high winds resulting in blowing dust) cause exceedances of the health-based national standards for PM. In 2020, NMED developed a single mitigation plan for Doña Ana and Luna Counties and recently updated this plan on March 10, 2021 (NMED 2021a). The Dust Mitigation Plan and the

associated Fugitive Dust Control Rule (N.M.A.C. 20.2.23) enhance existing local dust control ordinances and provide coverage where there are gaps. The NMED Air Quality Bureau Fugitive Dust Control Rule was published in conjunction with the original Dust Mitigation Plan and became effective on January 1, 2019. The rule applies to sources of fugitive dust that are not required to obtain a construction permit from the Air Quality Bureau, including disturbed areas greater than 1.0 acre from construction/demolition activities and earthmoving. Control measures are required to stabilize surfaces to ensure emissions are not crossing the property line or exceeding opacity limits. Control measures listed in the rule include:

- o watering and/or applying dust suppressant unpaved surfaces,
- o limiting on-site vehicles speeds,
- o prohibiting activities during high winds,
- o watering exposed area before high winds,
- o planting trees or shrubs as a windbreak, and
- o revegetating disturbed area with native plants (NMED 2021a).

- **SO_2 Maintenance Area in Grant County (west of the CFO Planning Area, at the Arizona border):** This maintenance area is at the Phelps Dodge Chino Copper Smelter in Grant County. The maintenance area is defined as a 3.5-mile-radius region around the smelter. The maintenance area also includes high-elevation areas within an 8-mile radius. The State submitted a SIP to the regional EPA headquarters in August 1978. The New Mexico Air Quality Bureau submitted a redesignation plan to the EPA in February 2003 seeking to redesignate the portion of Grant County, New Mexico, from nonattainment to attainment for the SO_2 NAAQS. In this plan, it was reported that air monitoring data for this area revealed values better than NAAQS for SO_2. The February 2003 submittal also included a contingency measures plan that consists of monitoring measures and a maintenance plan for this area to ensure that attainment of the SO_2 NAAQS will be maintained through permitting and the applicable SIP rules. The redesignation plan was approved by the EPA in September 2003. The Grant County SO_2 Limited Maintenance Plan was submitted to the EPA in November 2013 to fulfill the second 10-year maintenance plan requirement under Section 175A(b) of the CAA to ensure maintenance of the 1971 SO_2 NAAQS through 2025 and was approved by the EPA on July 18, 2014 (NMED 2024b).

Texas Nonattainment Areas: There are currently 10 key nonattainment areas in Texas: one for PM_{10} (city of El Paso); three for O_3 (Houston-Galveston-Brazoria area [eight counties], Dallas-Fort Worth area [10 counties], and Bexar County in San Antonio); and several areas not meeting the SO_2 2010 standard and therefore designated in part as nonattainment (Freestone and Anderson Counties, Howard County, Hutchinson County, Navarro County, Rusk and Panola Counties, and Titus County) (EPA 2024l).

The Houston-Galveston-Brazoria area has several counties in nonattainment status. The following counties are currently not meeting the 8-hour 2015 O_3 standard of 0.070 ppm (70 ppb): Brazoria, Chambers, Fort Bend, Galveston, Harris, and Montgomery. Each of these counties has been designated as marginal nonattainment for the 2015 O_3 nonattainment. Additionally, the six counties listed for nonattainment with the 2015 O_3 standard are also in nonattainment with the 8-hour 2008 O_3 standard along with Liberty County and Waller County. Each of these counties has been designated as serious nonattainment for the 2008 O_3 nonattainment (serious nonattainment for 2008 O_3 is an area with a design value of 0.100 up to but not including 0.113 ppm). De minimis values for areas designated as serious for both NO_x and VOCs are 50 tons per year (tpy) (EPA 2024l). The Dallas-Fort Worth area also has several counties in nonattainment status. The following counties are currently not meeting the

8-hour 2015 O_3 standard of 0.070 ppm (70 ppb): Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise Counties. The severity of the 2015 O_3 nonattainment for these counties is classified as marginal (an area with a design value of 0.071 up to but not including 0.081 ppm). Additionally, the following counties are designated nonattainment with respect to the 2008 8-hour O_3 standard: Collin, Dallas, Denton, Ellis, Johnson, Parker, Rockwall, Tarrant, and Wise Counties. These counties are designated as serious nonattainment areas. De minimis values for a serious designation in this area are 50 tpy for NO_x and VOCs (EPA 2024l).

3.10.1 KANSAS AND OKLAHOMA

There are currently no nonattainment areas for any criteria pollutant in the states of Kansas and Oklahoma.

4   NATIONAL EMISSIONS INVENTORY DATA

The NEI data present the emissions of each criteria pollutant by national, state, county, and tribal areas for major source sectors. National emissions trends are reported in the *2020 National Emissions Inventory and Trends Report* (2020 NEI Report) (EPA 2023k). The NEI data are updated every three years, with new emission inventory data incurring a 2- to 3-year data gathering period for final use. The most recent NEI is for 2020 and was released in March 2023. Emissions data are expressed in tons per year or total volume of pollutant released to the atmosphere. Emissions data are useful in comparing source categories to determine which industries or practices are contributing the most to the general level of pollution in an area.

Details of the anthropogenic sectors mentioned in the report are:

(1) Electricity generation is fuel combustion from electric utilities.

(2) Fossil fuel combustion is fuel combustion from industrial boilers, internal combustion engines, and commercial/institutional or residential use.

(3) Industrial processes include manufacturing of chemicals, metals, and electronics; storage and transfer operations; pulp and paper production; cement manufacturing; petroleum refineries; and oil and gas production.

(4) On-road vehicles category includes both gasoline- and diesel-powered vehicles for on-road use.

(5) Non-road equipment includes gasoline- and diesel-powered equipment for non-road use, as well as planes, trains, and ships.

(6) Road dust includes dust from both paved and unpaved roads. Presentation of emissions data by source sector provides a better understanding of the activities that contribute to criteria pollutant emissions.

NEI data by pollutant (CO, NO_x, PM_{10} and $PM_{2.5}$, SO_2, and VOCs) for the major sources within New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix D.

The 2020 NEI data are broken down into the following emission source categories:

- Solvents – consumer and commercial solvent use, degreasing, dry cleaning, graphic arts, industrial surface coating and solvent use, and non-industrial surface coating.

- Mobile sources – aircraft, commercial marine vessels, locomotives, non-road equipment, and on-road vehicles.

- Industrial processes – cement manufacturing, chemical manufacturing, ferrous metals, mining, NEC, nonferrous metals, oil and gas production, petroleum refineries, pulp and paper, and storage and transfer.

- Fires – agricultural field burning, prescribed burning, and wildfires.

- Biogenic sources – vegetation and soil.

- Fuel combustion – institutional, electric generation, industrial boilers, internal combustion engines (ICEs), and residential (for biomass, coal, natural gas, oil).

- Agriculture – crops and livestock dust, fertilizer application, and livestock waste.

- Dust – construction dust, paved road dust, and unpaved road dust.

The figures below show the 2020 NEI VOC, NO_X, CO, PM_{10}, $PM_{2.5}$, and SO_2 emissions for the states of New Mexico, Texas, Oklahoma, and Kansas, showing the estimated percentage of total emissions from each of the applicable emission source categories above.

4.1   2020 NATIONAL EMISSIONS INVENTORY DATA

Total emissions within the United States and BLM NMSO area of operations are reported in Table 21 based on 2020 NEI data in tons per year (EPA 2023k). Table 22 reports total emissions within each county in New Mexico (EPA 2023k).

Table 21. 2020 NEI Air Pollutant Emissions in Tons per Year for United States and BLM NMSO States

State/*County*	NO$_X$	CO	VOC	PM$_{10}$	PM$_{2.5}$	SO$_2$	HAPs
U.S.	8,814,608	66,065,689	46,140,059	16,761,114	5,815,036	1,838,518	5,964,882
New Mexico	199,462	615,513	712,639	129,132	42,623	87,828	105,524
Kansas	199,314	927,620	698,701	500,208	146,908	14,794	128,527
Texas	963,226	4,070,107	4,355,399	1,549,000	362,101	248,177	470,542
Oklahoma	239,316	1,236,732	1,190,095	503,476	142,324	34,886	131,286

Source: EPA (2023k). NEI data pulled September 13, 2024.

Note: Reports both biogenic and human-caused emissions in the table above. Values may not always sum correctly if queried on demand as the NEI database updates its emissions periodically with newer emission information. Values include summaries for each county, including combustion, industrial, on-road/nonroad, and miscellaneous sectors.

Table 22. 2020 NEI Air Pollutant Emissions in Tons per Year for New Mexico Counties

State/*County*	NO$_X$	CO	VOC	PM$_{10}$	PM$_{2.5}$	SO$_2$	HAPs
New Mexico counties in the major oil and gas basin	119,806	218,232	394,181	44,803	12,312	85,822	45,785
Chaves	5,008	13,034	17,379	4,038	975	1,202	3,234
Eddy	26,808	45,159	101,008	7,325	2305	35,502	11,764

State/County	NOx	CO	VOC	PM10	PM2.5	SO2	HAPs
Lea	32,702	46,128	126,317	6,245	2295	46,579	13,507
McKinley	7,019	13,292	20,054	5,140	1179	444	3,558
Rio Arriba	12,423	26,303	53,474	3,632	919	61	4,829
Roosevelt	1,580	5,156	7,683	2,977	695	238	2,003
Sandoval	4,106	20,065	16,604	8,413	1885	140	2,618
San Juan	30,160	49,095	51,662	7,033	2059	1,656	4,272
Remaining NM Counties	70,813	392,123	317,947	84,038	30,182	1,913	59,541
Bernalillo	14,644	72,054	15,944	21,064	5,189	360	3,504
Catron	1,697	36,857	40,085	4,063	2,924	264	6,328
Cibola	3,515	5,416	16,147	1,411	410	13	2,961
Colfax	2,688	7,911	17,859	1,575	390	10	2,656
Curry	2,292	5,737	6,867	4,297	1,014	28	1,727
De Baca	2,271	5,322	5,086	972	414	22	1,344
Dona Ana	6,768	25,244	12,564	5,467	1,655	92	2,491
Grant	1,881	35,427	21,961	5,118	2,966	255	3,603
Guadalupe	2,853	5,082	6,040	775	208	5	1,722
Harding	752	1,831	5,146	289	68	1	1,359
Hidalgo	1,654	3,013	8,324	538	157	6	1,381
Lincoln	1,790	10,708	15,386	2,597	857	54	2,755
Los Alamos	382	2,211	1,872	909	216	3	318.9675
Luna	2,586	5,988	5,773	1,282	386	40	1,119
Mora	1,071	40,549	17,277	4,531	3,359	244	2,528
Otero	2,017	11,108	22,883	3,989	824	19	3,435
Quay	1,988	5,359	6,092	1,395	354	8	1,704
San Miguel	1,825	15,740	15,886	2,752	1,239	86	3,170
Santa Fe	3,792	31,445	11,567	7,790	2,535	116	2,338
Sierra	1,254	5,771	11,519	755	232	11	2,108
Socorro	2,598	28,870	20,726	3,469	2,244	192	4,181
Taos	1,052	10,897	11,208	3,375	1,000	39	1,623
Torrance	4,738	6,979	7,769	1,611	447	12	1,922
Union	1,402	4,293	9,522	2,202	496	10	2,240
Valencia	3,303	8,311	4,444	1,812	598	23	1,022

Source: EPA (2023k). NEI data pulled September 13, 2024.

Note: Reports both biogenic and human-caused emissions in the table above. Values may not always sum correctly if queried on demand as the NEI database updates its emissions periodically with newer emission information. Values include summaries for each county, including combustion, industrial, on-road/nonroad, and miscellaneous sectors.

The largest NEI anthropogenic sources of criteria air pollutants in New Mexico are oil and gas sources for CO, NOx, SO_2, and VOCs (Table 23). The Area Sources category includes all area sources except biogenic (natural) sources, forest wildfires, and prescribed fires. From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x increased from 197,830 tons in 2008 to 199,462 tons in 2020, and SO_2 increased from 24,669 tons to 87,828 tons. However, PM_{10} decreased from 821,631 tons to 129,132 tons, $PM_{2.5}$ decreased from 101,998 tons to 42,623 tons, CO emissions decreased from 813,515 tons in 2008 to 615,513 tons in 2020, and VOCs decreased from 1,315,442 tons to 712,639 tons. Emissions from natural sources (biogenics) decreased from 1,499,241 tons in 2008 to 416,849 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 15,451 to 513,566 tons (EPA 2023k).

Table 23. 2020 Air Pollutant Emissions in Tons per Year by Source – New Mexico

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOC
Area sources	10,322	83,628	2,218	97,936	15,646	434	32,364
Oil and gas sources	100,695	4	67,956	2,171	2,005	83,175	257,560
Non-road mobile	64,346	15	20,430	969	925	72	5,730
On-road mobile	139,109	794	39,531	2,195	1,115	77	10,074
Point sources	79,958	1,128	50,508	9,741	9,273	2,824	28,385
VOC refueling	5	0	2	0	0	0	5,745
Natural sources (biogenics)	64,591	0	16,459	0	0	0	335,799
Forest wildfires	146,933	2,417	2,196	15,120	12,811	1,164	34,718
Prescribed fires	9,554	158	162	1,000	848	82	2,264
Total for New Mexico	615,513	88,144	199,462	129,132	42,623	87,828	712,639

Source: EPA (2023k). NEI data pulled September 13, 2024.

The largest NEI anthropogenic sources of criteria air pollutants in Texas is oil and gas sources for NO_x and VOCs (Table 24). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x decreased from 1,717,979 tons in 2008 to 933,997 tons in 2020, SO_2 decreased from 619,281 tons to 247,247 tons, PM_{10} decreased from 2,514,908 tons to 1,548,279 tons, $PM_{2.5}$ decreased from 462,178 tons to 361,420 tons, CO emissions decreased from 5,601,235 tons in 2008 to 4,066,407 tons in 2020, and VOC decreased from 6,028,204 tons to 4,354,204 tons. Emissions from natural sources (biogenics) decreased from 4,687,170 tons in 2008 to 2,777,116 tons in 2020, and criteria air pollutant emissions from oil and gas production decreased from 1,789,026 to 1,686,327 tons (EPA 2023k).

Table 24. 2020 Air Pollutant Emissions Tons per Year by Source – Texas

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOC
Area sources	256,981	518,847	66,505	1,391,488	233,612	46,988	336,696

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOC
Oil and gas sources	188,033	31	236,288	3,237	3,220	47,556	1,207,962
Non-road mobile	905,234	106	101,950	7,584	7,162	981	67,042
On-road mobile	1,172,835	7,595	210,029	15,969	6,575	805	66,713
Point sources	183,664	7,054	199,302	23,251	20,378	142,378	53,842
VOC refueling	65	1	84	8	7	11	39,449
Natural sources (biogenics)	334,168	0	103,142	0	0	0	2,339,806
Forest wildfires	80,902	1,330	1,572	8,654	7,337	745	19,224
Prescribed fires	944,525	15,545	15,125	98,088	83,129	7,783	223,470
Total for Texas	4,066,407	550,509	933,997	1,548,279	361,420	247,247	4,354,204

Source: EPA (2023k). NEI data pulled September 13, 2024.

The largest NEI anthropogenic sources of criteria air pollutants in Kansas is oil and gas sources for VOCs (Table 25). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NOₓ decreased from 357,510 tons in 2008 to 199,312 tons in 2020, SO₂ decreased from 118,860 tons to 14,794 tons, PM₁₀ decreased from 866,070 tons to 500,208 tons, PM₂.₅ decreased from 193,662 tons to 146,908 tons, CO emissions decreased from 1,355,031 tons in 2008 to 927,620 tons in 2020, and VOCs decreased from 771,768 tons to 698,701 tons. Emissions from natural sources (biogenics) decreased from 688,504 tons in 2008 to 513,882 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 854 to 113,371 tons (EPA 2023k).

Table 25. 2020 Air Pollutant Emissions Tons per Year by Source – Kansas

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOC
Area sources	52,710	202,047	7,664	418,547	71,697	3,568	71,332
Oil and gas sources	33,055	22	22,337	603	603	124	56,627
Non-road mobile	116,899	12	38,572	2,257	2,150	164	9,495
On-road mobile	177,881	890	34,667	1,918	966	68	11,847
Point sources	47,909	1,049	41,931	6,672	6,115	4,424	7,846
VOC refueling	14	0	7	0	0	0	9,090
Natural sources (biogenics)	70,723	0	37,290	0	0	0	405,869
Forest wildfires	9,605	155	232	1,095	934	101	2,323
Prescribed fires	418,824	6,318	16,612	69,116	64,443	6,345	124,272
Total for Kansas	927,620	210,493	199,312	500,208	146,908	14,794	698,701

Source: EPA (2023k). NEI data pulled September 13, 2024.

The largest NEI anthropogenic sources of criteria air pollutants in Oklahoma is oil and gas sources for VOCs (Table 26). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NOₓ decreased from 463,786 tons in 2008 to 239,248 tons in 2020, SO₂ decreased from 148,620 tons to

34,886 tons, PM_{10} decreased from 809,138 tons to 503,474 tons, $PM_{2.5}$ decreased from 168,525 tons to 142,322 tons, CO emissions decreased from 1,736,048 tons in 2008 to 1,236,722 tons in 2020, and VOCs decreased from 1,356,316 tons to 1,190,093 tons. Emissions from natural sources (biogenics) decreased from 1,045,049 tons in 2008 to 822,989 tons in 2020, and criteria air pollutant emissions from oil and gas production decreased from 322,241 to 276,709 tons (EPA 2023k).

Table 26. 2020 Air Pollutant Emissions Tons per Year by Source – Oklahoma

Source	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Area sources	58,170	184,623	14,030	420,628	71,617	19,298	72,465
Oil and gas sources	45,423	0	46,040	1,134	1,106	958	182,048
Non-road mobile	176,121	15	26,395	1,699	1,612	287	15,394
On-road mobile	252,943	1,355	50,832	3,026	1,423	131	17,525
Point sources	70,607	1,553	64,174	13,467	12,045	8,498	24,813
VOC refueling	28	0	3	1	1	0	15,235
Natural sources (biogenics)	71,737	0	25,174	0	0	0	726,078
Forest wildfires	62,451	1,034	1,309	6,756	5,724	606	14,861
Prescribed fires	499,242	8,186	11,291	56,763	48,794	5,108	121,674
Total for Oklahoma	1,236,722	196,766	239,248	503,474	142,322	34,886	1,190,093

Source: EPA (2023k). NEI data pulled September 13, 2024.

The largest NEI anthropogenic source of criteria air pollutants in the San Juan Basin (McKinley, Sandoval, San Juan, and Rio Arriba Counties) is oil and gas sources for CO, NO_x, and VOCs (Table 27). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x decreased from 57,085 tons in 2008 to 53,708 tons in 2020, SO_2 decreased from 13,146 tons to 2,301 tons, PM_{10} decreased from 221,003 tons to 24,218 tons, $PM_{2.5}$ decreased from 25,868 tons to 6,042 tons, CO emissions decreased from 147,491 tons in 2008 to 108,755 tons in 2020, and VOCs decreased from 209,861 tons to 141,794 tons. Emissions from natural sources (biogenics) decreased from 229,692 tons in 2008 to 81,279 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 2,309 to 116,232 tons (EPA 2023k). The NEI data by source for each county in the San Juan Basin are presented in Appendix A.

Table 27. 2020 Air Pollutant Emissions Tons per Year by Source – San Juan Basin

Source	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs
Area sources	2,064	5,605	322	20,805	2,989	34	4,571
Oil and gas sources	33,662	0	22,582	287	283	289	59,129
Non-road mobile	7,469	2	2,978	128	124	4	737
On-road mobile	25,162	146	6,826	362	193	14	1,763
Point sources	25,670	200	18,591	2,264	2,139	1,926	6,216
VOC refueling	0	0	0	0	0	0	924

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOCs
Natural sources (biogenics)	11,304	0	2,336	0	0	0	67,639
Forest wildfires	3,039	51	64	330	279	30	723
Prescribed fires	385	6	9	42	35	4	92
Total for San Juan Basin	108,755	6,010	53,708	24,218	6,042	2,301	141,794

Source: EPA (2023k). NEI data pulled September 13, 2024.

The largest NEI anthropogenic source of criteria air pollutants in the Permian Basin (Eddy, Chaves, Lea, and Roosevelt Counties) is oil and gas sources for CO, NOₓ PM₁₀, PM₂.₅, SO₂, and VOCs (Table 28). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NOx increased from 31,514 tons in 2008 to 66,098 tons in 2020, SO₂ increased from 9,995 tons to 83,521 tons, CO emissions increased from 98,963 tons in 2008 to 109,477 tons in 2020, and VOCs increased from 165,371 tons to 252,387 tons. However, PM₁₀ decreased from 100,800 tons to 20,585 tons, and PM₂.₅ decreased from 13,332 tons to 6,270 tons. Emissions from natural sources (biogenics) decreased from 198,891 tons in 2008 to 38,958 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 12,974 to 389,973 tons (EPA 2023k). The NEI data by source for each county in the Permian Basin are presented in Appendix A.

Table 28. 2020 Air Pollutant Emissions Tons per Year by Source – Permian Basin

Source	CO	NH₃	NOₓ	PM₁₀	PM₂.₅	SO₂	VOCs
Area sources	1,731	26,246	503	16,733	2,786	162	7,755
Oil and gas sources	63,937	3	43,049	1,838	1,689	82,882	196,575
Non-road mobile	5,131	0	1,257	78	72	10	498
On-road mobile	15,136	88	3,422	213	100	7	999
Point sources	14,521	161	15,632	1,560	1,485	444	15,366
VOC refueling	0	0	0	0	0	0	1,635
Natural sources (biogenics)	7,549	0	2,201	0	0	0	29,208
Forest wildfires	906	14	19	99	83	9	215
Prescribed fires	566	9	15	64	55	7	136
Total for Permian Basin	109,477	26,521	66,098	20,585	6,270	83,521	252,387

Source: EPA (2023k). NEI data pulled September 13, 2024.

The 2020 NEI VOC emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 3, which shows the estimated percentage of total VOC emissions from the largest source categories: biogenic sources, fires, industrial processes, mobile sources, and solvents (EPA 2023k).
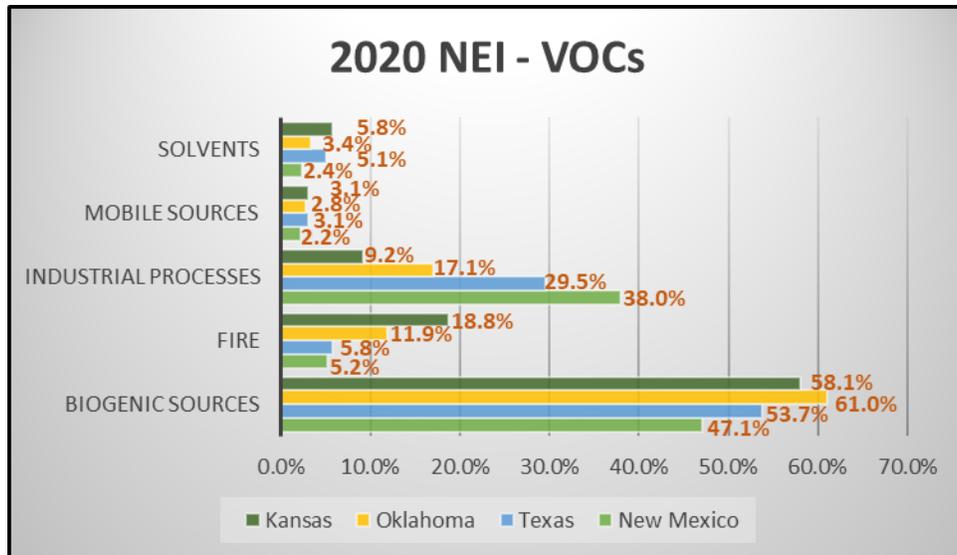
Figure 3. 2020 NEI – VOCs.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that biogenic sources and fuel combustion account for 47.7% and 3.0% of total VOC emissions, respectively, in the area (EPA 2023k). Industrial processes account for 43.7%, of which approximately 95.3% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that biogenic sources and fuel combustion account for 11.6% and 2.7% of total VOC emissions, respectively, in the area (EPA 2023k). Industrial processes account for 81.5%, of which approximately 95.5% is from oil and gas production.

4.1.1 NITROGEN OXIDES EMISSIONS

The 2020 NEI NO_x emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 4, which shows the estimated percentage of total NO_x emissions from the largest source categories: fuel combustion, biogenic sources, fires, industrial processes, and mobile sources (EPA 2023k).
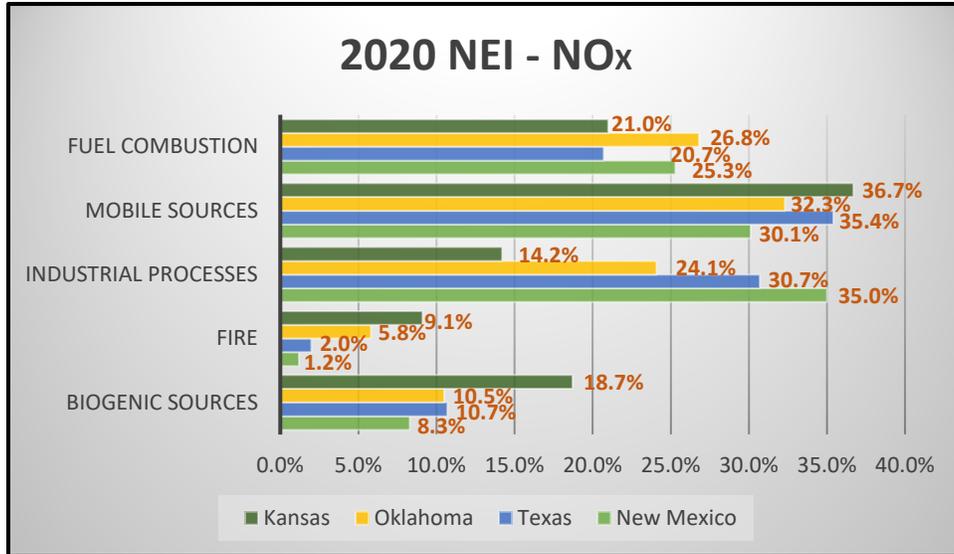
Figure 4. 2020 NEI – NO$_X$.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and mobile sources account for 34.6% and 18.3% of total NO$_x$ emissions, respectively, in the area (EPA 2023k). Industrial processes account for 42.5%, of which approximately 98.9% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion and mobile sources account for 23.6% and 7.1% of total NO$_x$ emissions, respectively, in the area (EPA 2023k). Industrial processes account for 65.8%, of which approximately 98.9% is from oil and gas production.

4.1.2 CARBON MONOXIDE EMISSIONS

The 2020 NEI CO emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 5, which shows the estimated percentage of total CO emissions from the largest source categories: fuel combustion, biogenic sources, fires, industrial processes, and mobile sources (EPA 2023k).
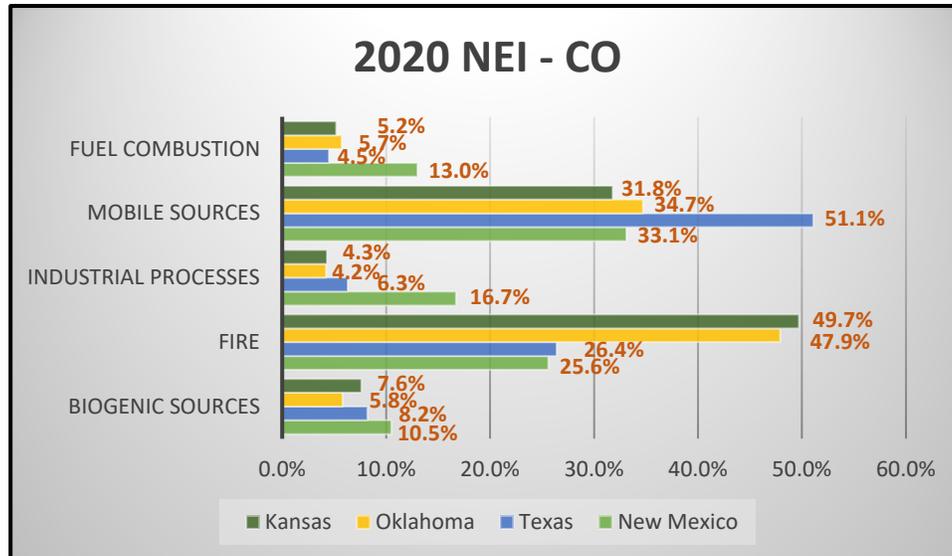
Figure 5. 2020 NEI – CO.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and mobile sources account for 23.6% and 30.0% of total CO emissions, respectively, in the area (EPA 2023k). Industrial processes account for 31.2%, of which approximately 99.2% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion and mobile sources account for 13.3% and 18.5% of total CO emissions, respectively, in the area (EPA 2023k). Industrial processes account for 59.2%, of which approximately 98.7% is from oil and gas production.

4.1.3 PARTICULATE MATTER

The 2020 NEI PM_{10} and $PM_{2.5}$ emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 6 and Figure 7, which show the estimated percentage of total VOC emissions from the largest source categories: dust sources, fuel combustion, agriculture, fires, industrial processes, and mobile sources (EPA 2023k).
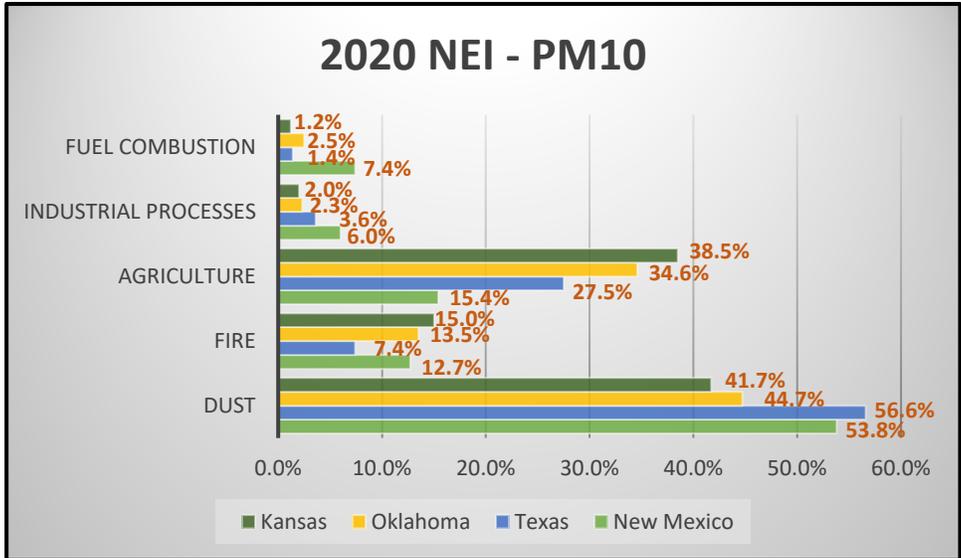
Figure 6. 2020 NEI - PM$_{10}$.
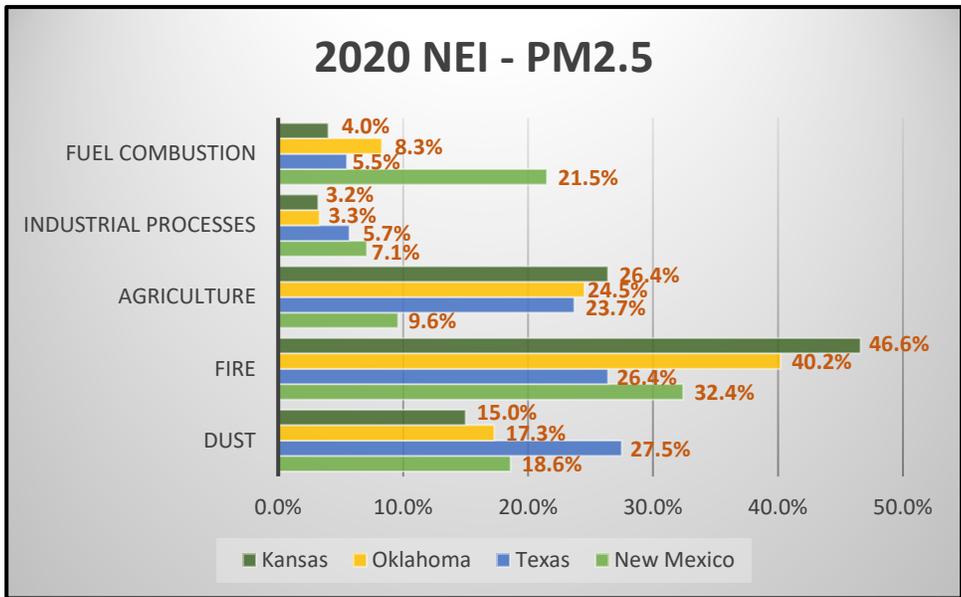
Figure 7. 2020 NEI - PM$_{2.5}$.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that dust, fires, and fuel combustion account for 66.8%, 1.6%, and 9.2% of total PM$_{10}$ emissions, respectively, in the area (EPA 2023k). Industrial processes account for 11.7%, of which approximately 10.1% is from oil and gas production. Dust, fires, and fuel combustion account for 30.3%, 5.4%, and 35.3%, respectively, of total PM$_{2.5}$ emissions. Industrial processes account for 10.5%, of which approximately 44.6% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that dust and agriculture account for 47.6% and 27.1% of total PM$_{10}$ emissions, respectively, in the area (EPA 2023k). Industrial processes account for 14.0%, of which

approximately 63.6% is from oil and gas production. Dust and agriculture account for 17.4% and 18.3%, respectively, of total $PM_{2.5}$ emissions. Industrial processes account for 31.5%, of which approximately 85.6% is from oil and gas production.

4.1.4   SULFUR DIOXIDE EMISSIONS

The 2020 NEI SO_2 emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 8, showing the estimated percentage of total SO_2 emissions from the largest source categories: fuel combustion, fires, industrial processes, and mobile sources (EPA 2023k).
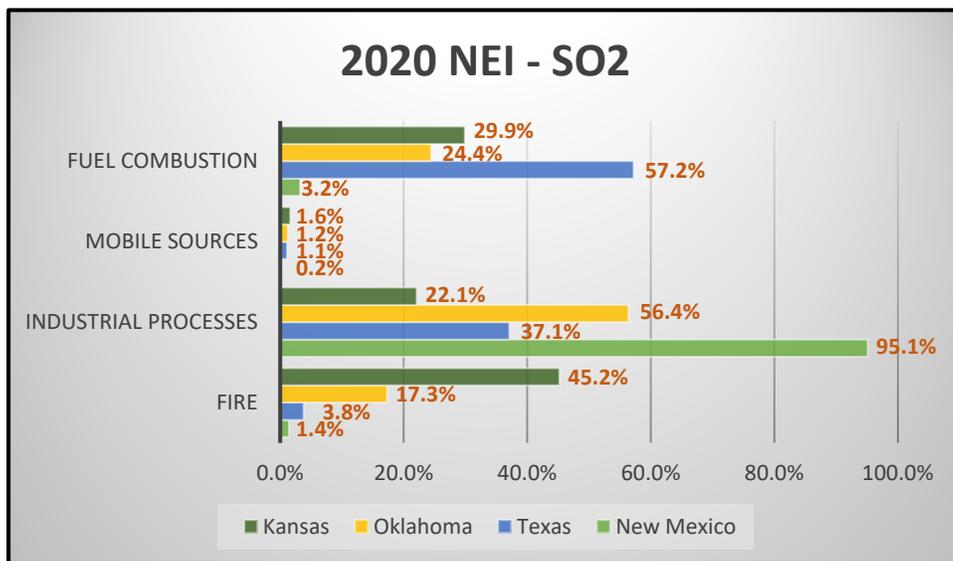
Figure 8. 2020 NEI - SO₂.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and fires account 83.7% and 1.5% of total SO_2 emissions, respectively, in the area (EPA 2023k). Industrial processes account for 13.3%, of which approximately 94.8% come from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion accounts for 0.5% of total SO_2 emissions in the area (EPA 2023k). Industrial processes account for 99.4%, of which approximately 99.8% is from oil and gas production.

4.1.5   HAZARDOUS AIR POLLUTANTS

The 2020 NEI HAPs emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 9, showing the estimated percentage of total HAPs emissions from the largest source categories: biogenics, fuel combustion, fires, industrial processes, and mobile sources (EPA 2023k). The NEI HAP emissions by state and county are summarized in Table 29 and Table 30.
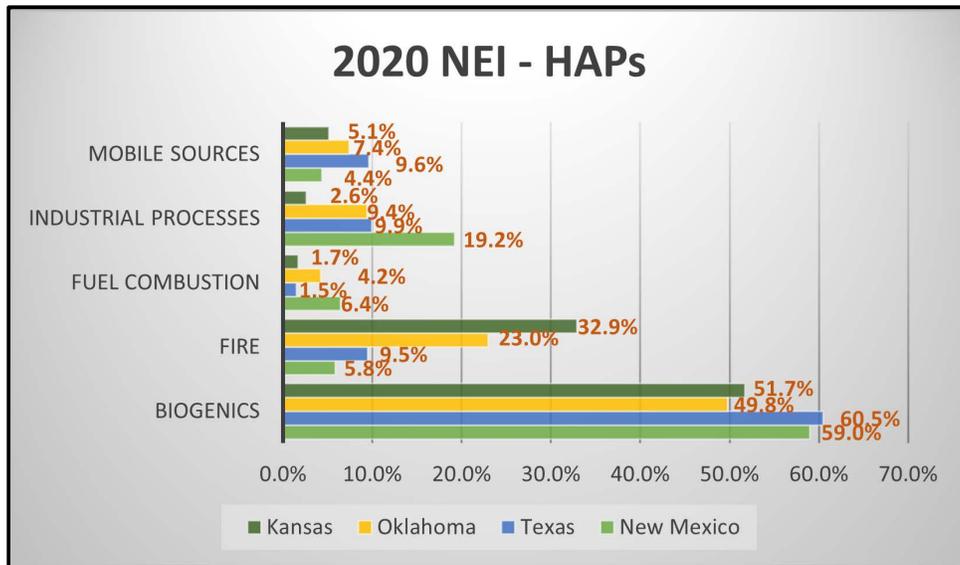
Figure 9. 2020 NEI - HAPs.

Table 29. Hazardous Air Pollutants in Tons per Year for BLM NMSO States

State	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes	Total HAPs
Kansas	20,514.77	2,736.95	613.791	22,799.94	1,390.88	57,983.92	820.83	4,523.74	2,542.30	128,527
Texas	47,402.85	17,442.72	3896.0755	73,172.96	9,553.91	219,649.11	3,188.44	29,293.32	16,091.20	470,542
Oklahoma	15,708.77	3,299.96	915.802	25,065.93	1,824.73	58,314.69	1,642.04	6,977.34	4,849.26	131,286
New Mexico	11,803.29	4,170.10	489.919	26,168.15	1,221.89	47,572.00	593.74	4,486.80	1,925.96	105,524

Source: EPA (2023k). NEI data pulled September 13, 2024.

Table 30. Hazardous Air Pollutants in Tons per Year for New Mexico Counties

County	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes	Total HAPs
NM Counties in the major oil and gas basin	4,335.8	3,370.6	226.1	15,437.0	828.6	14,897.8	124.9	2,486.6	777.6	45,785.0
Chaves	346.2	40.6	18.0	583.0	21.9	1,798.6	7.0	90.7	32.9	3,234.0
Eddy	905.6	1,389.9	56.6	5,485.7	242.2	1,668.7	27.4	810.0	219.8	11,764.0
Lea	1,038.2	1,663.1	77.5	5,888.2	377.9	2,124.0	27.9	997.8	255.4	13,507.0
McKinley	428.2	27.4	11.1	637.8	18.0	2,169.5	11.7	73.7	37.0	3,558.0
Rio Arriba	604.0	40.1	12.1	1,075.1	34.9	2,783.1	8.5	80.6	46.9	4,829.0
Roosevelt	218.1	12.8	3.4	285.6	5.4	1,276.8	4.0	26.8	11.8	2,003.0
Sandoval	325.0	44.8	21.3	461.0	30.3	1,261.8	18.7	147.0	68.7	2,618.0
San Juan	470.5	151.9	26.1	1,020.6	98.0	1,815.3	19.7	260.0	105.1	4,272.0
Remaining NM Counties	7,447.0	783.8	264.0	10,636.2	392.8	32,661.5	460.5	1,993.9	1,144.6	59,540.5
Bernalillo	349.7	147.4	97.2	368.7	121.4	479.2	55.9	654.9	340.5	3,504.0
Catron	926.8	63.2	1.0	1,501.8	7.7	3,448.4	66.4	53.0	32.1	6,327.6
Cibola	371.8	11.7	5.2	578.4	8.2	1,872.4	5.8	35.0	18.6	2,961.4

County	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes	Total HAPs
Colfax	335.3	9.7	3.9	532.2	5.5	1,680.7	3.8	24.3	13.6	2,655.6
Curry	178.0	12.3	6.4	183.0	11.6	1,003.5	4.4	47.0	21.2	1,726.9
De Baca	160.5	8.1	1.3	227.1	2.2	887.3	5.6	12.1	7.1	1,343.7
Doña Ana	264.8	50.5	33.3	312.2	55.2	1,033.1	20.0	235.1	111.5	2,490.9
Grant	515.9	64.1	5.7	760.4	13.6	1,816.3	61.8	80.4	44.5	3,603.3
Guadalupe	186.3	5.3	2.9	257.7	5.1	1,208.9	2.7	19.5	11.7	1,721.8
Harding	134.8	34.2	1.7	186.1	0.8	909.3	0.3	19.7	64.3	1,359.1
Hidalgo	157.9	3.3	1.6	217.2	2.6	964.8	1.5	10.4	5.8	1,381.4
Lincoln	348.0	19.7	5.2	532.9	7.7	1,681.7	13.7	40.2	22.0	2,755.4
Los Alamos	41.9	5.3	2.8	52.8	4.3	149.9	2.0	19.1	8.6	319.0
Luna	128.7	9.8	6.2	180.2	13.0	663.8	3.6	41.7	21.1	1,118.9
Mora	375.0	60.4	2.4	555.9	8.3	1,151.7	61.9	55.5	34.5	2,528.1
Otero	498.5	20.2	11.1	804.0	14.5	1,858.3	7.6	75.0	35.7	3,435.2
Quay	196.3	6.9	3.5	261.4	5.7	1,149.5	3.4	23.3	12.9	1,704.3
San Miguel	402.3	33.3	7.5	558.1	11.0	1,900.8	24.7	60.3	32.8	3,169.9
Santa Fe	300.0	69.4	28.7	357.1	39.2	876.0	36.4	198.0	102.9	2,337.6
Sierra	257.9	11.1	6.5	372.8	9.0	1,336.6	2.8	41.2	23.6	2,108.5
Socorro	538.2	49.2	3.6	772.4	10.3	2,464.3	48.9	57.9	33.3	4,181.4
Taos	225.6	21.9	7.3	301.2	9.4	871.3	11.9	50.3	25.8	1,623.3
Torrance	211.3	11.8	4.7	306.4	7.5	1,270.9	5.1	30.8	16.8	1,922.0
Union	229.7	36.4	2.7	313.3	2.4	1,509.8	3.0	27.5	64.5	2,240.0
Valencia	111.8	18.5	11.5	142.8	16.6	472.8	6.9	81.4	39.1	1,021.5

Source: EPA (2023k). NEI data pulled September 13, 2024.

Currently there are 187 specific pollutants and chemical groups known as HAPs. The list has been modified over time. HAPs are chemicals or compounds that are known or suspected to cause cancer or other serious health effects, such as compromises to immune and reproductive systems, birth defects, developmental disorders, or adverse environmental effects and may result from either chronic (long-term) and/or acute (short-term) exposure. CAA Sections 111 and 112 establish mechanisms for controlling HAPs from stationary sources, and the EPA is required to control emissions of the 187 HAPs. The U.S. Congress amended the federal CAA in 1990 to address a number of air pollutants that are known to cause or may reasonably be anticipated to cause adverse effects on human health or adverse environmental effects.

Ambient air quality standards do not exist for HAPs; however, the CAA requires control measures for HAPs. Mass-based emissions limits and risk-based exposure thresholds have been established as significance criteria to require maximum achievable control technologies (MACT) under the EPA promulgated National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for 96 industrial source classes. NESHAPs are issued by the EPA to limit the release of specified HAPs from specific industrial sectors. These standards are technology based, meaning that they represent the MACT that are economically feasible for an industrial sector.

NESHAPs for Oil and Natural Gas Production and Natural Gas Transmission and Storage were published by the EPA on June 17, 1999. These NESHAPs were directed toward major sources and intended to control benzene, toluene, ethylbenzene and mixed xylenes (BTEX) and n-hexane. An additional NESHAP for Oil and Natural Gas Production Facilities directed toward area sources was published on January 3, 2007, and specifically addresses benzene emissions from triethylene glycol dehydrations units. The EPA issued a final rule revising the NESHAP rule effective October 15, 2012. The final rule includes revisions to the existing leak detection and repair requirements and established emission limits reflecting MACT for currently uncontrolled emission sources in oil and gas production and natural gas transmission and storage (Federal Register 77(159):49490–49600).

The EPA NESHAPs that are most likely to have applicability to oil and gas operations are as follows (in addition to the NESHAPs common/general provisions):

- NESHAP Subpart HH – National Emission Standard for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities

- NESHAP Subpart ZZZZ - National Emission Standard for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines

Note that several of the NSPSs that are potentially applicable to oil and gas operations (listed in Section 2) also regulate emissions of VOCs, a component of which includes HAP emissions. Although the NSPS rules are not designed to directly regulate HAP emissions, control of VOCs results in the co-benefit of HAP reductions.

The CAA defines a major source for HAPs to be one emitting 10 tpy of any single HAP or 25 tpy of any combination of HAPs. Under state regulations, a construction or operating permit may be required for any major source, though some exceptions apply. In New Mexico, these regulations are N.M.A.C. 20.2.70 and 20.2.73; in Texas, the regulation is 30 Texas Administrative Code (T.A.C.) § 122; in Kansas, the regulation is Kansas Administrative Regulations (K.A.R.) 28-19-500; and in Oklahoma, the regulation

is Oklahoma Register 252-100-7. Within its definition of a major source in the above-referenced regulations, the State of New Mexico includes the following language:

> *…hazardous emissions from any oil or gas exploration or production well (with its associated equipment) and hazardous emissions from any pipeline compressor or pump station shall not be aggregated with hazardous emissions from other similar units, whether or not such units are in a contiguous area or under common control, to determine whether such units or stations are major sources…*

In other words, in determining a major source, each oil and gas exploration and production well must be considered singularly. Kansas, Texas, and Oklahoma regulations include similar language.

The State of New Mexico incorporates federal NESHAPs for pollutants through updates to N.M.A.C. 20.2.78, which adopts 40 C.F.R. § 61, and federal NESHAPs for source categories through updates to N.M.A.C. 20.2.82, which adopts 40 C.F.R. § 63. Similarly, Texas incorporates federal NESHAPs for both 40 C.F.R. § 61 and 40 C.F.R. § 63 through updates to 30 T.A.C. § 113. Kansas incorporates federal NESHAPs by adopting 40 C.F.R. § 61 through updates to K.A.R. 28-19-735 and incorporates NESHAP source categories at 40 C.F.R. § 63 through updates to K.A.R. 28-19-750. Oklahoma incorporates both 40 C.F.R. § 61 and 40 C.F.R. § 63 through Oklahoma Register 252-100-41-2 and the Oklahoma Administrative Code Appendix Q.

Although HAPs do not have federal air quality standards some states have established "thresholds" to evaluate human exposure for potential chronic inhalation illness and cancer risks. There are no applicable federal or state ambient air quality standards for assessing potential HAP impacts to human health and monitored background concentrations are rarely available. Therefore, RfCs for chronic inhalation exposures and reference exposure levels (RELs) for acute inhalation exposures can be applied as evaluation criteria. Table 31 below provides the RfCs and RELs. Both the RfC and REL guideline values are for noncancer effects.

Table 31. HAP RELs and RfCs

HAPs	Acute RELs[1]	Noncancer Chronic RfC[2]	Inhalation Unit Risk (IUR)[2]
Benzene	27	30	7.8E-06
Toluene	5,000	5,000	Not applicable (n/a)
Ethylbenzene	22,000	1,000	2.5E-06
Xylenes	8,700	100	n/a
n-Hexane	180,000	700	n/a
Formaldehyde	55	9.8[3]	1.3E-05

[1]Values referenced from EPA (2021a).

[2]Values referenced from EPA (2024m).

[3]There is no RfC for formaldehyde. The Agency for Toxic Substances and Disease Registry (ATSDR) chronic minimal risk level (MRL) of 0.008 ppm was used and converted to $\mu g/m^3$.

5.1   COLORADO STATE UNIVERISTY HAPS MODELING STUDY

Potential health risks associated with HAPs released into the air from oil and gas operations have been evaluated by review of existing emissions data, air quality monitoring, and modeling studies assessed.

For example, a 2019 health assessment study was completed, the Final Report: Human Health Risk Assessment for Oil and Gas Operations in Colorado (ICF and Colorado State University [CSU] 2019), for which scientists from CSU conducted on-site air monitoring for 47 VOCs (including HAPs) during various stages of well development and production at oil and gas extraction facilities in Colorado. The study used tracer gas controlled-release sampling to develop calculated emission rates during various stages of well development and production for well pads of various sizes and at various locations in Colorado. Acetylene was released at a controlled, constant rate while samples were collected in canisters downwind of the well pads. The samples collected were analyzed in a lab for acetylene and 47 other VOC species, including a number of HAPs such as acetaldehyde and BTEX, to determine the concentration of each species. The ratio of the known acetylene release rate to the measured downwind sample concentration was then used to calculate emission rates of each VOC species for each sample. Dispersion modeling with the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was then performed in which rings of receptors were established at various distances from 300 to 2,000 feet from the center of the well pads to estimate short- and long-term chemical air concentrations (ICF and CSU 2019). The maximum results of the dispersion modeling for each distance were then used in EPA Air Pollutants Exposure Model (APEX) to compare the calculated exposure levels from each scenario and each distance against acute, subchronic, and chronic exposure standards for each VOC species.

Results of the study indicate that acute (1-hour) exposures were below guideline levels (hazard index under 1, indicating short-term health impacts are unlikely to occur) for most chemicals. At the 500-foot distance, for a small number of chemicals (including benzene, toluene, and ethyltoluenes), the highest estimated acute exposures exceeded guideline levels at the most exposed (downwind) locations, in isolated cases by a factor of 10 or more, particularly during flowback activities at smaller well pads. Flowback is defined in the study as the period after the entire well is fracked and the plugs are drilled out to enable the flow of fracking fluid, water, oil, and natural gas to the surface (ICF and CSU 2019).

For a relatively small number of development scenarios, those highest predicted acute exposures decreased rapidly with distance, but remained above guideline levels out to 2,000 feet (ICF and CSU 2019). Flowback occurs during well completion when fracturing fluids, water, and reservoir gas come to the surface at high velocity and volume and contain a mixture of VOCs, CH_4, benzene, ethylbenzene, and n-hexane. As noted by the study, the identification of these estimated exceedances of acute health guidelines (hazard index above 1) is highly conservative, and the highest exposures occur rarely (ICF and CSU 2019). Subchronic modeled hazard indexes were generally lower than acute modeled hazard indexes. Most subchronic (multi-day/lasting less than 1 year) exposures were below subchronic guideline levels (all exposures at the 500-foot distance and beyond) during development activities, although subchronic exposures slightly above guideline levels for combined exposures to multiple chemicals were noted during fracking at distances out to 800 feet. As with acute exposure estimates, the study noted that the subchronic exposure estimates are also conservative (ICF and CSU 2019).

Chronic exposure was estimated for production operations, development and operations, and long flowback operations. Exposures at the 500-foot distance for the flowback periods were far below guideline levels for individual chemicals and only slightly above guideline levels for combined exposures to multiple chemicals (ISF and CSU 2019). The chronic exposures during production operations were generally the lowest, relative to guideline levels, from all modeled scenarios. At the 500-foot distance from the facility, all chronic exposures during production activities were below guideline levels, and the average incremental lifetime cancer risk from chronic benzene exposure was 5 in 1 million or less (dropping below 1 in 1 million before the 2,000-foot distance). When estimates of chronic exposure

include exposure to development activities occurring sequentially with exposure to production activities, exposures were only slightly higher than those estimated during the production activities alone.

The hazard index for chronic health impacts was 1 or less, often by more than an order of magnitude, at receptors that are 2,000 feet from the modeled well pad scenarios (ICF and CSU 2019). Table 32 summarizes cancer risks over a lifetime of exposure during oil and gas production operations (ICF and CSU 2019).

Table 32. Cancer Risks Over a Lifetime of Exposure During Production Operations of Oil and Gas Activities

Distance (feet)	Average Incremental Lifetime Cancer Risk	Maximum Exposed Individual Cancer Risk
300	10 in 1 million	–
400	–	10 in 1 million
500	4 in 1 million	7 in 1 million
1,400	1 in 1 million	–
2,000	–	1 in 1 million

Source: ICF and CSU (2019).

In summary, simulated cancer risks to average individuals were below 1 in 1 million at distances of 1,400 feet from the well pads, 4 in 1 million at 500 feet from the well pads, and 10 in 1 million at 300 feet from the well pads. Risk to maximum exposed individuals were below 1 in 1 million at distances of 2,000 feet from the well pads, 7 in 1 million at 500 feet from the well pads, and 10 in 1 million at 400 feet from the well pads (ICF and CSU 2019).

5.2   AIR TOXICS SCREENING ASSESSMENT

The AirToxScreen is the EPA ongoing review of air toxics in the United States. The EPA developed AirToxScreen as a screening tool for state, local, and tribal air agencies. AirToxScreen results help the EPA and other agencies identify which pollutants, emission sources, and places they may wish to study further to better understand any possible risks to public health from air toxics. AirToxScreen is the successor to the National Air Toxics Assessment, or NATA. In May 2024, EPA began rolling out the results of the 2020 AirToxScreen; however, until complete, the 2019 AirToxScreen results are presented and discussed.

AirToxScreen calculates concentration and risk estimates from a single year of emissions data using meteorological data for that same year. The risk estimates assume a person breathes these emissions each year over a lifetime (or approximately 70 years). AirToxScreen then provides quantitative estimates of potential cancer risk and five classes of noncancer hazards (grouped by organ/system: immunological, kidney, liver, neurological, and respiratory) associated with chronic inhalation exposure to real-world toxics. The 2019 AirToxScreen assessment includes emissions, ambient concentrations, and exposure estimates for about 181 of the 188 CAA air toxics plus diesel particulate matter (diesel PM). For about 140 of these air toxics (those with health data based on long-term exposure), the assessment estimates cancer risks, noncancer health effects, or both. The assessment includes noncancer health effects for diesel PM.

AirToxScreen potential cancer risk values represent statistical probabilities of developing cancer over a lifetime. AirToxScreen noncancer hazards are expressed as a ratio of an exposure concentration to an RfC associated with observable adverse health effects (i.e., a hazard quotient). "For a given air toxic, exposures at or below the RfC (i.e., hazard quotients are 1 or less) are *not* likely to be associated with adverse health effects. As exposures increase above the RfC (i.e., hazard quotients are greater than 1), the potential for adverse effects also increases" (EPA 2024n).

RfCs are indicators defined by the EPA as the daily inhalation concentrations at which no long-term adverse health impacts are expected. Short-term (1-hour) HAP concentrations will be compared with acute RELs. RELs are defined as concentrations at or below which no adverse health effects are expected (California Office of Environmental Health Hazard Assessment 2023). The primary air toxics of concern for oil and gas operations are BTEX, formaldehyde, and n-hexane.

It is important to note that AirToxScreen focuses solely on exposures from inhalation of outdoor ambient air. The AirToxScreen framework does not address inhalation from indoor ambient air, estimate human exposure to chemicals via ingestion or through dermal contact, or account for exposures that may take place via other mechanisms.

In addition, although AirToxScreen reports results at the census tract level, average risk estimates are far more uncertain at this level of spatial resolution than at the county or state level. To analyze air toxics in smaller areas, such as census blocks or in suspected "hotspots," other tools such as site-specific monitoring and local-scale assessments should be used (EPA 2024n). AirToxScreen results are best used to focus on patterns and ranges of risks across the country. Additional AirToxScreen limitations can be reviewed at https://www.epa.gov/AirToxScreen/airtoxscreen-limitations.

In accordance with the AirToxScreen Technical Support Document (EPA 2024n), AirToxScreen is consistent with the EPA definition of a cumulative risk assessment, as stated in the EPA Framework for Cumulative Risk Assessment (EPA 2003:6), as "an analysis, characterization, and possible quantification of the combined risks to health or the environment from multiple agents or stressors." (EPA 2003, 2024n). Table 33 shows the cancer risk (per million) and noncancer risk (hazard index) for the United States, Texas, Oklahoma, Kansas, and New Mexico from 2018 through 2019. Table 34 shows the cancer risk (per million) and noncancer risk (hazard index) for all the New Mexico counties from 2018 through 2019 (EPA 2023l, 2024o). For the eight New Mexico counties located in the major oil and gas basin, the EPA has determined that for the four counties in the BLM Farmington Field Office (FFO) (San Juan, Sandoval, Rio Arriba, and McKinley), the total cancer risk is a maximum of 18.72 in 1 million. The maximum contribution of the oil and gas industry to the cancer risk in the BLM FFO is 2.06 in 1 million. The EPA has determined that for Eddy and Lea Counties, the total cancer risk is a maximum of 22.25 in 1 million. The maximum contribution of the oil and gas industry to the cancer risk in Eddy and Lea Counties is 3.91 in 1 million. The total cancer risk is a maximum of 27.03 in 1 million for the remaining New Mexico Counties, and the maximum contribution of the oil and gas industry to the cancer risk is 0.40 in 1 million. The total cancer risk is within the acceptable range of risk published by the EPA of 100 in 1 million as discussed in the National Contingency Plan, 40 C.F.R. § 300.430.

Table 33. Total Cancer Risk and Noncancer Respiratory Hazard from Existing HAP Emissions for United States and BLM NMSO States

United States and NMSO States	Respiratory Hazard Index			Total Cancer Risk (per million)			Oil and Gas Cancer Risk (per million)		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
United States	0.36	0.32	0.31	28.68	25.00	25.50	0.15	0.19	0.12
States									
Kansas	0.33	0.30	0.28	24.76	21.61	21.70	0.13	0.15	0.10
Oklahoma	0.39	0.34	0.30	28.96	24.70	24.85	0.55	0.64	0.34
Texas	0.35	0.29	0.30	31.33	25.81	28.13	0.27	0.32	0.30
New Mexico	0.24	0.21	0.22	20.27	17.57	19.10	0.24	0.33	0.34

Source: EPA (2023l, 2024o).

Table 34. Total Cancer Risk and Noncancer Respiratory Hazard from Existing HAP Emissions for New Mexico Counties

New Mexico Counties	Respiratory Hazard Index			Total Cancer Risk (per million)			Oil and Gas Cancer Risk (per million)		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
NM Counties in major oil and gas basin*									
Chaves	0.23	0.21	0.24	19.49	17.37	19.16	0.14	0.20	0.15
Eddy	0.24	0.22	0.23	21.41	20.09	22.25	2.25	3.38	3.91
Lea	0.23	0.20	0.21	20.27	18.30	20.16	2.15	2.86	3.05
McKinley	0.13	0.12	0.12	12.12	10.50	11.12	0.01	0.01	0.01
Rio Arriba	0.15	0.13	0.13	13.55	11.67	12.28	0.03	0.06	0.04
Roosevelt	0.17	0.15	0.15	15.46	13.71	14.63	0.02	0.04	0.03
Sandoval	0.24	0.21	0.22	20.29	17.37	18.72	0.01	0.01	0.01
San Juan	0.29	0.30	0.28	17.57	17.10	17.56	1.73	2.21	2.06
Remaining NM Counties*									
Bernalillo	0.32	0.28	0.29	25.09	21.40	23.01	0.00	0.00	0.00

New Mexico Counties	Respiratory Hazard Index			Total Cancer Risk (per million)			Oil and Gas Cancer Risk (per million)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Catron	0.13	0.14	0.09	11.52	11.07	9.84	0.00	0.00	0.00
Cibola	0.15	0.12	0.12	12.89	10.66	11.19	0.00	0.00	0.00
Colfax	0.12	0.12	0.10	11.01	10.41	10.27	0.02	0.03	0.08
Curry	0.19	0.17	0.18	16.44	14.59	15.53	0.00	0.00	0.00
De Baca	0.16	0.15	0.15	14.86	13.28	14.38	0.01	0.01	0.02
Doña Ana	0.26	0.22	0.23	26.40	22.31	27.03	0.00	0.00	0.00
Grant	0.14	0.11	0.11	13.13	10.94	11.74	0.00	0.00	0.00
Guadalupe	0.15	0.13	0.13	13.72	11.86	12.58	0.00	0.00	0.00
Harding	0.12	0.11	0.11	11.82	10.69	11.37	0.36	0.40	0.34
Hidalgo	0.18	0.15	0.15	16.20	13.38	14.45	0.00	0.00	0.00
Lincoln	0.12	0.10	0.10	11.72	9.93	10.54	0.00	0.00	0.00
Los Alamos	0.13	0.11	0.11	12.08	10.49	11.16	0.00	0.00	0.00
Luna	0.20	0.17	0.18	17.40	14.61	16.34	0.00	0.00	0.00
Mora	0.10	0.09	0.09	10.04	8.98	9.18	0.00	0.00	0.00
Otero	0.16	0.14	0.14	16.07	13.68	14.42	0.00	0.00	0.00
Quay	0.16	0.14	0.14	14.71	12.68	13.76	0.01	0.01	0.01
San Miguel	0.13	0.12	0.11	12.37	10.88	11.45	0.00	0.00	0.00
Santa Fe	0.18	0.16	0.16	16.45	14.21	14.75	0.00	0.00	0.00
Sierra	0.17	0.14	0.14	15.25	12.89	13.73	0.00	0.00	0.00
Socorro	0.15	0.13	0.13	13.65	11.92	12.32	0.00	0.00	0.00
Taos	0.14	0.12	0.11	12.25	10.69	11.20	0.00	0.00	0.00
Torrance	0.13	0.12	0.12	12.61	10.88	11.48	0.00	0.00	0.00
Union	0.12	0.11	0.11	11.76	10.76	11.27	0.19	0.22	0.17

New Mexico Counties	Respiratory Hazard Index			Total Cancer Risk (per million)			Oil and Gas Cancer Risk (per million)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Valencia	0.22	0.19	0.19	17.45	15.06	16.01	0.00	0.00	0.00

Source: EPA (2023l, 2024o).

*These eight counties are where parcels are regularly nominated for BLM New Mexico Quarterly Oil and Gas Lease Sales.

The total risk for noncancer respiratory hazard index is estimated from a variety of factors from inhalation of air toxics nationwide, in both urban and rural areas. Background concentrations include pollutants that exist in the air that do not come from specific sources and may be derived from a natural source (biogenic) or from distance sources or pollutants that persist in the environment due to a long half-life. Background concentrations can explain pollutant concentrations found even without recent human-caused emissions. Oil and gas cancer risks are estimated from emissions from oil and gas operations such as emissions from individual well locations and production equipment such as pumps, dehydrators, tanks, and engines. Total cancer risk for the state of New Mexico (19.1 cases per million) was less than that of the United States (25.5 cases per million) (see Table 33). In addition, the respiratory noncancer hazard quotient values were consistently lower in the state of New Mexico (respiratory: 0.22) than national values (respiratory: 0.31).

At the county level, all eight counties (Chaves, Eddy, Lea, McKinley, Rio Arriba, Sandoval, San Juan, and Roosevelt) had cancer risk values and total hazard quotients less than those of the United States, with all total hazard quotients reported being less than 1 (<1.0).

5.3   FFO AND PDO HAPS MODELING

The U.S. Court of Appeals for the Tenth Circuit directed the BLM to analyze cumulative HAPs emissions for the San Juan Basin in its oil and gas leasing under NEPA (Diné Citizens Against Ruining Our Env't v. Haaland, 59 F.4th 1016, 1047 (10th Cir. 2023) ("*Diné CARE II* "),[2] the BLM has also created the same analysis for the PDO. The BLM Cumulative Hazardous Air Pollutant Modeling – Final Report (Ramboll and BLM 2023) and the BLM Summary of Cumulative Oil and Gas Hazardous Air Pollutant Analysis for the PDO (BLM 2024d), incorporated by reference and summarized below, detail the modeling methods used and the results of the modeling. The tables below also include information for FFO, incorporated from the BLM Summary of Cumulative Oil and Gas HAP Analysis for FFO (BLM 2024e).

The BLM's Western United States HAP photochemical modeling assessment was prepared to support BLM's analysis of cumulative oil and gas impacts from HAPs originating from oil and gas production in Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming (states where the BLM commonly authorizes federal activities for fossil energy development) on public health. In regard to which HAPs to consider in the analysis, the *Diné CARE II* Court specifically mentioned five HAPs—benzene, toluene, ethylbenzene, mixed xylenes, and n-hexane—as applying to oil and gas development activities based on the NESHAPs, see 43 C.F.R. § 63. The modeling assessment evaluated emissions from existing federal, new federal, and non-federal oil and gas sources and includes six key HAPs—benzene, toluene, ethylbenzene, xylene, n-hexane, and formaldehyde—because these compounds are common in the oil and gas sector and consistent with regulatory requirements described in the EPA's NSPS, see 43 C.F.R. § 60, and NESHAPs. HAP emissions in this study include emission sources associated with wellsite exploration, wellsite production, and midstream sources (Ramboll and BLM 2023). The modeling analysis evaluated air quality out to a future year of 2032[3] using data from the 2028 Western Regional Air Partnership (WRAP)/Western Air Quality Study (WAQS) modeling platform, the EPA SPECIATE 5.14 speciation profiles, the EPA's 2016v2 emissions modeling platform (EPA 2022a), and the BLM oil and gas development projections to quantify and apportion federal and non-federal oil and gas emissions

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[2] The federal Clean Air Act defines a hazardous air pollutant (HAP) as "any air pollutant" of which "emissions, ambient concentrations, bioaccumulation or deposition of the substance are known to cause or may reasonably be anticipated to cause adverse effects to human health or adverse environmental effect." 42 U.S.C. § 7412.

[3] EPA's 2016v2 modeling platform (EPA 2022a), the most advanced dataset at the time of model development, includes emissions for the years 2016, 2023, 2026, and 2032. Future year 2032 was used in this modeling assessment.

(Ramboll and BLM 2023). The model output allows the BLM to compare concentrations of HAPs to calculated risk-based thresholds in order to provide the hard look at the effects on public health required by NEPA.

Carcinogenic and noncarcinogenic chronic risks from modeled oil and gas concentrations were calculated for future year 2032. The emissions inventory for the PDO was based on Annual Energy Outlook (AEO) oil and gas projections for the Permian Basin. These projections describe the reasonably foreseeable oil and gas development anticipated to occur within the Permian Basin projected out to 2032, providing the temporal component of the cumulative oil and gas analysis as described by the CEQ regulations. These projections reflect the best currently available information for projected oil and gas development in the Permian Basin. Health-based inhalation thresholds and cancer unit risk estimate threshold values were obtained from the weight of evidence for carcinogenicity under the 2005 EPA cancer guidelines (without revisions) (EPA 2021b, 2022b). A residency exposure adjustment factor was applied to the cancer inhalation risk by multiplying the annual modeled concentration by the cancer unit risk factor and multiplying this product by an applicable exposure adjustment factor. The residency exposure adjustment factor[4] is computed by taking the average residency of the county where development is proposed (Table 35) and dividing that by the length of exposure over an assumed 70-year life span. For example, for Eddy County, the residency exposure adjustment factor would be 15.0/70. All other values in Table 35 and Table 36 are raw model outputs with no adjustment applied.

Table 35. U.S., State, and County-Specific Residency Information

United States/State/County	Years
United States	13.4
New Mexico	15.9
Bernalillo	13.1
Catron	19.8
Chaves	14.9
Cibola	16.9
Colfax	15.1
Curry	12.6
De Baca	15.0
Dona Ana	13.2
Eddy	15.0
Grant	15.2
Guadalupe	18.9
Harding	15.7
Hidalgo	15.9
Lea	14.0

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[4] EPA's Exposure Assessment Tools by Routes – Inhalation; https://www.epa.gov/expobox/exposure-assessment-tools-routes-inhalation.

United States/State/County	Years
Lincoln	14.3
Los Alamos	13.4
Luna	14.7
McKinley	18.5
Mora	22.1
Otero	13.2
Quay	15.6
Rio Arriba	19.8
Roosevelt	14.1
Sandoval	14.1
San Juan	15.5
San Miguel	18.3
Santa Fe	14.3
Sierra	15.9
Socorro	17.9
Taos	17.6
Torrance	16.1
Union	16.4
Valencia	16.1

Source: Estimate based on data from U.S. Census Bureau- 2018-2022 American Community Survey 5-Year Estimates, Table S2502 Demographic Characteristics for Occupied Housing Units, U.S. Census Bureau (2023).

Table 36 shows the oil and gas cancer risk from federal sources (existing and new) and from all mineral designations together from the combination of benzene, ethylbenzene, and formaldehyde. The risk analysis was only performed for three HAPs (benzene, ethylbenzene, and formaldehyde) because these pollutants had EPA-provided non-zero unit risk estimate values based on the weight of evidence approach (EPA 2021b). The non-adjusted (70-year) cancer risk from all oil and gas sources for all New Mexico counties is less than 30 in 1 million (maximum of 27.48 in San Juan County). The maximum total oil and gas residency exposure-adjusted cancer risk for all New Mexico counties, as described above, is below 6.15 in 1 million.

Table 36. Estimated Cancer Risk from 2032 Oil and Gas Production in the New Mexico by Mineral Designation

County	Cancer Risk* from Existing Federal Wells (per million)	Cancer Risk* from New Federal Wells (per million)	Cancer Risk* from Total Federal Wells (per million)	Cancer Risk* from Non-Federal Wells (per million)	Cancer Risk* from Cumulative Oil and Gas Production (per million)	Adjusted Cancer Risk[†] From Cumulative Oil and Gas Production (per million)
CFO						
Chaves[‡]	0.20 to 2.51	0.07 to 1.54	0.26 to 3.95	0.20 to 3.53	0.46 to 7.48	0.10 to 1.59
Eddy	0.20 to 6.91	0.08 to 2.95	0.28 to 7.57	0.22 to 8.95	0.51 to 15.10	0.11 to 3.24
Lea	0.45 to 4.65	0.25 to 4.86	0.72 to 7.10	0.79 to 6.46	1.61 to 13.11	0.32 to 2.62
FFO						
McKinley[§]	0.04 to 0.84	0.02 to 0.55	0.06 to 1.39	0.05 to 0.88	0.11 to 2.21	0.03 to 0.58
Rio Arriba[¶]	0.29 to 15.51	0.13 to 2.75	0.42 to 18.26	0.25 to 4.27	0.67 to 21.74	0.19 to 6.15
Sandoval[§]	0.12 to 2.76	0.07 to 3.11	0.19 to 5.87	0.13 to 3.91	0.32 to 9.60	0.06 to 1.93
San Juan	0.07 to 16.70	0.04 to 4.02	0.11 to 20.72	0.09 to 7.18	0.20 to 27.48	0.04 to 6.09
RPFO						
Bernalillo	0.1 to 0.2	0.06 to 0.12	0.16 to 0.32	0.12 to 0.2	0.28 to 0.52	0.05 to 0.1
Cibola	0.03 to 0.1	0.02 to 0.06	0.04 to 0.16	0.04 to 0.11	0.08 to 0.27	0.02 to 0.07
Torrance	0.11 to 0.17	0.06 to 0.1	0.18 to 0.28	0.14 to 0.24	0.32 to 0.47	0.07 to 0.11
Valencia	0.07 to 0.14	0.04 to 0.09	0.12 to 0.23	0.09 to 0.16	0.21 to 0.39	0.05 to 0.09
RFO						
Curry	0.19 to 0.3	0.13 to 0.18	0.32 to 0.47	0.33 to 0.52	0.64 to 0.99	0.12 to 0.18
De Baca	0.19 to 0.48	0.1 to 0.24	0.29 to 0.7	0.24 to 0.7	0.52 to 1.4	0.11 to 0.3
Guadalupe	0.16 to 0.25	0.09 to 0.14	0.25 to 0.39	0.19 to 0.37	0.44 to 0.76	0.12 to 0.2
Lincoln	0.11 to 0.44	0.05 to 0.11	0.16 to 0.56	0.14 to 0.48	0.29 to 0.93	0.06 to 0.19
Quay	0.15 to 0.29	0.12 to 0.16	0.28 to 0.45	0.26 to 0.43	0.54 to 0.88	0.12 to 0.2
Roosevelt	0.22 to 0.62	0.15 to 0.32	0.36 to 0.93	0.45 to 12.8	0.87 to 13.45	0.18 to 2.71
Las Cruces DO						
Doña Ana	0.05 to 0.11	0.03 to 0.05	0.08 to 0.15	0.08 to 0.23	0.16 to 0.34	0.03 to 0.06
Grant	0.03 to 0.05	0.02 to 0.03	0.05 to 0.08	0.05 to 0.07	0.09 to 0.15	0.02 to 0.03
Hidalgo	0.02 to 0.04	0.01 to 0.02	0.04 to 0.06	0.03 to 0.06	0.07 to 0.12	0.02 to 0.03
Luna	0.04 to 0.06	0.02 to 0.03	0.06 to 0.09	0.06 to 0.31	0.12 to 0.4	0.02 to 0.08
Otero	0.09 to 0.42	0.04 to 0.11	0.13 to 0.53	0.12 to 0.36	0.25 to 0.89	0.05 to 0.17
Sierra	0.04 to 0.1	0.02 to 0.05	0.05 to 0.15	0.05 to 0.13	0.11 to 0.29	0.02 to 0.07

County	Cancer Risk* from Existing Federal Wells (per million)	Cancer Risk* from New Federal Wells (per million)	Cancer Risk* from Total Federal Wells (per million)	Cancer Risk* from Non-Federal Wells (per million)	Cancer Risk* from Cumulative Oil and Gas Production (per million)	Adjusted Cancer Risk[†] From Cumulative Oil and Gas Production (per million)
SFO						
Catron	0.02 to 0.05	0.01 to 0.03	0.03 to 0.07	0.03 to 0.06	0.07 to 0.13	0.02 to 0.04
Socorro	0.04 to 0.12	0.02 to 0.07	0.06 to 0.19	0.06 to 0.16	0.12 to 0.35	0.03 to 0.09
TFO						
Colfax	0.14 to 0.3	0.1 to 0.13	0.25 to 0.43	0.22 to 0.54	0.48 to 0.85	0.1 to 0.18
Harding	0.14 to 0.18	0.1 to 0.13	0.25 to 0.3	0.22 to 0.28	0.48 to 0.58	0.11 to 0.13
Los Alamos	0.27 to 0.27	0.13 to 0.13	0.4 to 0.4	0.25 to 0.25	0.66 to 0.66	0.13 to 0.13
Mora	0.17 to 0.28	0.1 to 0.13	0.26 to 0.41	0.2 to 0.26	0.47 to 0.67	0.15 to 0.21
San Miguel	0.16 to 0.22	0.09 to 0.12	0.25 to 0.33	0.18 to 0.29	0.43 to 0.62	0.11 to 0.16
Santa Fe	0.16 to 0.36	0.1 to 0.15	0.27 to 0.52	0.18 to 0.29	0.44 to 0.81	0.09 to 0.16
Taos	0.26 to 0.43	0.12 to 0.17	0.38 to 0.6	0.24 to 0.35	0.61 to 0.93	0.15 to 0.23
Union	0.11 to 0.16	0.11 to 0.13	0.24 to 0.28	0.22 to 0.26	0.46 to 0.54	0.11 to 0.13

Notes: SCO = Socorro Field Office; TFO = Taos Field Office; RFO = Roswell Field Office; Las Cruces DO = Las Cruces District Office

*Cancer risk from emissions of benzene, ethylbenzene, and formaldehyde.

[†]Adjusted residency risk based on residency factors by county from Table 35.

[‡]Chaves County is split between Carlsbad and Roswell Field Offices but presented in the CFO.

[§]McKinley County and Sandoval County are split between Farmington and Rio Puerco but presented in FFO.

[¶]Rio Arriba County is split between Farmington and Taos FO but presented in FFO.

Risk characterization is a description of the nature and, often, magnitude of human risk, including resulting uncertainties. Risk characterization is accomplished by integrating information from the components of the risk assessment and synthesizing an overall conclusion about risk that is complete, informative, and useful for decision makers (EPA 2000). A "bright line" in risk characterization refers to a threshold value that separates acceptable and unacceptable levels of risk. It is regarded as a clear and unambiguous limit used to determine whether a particular level of exposure to a hazardous substance is safe. Bright lines were not used in the analysis of the cumulative oil and gas HAP results to determine if a particular risk level was acceptable or not, as no such construct for risk exists within the Clean Air Act framework akin to the NAAQS (that is, there are no NAAQSs against which to compare modeled HAP concentrations). Rather, values or ranges of values published by EPA (e.g., AirToxScreen [NATA] or 40 C.F.R. § 300.430 [Remedial Investigation/Feasibility Study]) were used to provide useful context to risk estimates associated with the cumulative oil and gas HAP study. As described in the BLM Cumulative Hazardous Air Pollutants Modeling – Final Report (Ramboll and BLM 2023), while no explicit risk thresholds are available, EPA uses a one in 1 million and 100 in 1 million risk for context (EPA 2022b). As a result, both the 70-year cancer risk and the adjusted cancer risk in Table 36 are within the contextual range published by the EPA. It is important to note that the cancer risks estimated by this assessment only consider cumulative oil and gas sources and six common oil and gas HAPs. While the

cumulative oil and gas contribution is within the contextual range published by EPA (one in 1 million and 100 in 1 million), additional HAPs from non-oil and gas sources could increase the overall risk in the project area. This modeling assessment looked at cumulative oil and gas sources to address the Court's holding in regard to analysis of cumulative HAP emissions. It was beyond the scope of this modeling assessment to determine cumulative HAP values from non-oil and gas sources.

AirToxScreen is consistent with EPA's definition of a cumulative risk assessment. The contribution, based on EPA's most recent AirToxScreen results (2019), of the oil and gas industry to the cancer risk in New Mexico counties ranged from 0 to 3.91 in 1 million, and the overall state of New Mexico is 0.34 in 1 million (EPA 2024o). While not paired in time, the BLM's cumulative oil and gas study showed the contribution of the oil and gas industry to cancer risk (ca. 2032) statewide ranges from 0.02 to 6.15 in 1 million. While different methods were used by EPA and the BLM to determine cumulative oil and gas contributions and this could result in inconsistencies when comparing the data, the overall trend projects cumulative oil and gas contribution will be steady to slightly decreasing between 2019 and ca. 2032. The overall HAPs trend could be further affected by projected declines in other sectors based on increased electrification, equipment efficiency, and renewable technologies for electricity generation (U.S. Energy Information Administration [EIA] 2023). To have an entirely consistent analysis between BLM and EPA would have required BLM to project the entire NEI forward to a common future year (2032 in the BLM study) and use the Community Multiscale Air Quality Modeling System (CMAQ) model with the unique chemical mechanism within the CMAQ used in AirToxScreen. To BLM's knowledge, in the near 30-year history of EPA's NATA, of which AirToxScreen is a part, a future year projection for NATA has never been attempted and such an exercise would be outside the scope of this environmental assessment (EA) and would not contribute to informed decision-making for the proposed action. Therefore, using the AirToxScreen results described above, if one were to simply add the risk values for the respective counties between EPA's and BLM's modeling (would not be scientifically valid given the varying methodologies), the addition of the other source categories places the total risk from other sources, in addition to future projections of HAPs impacts from oil and gas development, still well within the one in 1 million and 100 in 1 million risk range.

Table 37 through Table 43 show the hazard quotients (HQs) for each compound and the hazard index (HI). EPA estimates chronic noncancer HQs by dividing a chemical's estimated long-term exposure concentration by the RfC for that chemical for each field office. Chronic noncancer hazards from multiple air toxics were assessed by calculating an HI through the summation of individual HAP HQs that share similar adverse health effects, resulting in a target organ–specific HI representing the risk to a specific organ or organ system. An HQ or HI value less than 1 indicates that the exposure is not likely to result in adverse noncancer effects (EPA 2022b; Ramboll and BLM 2023). Statewide HQ and HI values are below 1 for all mineral designations except for Rio Arriba and San Juan Counties, indicating that cumulative oil and gas–source exposure is not likely to result in adverse noncancer effects.
The maximum HI from total oil and gas production for Rio Arriba and San Juan Counties is 0.1679 and 0.2082, respectively. It is important to note that the noncancer risks estimated by this assessment only consider cumulative oil and gas sources and the six common oil and gas pollutants. While the cumulative oil and gas contribution is below 1, additional HAPs from non-oil and gas sources could increase the overall risks in the project area. This modeling assessment looked at cumulative oil and gas sources to address the Court's holding in regard to analysis of cumulative HAP emissions. It was beyond the scope of this modeling assessment to determine cumulative HAP values from non-oil and gas sources.

Table 37. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Carlsbad Field Office by Mineral Designation

Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	Hazard Index
	Hazard Quotient						**Hazard Index**
Chaves County							
Existing federal	<0.0001 to 0.0008	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0001	Range is <0.0001	0.0015 to 0.0181	0.0015 to 0.0191
New federal	<0.0001 to 0.0019	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	0.0005 to 0.0085	0.0005 to 0.0109
Total federal	<0.0001 to 0.0026	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0004	0.0019 to 0.0263	0.002 to 0.0294
Non-federal	<0.0001 to 0.0017	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	0.0015 to 0.0259	0.0015 to 0.027
Total	*0.0001 to 0.0034*	*Range is <0.0001*	*Range is <0.0001*	*<0.0001 to 0.0003*	*<0.0001 to 0.0005*	*0.0034 to 0.0522*	*0.0035 to 0.0564*
Eddy County							
Existing federal	<0.0001 to 0.0039	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	<0.0001 to 0.0006	0.0015 to 0.047	0.0016 to 0.0516
New federal	<0.0001 to 0.0037	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0008	0.0005 to 0.0162	0.0006 to 0.0208
Total federal	<0.0001 to 0.0052	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0005	<0.0001 to 0.0008	0.0021 to 0.0528	0.0021 to 0.0563
Non-federal	<0.0001 to 0.0043	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	<0.0001 to 0.0008	0.0017 to 0.0632	0.0017 to 0.0679
Total	*0.0001 to 0.0069*	*Range is <0.0001*	*Range is <0.0001*	*<0.0001 to 0.0007*	*<0.0001 to 0.0009*	*0.0037 to 0.1066*	*0.0039 to 0.1145*
Lea County							
Existing federal	0.0001 to 0.0014	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0002	0.0033 to 0.0353	0.0034 to 0.0361
New federal	0.0002 to 0.012	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0029	0.0015 to 0.0156	0.0018 to 0.0309
Total federal	0.0004 to 0.0127	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0003	<0.0001 to 0.003	0.0049 to 0.0491	0.0054 to 0.0511
Non-federal	0.0003 to 0.0016	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0003	0.0057 to 0.0477	0.006 to 0.0496
Total	*0.0008 to 0.0133*	*Range is <0.0001*	*Range is <0.0001*	*<0.0001 to 0.0003*	*<0.0001 to 0.003*	*0.0111 to 0.0968*	*0.0121 to 0.1007*

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 38. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Farmington Field Office by Mineral Designation

Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	Hazard Index
McKinley County							
Existing federal	<0.0001 to 0.0003	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.006	0.0003 to 0.0064
New federal	<0.0001 to 0.0005	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0001	0.0001 to 0.0033	0.0002 to 0.004
Total federal	<0.0001 to 0.0008	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	0.0004 to 0.0093	0.0004 to 0.0103
Non-federal	<0.0001 to 0.0005	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	0.0003 to 0.006	0.0004 to 0.0067
Total	<0.0001 to 0.0012	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0003	0.0007 to 0.015	0.0008 to 0.0167
Rio Arriba County							
Existing federal	<0.0001 to 0.0046	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0005	<0.0001 to 0.0021	0.0022 to 0.1130	0.0022 to 0.1203
New federal	<0.0001 to 0.0035	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0003	<0.0001 to 0.0007	0.0009 to 0.0168	0.0010 to 0.0214
Total federal	<0.0001 to 0.0071	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0007	<0.0001 to 0.0022	0.0031 to 0.1271	0.0032 to 0.1372
Non-federal	<0.0001 to 0.0033	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	<0.0001 to 0.0005	0.0019 to 0.0311	0.0019 to 0.0353
Total	0.0002 to 0.0083	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0009	<0.0001 to 0.0022	0.0049 to 0.1564	0.0051 to 0.1679
Sandoval County							
Existing federal	<0.0001 to 0.0017	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0004	0.0009 to 0.0186	0.0009 to 0.0209
New federal	<0.0001 to 0.0046	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0006	<0.0001 to 0.0007	0.0005 to 0.0155	0.0005 to 0.0215
Total federal	<0.0001 to 0.0054	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0007	<0.0001 to 0.0011	0.0014 to 0.0341	0.0014 to 0.0414
Non-federal	<0.0001 to 0.0026	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0003	<0.0001 to 0.0005	0.001 to 0.0257	0.001 to 0.0291
Total	<0.0001 to 0.0079	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.001	<0.0001 to 0.0016	0.0023 to 0.0598	0.0024 to 0.0705
San Juan County							
Existing federal	<0.0001 to 0.0055	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0006	<0.0001 to 0.001	0.0005 to 0.1210	0.0006 to 0.1282

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
New federal	<0.0001 to 0.005	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0006	<0.0001 to 0.0008	0.0003 to 0.022	0.0003 to 0.0285
Total federal	<0.0001 to 0.0082	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0009	<0.0001 to 0.0011	0.0008 to 0.143	0.0008 to 0.1534
Non-federal	<0.0001 to 0.0037	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0004	<0.0001 to 0.0006	0.0006 to 0.0516	0.0006 to 0.0563
Total	<0.0001 to 0.0107	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0012	<0.0001 to 0.0015	0.0014 to 0.1946	0.0015 to 0.2082

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 39. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Rio Puerco Field Office by Mineral Designation

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Bernalillo County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0015	0.0008 to 0.0015
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0008	0.0004 to 0.0009
Total federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0023	0.0012 to 0.0024
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0015	0.0009 to 0.0015
Total	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.002 to 0.0037	0.0021 to 0.004
Cibola County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0008	0.0002 to 0.0008
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0001 to 0.0004	0.0001 to 0.0004
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0011	0.0003 to 0.0012
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0008	0.0003 to 0.0009
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.002	0.0006 to 0.0021

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Torrance County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0013	0.0009 to 0.0013
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0007	0.0005 to 0.0008
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0013 to 0.002	0.0014 to 0.0021
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.001 to 0.0018	0.0011 to 0.0019
Total	0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0023 to 0.0034	0.0025 to 0.0036
Valencia County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.0011	0.0006 to 0.0011
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0006	0.0003 to 0.0007
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0017	0.0009 to 0.0017
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0011	0.0007 to 0.0012
Total	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0015 to 0.0028	0.0016 to 0.0029

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 40. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Roswell Field Office by Mineral Designation

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Curry County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0014 to 0.0022	0.0014 to 0.0023
New federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0012	0.001 to 0.0013
Total federal	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0023 to 0.0034	0.0024 to 0.0036
Non-federal	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0024 to 0.0037	0.0025 to 0.0039

	Hazard Quotient						Hazard Index
Source	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylene**	**n-Hexane**	**Formaldehyde**	
Total	0.0002 to 0.0004	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0046 to 0.0071	0.0049 to 0.0075
De Baca County							
Existing federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0014 to 0.0035	0.0015 to 0.0036
New federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0016	0.0007 to 0.0018
Total federal	<0.0001 to 0.0003	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0021 to 0.0051	0.0022 to 0.0054
Non-federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0017 to 0.0051	0.0018 to 0.0053
Total	0.0002 to 0.0005	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0038 to 0.0101	0.004 to 0.0107
Guadalupe County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0019	0.0012 to 0.0019
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.001	0.0006 to 0.0011
Total federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0018 to 0.0029	0.0019 to 0.003
Non-federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0014 to 0.0027	0.0015 to 0.0028
Total	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0032 to 0.0055	0.0033 to 0.0058
Lincoln County							
Existing federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0033	0.0008 to 0.0034
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0008	0.0004 to 0.0009
Total federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0041	0.0012 to 0.0043
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.001 to 0.0036	0.001 to 0.0037
Total	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0021 to 0.0068	0.0022 to 0.0071
Quay County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0011 to 0.0022	0.0012 to 0.0022

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0011	0.0009 to 0.0012
Total federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.002 to 0.0032	0.0021 to 0.0034
Non-federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0019 to 0.0031	0.002 to 0.0033
Total	0.0002 to 0.0003	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0039 to 0.0064	0.0041 to 0.0067
Roosevelt County							
Existing federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0016 to 0.0047	0.0017 to 0.0048
New federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.001 to 0.0022	0.0011 to 0.0024
Total federal	0.0001 to 0.0004	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0026 to 0.0068	0.0027 to 0.0071
Non-federal	0.0001 to 0.0097	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0011	<0.0001 to 0.0024	0.0032 to 0.0837	0.0034 to 0.0955
Total	0.0003 to 0.0101	Range is <0.0001	<0.0001 to 0.0001	<0.0001 to 0.0011	<0.0001 to 0.0025	0.0061 to 0.0882	0.0066 to 0.1004

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 41. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Las Cruces District Office by Mineral Designation

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Doña Ana County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0008	0.0004 to 0.0008
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0003	0.0002 to 0.0004
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.0011	0.0006 to 0.0012
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.0018	0.0006 to 0.0018
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0025	0.0012 to 0.0026

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Grant County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0004	0.0003 to 0.0004
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0001 to 0.0002	0.0001 to 0.0002
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0006	0.0004 to 0.0006
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0005	0.0004 to 0.0006
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0011	0.0007 to 0.0011
Hidalgo County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0003	0.0002 to 0.0003
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0001	0.0001 to 0.0002
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0004	0.0003 to 0.0005
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0004	0.0003 to 0.0005
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0005 to 0.0009	0.0005 to 0.0009
Luna County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0005	0.0003 to 0.0005
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0001 to 0.0002	0.0002 to 0.0002
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0007	0.0005 to 0.0007
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0024	0.0004 to 0.0024
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.003	0.0009 to 0.0031
Otero County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.0031	0.0007 to 0.0032
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0008	0.0003 to 0.0008

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Total federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0039	0.001 to 0.0041
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0026	0.0009 to 0.0027
Total	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0018 to 0.0065	0.0019 to 0.0068
Sierra County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0008	0.0003 to 0.0008
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0001 to 0.0004	0.0001 to 0.0004
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0011	0.0004 to 0.0012
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.001	0.0004 to 0.001
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0021	0.0008 to 0.0022

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 42. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Socorro Field Office by Mineral Designation

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Catron County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0003	0.0002 to 0.0004
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	<0.0001 to 0.0002	<0.0001 to 0.0002
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0005	0.0003 to 0.0005
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0002 to 0.0004	0.0002 to 0.0005
Total	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0005 to 0.0009	0.0005 to 0.001
Socorro County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0003 to 0.0009	0.0003 to 0.001

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0001 to 0.0005	0.0002 to 0.0005
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0014	0.0005 to 0.0014
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0004 to 0.0012	0.0004 to 0.0013
Total	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0026	0.0009 to 0.0027

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

Table 43. Estimated Hazard Quotients and Hazard Index from ca. 2032 Oil and Gas Production in the Taos Field Office by Mineral Designation

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Colfax County							
Existing federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0011 to 0.0023	0.0011 to 0.0023
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.001	0.0008 to 0.001
Total federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0018 to 0.0032	0.0019 to 0.0033
Non-federal	<0.0001 to 0.0013	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0015 to 0.002	0.0016 to 0.0032
Total	0.0002 to 0.0014	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0034 to 0.0052	0.0036 to 0.0056
Harding County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0011 to 0.0013	0.0011 to 0.0014
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0009	0.0008 to 0.0009
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0019 to 0.0022	0.0019 to 0.0023
Non-federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0016 to 0.002	0.0017 to 0.0022
Total	0.0002 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0034 to 0.0042	0.0036 to 0.0044

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Los Alamos County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.002 to 0.002	0.0021 to 0.0021
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0009 to 0.0009	0.001 to 0.001
Total federal	0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.003 to 0.003	0.0031 to 0.0031
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0019 to 0.0019	0.0019 to 0.0019
Total	0.0002 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0048 to 0.0048	0.005 to 0.005
Mora County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0021	0.0013 to 0.0022
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0009	0.0007 to 0.001
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0019 to 0.003	0.002 to 0.0031
Non-federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0015 to 0.0019	0.0015 to 0.002
Total	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0034 to 0.0049	0.0036 to 0.0051
San Miguel County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0016	0.0012 to 0.0017
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0006 to 0.0009	0.0007 to 0.0009
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0018 to 0.0024	0.0019 to 0.0025
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0013 to 0.0021	0.0014 to 0.0022
Total	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0032 to 0.0045	0.0033 to 0.0047
Santa Fe County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0012 to 0.0027	0.0013 to 0.0028
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0007 to 0.0011	0.0008 to 0.0011

	Hazard Quotient						Hazard Index
Source	Benzene	Toluene	Ethylbenzene	Xylene	n-Hexane	Formaldehyde	
Total federal	<0.0001 to 0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0019 to 0.0038	0.002 to 0.004
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0013 to 0.0021	0.0013 to 0.0022
Total	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0032 to 0.0059	0.0034 to 0.0062
Taos County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.002 to 0.0032	0.002 to 0.0033
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0012	0.0009 to 0.0013
Total federal	<0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0028 to 0.0044	0.0029 to 0.0046
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0018 to 0.0026	0.0018 to 0.0027
Total	0.0001 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0046 to 0.0068	0.0047 to 0.0071
Union County							
Existing federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0012	0.0008 to 0.0012
New federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0008 to 0.0009	0.0008 to 0.001
Total federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0017 to 0.0021	0.0018 to 0.0021
Non-federal	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0015 to 0.0019	0.0017 to 0.002
Total	0.0002 to 0.0002	Range is <0.0001	Range is <0.0001	Range is <0.0001	Range is <0.0001	0.0032 to 0.004	0.0034 to 0.0041

Notes: HQ and HI values may vary slightly due to the rounding of these very small values.

5.4   HYDROGEN SULFIDE

Hydrogen sulfide (H_2S) is a colorless flammable gas with a rotten egg smell that is a naturally occurring by-product of oil and gas development in some areas, including the New Mexico portion of the Permian Basin. H_2S is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Effects may range from eye, nose, and throat irritation to dizziness, headaches, and nausea. High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma, and death. Effects can occur within a few breaths and possibly a single breath.

H$_2$S was originally included in the list of Toxic Air Pollutants defined by Congress in the 1990 amendments to the CAA. It was later determined that H$_2$S was included through a clerical error, and it was removed by Congress from the list. H$_2$S was addressed under the accidental release provisions of the CAA. Congress also tasked the EPA with assessing the hazards to public health and the environment from H$_2$S emissions associated with oil and gas extraction. That report was published in October 1993 (EPA 1993).

H$_2$S was added to the Emergency Planning and Community Right-to-Know Act list of toxic chemicals in 1993. In 1994, the EPA issued an administrative stay of reporting requirements for H$_2$S while further analysis was conducted. The administrative stay was lifted and Toxic Release Inventory reporting due in July 2013 for calendar year 2012 emissions required reporting of H$_2$S.

Although there are no NAAQS for H$_2$S, a number of states, especially those with significant oil and gas production, have set standards at the state level. Table 44 summarizes these standards for states under BLM NMSO area of operation.

Table 44. State Ambient Air Quality Standards for H$_2$S

State	Standard	Averaging time	Remarks
Kansas	None	Not applicable (N/A)	N/A
Oklahoma	200 ppb (0.2 ppm)	24 hour	N/A
New Mexico	0.010 ppm (10 ppb)	1 hour[1]	Statewide except Pecos-Permian Basin Intrastate Air Quality Control Region*
	0.100 ppm (100 ppb)	0.5 hour[2]	Pecos-Permian Basin Intrastate Air Quality Control Region
	0.030 ppm (30 ppb)	0.5 hour	Within municipal boundaries and within 5 miles of municipalities with population >20,000 in Pecos-Permian Basin Air Quality Control Region
Texas	0.08ppm (80 ppb)	0.5 hour	If downwind concentration affects a property used for residential business or commercial purposes
	0.12 ppm (120 ppb)	0.5 hour	If downwind concentration affects only property not normally occupied by people

Source: Skrtic (2006).

* The Pecos-Permian Basin Intrastate Air Quality Control Region is composed of Quay, Curry, De Baca, Roosevelt, Chaves, Lea, and Eddy Counties in New Mexico.

[1] Pecos-Permian Basin intrastate air quality control region has a 0.5-hour standard of 0.10 ppm.

[2] Not to be exceeded more than once per year.

NMED has no routine monitors for H$_2$S. However, a one-time study in 2002 sheds some light on the levels that can be expected near oil and gas facilities (Skrtic 2006). These readings are averaged over 3-minute periods so are not comparable with the standard, which has longer averaging periods. The New Mexico data indicate that ambient concentrations of H$_2$S at the sampling locations, which included both oil and gas facilities and sites without oil and gas facilities, are at least an order of magnitude greater than 0.11 to 0.33 ppb, which are the ambient levels of H$_2$S that can be expected in urban areas. The ambient levels recorded at the two sites without expected sources of H$_2$S—Indian Basin Hilltop, no facility, and Carlsbad City Limits, Tracy-A—both averaged 7 ppb, indicating that H$_2$S

concentrations in this part of New Mexico are higher than normal urban background levels (Skrtic 2006) (Table 45).

H$_2$S levels measured at flaring, tank storage, and well drilling sites, averaging from approximately 100 to 200 ppb, are significantly elevated compared with normal background levels usual background H$_2$S concentrations in this area of New Mexico (Skrtic 2006). Although these concentrations generally produce a nuisance due to odors that may translate into headaches, nausea, and sleep disturbances if exposure is constant, one study found central nervous system, respiratory system, and ear, nose, and throat symptoms associated with annual average H$_2$S levels ranging from 7 to 27 ppb (Skrtic 2006). Overall, the data show that concentrations of H$_2$S vary widely, even at similar facilities: at one compressor/dehydrator, the average concentration over the course of monitoring was 4 ppb, whereas at another, the average was 1,372 ppb. The data further demonstrate that H$_2$S is present, often at elevated levels, at oil and gas facilities (Skrtic 2006).

Table 45. Summary of Monitoring Data from New Mexico Study

Facility Type	H$_2$S Concentration Measured at Monitoring Site (ppb)	
	Range	Average
Indian Basin hilltop, no facility	5–8	7
Indian Basin compressor station	3–9	6
Indian Basin active well drilling site	7–190	114
Indian Basin flaring, production, and tank storage site	4–1,200	203
Marathon Indian Basin refining and tank storage site	2–370	16
Carlsbad city limits, near 8 to 10 wells and tank storage sites	5–7	6
Carlsbad city limits, Tracy-A	5–8	7
Compressor station, dehydrators – Location A	4–5	4
Compressor station, dehydrators – Location B	2–15,000	1,372
Huber flare/dehydrating facility	4–12	77
Snyder oil well field	2–5	4
Empire Abo gas processing plant	1–1,600	300
Navajo oil refinery	3–14	7–8

Source: Skrtic (2006).

In Oklahoma, routine monitoring downwind of two refineries in Tulsa showed H$_2$S levels that were within State standards but above normal background levels. The levels of H$_2$S in both neighborhoods, although not very high, are nevertheless above the EPA RfC of 1.4 ppb and are elevated well above normal background levels of 0.11 to 0.33 ppb. It is possible that continuous exposure to these levels poses health risks. Although the Oklahoma DEQ is monitoring H$_2$S levels, there is no concurrent community health or exposure study investigating the health effects of chronic exposure to these levels of H$_2$S (Skrtic 2006). In Texas, which has 12 routine monitors, H$_2$S levels generally ranged from 0.1 to 5 ppb. One monitor at a compressor station, however, showed frequent levels exceeding the State standard of 0.8 ppm (Skrtic 2006). In December 2005, the last month for which the data have been

validated by the TCEQ, 20% of the hourly readings exceeded the State standard of 0.8 ppm. Chronic exposure to such levels, generally considered a nuisance due to odor, has also been shown to adversely affect human health (Skrtic 2006).

6   AIR QUALITY MODELING

Traditional air quality modeling generally falls into three categories: 1) near-field dispersion modeling is applied to criteria pollutants, HAPs, and AQRVs, where a small to medium number of sources are involved to cover an area within 50 kilometers (km) of a proposed project; 2) far-field or transport modeling is used to provide regional assessments of cumulative and incremental impacts at distances greater than 50 km; and 3) photochemical modeling may be used for large-scale projects with a large number of sources or with complex issues including O_3 and secondary particulate impacts.

6.1   NEW MEXICO OZONE ATTAINMENT INITIATIVE (OAI) PHOTOCHEMICAL MODELING STUDY

The State of New Mexico initiated the New Mexico Ozone Attainment Initiative (OAI) Photochemical Modeling Study (New Mexico OAI Study) in the spring of 2018 to address the high O_3 concentrations in the state, protect the O_3 attainment status of the state, and ensure health and welfare of the residents of the state for future generations (NMED 2021b). Based on the WRAP, WAQS Comprehensive Air Quality Model with extensions (CAMx) 2014 36/12-km modeling platform, a CAMx 2014 36/12/4-km O_3 modeling platform was developed with the 4-km domain focused on New Mexico and adjacent states. The New Mexico OAI Study also looked at 2028 future year base case modeling and oil and gas control sources. The 2028 oil and gas control strategy reduced oil and gas NO_x emissions by approximately 21,000 tpy (or by 64% compared to the 2028 base case) and oil and gas VOC emissions by approximately 53,000 tpy (or by 46% compared to the 2028 base case) (NMED 2021b). This study has been incorporated by reference.

6.1.1   2028 OZONE MODELING RESULTS

The 2028 base case and 2028 oil and gas control strategy modeling results followed EPA guidance, which recommended using a current year design value based on an average of three O_3 design values centered on the base modeling year (2014 in the New Mexico OAI Study). As a result, this part of the New Mexico OAI Study used a current year design value from 2012 through 2016.

To develop the 2028 O_3 future year design values for the specific scenarios, the current year design value (2012–2016, average of three design values over 5 years) was scaled by relative response factors (RRFs), which are model-derived scaling factors. In the New Mexico OAI Study, the RRFs are the ratio of the 2028 future scenario (base case or oil and gas control strategy scenario) over the 2014v2 base case CAMx O_3 results (RRF = Σ Model2028 / Σ Model2014). This method allowed for the development of a projected 2028 O_3 future year design value for the respective scenarios (base case or oil and gas control strategy). The current 2012–2016 O_3 design values for sites in the counties in the major oil and gas basins of New Mexico (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves and Roosevelt) range from 61.0 to 71.0 ppb. The 2028 base case saw future O_3 design value reductions ranging from −2.0 to −5.6 ppb in the oil and gas New Mexico counties, including reductions of −2.3 ppb at Carlsbad in Eddy County, −2.0 ppb at Hobbs in Lea County, −5.6 ppb at Bernalillo in Sandoval County, and −2.2 ppb and −3.3 ppb at Bloomfield and Navajo Lake, respectively, in San Juan County. The 2028 base case future O_3 design values in the oil and gas New Mexico counties ranged from 58.4 to 66.7 ppb. The 2028 oil and gas control strategy saw future O_3 design value reductions ranging from −0.3 to −0.8 ppb, including

reductions of −0.3 ppb at Carlsbad, −0.7 ppb at Hobbs, −1.5 ppb and −0.8 ppb at Navajo Lake and Bloomfield, respectively, and −0.3 ppb at Bernalillo from the 2028 base case. The 2028 projected oil and gas control strategy O_3 design values in the oil and gas New Mexico counties ranged from 58.1 to 66.4 ppb. Using this method and following EPA guidance, all 2028 projected O_3 future design values at monitoring sites in New Mexico were below the 2015 NAAQS for O_3 of 70 ppb using the 2012–2016 design value (NMED 2021b).

With the recent upward trend in O_3 values in southeastern New Mexico, the New Mexico OAI study also looked at more recent design values (2015–2019 and 2017–2019). A similar method to that described above was used to determine the future 2015–2019 and 2017–2019 design values; however, it should be noted that because the New Mexico OAI Study used the CAMx 2014v2 base case results as the denominator in the RRF equation (RRF = Σ Model2028 / Σ Model2014) to develop 2028 O_3 future design value projections, any emission changes (increase or decreases) between 2014 and the end of the 2010 decade will not be accounted for (e.g., increases in oil and gas source emissions and decreases in mobile source emissions). This will result in uncertainties and will likely overstate the 2028 O_3 future design values in the Permian Basin emissions, as emissions from oil and gas sources are higher at the end of the 2010 decade than in 2014 (NMED 2021b).

The current 2015–2019 O_3 design values at the sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 62.0 to 79 ppb and included Carlsbad (79 ppb), Hobbs (71 ppb), Bernalillo (69 ppb), Bloomfield (69 ppb), and Navajo (70 ppb). The 2028 base case saw future O_3 design value reductions ranging from −1.7 ppb to −6.6 ppb, including reductions of −2.5 ppb at Carlsbad, −2.1 ppb at Hobbs, −2.3 ppb at Navajo Lake, −5.8 ppb at Bernalillo, and −3.4 ppb at Bloomfield. 2028 projected base case O_3 design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 61.0 to 71.2 ppb. Note that the 2015–2019 future O_3 design value had one monitoring site (Carlsbad) that exceeded the 2015 NAAQS for O_3 at 71.2 ppb. The 2028 oil and gas control strategy saw future O_3 design value reductions ranging from 0.0 to −1.5 ppb, including reductions of −0.3 ppb at Carlsbad, −0.7 at Hobbs, −0.8 at Coyote Ranger District, −0.3 at Bernalillo, −0.8 at Bloomfield, and −1.5 at Navajo Lake, from the 2028 base case. 2028 projected oil and gas control strategy O_3 design values at all New Mexico sites selected for this sensitivity test ranged from 60.5 to 70.9 ppb. Emission controls in the 2028 oil and gas control strategy were sufficient to reduce the 2028 future O_3 value at Carlsbad (70.9 ppb) to below the NAAQS for O_3 (NMED 2021b).

The current 2017–2019 O_3 design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 66.0 to 79.0 ppb and included Carlsbad (79.0 ppb), Hobbs (71.0 ppb), Coyote Ranger District (67.0 ppb), Bloomfield (68.0 ppb), Navajo Lake (69.0 ppb) and Bernalillo (68.0 ppb). The 2028 base case saw future O_3 design value reductions ranging from −2.1 to −6.7 ppb, including reductions of −2.6 ppb at Carlsbad, −2.1 ppb at Hobbs, −2.3 ppb at Navajo Lake, −5.9 ppb at Bernalillo, −3.4 ppb at Bloomfield, and −3.4 ppb Coyote Ranch District. The 2028 projected base case O_3 design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 61.9 to 76.4 ppb. Note that the 2017–2019 future O_3 design value had one monitoring site in the oil and gas New Mexico counties (Carlsbad – 76.4 ppb) and one other monitoring site in Doña Ana County (Desert View, Doña Ana County, with 71.6 ppb) that exceeded the 2015 NAAQS for O_3. The 2028 oil and gas control strategy saw future O_3 design value reductions ranging from −0.0 to −1.5 ppb, including reductions of −0.4 ppb at Carlsbad, −0.8 ppb at Hobbs, −1.5 ppb at Navajo Lake, −0.3 ppb at Bernalillo, −0.9 ppb at Bloomfield, and −0.8 ppb Coyote Ranch District, from the 2028 base case. The 2028 projected oil and gas control strategy O_3 design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 61.4 to 76.0 ppb. The 2028 future design value at Carlsbad of 76.0 ppb (with the oil and gas control strategy) exceeds the 2008 and 2015 NAAQS

for O_3. However, as mentioned above, the design of this sensitivity study will result in uncertainties and will likely overstate the 2028 O_3 future design values in the Permian Basin, as emissions from oil and gas sources are higher at the end of the 2010 decade than in 2014 (NMED 2021b). The final part of the New Mexico OAI Study investigated source apportionment and was conducted to determine the contributions of source sectors to 2028 future year O_3 design values under the oil and gas control strategy scenario. One investigation involved international emissions. The speciated modeled attainment test (SMAT) O_3 projection tool was run without the contributions of international anthropogenic emissions for current design values 2012–2016, 2015–2019, and 2017–2019. In New Mexico, international anthropogenic emissions contributed from 11 to 26 ppb to the projected 2028 future design values. The Bloomfield site, in the northern part of the state and in San Juan County, had reductions of 13.8 ppb, 14.5 ppb, and 14.6 ppb, respectively. Bloomfield, which had not produced a projected 2028 O_3 exceedance for either the 2008 and 2015 NAAQS for O_3 under the current design value 2017–2019 scenario (68 ppb), was below 50 ppb for a future design value under all three design value scenarios (2012–2016, 2015–2019, and 2017–2019). The Carlsbad site had reductions of 20.3 ppb, 21.7 ppb, and 23.2 ppb, respectively. Carlsbad, which had produced a projected 2028 exceedance for both the 2008 and 2015 NAAQS for O_3 under the current design value 2017–2019 scenario, was below 55 ppb for a future design value under all three design value scenarios (2012–2016, 2015–2019, and 2017–2019) (NMED 2021b).

6.2   CARMMS 2.0 NORTHERN NEW MEXICO MODELING STUDY

The Comprehensive Air Quality Model with Extensions (CAMx) photochemical grid model (PGM) is used in the CARMMS 2.0 to assess the air quality and AQRV impacts associated with BLM-authorized mineral development on federal lands within BLM Colorado and the BLM FFO Planning Areas. CARMMS 2.0 uses data from the modeling platform of WAQS from the Intermountain West Data Warehouse (IWDW) for the 2011 base year and 2025 future year air quality modeling and has adopted a two-way nested 12/4-km horizontal resolution domain. Three 2025 future year oil and gas levels were developed for a range of potential outcomes: a high-development scenario, a low-development scenario, and a medium-development scenario (which is a mitigated version of the high-development scenario where additional emission controls were applied). Additional information on CARMMS 2.0 methodology can be found in the CARMMS 2.0 *Air Impact Assessment for BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2018), incorporated by reference. The estimated emissions, air quality, and AQRV impacts from oil and gas development from the Mancos Shale modeled in CARMMS 2.0 (BLM and Ramboll 2018) are used to estimate impacts from development by the BLM FFO in the Air Impact Assessment for *BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2018), incorporated by reference. In CARMMS 2.0, 74% of Mancos Shale gas well activity is assumed to occur in New Mexico, with remaining Mancos Shale gas well activity occurring in Colorado. All Mancos Shale oil well activity is estimated to occur in New Mexico. Most Mancos Shale activity in New Mexico occurs in the FFO; a small portion of the southeastern part of Mancos Shale activity is located outside of the FFO (in the Rio Puerco Field Office [RPFO]). The Mancos Shale was treated as a separate source group in the CARMMS 2.0 modeling, and air quality and AQRV impacts from the Mancos Shale were separately quantified, enabling this analysis for the BLM FFO. As stated above (with consideration of both the Mancos-Gallup and RPFO reasonably foreseeable development [RFD] scenarios), there would be an estimated 3,400 (federal and non-federal) wells drilled within the New Mexico portion of the San Juan Basin by 2039. The Mancos-Gallup RFD predicts 809 total wells, with 629 being federal wells, between 2018 and 2025. In contrast, CARMMS 2.0 modeling estimates that between 2016 and 2025 there will be 2,756 new oil and gas wells for the high scenario and 1,378 new oil and gas wells for the low scenario in the Mancos Shale in New Mexico. To complete a comparison between the RFD and CARMMS 2.0, the

2016- and 2017-year estimates from CARMMS 2.0 were added to the Mancos-Gallup RFD to analyze the same years (2016–2025). As a result, the new Mancos-Gallup RFD well number estimates are 1,009 new total oil and gas wells and 829 new federal oil and gas wells between 2016 and 2025. Compared to the Mancos-Gallup RFD, CARMMS 2.0 predicts that an additional 369 total wells under the low scenario and an additional 1,747 total wells under the high scenario would be developed by 2025 than predicted by the RFD. Note that if all 200 wells from the RPFO RFD, the new well total through 2039, were added into the comparison of the CARMMS 2.0 modeling, it would still result in more wells developed by 2025 in the CARMMS 2.0 modeling than predicted by the RFD. While the wells associated with these APDs are included as part of the RFD, even if they were not, the CARMMS 2.0 modeling would still result in more wells developed by 2025 than predicted by the RFD. As a result, the low and high scenarios of CARMMS 2.0 well development estimates are conservatively high relative to the RFD baseline scenario and current development (BLM and Ramboll 2018:Section 2.1.1.1). Therefore, the low scenario can be used to represent a conservative estimate of federal and planning area-wide impacts through 2025.

The NAAQS for O_3 is defined as the 3-year average of the fourth highest daily maximum 8-hour (DMAX8) O_3 concentration. Because CARMMS 2.0 only uses 1 year of meteorology (2011), the 2025 fourth highest DMAX8 O_3 concentration is used as a pseudo-NAAQS comparison metric. For the 2011 base case, there are vast regions where the modeled fourth highest DMAX8 O_3 level exceeds the NAAQS (all source groups). In the 2025 high-, low-, and medium-development scenarios, the areas of O_3 exceedances decrease from the 2011 base case, with the 2025 to 2011 O_3 differences showing decreases in almost all areas. The large contribution of natural emissions (natural wildfires) to the modeled fourth highest DMAX8 O_3 concentrations was noted in the analysis. Maximum O_3 contributions to the 2025 fourth highest DMAX8 O_3 due to the BLM FFO are 1.7 ppb, 0.9 ppb, and 1.0 ppb for the 2025 high, low, and medium-development scenarios, respectively. Maximum contributions of the BLM FFO O_3 to the fourth highest DMAX8 O_3 level above the current O_3 NAAQS for O_3 (71.0 ppb and higher) for the 2025 high, low, and medium-development scenarios were 2.01%, 0.84%, and 0.90%, respectively (BLM and Ramboll 2017).

There are two NAAQS for $PM_{2.5}$, one for a 24-hour averaging time that is expressed as a 3-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 eight highest daily $PM_{2.5}$ concentration in a year. The modeling of the differences between the 2025 Scenarios and 2011 base case (all sources) shows decreases of $PM_{2.5}$ concentrations in most of the domain, but also increases in a number of regions, including Denver, eastern Utah, and central and northwest New Mexico. Maximum $PM_{2.5}$ contributions to the eighth highest daily $PM_{2.5}$ concentrations are 0.8, 0.4, and 0.4 $\mu g/m^3$ in the 2025 high-, low-, and medium-development scenarios, respectively. Compared to 2011, 2025 annual $PM_{2.5}$ concentrations for all sources are reduced in most of the domain but increase in a number of regions, including near Denver. Maximum contributions to the annual average $PM_{2.5}$ concentrations for the BLM FFO are 0.3, 0.1, and 0.1 $\mu g/m^3$ in the 2025 high-, low-, and medium-development scenarios, respectively. Maximum contributions to the second highest daily average PM_{10} for the BLM FFO are 2.7, 1.3, and 1.1 $\mu g/m^3$ in the 2025 high-, low-, and medium-development scenarios, respectively (BLM and Ramboll 2017).

The differences in 1-hour NO_2 concentrations between the 2011 and 2025 emission scenarios (all sources) indicate increases at various regions throughout the domain, including large increases in northern and eastern Arizona and New Mexico. Maximum contributions to the 1-hour NO_2 concentrations for the BLM FFO are 5.8, 3.0, and 3.2 $\mu g/m^3$ in the 2025 high-, low-, and medium-development scenarios, respectively. Maximum contributions to the annual average NO_2 concentrations

for the BLM FFO are 1.5, 0.8, and 0.9 $\mu g/m^3$ in the 2025 high-, low-, and medium-development scenarios, respectively (BLM and Ramboll 2017).

Contributions of the CAA Prevention of Significant Deterioration (PSD) pollutant concentrations across all PSD Class I and sensitive Class II areas due to emissions from the BLM FFO for each development scenario were also developed. Contributions of BLM FFO emissions to PSD pollutant concentrations at Class I and Sensitive Class II areas for the 2025 high-, low-, and medium-development scenarios can be found in the *Air Impact Assessment for BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2017) and have been incorporated by reference. All BLM FFO contributions are below the PSD Class I and Sensitive Class II pollutant increments at the high-, low-, and medium-development scenarios.

In summary, the CARMMS 2.0 low-development scenario, which represents a conservative estimate of federal impacts through 2025, does not exceed the indicator thresholds for any of the NAAQS, PSD Class I or Class II increment thresholds, the sulfur deposition threshold, the change in visibility threshold at any Class I area, or the thresholds for acid-neutralizing capacity at sensitive lakes. The low-development scenario would exceed the indicator threshold for change in visibility at one Class II area, the Aztec Ruins National Monument, and the nitrogen deposition threshold at Mesa Verde National Park, San Pedro Parks Wilderness, Weminuche Wilderness, Aztec Ruins National Monument, Chama River Canyon Wilderness, South San Juan Wilderness, and Cruces Basin Wilderness. The CARMMS 2.0 high-development scenario would not exceed any of the PSD Class I or Class II increment thresholds, the change in visibility threshold at Class I areas, the sulfur deposition threshold, or the thresholds for acid-neutralizing capacity at sensitive lakes. It would exceed the NAAQS indicator thresholds for O_3, annual average $PM_{2.5}$, and annual average NO_2; the change in visibility threshold at one Class II area, Aztec Ruins National Monument; and the nitrogen deposition threshold at Bandelier Wilderness, Mesa Verde National Park, San Pedro Parks Wilderness, Weminuche Wilderness, Aztec Ruins National Monument, Chama River Canyon Wilderness, Cruces Basin Wilderness, Dome Wilderness, Monte Vista National Wildlife Refuge, South San Juan Wilderness, and Sandia Mountain Wilderness.

6.3 2032 BLM REGIONAL CRITERIA AIR POLLUTANT PHOTOCHEMICAL MODELING STUDY

The BLM developed a photochemical model using the CAMx photochemical modeling platform and 12-kilometer grid spacing to assess the impacts of oil and gas development and coal production and other cumulative sources on air quality in the western United States (Utah, Colorado, New Mexico, Wyoming, Montana, North Dakota, and South Dakota). The modeling analysis evaluated air quality and AQRVs out to a future year of ca. 2032 using data from the WRAP/WAQS modeling platform, the EPA's 2016v2 emissions modeling platform (EPA 2022b), and the BLM oil and gas development projections to quantify and apportion federal and non-federal oil and gas emissions (BLM and Environmental Management and Planning Solutions Inc. [EMPSi] 2023). The photochemical modeling was conducted using a scenario that included coal, oil and gas development, natural and other anthropogenic emissions, representative of the cumulative sources around the year 2032. Additional methodology can be found in the BLM Regional Criteria Air Pollutant Photochemical Modeling Study (BLM and EMPSi 2023), incorporated by reference. Future modeling is working to include counties in Texas, Oklahoma, and Kansas but currently these are modeled on a case-by-case basis. Specific county data are not available; however, a general discussion of Texas and Kansas are included below as they are part of the extended modeled domain.

The BLM Regional Criteria Air Pollutant Modeling Study (BLM and EMPSi 2023) results show that the cumulative concentrations of O_3 over New Mexico range between 50 ppb and 65 ppb in New Mexico,

with the higher concentrations in the San Juan Basin and isolated regions on the western side of the state. The modeled values did not lead to any O_3 NAAQS exceedances in the state, including for the Pecos District or Farmington area. Farmington area O_3 cumulative concentrations range from 55 to 65 ppb (highest value of 64.4 ppb), while the those of the Carlsbad area range from 50 to 60 ppb. The largest contributions to O_3 are due to the modeled boundary conditions, followed by other anthropogenic sources (i.e., those not including oil, gas, or coal source groups) and natural sources. Kansas modeled values did not lead to any O_3 NAAQS exceedances in the state. Results show that the O_3 cumulative concentrations over Kansas range between 40 and 65 ppb, with the higher concentrations on the east side of the state and lower concentrations on the west side of the state. The model domain also includes the majority of Texas (excluding the southern and eastern counties). The results show that the O_3 cumulative concentrations over the modeled portion of Texas range between 45 and 80 ppb, with the higher concentrations in the southeast, east, mid-north, and western edge of the state; lower concentrations are generally located in the western to central part of the state. Most of the modeled portion of Texas had concentrations that did not exceed 70 ppb, except one location in northeast Texas (near Dallas). Oklahoma modeled values did not lead to any O_3 NAAQS exceedances in the state. Results show that the O_3 cumulative concentrations over Oklahoma range between 45 and 60 ppb, with the higher concentrations on the east side of the state and lower concentrations in the middle and western part of the state.

The 1-hour NO_2 modeled cumulative concentrations showed the highest concentrations over the San Juan Basin (highest value of 60.0 ppb); the El Paso and Dallas, Texas area; and the Permian Basin. The modeled values did not lead to any 1-hour NO_2 NAAQS exceedances in New Mexico, including for the Pecos District (values range from 0.50 to 50 ppb) or Farmington area (values range from 0.5 to 60 ppb). The largest contributions to 1-hour NO_2 are due to federal, non-federal, and tribal oil and gas development. For Kansas, the 1-hour NO_2 modeled cumulative concentrations show the highest concentrations over eastern and southern Kansas. Values range from less than 2 ppb to 30 ppb across Kansas, and the modeled values did not lead to any 1-hour NO_2 NAAQS exceedances in Kansas. For Texas, the 1-hour NO_2 modeled cumulative concentrations show the highest concentrations over northeast, southeast, and west Texas, excluding the southern and eastern portions of Texas that were not included in the model. Values range from less than 2 ppb to 60 ppb across Texas, and the modeled values did not lead to any 1-hour NO_2 NAAQS exceedances in the modeled portion of Texas. For Oklahoma, the 1-hour NO_2 modeled cumulative concentrations show the highest concentrations in mid-Oklahoma. Values range from 2 ppb to 30 ppb across Oklahoma, and the modeled values did not lead to any 1-hour NO_2 NAAQS exceedances in Oklahoma.

The annual NO_2 modeled cumulative concentrations showed the highest concentrations over the San Juan Basin (highest value of 23.9 ppb); the Dallas, Texas area; and the Permian Basin. The modeled values did not lead to any annual NO_2 NAAQS exceedances in New Mexico, including for the Pecos District (values range from 0.1 to 15 ppb) or Farmington area (values range from 0.1 to 24 ppb). The largest contributions to annual NO_2 are due to federal, non-federal, and tribal oil and gas development. For Kansas, the annual NO_2 modeled cumulative concentrations show the highest concentrations over eastern and southern Kansas. Values range from less than 2 ppb to 15 ppb across Kansas, and the modeled values did not lead to any annual NO_2 NAAQS exceedances in Kansas. For Texas, the annual NO_2 modeled cumulative concentrations show the highest concentrations over west, northeast and southeast Texas, excluding the southern and eastern portions of Texas that were not included in the model. Values range from less than 2 ppb to 23 ppb across Texas, and the modeled values did not lead to any annual NO_2 NAAQS exceedances in the modeled portion of Texas. For Oklahoma, the annual NO_2 modeled cumulative concentrations show the highest concentrations over northeast and mid-Oklahoma. Values range from less than 2 ppb to 15 ppb across Oklahoma, and the modeled values did not lead to any annual NO_2 NAAQS exceedances in Oklahoma.

The 24-hour $PM_{2.5}$ modeling showed a northwest-to-southeast gradient, with larger $PM_{2.5}$ concentrations on the southeastern side of New Mexico. The largest 24-hour $PM_{2.5}$ concentration in the state is 47.2 $\mu g/m^3$ in Socorro County (primarily due to wildfires). As a result, the modeled values did exceed the 24-hour $PM_{2.5}$ NAAQS in Socorro County, New Mexico, but nowhere else in New Mexico was the NAAQS exceeded. The largest contributors to 24-hour $PM_{2.5}$ are wildfires and non-coal, oil, or gas anthropogenic sources. Annual $PM_{2.5}$ modeled values showed cumulative concentrations over New Mexico did lead to an annual $PM_{2.5}$ NAAQS exceedance in the Albuquerque area based on the new $PM_{2.5}$ NAAQS standard of 9.0 $\mu g/m^3$, but nowhere else in New Mexico was the NAAQS exceeded. Cumulative annual $PM_{2.5}$ concentrations were highest near Albuquerque (9.2 $\mu g/m^3$), which were due to other anthropogenic sources (i.e., those not including oil, gas, or coal source groups) and generally less than 4 $\mu g/m^3$ within the rest of New Mexico. Farmington area annual $PM_{2.5}$ cumulative concentrations range from 0.7 to 6 $\mu g/m^3$, while those for the Carlsbad area range from 0.7 to 4 $\mu g/m^3$. The largest contributors to annual $PM_{2.5}$ are the anthropogenic and wildfire sources. For Kansas, the 24-hour $PM_{2.5}$ modeling shows a west-to-east gradient across the state, with larger $PM_{2.5}$ concentrations on the east side of Kansas. Values range from 4 $\mu g/m^3$ in western Kansas to 25 $\mu g/m^3$ in eastern Kansas. The modeled values did not lead to any $PM_{2.5}$ NAAQS exceedances in Kansas. Annual $PM_{2.5}$ modeled values show cumulative concentrations over Kansas did lead to an annual $PM_{2.5}$ NAAQS exceedance over the Kansas City area based on the new $PM_{2.5}$ NAAQS standard of 9.0 $\mu g/m^3$, but nowhere else in the state was the NAAQS exceeded. Cumulative annual $PM_{2.5}$ concentrations are highest on the east side of the state, with lower concentrations on the west side of Kansas. Values range from less than 2 $\mu g/m^3$ in the western part of Kansas to 10 $\mu g/m^3$ on the east side of the state. For Texas, the 24-hour $PM_{2.5}$ modeling shows an east-to-west gradient across the state, with larger $PM_{2.5}$ concentrations on the east side of the modeled portion of Texas. Values range from 2 $\mu g/m^3$ in western Texas to 25 $\mu g/m^3$ in eastern Texas. The 24-hour $PM_{2.5}$ modeled values did not lead to any 24-hour $PM_{2.5}$ NAAQS exceedances in the modeled portion of Texas. Cumulative annual $PM_{2.5}$ concentrations are highest on the east side of Texas, with lower concentrations on the west side of the state. Values range from less than 2 $\mu g/m^3$ in the western part of Texas to 10 $\mu g/m^3$ on the east side of the state. Annual $PM_{2.5}$ modeled values did not lead to any NAAQS exceedances in the modeled portion of the state, except for potentially around the Houston area. For Oklahoma, the 24-hour $PM_{2.5}$ modeling shows a west-to-east gradient across the state, with larger $PM_{2.5}$ concentrations on the east side of Oklahoma. Values range from 2 $\mu g/m^3$ in western Oklahoma to 80 $\mu g/m^3$ in eastern Oklahoma. The largest 24-hour $PM_{2.5}$ concentration in the state is around 80 $\mu g/m^3$ in Latimer County, Haskell County, and Le Flore County. As a result, the modeled values did exceed the 24-hour $PM_{2.5}$ NAAQS in Latimer County, Haskell County, and Le Flore County, Oklahoma, but nowhere else in Oklahoma was the NAAQS exceeded. Annual $PM_{2.5}$ modeled values show cumulative concentrations over Oklahoma did lead to an annual $PM_{2.5}$ NAAQS exceedance over the Sequoyah County area based on the new $PM_{2.5}$ NAAQS standard of 9.0 $\mu g/m^3$, and potential exceedances in the Osage County and Tulsa County area, but nowhere else in the state was the NAAQS exceeded. Cumulative annual $PM_{2.5}$ concentrations are highest on the east side of the state, with lower concentrations on the west side of Oklahoma. Values range from less than 2 $\mu g/m^3$ in the western part of Oklahoma to 12 $\mu g/m^3$ on the north and east side of the state.

The 24-hour PM_{10} cumulative concentrations showed PM_{10} NAAQS exceedances in a few grid cells in southwestern New Mexico (primarily due to wildfires), but nowhere else in the state, including the Pecos District, was the NAAQS exceeded. PM_{10} cumulative concentrations over most of New Mexico range between 2 and 30 milligrams per cubic meter (mg/m^3), with smaller areas of concentrations between 30 and 150 mg/m^3. Farmington area 24-hour PM_{10} cumulative concentrations range from 2 to 30 $\mu g/m^3$, while those of the Carlsbad area range from 5 to 50 $\mu g/m^3$. The largest contributors to annual

PM_{10} are wildfires and other anthropogenic sources (i.e., those not including oil, gas, or coal source groups). For Kansas, the 24-hour PM_{10} modeling shows a west-to-east gradient across the state, with larger PM_{10} concentrations on the south and east side of Kansas. Values range from 20 µg/m^3 in western Kansas to 150 µg/m^3 in southern Kansas. The modeled values did not lead to any 24-hour PM_{10} NAAQS exceedances in Kansas. For Texas, the 24-hour PM_{10} modeling shows an east-to-west gradient across the state, with larger PM_{10} concentrations on the east side of the modeled portion of Texas. Values range from 10 µg/m^3 in western Texas to 150 µg/m^3 in eastern Texas. The 24-hour $PM_{2.5}$ modeled values did not lead to any 24-hour PM_{10} NAAQS exceedances in the modeled portion of Texas. For Oklahoma, the 24-hour PM_{10} modeling shows a west-to-east gradient across the state, with larger PM_{10} concentrations on the east side of Kansas. Values range from 10 µg/m^3 in western Oklahoma to 200 µg/m^3 in east Oklahoma, although most of eastern Oklahoma is below 200 µg/m3. The modeled values show cumulative concentrations over Oklahoma did lead to a 24-hour PM_{10} exceedance over the Pittsburg County area, but nowhere else in the state was the NAAQS exceeded.

The 1-hour SO_2 modeled cumulative concentrations over New Mexico did not lead to any 1-hour SO_2 NAAQS exceedances. Most of the state had concentrations that did not exceed 10 ppb, except for a few southeastern counties (e.g., Eddy, Lea, and Roosevelt Counties) where concentrations range from 5 to 69 ppb. The Farmington area 1-hour SO_2 cumulative concentrations range from >0 to 5 ppb. The largest contributors to 1-hour SO_2 concentrations in New Mexico are oil and gas activities and wildfires. The 3-hour SO_2 modeled cumulative concentrations shows no exceedances of the 3-hour SO_2 NAAQS in the state of New Mexico. Farmington area 3-hour SO_2 cumulative concentrations range from >0 to 5 ppb, while those of the Carlsbad area range from >0 to 69 ppb . The largest contributors to the 3-hour SO_2 concentrations in New Mexico are oil and gas activities, other anthropogenic sources (i.e., those not including oil, gas, or coal source groups), and wildfires. For Kansas, the 1-hour SO_2 modeled cumulative concentrations over the state did not lead to any 1-hour SO_2 NAAQS exceedances. Most of Kansas had concentrations that did not exceed 5 ppb. The 3-hour SO_2 modeled cumulative concentrations in Kansas showed no exceedances of the 3-hour SO_2 NAAQS. Most of Kansas had concentrations that did not exceed 10 ppb, except for one location in south-central Kansas. For Texas, the 1-hour SO_2 modeled cumulative concentrations over the modeled portion of the state did not lead to any 1-hour SO_2 NAAQS exceedances. All of the modeled portion of Texas had concentrations that did not exceed 20 ppb. The 3-hour SO_2 modeled cumulative concentrations in Texas showed no exceedances of the 3-hour SO_2 NAAQS. None of the modeled portion of Texas had concentrations that exceeded 20 ppb. For Oklahoma, the 1-hour SO_2 modeled cumulative concentrations over the state did not lead to any 1-hour SO_2 NAAQS exceedances. All of Oklahoma had concentrations that did not exceed 20 ppb. The 3-hour SO_2 modeled cumulative concentrations in Oklahoma showed no exceedances of the 3-hour SO_2 NAAQS. None of the Oklahoma had concentrations that exceeded 20 ppb.

The 1-hour CO modeled cumulative concentrations over New Mexico did not lead to any 1-hour CO NAAQS exceedances. Most of the state had concentrations less than 5 ppm, although Socorro County had concentrations up to 10 ppm. Farmington area 1-hour CO cumulative concentrations range from 0.1 to 3 ppm, while those of the Carlsbad area range from 0.1 to 3 ppm. The 8-hour CO modeled cumulative concentrations over New Mexico did not lead to any 8-hour CO NAAQS exceedances. Most of the state had concentrations less than 5 ppm, although Socorro County had concentrations up to 6.9 ppm. Farmington area 8-hour CO cumulative concentrations range from 0.1 to 0.8 ppm, while those of the Carlsbad area range from 0.1 to 1.0 ppm. The location of the higher 1-hour and 8-hour CO concentrations is the same location as the PM_{10} peak, indicating that natural sources (likely fires) are responsible for the higher 1-hour and 8-hour CO concentrations in this area (BLM and EMPSi 2023). For Kansas, the 1-hour CO modeled cumulative concentrations over the state did not lead to any 1-hour CO NAAQS exceedances. Most of Kansas had concentrations less than 5 ppm, although a couple locations in southwestern and south-central Kansas had concentrations to up 10 ppm. The 8-hour CO modeled cumulative concentrations over Kansas did lead to an exceedance of the 8-hour CO NAAQS

over southwestern Kansas, but nowhere else in the state was the NAAQS exceeded. Most of Kansas had concentrations less than 5 ppm, although southwestern Kansas had concentrations to up 20 ppm (BLM and EMPSi 2023). For Texas, the 1-hour CO modeled cumulative concentrations over the modeled portion of Texas did not lead to any 1-hour CO NAAQS exceedances. All modeled portions of the state had concentrations less than 5 ppm. The 8-hour CO modeled cumulative concentrations over the modeled portion of Texas did not lead to an exceedance of the 8-hour CO NAAQS and had concentrations less than 3 ppm (BLM and EMPSi 2023). For Oklahoma, the 1-hour CO modeled cumulative concentrations over the state did not lead to any 1-hour CO NAAQS exceedances. Most of Oklahoma had concentrations less than 5 ppm, although a couple locations in western and mid-Oklahoma had concentrations to up 8 ppm. The 8-hour CO modeled cumulative concentrations over Oklahoma did not lead to an exceedance of the 8-hour CO NAAQS. Oklahoma had concentrations less than 3 ppm, although eastern Oklahoma had concentrations to up 5 ppm. Additional modeling results can be found in the BLM Regional CAP Photochemical Modeling Study (BLM and EMPSi 2023).

Cumulative annual nitrogen deposition over most of New Mexico varies between around 1 and 6 kilograms of nitrogen per hectare per year (kg N/ha-year) with an east-to-west gradient. The eastern part of New Mexico shows nitrogen deposition generally between 2 and 6 kg N/ha-year, whereas the west side of the state is generally lower, with nitrogen deposition range from 1 to 4 kg N/ha-year (although higher deposition is present in a few grid cells in San Juan County). Nitrogen critical loads for the Class I areas in the New Mexico analysis area range from 3.0 to 7.54 kg N/ha. The cumulative average nitrogen deposition ranges from 1.2 at Petrified Forest National Park to 2.7 kg N/ha-year at Carlsbad Caverns National Park. None of the areas exceed the critical load thresholds for cumulative average nitrogen deposition. The largest contributors to the cumulative average nitrogen deposition are other anthropogenic sources (i.e., those not including oil, gas, or coal source groups), ranging from 40% to 60% depending on the area of interest. The cumulative maximum nitrogen deposition values in all Class I areas of interest are below their critical loads for atmospheric nitrogen deposition, except for Carlsbad Caverns National Park. Cumulative annual sulfur deposition over most of New Mexico range between 0.1 and 2.0 kilograms of sulfur per hectare per year (kg S/ha-year), with higher concentrations in the southeastern part of the state. In the southeastern part of New Mexico, concentrations generally range between 1 and 4 kg S/ha-year (although a few grid cells show concentrations between 4 and 9 kg S/ha-year in Roosevelt, Eddy, and Lea Counties.) For total sulfur deposition, the 5 kg/ha-year threshold published by Fox et al. (1989) is used as critical load for each area of interest. The cumulative average sulfur deposition ranges from 0.1 at Petrified Forest National Park/Great Sand Dunes National Park to 1.8 kg S/ha-year at Carlsbad Caverns National Park. None of the areas exceed the critical load thresholds for cumulative average and maximum sulfur deposition. The largest contributors to sulfur deposition in New Mexico are oil and gas non-federal and existing federal sources (BLM and EMPSi 2023).

Visibility impacts in New Mexico are discussed in Section 5.3.3 of the BLM Regional Criteria Air Pollutant Modeling Study. The cumulative visibility design values are calculated by SMAT-CE and presented in Table 5.3-20 of the BLM Regional Criteria Air Pollutant Modeling Study. The future year design values (DVF) for both haze index (in deciview) and the corresponding light extinction (in inverse megameters) are provided for both the 20 percent clearest days and most impaired days (MID). The area with the highest cumulative values in ca. 2032 for the MID is Salt Creek Wilderness. This is also the only area in this table that has visibility design values for the most impaired days that are projected to be above (by 1.6 deciview) the uniform rate of progress toward the 2064 visibility goals.

The contribution to the cumulative design value (as light extinction) for both the 20% best and most impaired days, respectively, are presented in Table 5.3-21 and Table 5.3-22 of the BLM Regional Criteria Air Pollutant Modeling Study. During MID, the contributions of natural sources are small, while wildfires'

contributions range between 1% and 9%. The maximum impacts are observed at Bandelier Wilderness. The contributions from oil and gas sectors to visibility impacts are usually less than 4%, except for the existing federal oil and gas from the rest of New Mexico that can contribute up to 17% of the total light extinction at Carlsbad Caverns NP. Among the coal source groups, coal EGUs affect Class I areas the most, with contributions between 1% and 4%. Impacts from other anthropogenic sources (both inside and outside the state) have significant impacts between 13% and 44%. This is not unexpected given the large number of urban and industrial emissions typically associated with this group. The maximum impact from this sector occurs at Salt Creek Wilderness.

Table 46, Table 47, and Table 48 shows ca. 2032 state total oil and gas activity estimates by mineral designation, ca. 2032 state total oil and gas activity estimates for federal existing and new activities, and ca. 2032 emission inventory estimates by state and mineral designation and by new and existing activity for federal emissions from the BLM Regional Criteria Air Pollutant Modeling Study (BLM and EMPSi 2023:Appendix A). Figures showing maps of county-level ca. 2032 oil and gas activity by well type and mineral designation for oil production, gas production, active well count, and spuds (drilled wells) in the seven Intermountain West states are also available in the BLM Regional Criteria Air Pollutant Modeling Study (BLM and EMPSi 2023:Appendix A).

Table 46. Modeled Federal Existing and New ca. 2032 Oil and Gas Activity by Mineral Ownership and State

State	Existing Wells	New Wells
Oil production (MMBbl/year)		
Colorado	4	17
Montana	4	16
North Dakota	12	43
New Mexico	38	96
South Dakota	0	1
Utah	2	15
Wyoming	18	89
Gas production (Billions of Cubic Feet [BCF]/year)		
Colorado	210	267
Montana	9	17
North Dakota	26	89
New Mexico	661	241
South Dakota	1	0
Utah	106	35
Wyoming	668	736
Well Count (number of wells)		
Colorado	11,918	2,894
Montana	3,908	1,993

State	Existing Wells	New Wells
North Dakota	1,247	1,441
New Mexico	33,663	13,019
South Dakota	110	30
Utah	8,757	2,784
Wyoming	28,729	9,047
Spud Count (number of spuds)		
Colorado	-	223
Montana	-	153
North Dakota	-	150
New Mexico	-	1,001
South Dakota	-	2
Utah	-	214
Wyoming	-	627

Source: Appendix A of the BLM Regional CAP model (BLM and EMPSi 2023).

Table 47. Modeled ca. 2032 (New plus Existing) Oil and Gas Emissions by State and Mineral Designation

State	Criteria Air Pollutant Emissions (short tons/year)					
	NO$_x$	VOC	CO	SO$_2$	PM$_{2.5}$	PM$_{10}$
Federal (excluding Tribal)						
Colorado	10,150	36,565	8,456	199	246	250
Montana	3,592	15,952	4,688	269	87	87
North Dakota	13,580	34,843	15,398	10,129	1,435	1,586
New Mexico	52,216	94,069	119,401	19,118	2,353	2,380
South Dakota	282	1,273	204	7	21	21
Utah	10,113	117,584	9,540	288	489	489
Wyoming	27,956	148,617	14,149	4,598	1,139	1,139
Tribal						
Colorado	8,339	1,035	6,863	15	82	87
Montana	639	2,343	836	23	12	12
North Dakota	8,177	38,035	12,793	3,217	258	278
New Mexico	5,528	13,646	16,972	44	279	285
South Dakota	23	1	8	0	2	2
Utah	5,449	26,535	5,670	185	267	267

State	Criteria Air Pollutant Emissions (short tons/year)					
	NOₓ	VOC	CO	SO₂	PM₂.₅	PM₁₀
Wyoming	269	1,370	254	464	12	12
Non-federal						
Colorado	28,363	68,325	28,615	290	835	863
Montana	5,250	25,733	6,708	418	100	100
North Dakota	85,737	412,034	136,940	31,448	2,232	2,383
New Mexico	33,790	46,998	50,228	18,898	1,201	1,214
South Dakota	390	1,792	269	10	53	53
Utah	3,763	30,953	3,651	156	189	189
Wyoming	8,870	46,817	4,730	1,419	408	408
Totals						
Colorado	46,851	105,925	43,934	504	1,164	1,200
Montana	9,482	44,027	12,232	711	199	199
North Dakota	107,494	484,912	165,131	44,794	3,925	4,247
New Mexico	91,533	154,713	186,601	38,059	3,833	3,880
South Dakota	695	3,066	482	18	77	77
Utah	19,325	175,071	18,861	629	944	944
Wyoming	37,096	196,804	19,133	6,481	1,559	1,559

Source: Appendix A of the BLM Regional CAP model (BLM and EMPSi 2023).

Table 48. Modeled ca. 2032 "New" Oil and Gas Emissions: Federal (excluding Tribal), Tribal, and Combined

State	Criteria Air Pollutant Emissions (short tons/year)					
	NOx	VOC	CO	SO₂	PM₂.₅	PM₁₀
Federal (excluding Tribal)						
Colorado	4,734	25,215	3,701	103	150	152
Montana	2,328	8,055	3,071	160	55	55
North Dakota	8,705	24,805	11,250	6,447	912	1,008
New Mexico	13,922	35,214	26,608	4,028	492	499
South Dakota	169	491	84	4	13	13
Utah	2,420	71,667	1,995	28	121	121
Wyoming	19,331	118,696	7,417	3,208	584	584
Tribal						
Colorado	1,865	292	1,509	4	22	23

State	Criteria Air Pollutant Emissions (short tons/year)					
	NOx	VOC	CO	SO$_2$	PM$_{2.5}$	PM$_{10}$
Montana	208	765	329	11	5	5
North Dakota	5,260	27,248	9,813	2,036	161	173
New Mexico	2,305	6,975	5,477	20	78	80
South Dakota	14	0	5	0	1	1
Utah	1,904	15,803	1,925	34	90	90
Wyoming	149	421	139	288	7	7
Non-federal						
Colorado	28,363	68,325	28,615	290	835	863
Montana	5,250	25,733	6,708	418	100	100
North Dakota	85,737	412,034	136,940	31,448	2,232	2,383
New Mexico	33,790	46,998	50,228	18,898	1,201	1,214
South Dakota	390	1,792	269	10	53	53
Utah	3,763	30,953	3,651	156	189	189
Wyoming	8,870	46,817	4,730	1,419	408	408
Combined federal (including Tribal)						
Colorado	6,598	25,508	5,210	108	172	175
Montana	2,536	8,819	3,400	172	60	60
North Dakota	13,965	52,053	21,063	8,483	1,073	1,181
New Mexico	16,227	42,190	32,084	4,048	569	579
South Dakota	183	491	90	4	15	15
Utah	4,324	87,470	3,920	62	212	212
Wyoming	19,480	119,117	7,557	3,496	591	591

Source: Appendix A of the BLM Regional CAP model (BLM and EMPSi 2023).

6.4 FOUR CORNERS AIR QUALITY TASK FORCE

In 2002, NMED and local governments convened to sign an Early Action Compact for O$_3$ under an EPA program that required commitment for state and local action to resolving O$_3$ issues prior to a nonattainment designation. In 2005, the States of Colorado and New Mexico convened a group of stakeholders, then known as the Four Corners Air Quality Task Force (FCAQTF), to address air quality issues in the Four Corners region in light of continued energy development and growth in the region and consider options for mitigating air pollution. A report detailing a wide range of mitigation options was published in November 2007 (FCAQTF 2007).

In 2008, its task complete, the group became known as the Four Corners Air Quality Group (FCAQG) and continued as a forum for discussion of existing air quality issues and potential solutions. The FCAQG is

currently composed of more than 100 members and 150 interested parties representing a wide range of perspectives on air quality in the Four Corners region. Members include private citizens, representatives from public interest groups, universities, industry, state, tribal, and local governments, and federal agencies. The BLM has been an active participant from the beginning and maintains a representative on the steering committee. The last FCAQG met in person and virtually on November 7 and 8, 2023, in Durango, Colorado. For more information visit the FCAQG at the NMED website at https://www.env.nm.gov/air-quality/four-corners-air-quality-group/.

6.4.1 PREVIOUS STUDIES

Previous emissions inventories were conducted for New Mexico in 2007 and 2009, and a photochemical modeling analysis was completed for the FCAQTF in 2009. These inventories and modeling are discussed in more detail in the *Air Resources Technical Report for Oil and Gas Development in New Mexico, Oklahoma, Texas, and Kansas: 2020* (BLM 2021a).

6.4.1.1 COMPREHENSIVE AIR RESOURCES TECHNICAL SUPPORT DOCUMENT

The previous RFD scenario for oil and gas in the PDO (Engler et al. 2012; Engler and Cather 2014) was previously modeled in the ARTSD by URS Corporation (URS) which was prepared to report the potential air quality impacts resulting from this RFD scenario (URS 2013). This effort included atmospheric dispersion and PGM to predict concentrations of specific pollutants in and around the BLM CFO (in which most of the PDO oil and gas activity occurs). Updated modeling for the current 2023 BLM CFO RFD is in progress; therefore, the ARTSD modeling study is no longer representative of the current RFD. The results of ARTSD analysis are discussed in more detail in the 2022 ARTR (BLM 2023a).

6.5 AIR QUALITY MODELING FOR TEXAS

Numerous reports on air quality modeling projects done by and for the TCEQ, including modeling done for the several Texas county nonattainment areas, can be accessed on the Air Division website (TCEQ 2024a). The TCEQ has convened advisory groups in southeast Texas and Dallas-Fort Worth to assist the agency in addressing photochemical modeling issues.

6.6 PLANNED MODELING STUDIES

The following modeling studies are in progress and, when released, will be incorporated into this report:

- BLM Carlsbad Air Modeling Modification (HAPS and criteria pollutants).

7 OIL AND GAS SINGLE-WELL EMISSIONS

The per-well emissions factors (GHGs and non-GHGs) by phase (well development and production operations) on an annual basis. An emissions factor is a value that relates the quantity of a pollutant released into the atmosphere with an activity that generates the pollutant. They are typically expressed in units of weight or mass (e.g. pounds, kg, tons) per activity (e.g. duration of equipment operation, construction of an oil or gas well). Emissions factors are the basis for developing emissions inventories that are used for air quality management decisions. The BLM uses emissions inventories to evaluate the change to county-level emissions, comparison between NEPA alternatives, and as inputs for air quality

models if modeling is warranted. Over time emissions factors may change due to new emissions regulations, development of control technologies, or data and information improvements for emissions.

Air pollutant emissions from oil and gas activities occur during construction and operations of a well. Construction related emissions occur from the use of heavy machinery during pad construction, drilling, testing and completion, venting and flaring, interim reclamation, and vehicles. Construction emissions are typically a one-time occurrence. Operation-related emissions occur from well workovers, pump engines, heaters, tanks, truck loading, fugitive leaks, pneumatics, dehydrators, compressor engines, reclamation, and vehicle traffic. Emissions from operational activities occur throughout the life of a well. Several factors may influence actual emissions including location, geological formation, well depth, equipment used, supporting infrastructure, and other factors.

7.1   FIELD OFFICE

7.1.1   FARMINGTON FIELD OFFICE

The FFO Mancos-Gallup RFD (2018 RFD) estimates that there could be an additional 3,200 (federal and non-federal) wells drilled within the analysis area by 2037, of which 2,490 would be federal (Crocker and Glover 2018). In addition, the RPFO RFD (2019 RFD) estimates that an additional 200 wells will be built within the analysis area by 2039, of which 129 would be federal (Crocker and Glover 2019). With consideration of both RFDs, there would be an estimated 3,400 wells drilled within the New Mexico portion of the San Juan Basin by 2039, with an average of 170 wells per year (of which 131 would be federal).

The BLM FFO emission estimates were developed from the BLM Single Oil and Gas Well Emission Inventory Tool. The BLM Single Oil and Gas Well Emission Inventory Tool uses the EPA Compilation of Air Pollutant Emissions Factors (AP-42), EPA Motor Vehicle Emission Simulator (MOVES), EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, and other sources. The tool has also been modified to account for San Juan Basin gas profiles, typical project details, and recent EMNRD and NMED rules and regulations (Waste Prevention Rule and Ozone Precursor Rule). Production data from the IHS Markit Enerdeq database (commercial source), including an estimate of the total potential mineral yield, or estimated ultimate recovery (EUR), and the associated decline rates were included in the BLM Single Oil and Gas Well Emission Inventory Tool. Single-well estimates and associated production data were based on horizontal drilling (Max Emissions from Oil and Gas Scenarios–Single Well Emissions in the San Juan Basin). The horizontal oil emissions were based on the deep oil with high gas scenario. The horizontally drilled single-well emissions could be used in cases when well types are unknown, such as during leasing, providing a conversative estimate for vertically drilled wells. Whereas this information provides an estimate of emissions based on typical development occurring in New Mexico, actual emissions from the development of any given well may differ. Table 49 summarizes horizontally drilled single-well emissions for the BLM FFO/RPFO. The FFO/RPFO is calculating project-specific emissions on a project-specific basis. A weighted average single-well emission estimate based on project-specific data is currently being developed to be used for future lease sales.

Table 49. BLM FFO/RPFO Horizontal Single-Well Emissions

Well Type	Total Emissions (tons per year)						
	CO	NO$_x$	PM$_{10}$	PM$_{2.5}$	SO$_2$	VOCs	HAPs
Single-well construction/ development phase	3.69	14.50	9.45	1.48	0.0008	1.07	0.02
Single-well operation phase	5.75	2.54	4.35	0.56	0.0013	12.19	0.49
Single-well total	**9.44**	**17.04**	**13.80**	**2.04**	**0.0021**	**13.26**	**0.51**

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

Note: Max Emissions from Oil and Gas Scenarios - Single Well Emissions in the San Juan Basin

7.1.2   PECOS DISTRICT OFFICE

The RFD scenario for oil and gas in the CFO (Engler 2023) projects that, on average, 980 oil and gas wells would be completed within the CFO planning area each year over the 20-year scenario (2023–2043), for approximately 19,600 new wells (federal and non-federal), most of which are expected to be horizontally drilled. Of this, at least 12,500 wells in CFO planning area alone would be federal (Engler 2023). CFO well spud projections by year vary from 1,208 new federal and non-federal well spuds (770 federal) in 2023 to 769 new federal and non-federal well spuds (490 federal) in 2043. The CFO planning area encompasses Lea and Eddy Counties and portions of Chaves County. The CFO RFD does not account for future well development in the Roswell Field Office (RFO) portion of the PDO planning area (which encompasses portions of Chaves and Roosevelt Counties); therefore, well projections for the RFO planning area were extracted from the PDO RFD (Engler et al. 2012; Engler and Cather 2014). The PDO RFD projects that 800 oil and gas wells would be completed within the PDO each year for the 20-year scenario (2015–2035), for a total of approximately 16,000 new wells (federal and non-federal), most of which are expected to be horizontally drilled. Based on the review of cumulative production volumes through 2010 (see Summary Table 1 [page 49] in Engler et al. [2012]), most of the production has occurred in Eddy and Lea Counties, and development in Chaves and Roosevelt Counties represents approximately 4% of the cumulative production volumes for the PDO planning area. Assuming that this proportion of development in Chaves and Roosevelt Counties relative to the larger PDO planning area would remain relatively stable into the future, the number of projected wells from the PDO RFD that are likely to occur within Chaves and Roosevelt Counties would be approximately 640. When combined, the total number of projected wells for the PDO planning area is 20,240 (including 19,600 wells in CFO and 640 wells in RFO). PDO RFD projections over a 20-year time period show well development with an average of 1,012 wells per year (of which at least 625 would be federal).

The BLM PDO emission estimates were developed from the BLM Single Oil and Gas Well Emission Inventory Tool. The BLM Single Oil and Gas Well Emission Inventory Tool uses the EPA Compilation of Air Pollutant Emissions Factors (AP-42), EPA MOVES, EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, and other sources. The tool has also been modified to account for Permian Basin gas profiles, typical project details, and recent EMNRD and NMED rules and regulations (Waste Prevention Rule and Ozone Precursor Rule). Production data from the IHS Markit Enerdeq database (commercial source), including an estimate of the total potential mineral yield, or EUR, and the associated decline rates were included in the BLM Single Oil and Gas Well Emission Inventory Tool. Single-well estimates and associated production data were based on horizontal drilling. The horizontally drilled single-well emissions could be used in cases when well types are unknown, such as during leasing, providing a conversative estimate for vertically drilled wells. Whereas this information

provides an estimate of emissions based on typical development occurring in New Mexico, actual emissions from the development of any given well may differ. Table 50 summarizes horizontally drilled single-well emissions for the BLM PDO based on updated, project averaged travel distances and paved verses unpaved measurements.

Table 50. BLM PDO Horizontally Drilled Single-Well Emissions

Phase	Total Emissions (tons per year)						
	CO	NO$_x$	PM$_{10}$	PM$_{2.5}$	SO$_2$	VOCs	HAPs
Single-well construction/ development phase	3.16	13.21	2.73	0.75	1.11E-02	0.69	0.02
Single-well operation phase	1.21	0.97	1.40	0.51	4.50E-03	10.53	0.93
Single-well total	4.37	14.18	4.13	1.26	1.56E-02	11.21	**0.95**

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

7.1.3 OKLAHOMA FIELD OFFICE

Table 51 presents the current single-well emissions estimates for the Oklahoma Field Office (OFO) from the Reasonably Foreseeable Development Scenario – Kansas, Oklahoma, & Texas and Oklahoma, Kansas and Texas BLM Record of Decision and Approved Resource Management Plan (BLM 2016, 2020).

Table 51. BLM OFO Single-Well Emissions

Factor Type	Total Emissions (tons per year)						
	CO	NO$_x$	PM$_{10}$	PM$_{2.5}$	SO$_2$	VOCs[†]	HAPs
Single-well oil emission factors*	2.06	4.53	0.58	0.27	0.12	4.46	0.31
Single-well gas emission factors*	1.87	5.53	0.67	0.33	0.11	0.77	0.06

Source: BLM (2016, 2020).

Notes:

* The representative well used to calculate emissions is a horizontal oil well. Emissions for vertical wells were not used from this analysis due to current predominance in horizontal technological drilling methods and because presenting horizontal oil wells emissions estimates represents a more conservative summary of emissions compared with emissions from a vertical well, with the exception of SO2, which could be four to five times greater in a vertical well scenario. However, SO2 emissions are still estimated to be within the same magnitude and less than 1 ton per year of SO2 emissions per well. Estimated emissions from a typical horizontal gas well are higher for the criteria pollutants PM10, PM2.5, and NOx. However, estimated emissions from horizontal oil wells are higher for CO, VOC, and HAP emissions. Because the overall magnitude of emissions from oil wells is estimated to be higher in terms of total criteria pollutant emissions, an oil well is evaluated for the purpose of this analysis.

† VOC emissions at the operational phase represent uncontrolled emissions and estimate potential emissions representing the contribution for "one oil well" from the emissions at storage tanks, gathering facilities, etc. However, federally enforceable regulations, such as NSPS Subparts OOOO and OOOOa, require emission reduction of VOCs from well completions following hydraulic fracturing or refracturing and storage tanks with emissions greater than 6 tpy after federally enforceable controls. Therefore, actual emissions from the one-well scenario are likely be lower than represented.

7.1.4 ADDITIONAL INFORMATION REGARDING SINGLE-WELL EMISSION FACTORS

The single-well emissions in this document can be used to estimate emissions for all project types. Over time, calculators may be developed, or single-well emission may be modified to capture new or more

regionally specific oil and gas development parameters (through ongoing modeling efforts associated with RMP revisions), or new project-specific calculators may emerge (such as those related to oil and gas leasing, e.g., the lease sale emissions tool). As new or more refined tools become available, they may be used to make emissions projections as warranted.

7.2   WELL COUNTS

The number of active wells can vary greatly from year to year; in addition, counts are not static or logarithmic by nature. Well count data can be obtained from many sources, such as state oil and gas commission databases, university and research databases, and proprietary databases, as well as public federal databases. The sources reporting well counts may also differ in reporting methods. Reporting of well counts may include various types of wells such as active, new, temporarily abandoned, and inactive (shut in or temporarily abandoned). For the purposes of this report, the BLM uses the Petroleum Recovery Research Center, Automated Fluid Minerals Support System (AFMSS) and state oil and gas well count reporting. Table 52 show the active wells within each field office (NMOCD 2024).

Table 52. Active Wells

Field Office	Total (Federal and Non-Federal)	Federal
Pecos Development Office (PDO)	46,599	26,287
Farmington Field Office (FFO)	21,873	15,631
Roswell Field Office (RFO)	2,833	1,359
Carlsbad Field Office (CFO)	43,766	24,928

Source: NMOCD (2024).

To facilitate quantification, most project-level analyses tend to assume that all wells would be developed concurrently and in the same year, though it is possible that future potential development would not occur in this manner. Table 53 provides past well spud data (BLM 2024c). The BLM chose to report well spud data instead of completion data based on technical expertise of the petroleum engineers within the BLM.

Table 53. Past and Present Well Spud Data

			Number of BLM Well Spuds				
2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Carlsbad Field Office (CFO)							
196	522	650	785	823	1,150	1,195	1,431
Roswell Field Office (RFO)							
2	3	9	6	1	3	7	13
Pecos District Office (PDO)[1]							
198	525	659	791	824	1,153	1,202	1,444
Farmington Field Office (FFO) – Federal							
6	34	24	14	8	24	39	19
Farmington Field Office (FFO) - Indian							
14	33	19	19	3	25	32	16
Rio Puerco Field Office (RPFO) - Federal							
0	0	0	0	0	1	1	0
Rio Puerco Field Office (RPFO) – Indian							
0	0	0	0	0	0	1	0
FFO and RPFO[2]							
20	67	43	33	11	50	73	35
Oklahoma							
3	10	14	12	4	5	13	6
Texas							
3	0	7	5	7	8	18	6

Number of BLM Well Spuds							
2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Kansas							
0	0	0	0	1	0	0	0

Sources: BLM (2023b)

Notes:

(1) Total of CFO and RFO

(2) Total of FFO and RPFO

The EURs summarized in Table 54 are generated by performing decline curve analyses of existing production within each field district. To calculate the volumes of oil, natural gas, and water expected to be produced from future parcels, the projected number of wells are multiplied by the EURs of oil, natural gas, and produced water per well.

Table 54. Estimated Ultimate Recoveries for New Mexico

Basin	30-year or 20-year Lifetime/Average Producer	Horizontal or Vertical Well	Oil EUR (bbl)*	Gas EUR (mcf)*
San Juan Basin	30-year	Horizontal	173,019	964,701
		Vertical	10,044	406,555
San Juan Basin	20-year	Horizontal	172,749	962,778
		Vertical	9,108	334,678
Permian Basin	30-year	Horizontal	359,533	1,190,311
		Vertical	51,404	197,934
Permian Basin	20-year	Horizontal	347,292	1,189,482
		Vertical	51,183	196,268

Note: bbl = barrels; mcf = thousand cubic feet

* Data from the integrated air resource tool (iART tool), using IHS data.

7.3   EMIT SOIL AND CLIMATE DATA

Table 55 shows the surface and climate data for various New Mexico locations, for use in EMIT for cities across New Mexico.

Table 55. EMIT Soil and Climate Data

Basin	Soil Silt Content (%)	Soil Moisture Content (%)	Average Temp (F)	Days with Precip >0.01 inch (#)	Fastest wind gust (typically use 60 mph	Solar Radiation (kWh/m2/Day)
San Juan Basin (Farmington Regional Airport USW00023090)	8.5*	7.9†	53.2‡	60.3‡	60§	6.5-7.4¶
Permian Basin (Carlsbad USC00291469)	10.0**	7.9†	64.4‡	45.8‡	60§	6.5-7.4¶
Taos (Northeast NM USC00298668)	8.5*	7.9†	48.5‡	61.0‡	60§	6.0-7.4¶
Las Cruces (Southwest NM USC00298535)	8.5*	7.9†	63.2‡	47.1‡	60§	>7.0¶
Albuquerque (Central NM USW00023050)	8.5*	7.9†	57.9‡	56.1‡	60§	6.5-7.4¶
Socorro (Central NM USC00298387)	8.5*	7.9†	57.5‡	53.7‡	60§	>6.5¶
Roswell (Southeast NM USC00297605)	10.0**	7.9†	59.4‡	42.9‡	60§	7.0-7.4¶

Notes: The select area terrain and vegetation is sloped and small scrub (less than 10 feet). The percent of paved primary and secondary road lengths are calculated per project.

* AP-42, Table 13.2.2-1

† AP-42, Table 11.9-3

‡ Monthly Climate Normals 1991–2020: https://www.ncei.noaa.gov/access/us-climate-normals/#dataset=normals-monthly&timeframe=30&location=NM

§ 60 mph should be used unless better data are available

¶ http://www.nrel.gov/gis/assets/images/solar-annual-dni-2018-01.jpg

** Silt content from National Cooperative Soil Survey - Kermit Series. Soil type located in southern New Mexico and southwestern Texas.

8 AIR QUALITY–RELATED VALUES

AQRVs are resources sensitive to air quality and can include a wide variety of atmospheric chemistry–related indicators. AQRVs include visibility and specific scenic, cultural, physical, biological, ecological, and recreational resources identified for a particular area. The NAAQS secondary standards are promulgated to ensure non-health related air quality impacts, such as AQRVs, are protected. The BLM can reasonably rely on compliance with the secondary NAAQS to prevent adverse impacts to these resources. Monitoring and modeling of AQRVs help to provide a level of protection to sensitive areas such as Class I parks and wilderness areas. Congress established certain national parks and wilderness areas as mandatory Class I areas where only a small amount of air quality degradation is allowed. Defined by the CAA, Class I areas include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks. These areas must have been in existence at the time the CAA was passed by Congress in August 1977.

The goal of Class I management is to protect natural conditions, rather than the conditions when first monitored. That is, if initial monitoring in a Class I area identifies human-caused changes, appropriate actions should be taken to remedy them to move toward a more natural condition. The goal of Class I management is to protect not only resources with immediate aesthetic appeal (i.e., sparkling clean streams) but also unseen ecological processes (such as natural biodiversity and gene pools) (U.S. Forest Service [USFS] et al. 2000). The FLAG issued a revised Phase 1 report in 2010 (USFS et al. 2010). This report was developed as a tool to provide consistent approaches to the analysis of the effects of air pollution on AQRVs. The FLAG report focuses on three areas of potential impact: visibility, aquatic and terrestrial effects of wet and dry pollutant deposition, and terrestrial effects of O_3. This report is structured to address these same three areas of potential impact. The requirement to assess impacts to AQRVs is established in the PSD rules. PSD is a permitting program for new and modified major sources of air pollution that are in attainment areas. The majority of facilities that the BLM analyzes are below a major source of emissions.

The BLM goals include managing jurisdictional field office activities and development to protect and improve air quality and, within the scope of the BLM authority, minimize emissions that cause or contribute to violations of air quality standards or that negatively impact AQRVs (e.g., acid deposition, visibility).

8.1 PREVENTION OF SIGNIFICANT DETERIORATION

Although the PSD rule is only applicable to major stationary sources of air pollution, a PSD increment analysis can provide a useful measure for estimating how a new source of pollution would likely impact regional air quality. A PSD increment is the amount of pollution allowed to increase in an area while preventing air quality in the airshed from deteriorating to the level set by the NAAQS. The NAAQS is a maximum allowable concentration ceiling, whereas a PSD increment is the maximum allowable increase in concentration allowed to occur above a baseline concentration for a pollutant within the PSD area boundary. The baseline concentration for a pollutant is defined as the ambient concentration existing at the time that the first complete PSD permit application affecting the boundary is submitted. PSD applicable sources are required to provide an analysis to the state agency with jurisdiction to ensure their emissions in conjunction with other applicable emissions increases and decreases within an area will not cause or contribute to a violation of any applicable NAAQS or PSD increment. Significant deterioration occurs when the amount of new pollution exceeds the applicable PSD increment.
An official PSD increment analysis is the sole responsibility of the respective air district. Any subsequent

analysis performed for NEPA purposes will be used for informational purposes only. PSD increments for Class I and Class II areas are listed in Table 56.

Table 56. PSD Increments

Pollutant	Period	Maximum Allowable Increase (micrograms per cubic meter)	
		Class I	Class II
SO_2	3-hour	25	512
	24-hour	5	91
	Annual	2	20
NO_2	Annual	2.5	25
PM_{10}	24-hour	8	30
	Annual	4	17
$PM_{2.5}$	24-hour	2	9
	Annual	1	4

Source: 40 C.F.R. § 52 Subpart C, Chapter 1.

8.2 VISIBILITY

Pollution in the atmosphere can impair scenic views by degrading the contrast, colors, and distance an observer is able to see. Visibility can be assessed in terms of the distance that a person can distinguish a large dark object on the horizon and is measured as the standard visual range in miles. Visibility is of greatest concern in Class I areas, which are afforded the highest level of air quality protection by the CAA. Average natural visual range conditions for Class I areas can be found in FLAG (USFS et al. 2010). Visibility impairment is a result of regional haze, which is caused by the accumulation of pollutants from multiple sources in a region. Emissions from industrial and natural sources may undergo chemical changes in the atmosphere to form particles of a size that scatter or absorb light and result in reductions in visibility.

The EPA and other agencies have been monitoring visibility in national parks and wilderness areas since 1988. In 1999, the EPA announced a major effort to improve air quality in national parks and wilderness areas. The Regional Haze Rule (40 C.F.R. § 51, Subpart P, Protection of Visibility) calls for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas.

The rule requires the states, in coordination with the EPA, National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), USFS, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first state plans for regional haze were due in December 2007. States, tribes, and five multijurisdictional regional planning organizations worked together to develop the technical basis for these plans. Comprehensive periodic revisions to these initial plans were due July 31, 2021, again in 2028, and every 10 years thereafter (EPA 2023m). As of August 25, 2022, 15 states failed to submit 2021 regional haze plans to the EPA by both the first and second deadlines, July 31, 2021, and August 15, 2022. Therefore, New Mexico and 14 other states are included in the Findings of Failure to Submit (EPA 2023n). States implement the Regional Haze Program through SIPs in accordance with the Regional Haze Rule.

Texas proposed a 2021 regional haze SIP revision that is designed to address regional haze in Big Bend and Guadalupe Mountains National Parks in Texas and Class I areas outside Texas that may be affected by emissions from within the state. On June 30, 2021, the commission adopted the 2021 regional haze SIP revision (Project No. 2019-112-SIP-NR). The SIP revision demonstrates compliance with the regional haze requirements of Section 169A of the CAA and the Regional Haze Rule for the second planning period (TCEQ 2024b).

As part of the process of developing Oklahoma 2021 regional haze SIP, the ODEQ AQD identified 12 facilities that are reasonably anticipated to impact visibility conditions at the Wichita Mountains Wilderness Area and identified 21 sources in neighboring states that are reasonably anticipated to impact visibility conditions at the Wichita Mountains Wilderness Area (including sources in Texas) and have asked these states to consider the potential impact of the sources identified within their states for further analysis as part of the process for developing their 2021 regional haze SIP. The SIP was submitted to EPA Region 6 on August 9, 2022 (ODEQ AQD 2022).

In 1985, the EPA initiated a network of monitoring stations to measure impacts to visibility in Class I Wilderness Areas. These monitors are known as the Interagency Monitoring for the Protection of Visual Environments (IMPROVE) monitors and exist in some but not all Class I wilderness areas. Table 57 shows the Class I areas in the BLM NMSO area of operations and whether they have an IMPROVE monitor and, if not, which monitor is considered representative for that area. There are no Class I areas in Kansas.

Table 57. Class I Areas and IMPROVE Monitors

State	Class I Area	Agency	IMPROVE
New Mexico	Bandelier	NPS	Yes
	Bosque del Apache	USFWS	Yes
	Carlsbad Caverns	NPS	Guadalupe Mountains
	Gila	USFS	Yes
	Pecos	USFS	Wheeler Peak
	Salt Creek	USFWS	Yes
	San Pedro Parks	USFS	Yes
	Wheeler Peak	USFS	Yes
	White Mountain	USFS	Yes
Texas	Big Bend	NPS	Yes
	Guadalupe Mountains	NPS	Yes

Visibility is monitored using methodologies established by the IMPROVE Program. The particulates that contribute to haze are collected on filters at each IMPROVE site. Samples are then measured to determine how visibility is impacted over time and by which pollutants.

A deciview (dv) is a unit of measurement to quantify human perception of visibility. It is derived from the natural logarithm of atmospheric light extinction coefficient. A 1-dv change is roughly the smallest perceptible change in visibility. Because visibility at any one location is highly variable throughout the year, it is characterized by three groupings: the clearest 20% days, average 20% days, and haziest 20% days. Visibility degradation is primarily due to sulfate, nitrate, and PM in the atmosphere, with

contributions from both anthropogenic and natural sources. Measuring progress in air pollution control can be challenging because natural sources largely beyond human control such as dust storms and wildfires can produce significant visibility impairment over large areas for days to weeks at a time. Under the auspices of the 2017 Regional Haze Rule revisions, the EPA proposed a new visibility tracking—most impaired days—to better characterize visibility conditions and trends. The most impaired days are those with the most impairment from anthropogenic sources, whereas the haziest grouping now better represents days with haze from natural sources. Total haze on the most impaired days is used to track progress toward Regional Haze Rule goals. Comparing trends in the 20% haziest days with the 20% most impaired days provides a method to assess impacts from episodic events, like wildfires, which have greatly affected visibility throughout the western United States in recent years (Burke et al. 2021). More information about the EPA impairment framework can be found at: http://vista.cira.colostate.edu/Improve/impairment/.

Also required by the Regional Haze Rule, reasonable progress goals must provide for an improvement in visibility for the 20% most anthropogenically impaired days relative to baseline visibility conditions and ensure no degradation in visibility for the 20% clearest days relative to baseline visibility conditions (EPA 2019). Model simulations were used by EPA to project visibility by using the baseline for each Class I area as the average visibility (in dv) for the years 2014 through 2017. The visibility conditions in these years are the benchmark for the "provide for an improvement" and "no degradation" requirements. A line drawn between the end of the 2014–2017 baseline period and 2064 (dv/year) shows a uniform rate of progress or "glidepath" between these two points. The glidepath represents a linear or uniform rate of progress and is the amount of visibility improvement needed in each implementation period to stay on the glidepath; there is no rule requirement to be on or below the glidepath. Results for the Class I areas in the FFO show improving visibility trends for both the base (2014–2017) and future year (2028) deciview values on the 20% clearest and most impaired days. Results for the Class I areas in the CFO show improving visibility trends for both the base (2014–2017) and future year (2028) deciview values on the 20% clearest and most impaired days, although some locations show 2028 projections above the linear uniform rate of progress value of the glidepath. More information can be found in the *Technical Support Document for EPA's Updated 2028 Regional Haze Modeling* (EPA 2019), incorporated by reference.

Visibility information can be found at the Federal Land Managers Environmental Database (FED) (FED 2024). Figure 10 through Figure 20 illustrate visibility trends based on air monitoring data for the IMPROVE sites in the BLM NMSO area of operation for the clearest, haziest, and most impaired categories. Note that peaks such as those seen for Bandelier National Monument in 2000 may be accounted for by the occurrence of large wildfires. A downward sloping line means less reduction of visibility and therefore an improvement. In most cases, visibility trends have been flat or improving. Implementation of best available retrofit technology (BART) strategies as required under the Regional Haze Rule over the next few years should result in further improvements.

Trends for Class I areas affected by sources in northwestern New Mexico (see Figure 21 and Figure 22) are similar to trends for Class I areas in southern New Mexico. Although visibility on worst days at Guadalupe Mountains National Park may have diminished, a careful analysis of fire activity in the area would be necessary to draw conclusions about the cause of some peaks in recent years (CSU 2020).

A qualitative discussion of visibility impacts from oil and gas development in the *Farmington Resource Management Plan with Record of Decision* concludes that for the scenario modeled, which projected greater development than has occurred, there could potentially be significant impacts to visibility at Mesa Verde National Park, a Class I area in southwest Colorado (BLM 2003). Occasional impacts to

San Pedro Parks (north New Mexico) and Weminuche (southern Colorado) Wilderness Areas were also thought possible. However, visibility trends shown for San Pedro Parks, Mesa Verde, and Weminuche indicate that visibility on the best days has been flat to improving and visibility on worst days has shown little change over the period of record.

Visibility modeling performed for the BLM CFO area is discussed further in Section 6.3.
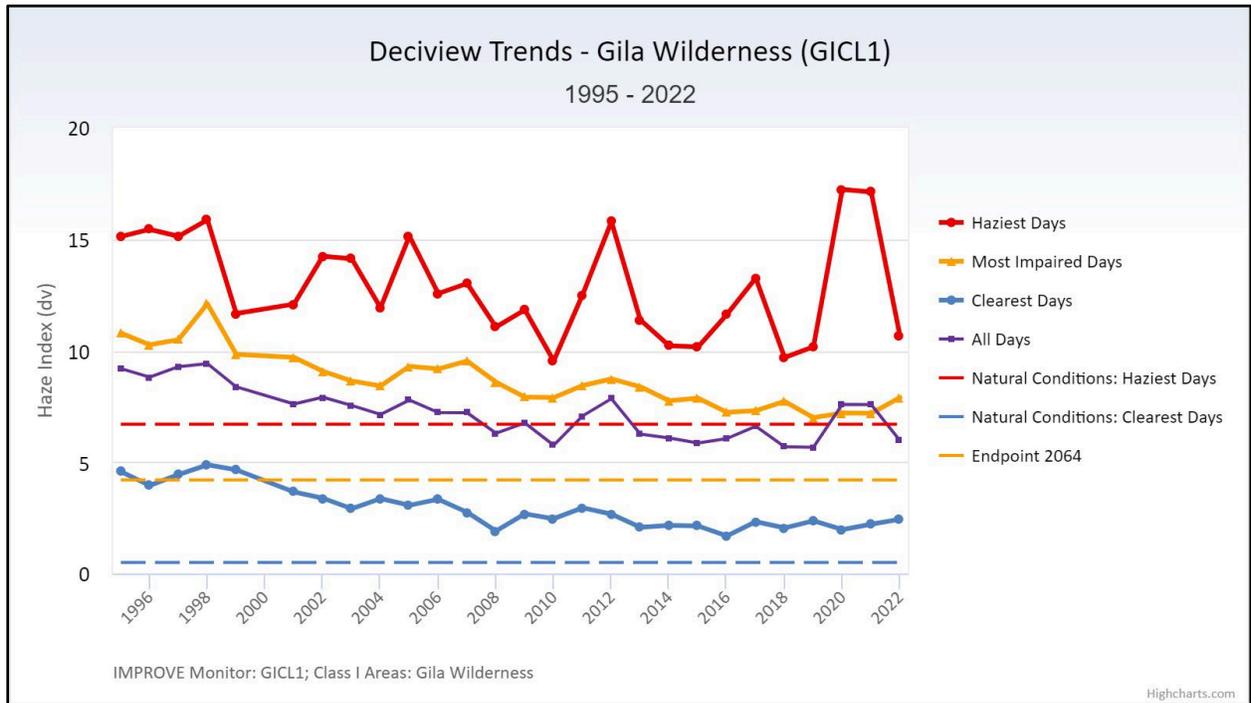
Figure 10. Visibility extinction trends for Gila Wilderness Area, New Mexico (FED Cooperative Institute for Research in the Atmosphere [CIRA] 2024).
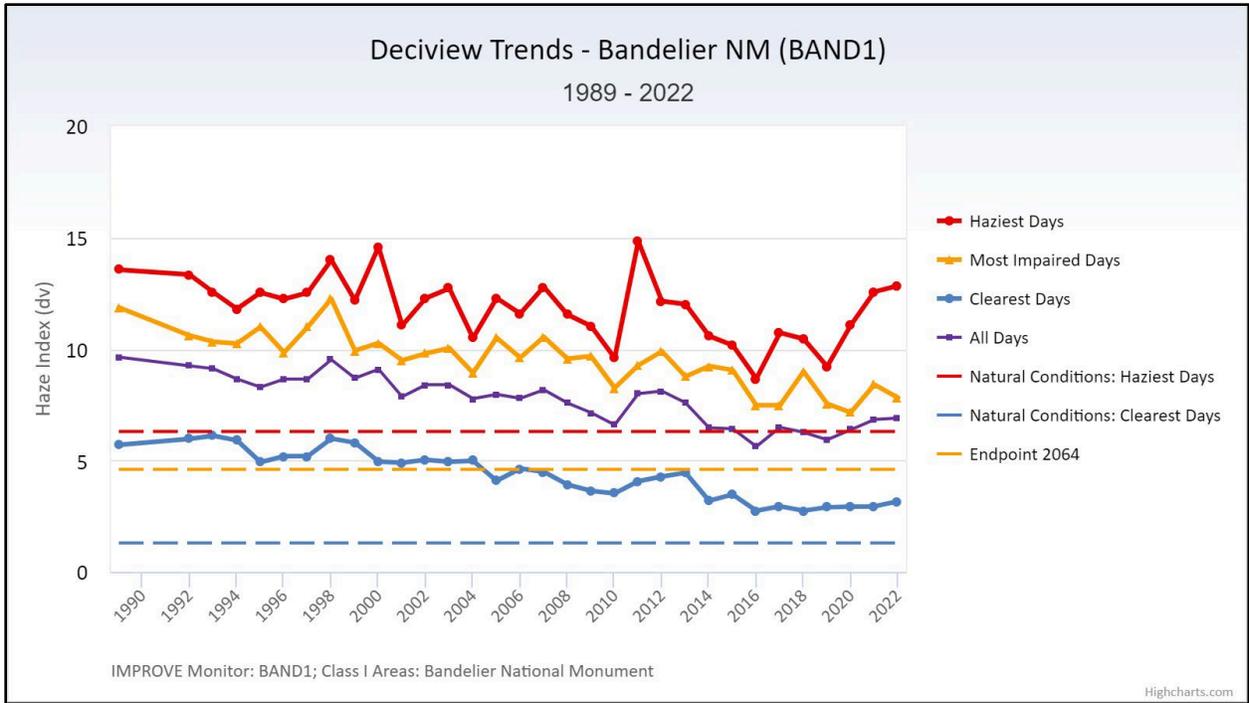
Figure 11. Visibility extinction trends for Bandelier National Monument, New Mexico (FED CIRA 2024).
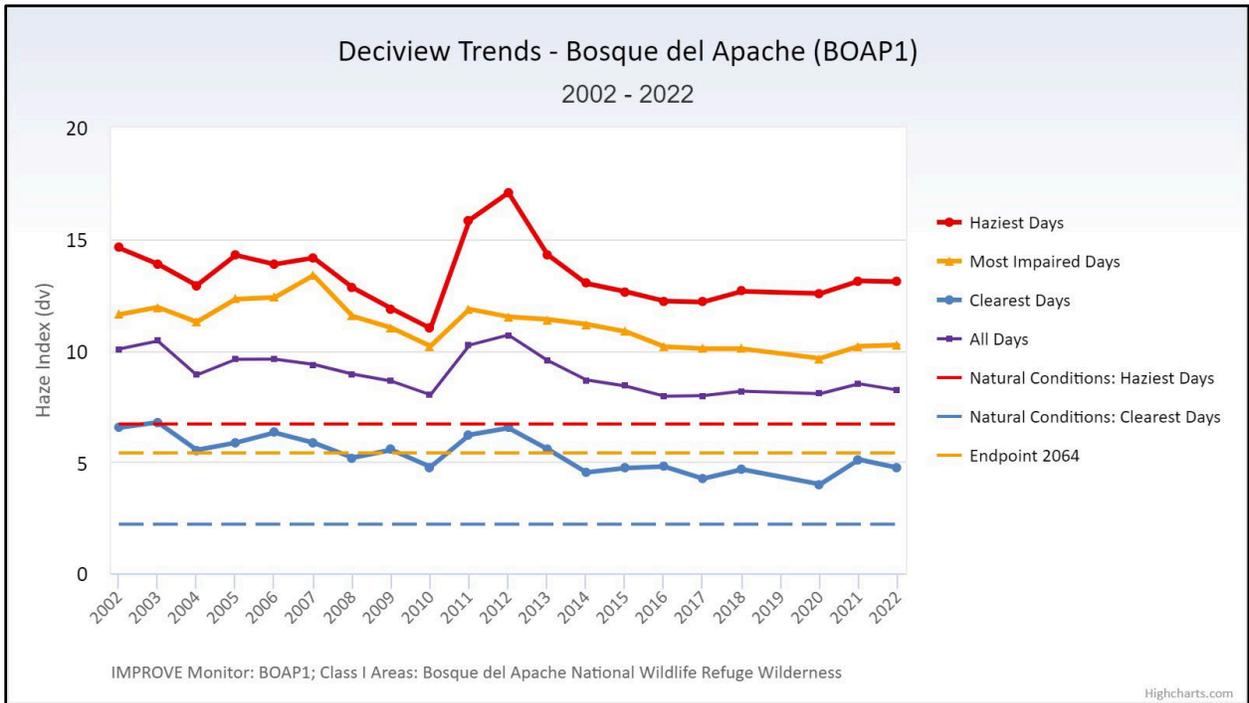
Figure 12. Visibility extinction trends for Bosque del Apache, New Mexico (FED CIRA 2024).
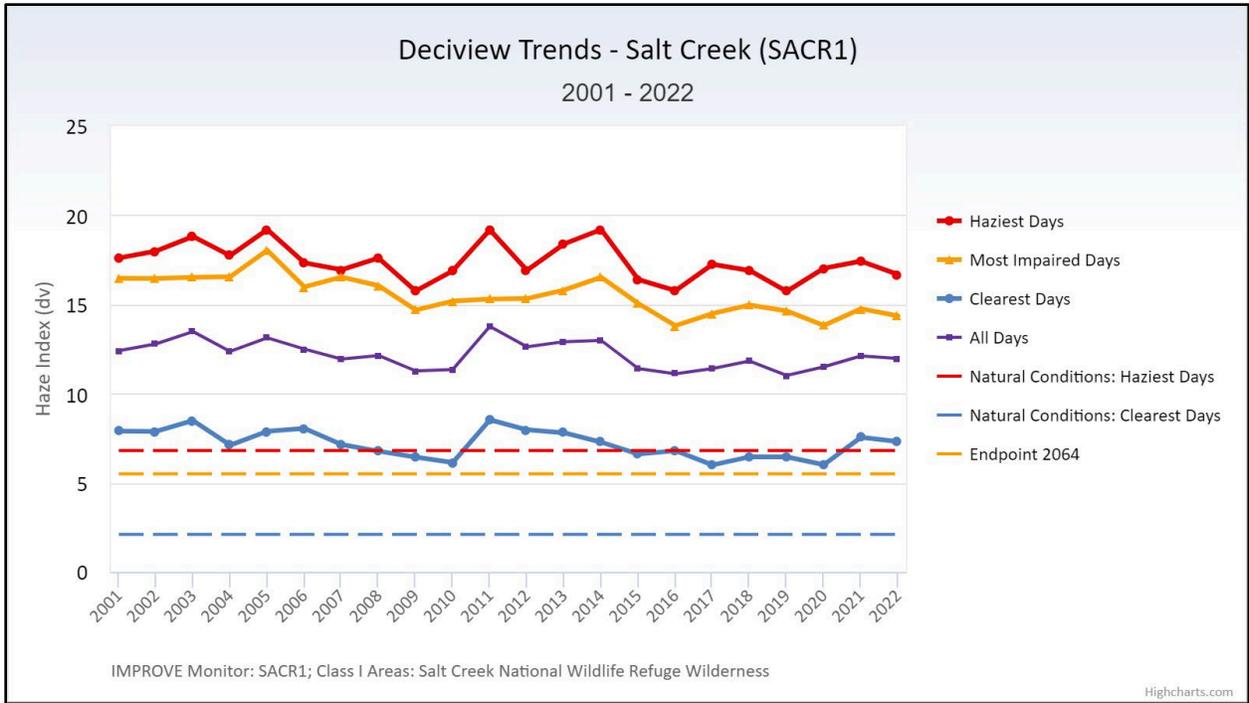
Figure 13. Visibility extinction trends for Salt Creek, New Mexico (FED CIRA 2024).
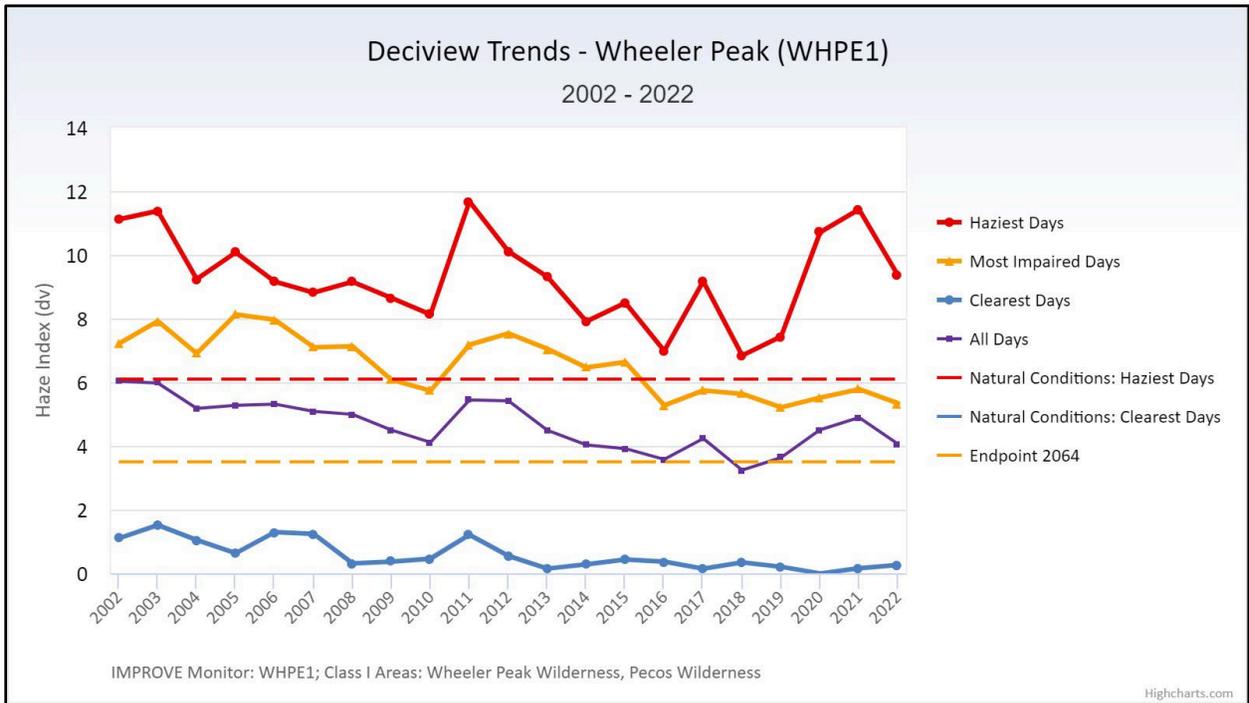
Figure 14. Visibility extinction trends for Wheeler Peak, New Mexico (FED CIRA 2024).
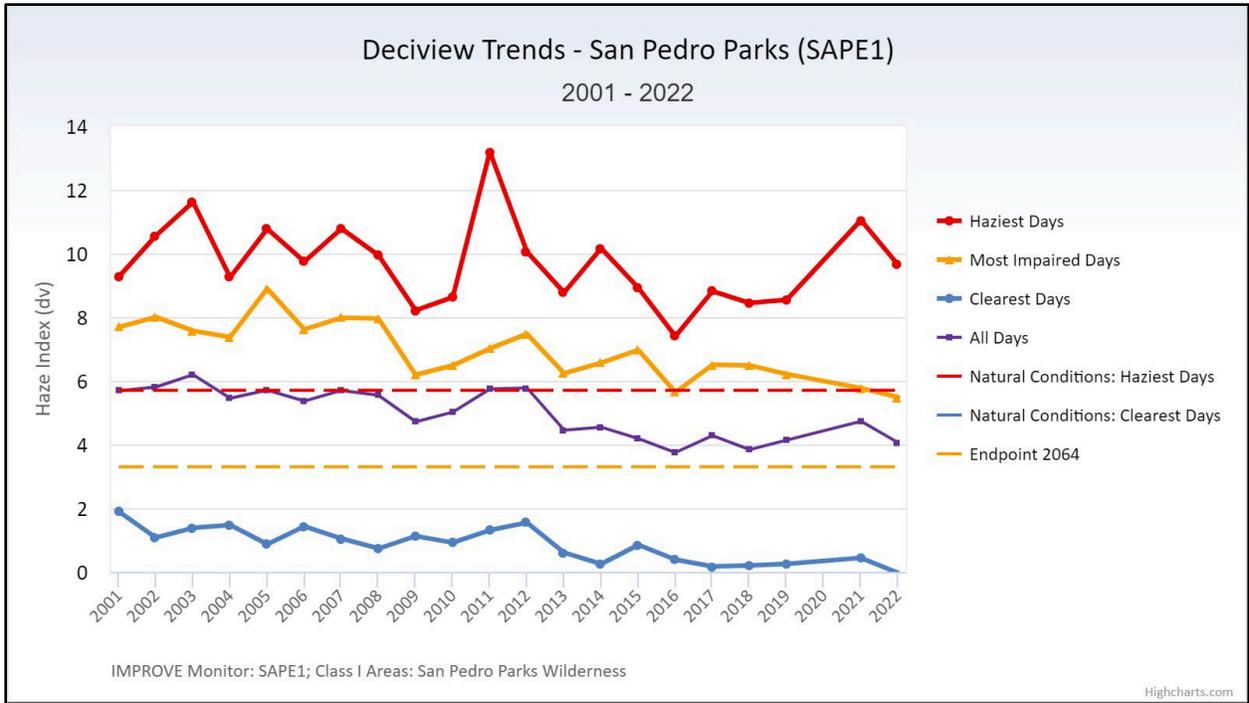
Figure 15. Visibility extinction trends for San Pedro Parks, New Mexico (FED CIRA 2024).
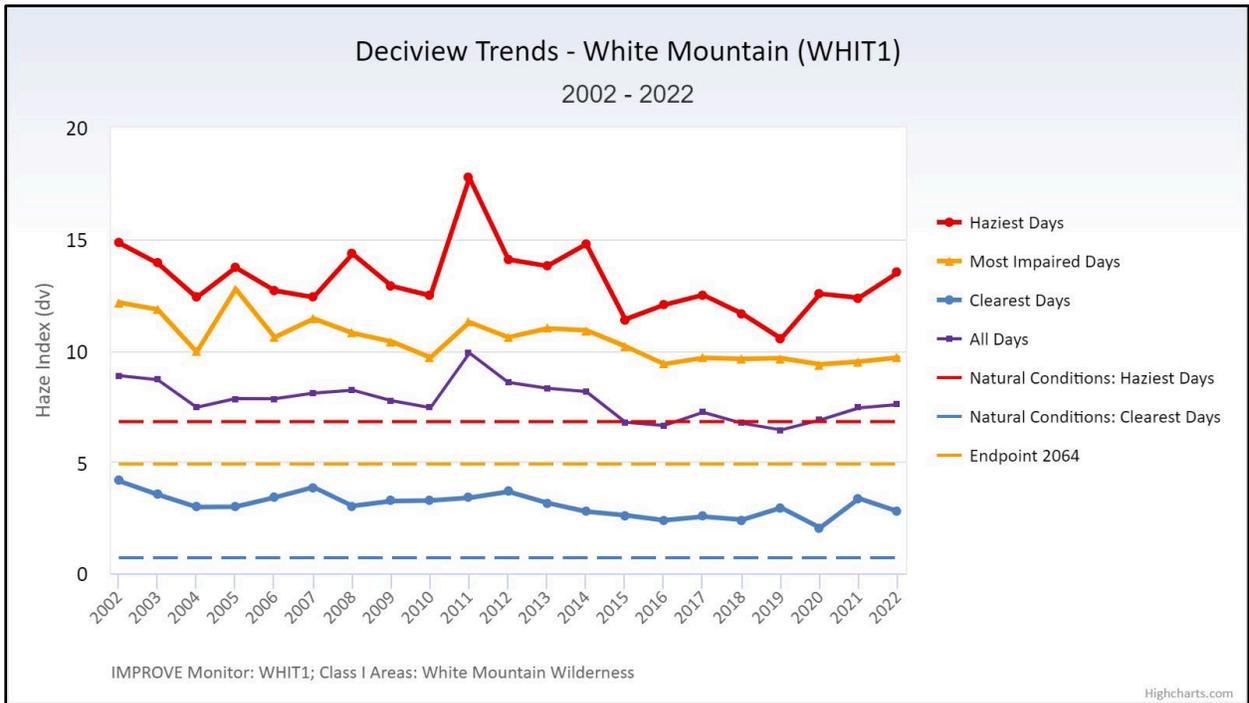
Figure 16. Visibility extinction trends for White Mountain, New Mexico (FED CIRA 2024).
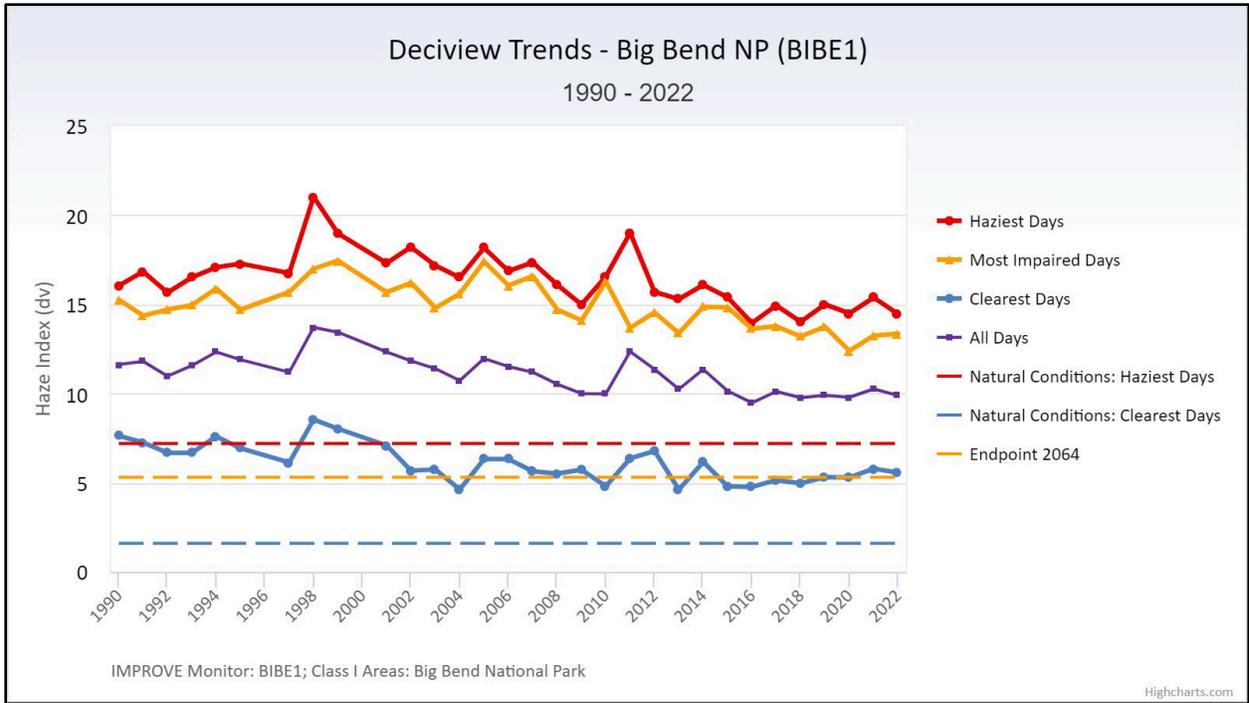
Figure 17. Visibility extinction trends for Big Bend National Park, Texas (FED CIRA 2024).
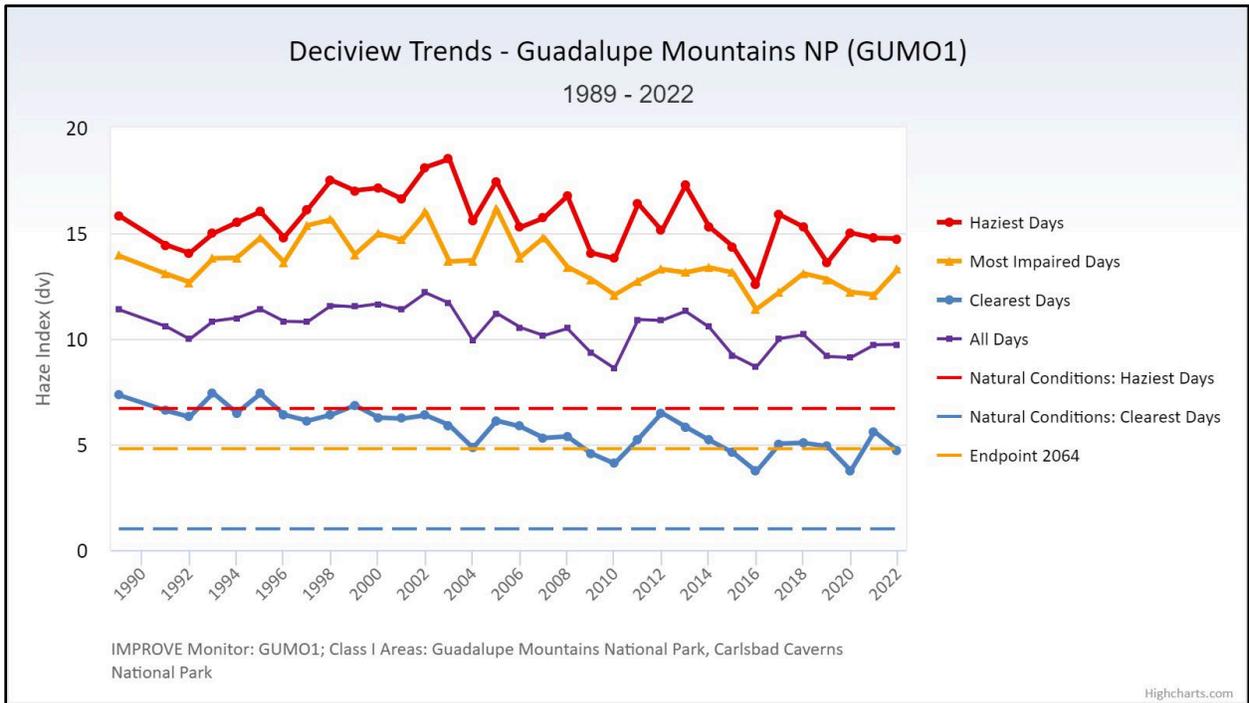
Figure 18. Visibility extinction trends for Guadalupe Mountains National Park, Texas (FED CIRA 2024).
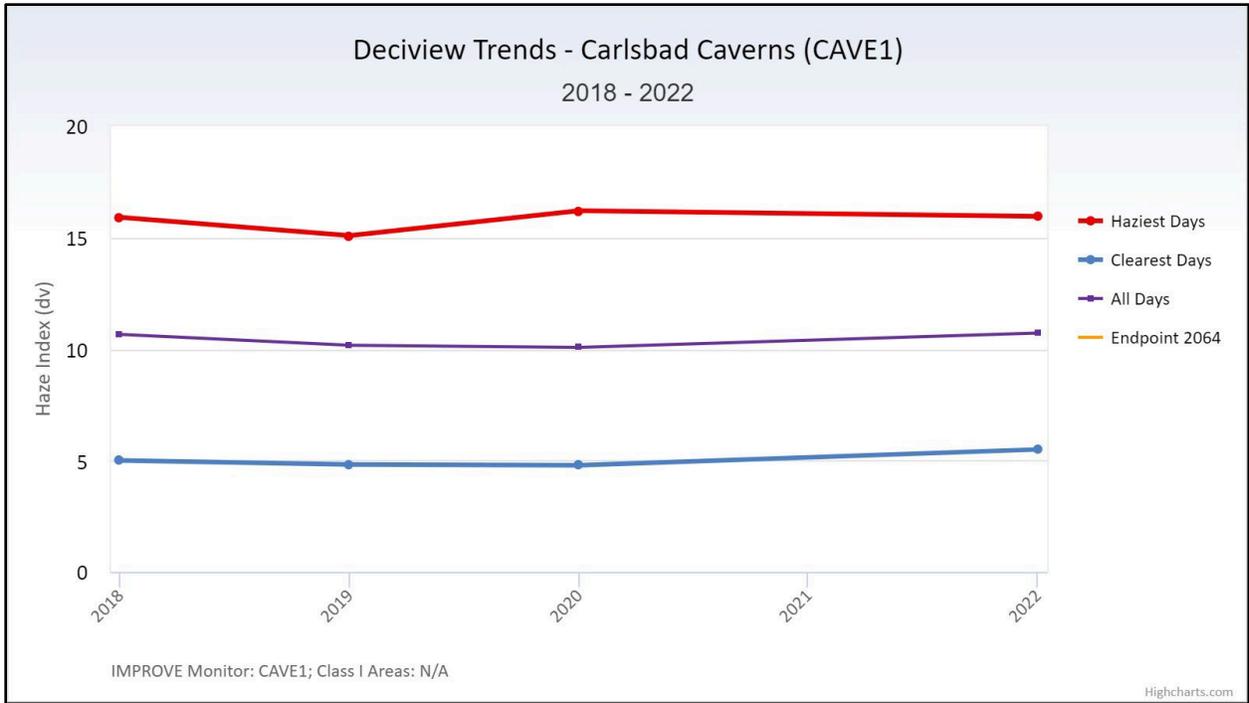
Figure 19. Visibility extinction trends for Carlsbad National Park, Texas (FED CIRA 2024).
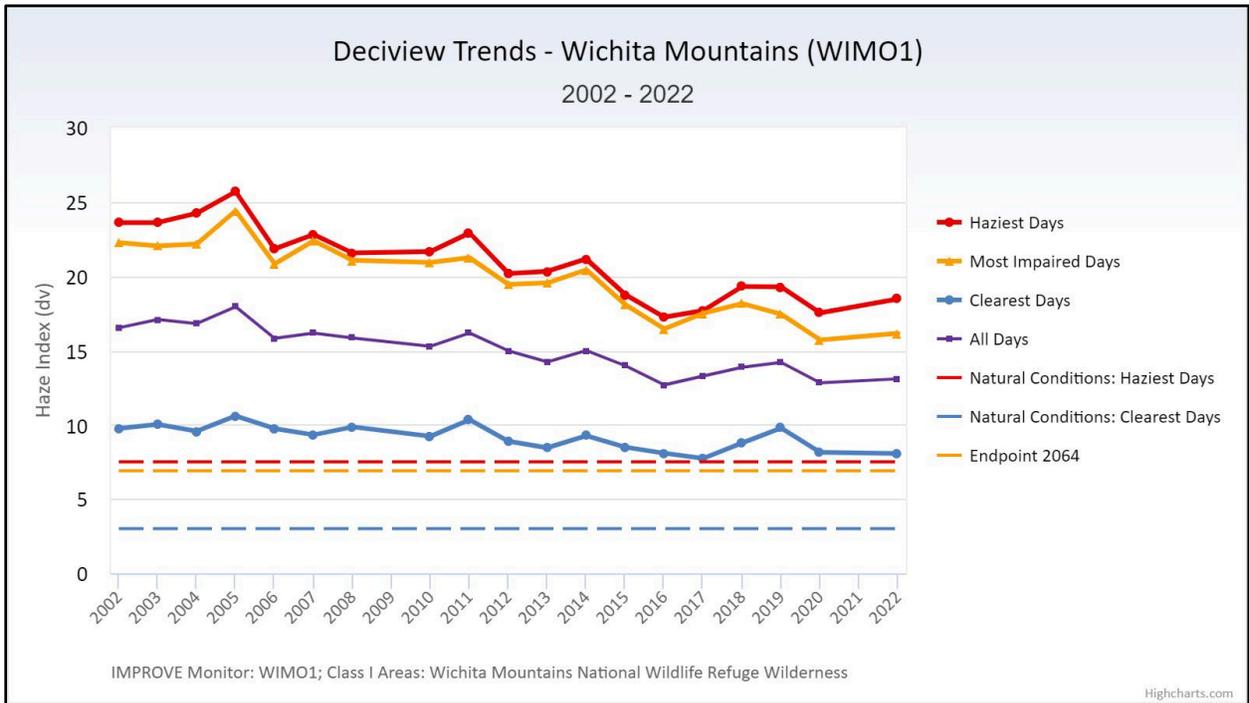
Figure 20. Visibility extinction trends for Wichita Mountains, Oklahoma (FED CIRA 2024).
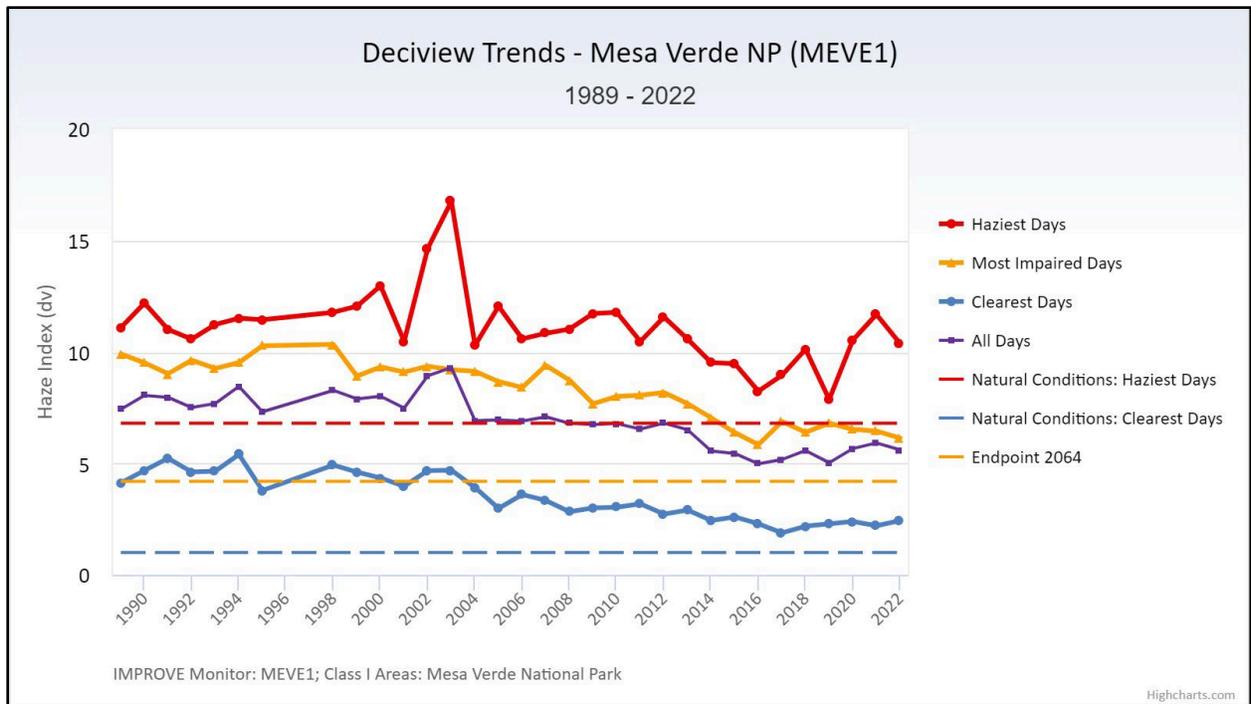
Figure 21. Visibility trends at Class I areas affected by sources in northwestern New Mexico – Mesa Verde National Park, Colorado (FED CIRA 2024).
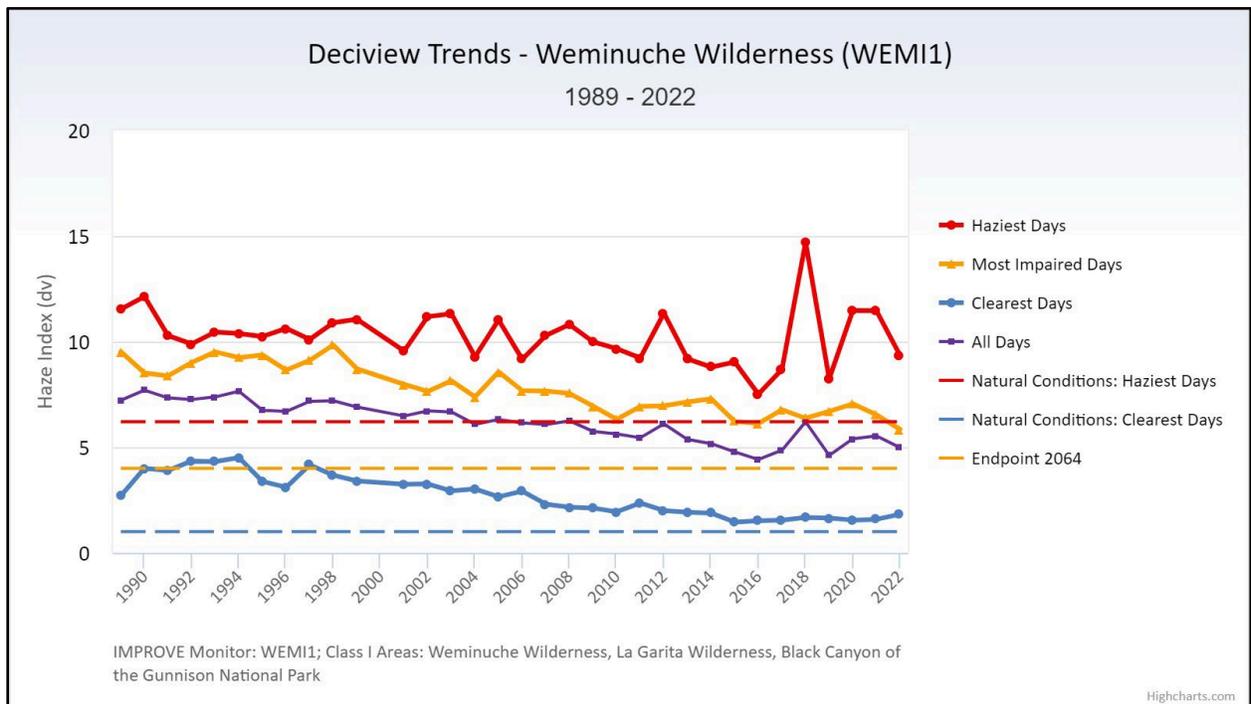
Figure 22. Visibility trends at Class I areas affected by sources in northwestern New Mexico – Weminuche Wilderness, Colorado (FED CIRA 2024).

Additional monitoring can be found in the National Atmospheric Deposition Program (NADP) 2022 Annual Summary at https://nadp.slh.wisc.edu/wp-content/uploads/2023/10/2022as2.pdf (NADP 2023).

8.3   WET AND DRY POLLUTANT DEPOSITION

Atmospheric deposition occurs when gaseous and particulate air pollutants are deposited on the ground, water bodies, or vegetation. The pollutants may settle as dust or be washed from the atmosphere in rain, fog, or snow. When air pollutants such as sulfur and nitrogen are deposited into ecosystems, they may cause acidification or enrichment of soils and surface waters. Atmospheric nitrogen and sulfur deposition may affect water chemistry, resulting in impacts to aquatic vegetation, invertebrate communities, amphibians, and fish. Deposition can also cause chemical changes in soils that alter soil microorganisms, plants, and trees. Excess nitrogen from atmospheric deposition can stress ecosystems by favoring some plant species and inhibiting the growth of others.

In general, the soils in New Mexico have a high acid-neutralizing capacity and surface water is scarce, resulting in minimal impacts in this area. Also, the EPA Acid Rain Program has resulted in greatly reduced levels of the most damaging pollutants. There are currently two active wet deposition monitors in New Mexico: Mayhill and Bandelier National Monument. In addition, monitors near the border at Mesa Verde and Guadalupe Mountains National Parks may shed some light on conditions in New Mexico. Data can be accessed through the NADP at https://nadp.slh.wisc.edu/networks/national-trends-network/. Wet deposition data are also available for monitoring sites in Kansas, Oklahoma, and Texas at this site (NADP 2024).

The EPA has operated the Clean Air Status and Trends Network (CASTNET) since 1991 to provide data to assess trends in air quality, deposition, and ecological effects due to changes in air emissions. Sites are in areas where urban influences are minimal. There are currently two CASTNET observation sites in New Mexico, three in Texas, two in Kansas, and one in Oklahoma. There is also a CASTNET site at Mesa Verde National Park in the Four Corners region. National maps of pollutant concentrations can be found at https://www3.epa.gov/castnet/airconc.html. These maps show that New Mexico and most of the western states have much lower concentrations of all monitored pollutants than the eastern states and Southern California. Nitrates are somewhat elevated in eastern Kansas and eastern Oklahoma, but this is likely associated with agricultural activities rather than oil and gas development. The maps also show that the trend over the past 30 years has been for decreases in all pollutants in most areas of the country. As an example, Figure 23 and Figure 24 show particulate nitrate and sulfate levels for 2000, 2021, and 2022 (EPA 2024p). All areas of the eastern United States have shown significant improvement, with an overall 73 percent reduction in wet sulfate deposition from 2000–2002 to 2020–2022. Between 2000–2002 and 2020–2022, the Northeast and Mid-Atlantic regions experienced a 78% reduction in wet sulfate deposition, and the South-Central region experienced a 44% reduction. SO_2 emissions reductions and the consequent decrease in the formation of sulfates that are transported long distances have resulted in significantly reduced sulfate deposition in the Northeast. The sulfate reductions documented in the region, particularly across New England and portions of New York, were also affected by SO_2 emissions reductions in eastern Canada. Wet deposition of inorganic nitrogen decreased an average of 29% in the Mid-Atlantic and 37% in the Northeast but stayed neutral in the Mountain and North and South-Central regions from 2000–2002 to 2020–2022. These neutral trends in the Rocky Mountain and North and South-Central regions reflect increases in wet deposition of reduced nitrogen, combined with decreases in deposition of oxidized nitrogen between 2000 and 2022. Reductions in nitrogen deposition recorded since the early 1990s have been less pronounced than those for sulfur. Emissions from other source categories (e.g., mobile sources, agriculture, biomass burning, and manufacturing) contribute to air concentrations and deposition of nitrogen. The reduction in total sulfur deposition (wet plus dry) in

the eastern United States was 82% from 2000–2002 to 2020–2022, a value of similar magnitude to that of wet sulfate deposition, and in the South-Central experienced a 51% reduction. Decreases in oxidized nitrogen (NO_X) have generally been greater than that of reduced nitrogen (NH_X) deposition. Total oxidized nitrogen deposition decreased 59% in the East and 40% in the South-Central region. In contrast, total deposition of reduced nitrogen increased by an average of 43% in the East and 91% in the South-Central region from 2000–2002 to 2020–2022 (EPA 2024q). Figure 25 through Figure 28 show the total nitrate and total dry and wet sulfur deposition trends through 2021. These trends in deposition levels are discussed in depth in the 2024 CASTNET annual network plan (EPA 2024x) and *CASTNET 2021 Annual Report* (EPA 2021c).
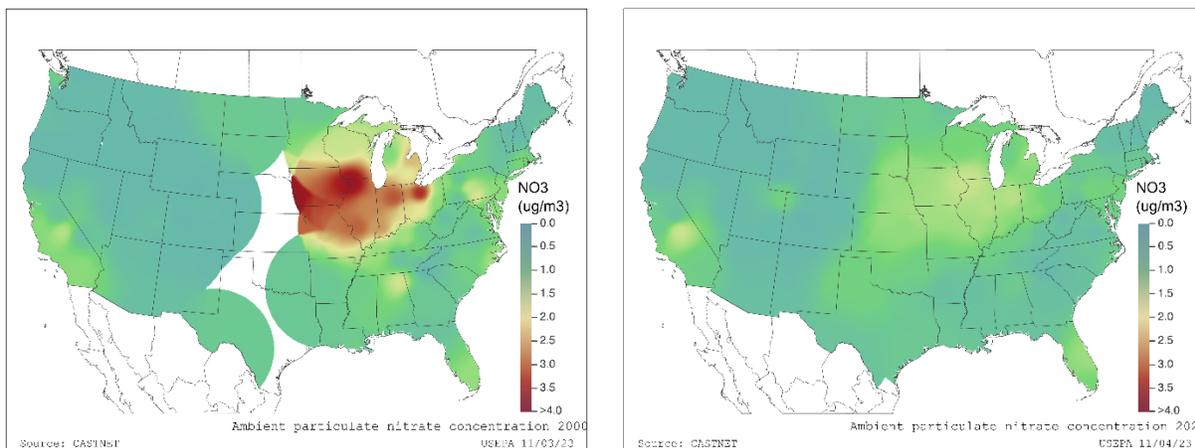
Figure 23. Particulate nitrate in 2000 (left) and 2021 (right).
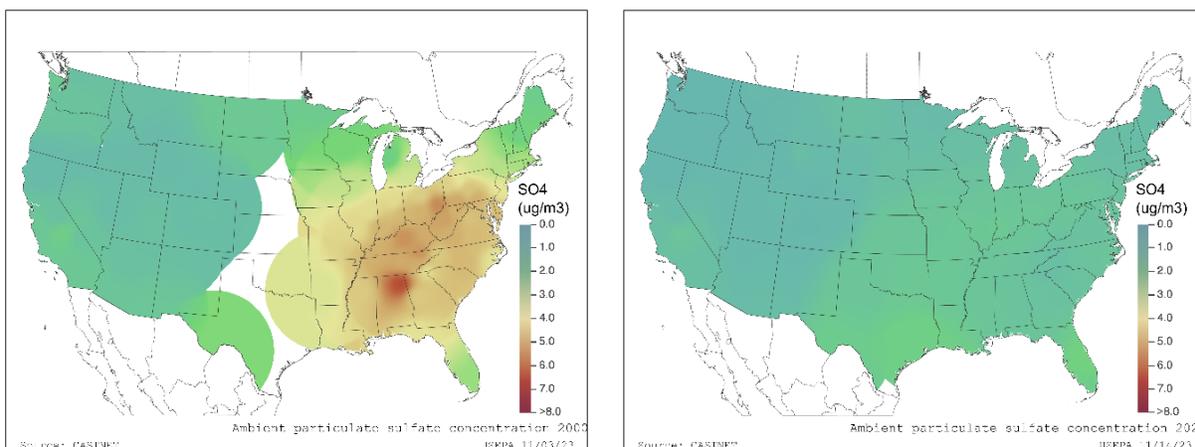
Figure 24. Particulate sulfate in 2000 (left) and 2022 (right).
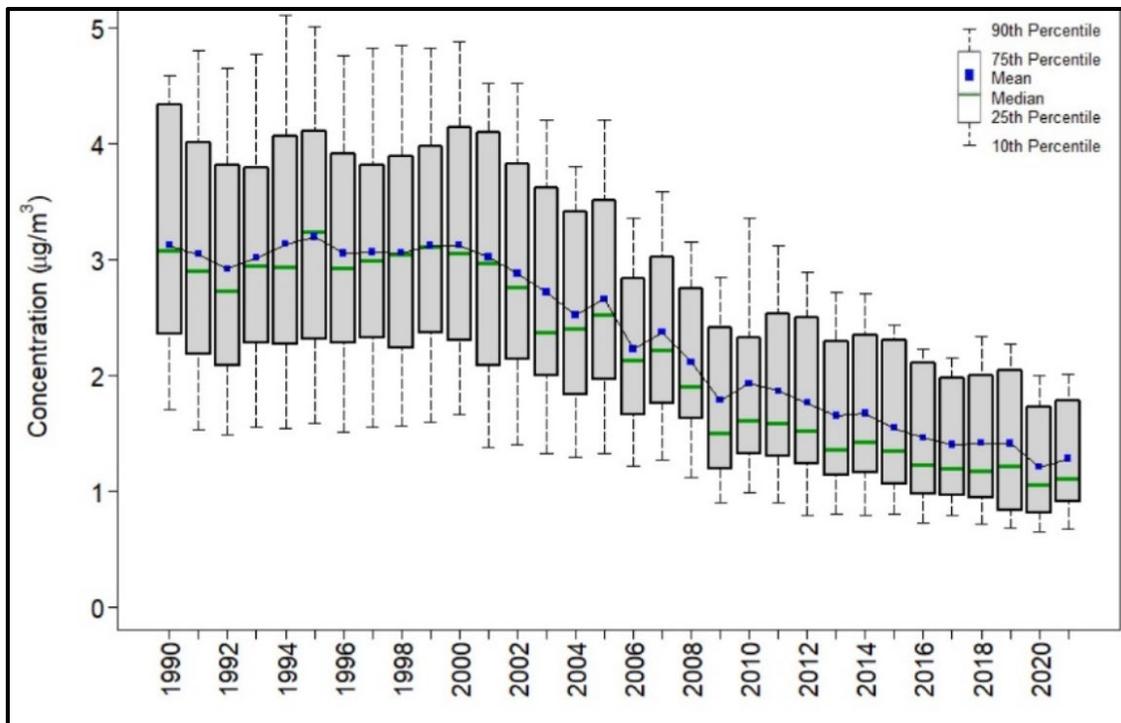
Figure 25. Trends in annual mean total nitrate concentrations – eastern reference sites.
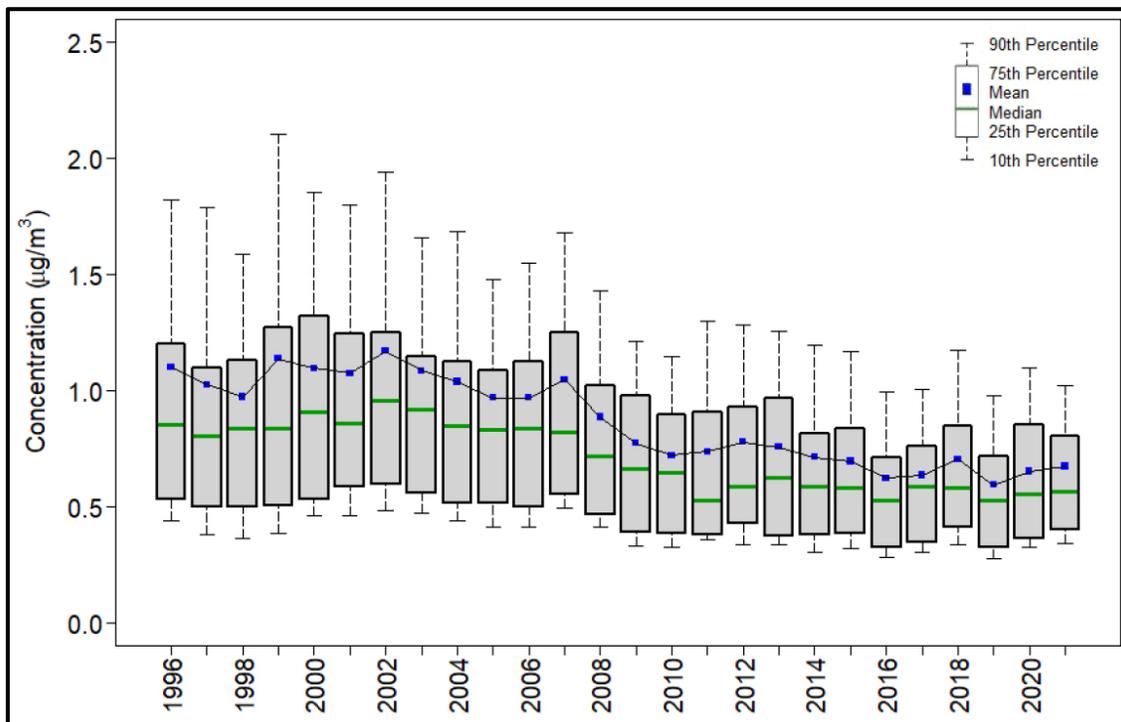
Figure 26. Trends in annual mean total nitrate concentrations – western reference sites.
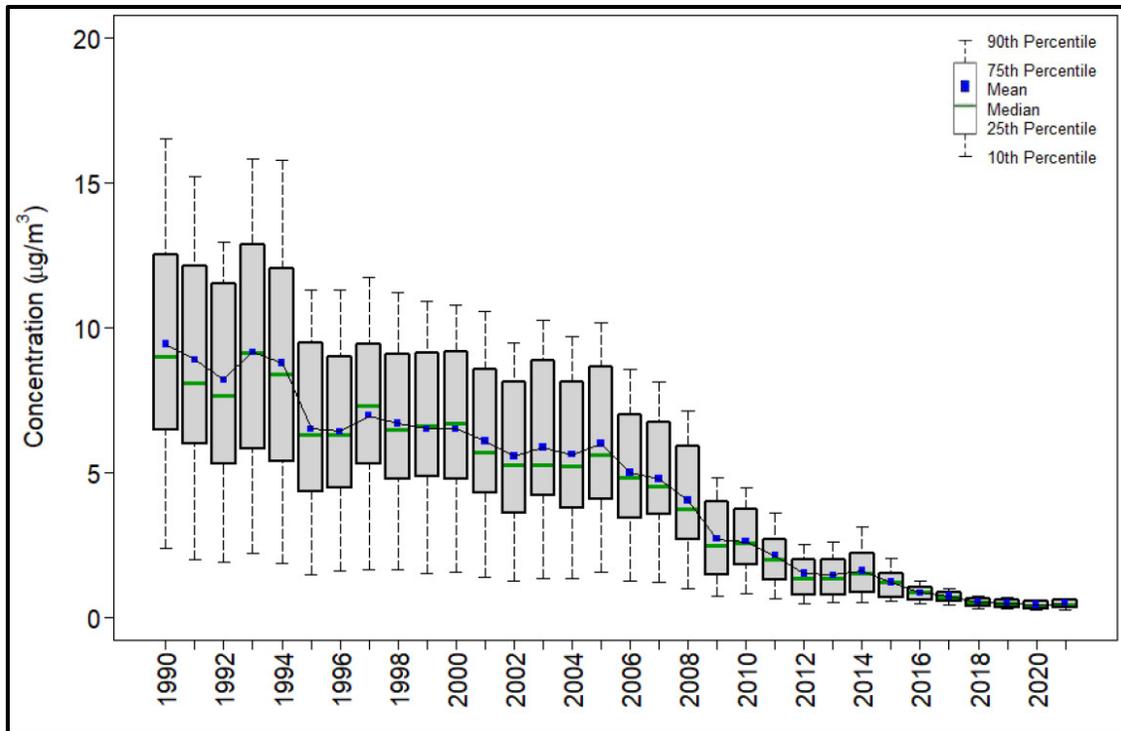
Figure 27. Trends in annual mean SO₂ concentrations – eastern reference sites.
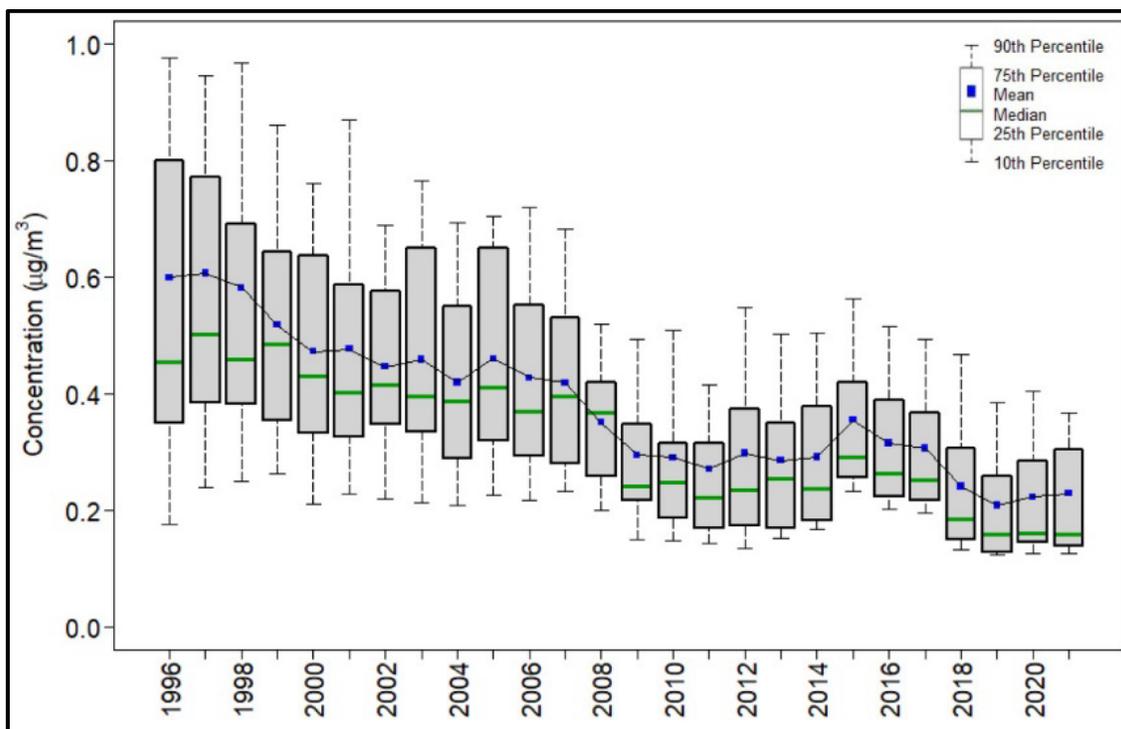
Figure 28. Trends in annual mean SO₂ concentrations – western reference sites.

The NPS also monitors and evaluates deposition to determine parks most at risk and where conditions are declining or improving (NPS 2022). Nitrogen deposition conditions, which are 5-year averages from

2018 through 2022, are fair to poor with an improving trends observed at Bandelier, though trend data are unavailable for many locations (Table 58). Sulfur deposition conditions are good to poor with trend data also unavailable for most locations. Additional deposition information can be found at http://www.nationalforestairqualityconditions.com/ for USFS lands.

Table 58. Nitrogen and Sulfur Deposition Conditions at Class I Areas

State	Class I Area	Nitrogen (Conditions/Trend)	Sulfur (Conditions/Trend)
New Mexico	Bandelier National Monument	Fair / Relatively Unchanging Trend	Good / Improving
	Bosque del Apache	n/a	n/a
	Carlsbad Caverns	Poor / Trend Not Available	Poor / Trend Not Available
	Gila Wilderness	Poor / Trend Not Available	Good / Trend Not Available
	Pecos Wilderness	Poor / Trend Not Available	Good / Trend Not Available
	Salt Creek Wilderness	n/a	n/a
	San Pedro Parks Wilderness	n/a	n/a
	Wheeler Peak Wilderness	n/a	n/a
	White Mountain Wilderness	n/a	n/a
Texas	Big Bend National Park	Poor / Relatively Unchanging Trend	Fair / Relatively Unchanging Trend
	Guadalupe Mountains National Park	Poor / Relatively Unchanging Trend	Fair / Relatively Unchanging Trend
Oklahoma	Wichita Mountains Wilderness	n/a	n/a

Source: NPS (2022).

n/a = Deposition condition data not available due to lack of monitoring data.

9   CUMULATIVE EFFECTS

More specific information about sources in New Mexico oil and gas producing regions that have the greatest impacts on air quality and GHGs is included below. The CEQ regulations define cumulative effects as "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 actions" (40 C.F.R. § 1508.7).

9.1   CURRENT AND REASONABLY FORESEEABLE CONTRIBUTIONS TO CUMULATIVE EFFECTS

A list of major sources (sources emitting more than 100 tpy of CO, VOC, NO_x, SO_2, $PM_{2.5}$, or PM_{10}) in New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix D. Any of these sources may contribute to cumulative effects within a local or regional context. All major sources represent emissions from the 2020 NEI Report (EPA 2023k).

10   CLIMATE, CLIMATE CHANGE, AND GREENHOUSE GASES

The BLM Specialist Report (BLM 2024a) presents the estimated emissions of GHGs attributable to fossil fuels produced on land and mineral estate managed by the BLM and will be reference throughout this report. The report is focused on estimating GHG emissions from coal, oil, and gas development that is occurring and is projected to occur on the federal onshore mineral estate. The report includes a summary of emissions estimates from reasonably foreseeable federal fossil fuel development and production over the next 12 months, as well as longer-term assessments of potential federal fossil fuel GHG emissions and the anticipated climate change impacts resulting from the cumulative global GHG burden. The report can provide context by disclosing cumulative impacts of GHG emissions from fossil fuel energy leasing and development authorizations on the federal onshore mineral estate relative to several emission scopes and base years. A detailed discussion of climate change science and predicted impacts (Section 4.0), including past and present climate impacts (Section 4.2) and climate change impacts in select states with BLM-authorized fossil fuels (Section 4.4), as well as the existing and reasonably foreseeable GHG emissions associated with BLM actions (Section 7.0), are included in the BLM Specialist Report.

10.1   CLIMATE AND CLIMATE CHANGE

Climate refers to atmospheric conditions (e.g., temperature, humidity, pressure, precipitation, solar radiation, wind) at a particular location averaged over a long period of time. The American Meteorological Society (AMS) defines climate change as "any systematic change in the long-term statistics of climate elements (e.g., temperature, pressure, or wind) sustained over several decades or longer" (AMS 2024). Climatologists commonly use 30-year averages of variables, such as temperature and precipitation, as benchmarks for historical comparison and climate change assessment. NOAA National Centers for Environmental Information (NCEI) climate normals are three-decade averages of climatological variables including temperature and precipitation, updated every 10 years, with the 1991–2020 U.S. climate normals dataset serving as the latest release. It contains average daily and monthly temperature, precipitation, snowfall, heating and cooling degree days, frost/freeze dates, and growing degree days calculated from observations at approximately 15,000 stations (NCEI 2023a). Climate normals representative for each field office are found in the climate normal section of Appendix C. Prevailing wind information is also presented in wind roses in Appendix C but are only available for airports with continuous measurements. Wind roses are a polar plot to visually present wind speed and direction.

Trend analysis is a technique used to estimate future conditions based on historical trends. The main assumption behind trend analysis is that what happened in the past is expected to happen in the future. Average temperature and precipitation and trend information for each New Mexico, Kansas, Oklahoma, and Texas climate division is compiled from the Climate at a Glance Website (NCEI 2024a). The averages for the most recent climate normal period (1991– 2020) are also presented for comparison to the average of all data from 1895 to 2024. Graphical representation of historical annual total precipitation (1895–2024) and trends and historical annual average temperature (1895–2024) and trends are provided in Appendix C.

The driver for the buildup of heat within the climate system is best described in terms of radiative forcing (RF). The term describes the energy balance (i.e., equilibrium), or the difference between solar radiation absorbed by Earth and the energy radiated back to space that will occur given the heliophysics of the sun-earth system and the basic laws of thermodynamics.

On longer time scales, GHG concentrations exert a larger influence on Earth's climate than the higher frequency oscillations that produce natural interannual to multiyear variability. Because GHG emissions dominate other sources of climate variability on the multidecade to century time scale, climate change models can project future states of Earth's climate based on GHG emissions scenarios.

Earth's climate system is complex and interwoven in ways that are not yet fully understood. There are several known climate feedback mechanisms that add uncertainty in terms of timing (fast and slow feedbacks) and overall sensitivity within the evaluation of the climate system. Sensitivity refers to the amount of positive or negative feedback that occurs in response to a given forcing. The feedbacks and processes connecting RF to a climate response can operate on a wide range of time scales. Reaching temperature equilibrium in response to anthropogenic activities (emissions and land use changes) takes decades or longer because some of the climate components—in particular the oceans and—are slow to respond due to their large thermal masses and the long-time scale of circulation between the ocean surface and the deep ocean. Some of the latest available climate feedback research indicates that relatively small changes in RF can initiate stronger responses in some feedback components. This suggests that some of these mechanisms, and the climate in general, may have a higher sensitivity than is currently understood. As with the forcing components, there are also positive and negative feedback mechanisms, and there is a relatively wide range of uncertainty concerning estimates of the climate sensitivity that leaves the subject open to further investigation. To quote directly from Chapter 8 of the Working Group I contribution to the *Climate Change 2014: Synthesis Report* (AR5) (Intergovernmental Panel on Climate Change Climate Change [IPCC] 2014), "In a complex and interconnected system, feedbacks can become increasingly complex, and uncertainty of the magnitude and even direction of feedback increases the further one departs from the primary perturbation, resulting in a trade-off between completeness and robustness, and hence utility for decision-making" (IPCC 2018). Section 4.1 of the BLM Specialist Report provides additional information on climate forcing and feedback.

10.2 GREENHOUSE GASES

Anthropogenic GHGs are commonly emitted air pollutants that include CO_2, CH_4, nitrous oxide (N_2O), and several fluorinated species of gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). CO_2 is by far the most abundant, and more than two-thirds of human-made CO_2 emissions in the United States come primarily from the transportation and electricity production sectors. CH_4 from human activities accounts for approximately 10% of total U.S. GHG emissions and results from primarily agriculture and natural gas and petroleum systems. N_2O emissions from agriculture, fuel combustion, and industrial sources account for approximately 7% of the U.S. total. GHG emissions. The BLM Specialist Report Sections 3.1–3.3 provide more details on these three GHG pollutants.

Atmospheric concentrations of naturally emitted GHGs have varied for millennia, and Earth's climate fluctuated accordingly. However, since the beginning of the industrial revolution around 1750, human activities have significantly increased GHG concentrations and introduced human-made compounds that act as GHGs in the atmosphere. Several types of activities contribute to the phenomenon of climate change, including emissions of GHGs from fossil fuels used as a primary energy source, large wildfires, changes to the natural carbon cycle, and changes to radiative forces and reflectivity (albedo). Concentrations of CO_2, CH_4, and N_2O are now substantially higher than concentrations found in various ice cores dating back to the past 800,000 years. From preindustrial times until today, the global average concentrations of CO_2, CH_4, and N_2O in the atmosphere have increased by around 51%, 166%, and 25%, respectively. Table 59 shows the average global concentrations of CO_2, CH_4, and N_2O in 1750, 2011, and 2023. Atmospheric concentrations of GHGs are reported in ppm and ppb. Section 4.1 of the BLM

Specialist Report provides additional information on historical GHG estimates and the NOAA published Annual Greenhouse Gas Index (AGGI). The AGGI was developed to provide an easily understood standard for expressing the climate-warming influence of long-lived GHGs. Specifically, the AGGI is the ratio of the total direct climate forcing from measured long-lived GHG concentrations compared to the 1990 baseline year (chosen because it is the baseline year for the Kyoto Protocol and the publication year of the first IPCC Scientific Assessment of Climate Change). The AGGI for 2022 was 1.49, which corresponds to a CO_2 equivalent atmospheric concentration of 523 ppm. This represents a 49% increase to climate forcing since 1990 and a 1.8% increase over 2021 levels. Whereas the AGGI does not predict the amount Earth's climate has warmed, it does provide a measure of the effect of GHG emissions on the climate system.

Table 59. Average Global Concentrations of GHGs in Select Years

Greenhouse Gas	Preindustrial 1750	2011	2023	Increase 1750–2023
Carbon dioxide (CO_2)	278 ppm	390.5 ppm	421 ppm[1]	51%
Methane (CH_4)	722 ppb	1,803 ppb	1,923 ppb[2]	166%
Nitrous oxide (N_2O)	270 ppb	324 ppb	337 ppb[2]	25%

Notes: ppm = parts per million; ppb = parts per billion.

[1] The atmospheric CO_2 concentration is the 2023 annual average at the Mauna Loa, Hawaii, station (NOAA 2024). The global atmospheric CO_2 concentration, computed using an average of sampling sites across the world, was 419 ppm in 2023 (NOAA 2024).

[2] The values presented for CH_4 and N_2O are global 2023 annual average mole fractions (NOAA 2024).

10.3 OTHER GASES, ATMOSPHERIC AEROSOLS, AND PARTICULATES

Several gases do not have a direct effect on climate change but indirectly affect the absorption of radiation by impacting the formation or destruction of GHGs. These gases include CO, NO_X, and non-CH_4 VOCs. Fossil fuel combustion and industrial processes account for most emissions of these indirect GHGs. Unlike other GHGs, these gases are short lived in the atmosphere.

Atmospheric aerosols (PM) also contribute to climate change. Aerosols directly affect climate by scattering and absorbing radiation (aerosol-radiation interactions) and indirectly affect climate by altering cloud properties (aerosol-cloud interactions). PM_{10} typically originate from natural sources and settle out of the atmosphere in hours or days. $PM_{2.5}$ often originate from human activities such as fossil fuel combustion. These so-called "fine" particles can exist in the atmosphere for several weeks and have local short-term impacts on climate. Aerosols can also act as cloud condensation nuclei, the particles upon which cloud droplets form.

Light-colored particles, such as sulfate aerosols, reflect and scatter incoming solar radiation, having a mild cooling effect, while dark-colored particles (often referred to as "soot" or "black carbon") absorb radiation and have a warming effect. There is also the potential for black carbon to deposit on snow and ice, altering the surface albedo (or reflectivity), and enhancing melting. There is high confidence that aerosol effects resulted in negative RF, offsetting a substantial portion of the positive RF resulting from the increase in GHGs, but the magnitude of their effects contribute the largest uncertainty to our understanding of climate (IPCC 2022).

10.4 THE NATURAL GREENHOUSE EFFECT

The natural greenhouse effect is critical to the discussion of climate change. The greenhouse effect refers to the process by which GHGs in the atmosphere absorb heat energy radiated by Earth's surface. Water vapor is the most abundant GHG, followed by CO_2, CH_4, N_2O, and several trace gases. Each of these GHGs exhibit a particular "heat trapping" effect, which causes additional heat retention in the atmosphere that would otherwise be radiated into space. The greenhouse effect is responsible for the earth's warm atmosphere and temperatures suitable for life on Earth. Different GHGs can have different effects on the earth's warming due to their ability to absorb energy ("radiative efficiency") and how long they stay in the atmosphere ("lifetime"). Without the natural greenhouse effect, the average surface temperature of the earth would be about zero degrees Fahrenheit (°F). Water vapor is often excluded from the discussion of GHGs and climate change since its atmospheric concentration is largely dependent upon temperature rather than being emitted by specific sources.

11 GREENHOUSE GAS REGULATORY ANALYSIS

11.1 FEDERAL RULES

Originally, the NSPS OOOOa – Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after September 18, 2015, and on or before December 6, 2022, draft and rule were promulgated to regulate VOCs and GHG (CH_4) emissions from specific sources within the oil and natural gas industry, which would have included new, modified, and reconstructed compressors, pneumatic controllers, pneumatic pumps, storage vessels, well completions, fugitive emissions from well sites and compressor stations, and equipment leaks at natural gas processing plants. NSPS OOOO – Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after August 23, 2011, and on or before September 18, 2015, requires reduction of VOCs from well completion operations and storage tanks constructed after August 23, 2011. NSPS OOOOa requires reduction of VOCs from well completion operations from new or refractured hydraulically fractured wells and requires reduction of storage tank emissions by 95% for tanks constructed after September 18, 2015, with emissions greater than 6 tpy of VOCs (which has the co-benefit of reducing CH_4 emissions as well). NSPS OOOOa also imposes semiannual leak detection and repair requirements for the collection of fugitive emission components at well sites constructed after September 18, 2015, that produce more than 15 barrels of oil equivalent (boe) per day. NSPS OOOOa also requires scheduled maintenance and/or emission control devices for reciprocating and centrifugal compressor venting at compressor stations and includes provisions to limit emissions from natural gas pneumatic devices and pumps. In September 2018 and August 2019, the EPA proposed changes to the rule to modify, amend, and/or rescind requirements for the 2012 and 2016 NSPS for the oil and gas industry, which have been incorporated into the final rule as of September 14, 2020. Following the 2020 amendment to OOOO and OOOOa, fugitive emissions monitoring is required only for those wells producing greater than 15 boe per day. These provisions aim to reduce fugitive emissions of VOCs at oil and gas facilities.

On March 8, 2024, EPA published a final rule, NSPS OOOOb—Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After December 6, 2022, that will sharply reduce emissions of methane and other harmful air pollution from oil and natural gas operations—including, for the first time, from existing sources nationwide. The final action includes NSPS to reduce methane and smog-forming VOCs from new, modified and reconstructed sources. It also includes emissions guidelines, which set procedures for states to follow as they develop plans to limit methane from existing sources (Subpart OOOOc). In May 2024, EPA notified petitioners

that it is granting reconsideration on two aspects of its final NSPS OOOOb in response to petitions from industry. The reconsideration will address narrow technical issues raised by industry petitioners related to monitoring and emergency operations for flares that were included in the final rule, which was published March 8, 2024. Through the reconsideration process, EPA intends to propose and take public comment on minor changes to the final rule in response to these petitions. Together, 40 C.F.R. 60, Subparts OOOO thru OOOOc, serve to control methane emissions from oil and natural gas industry sources by requiring reduced emissions completions ("green" completions) on new hydraulically fractured gas wells as well as emissions controls on pneumatic controllers, pumps, storage vessels, and compressors. EPA estimates the updated rules will avoid 58 million tons of methane emissions, 16 million tons of VOCs, and approximately 590,000 tons of air toxics from now until 2038.

11.2 COUNCIL ON ENVIRONMENTAL QUALITY NEPA GUIDANCE

The CEQ on May 1, 2024, published its Phase II regulations under the NEPA. As part of a multiphase effort to amend the NEPA regulations that straddled the statutory amendments under the Fiscal Responsibility Act (FRA) of 2023, the stated goals of the Phase II regulations are to provide for an effective environmental review process; ensure full and fair public engagement; enhance efficiency and regulatory certainty; and promote sound federal agency decision-making that is grounded in science, including consideration of relevant environmental, climate change, and environmental justice effects. Though NEPA's statutory and regulatory provisions remained relatively unchanged since the 1970s, recent years have brought numerous changes in rapid succession beginning with a comprehensive revision of the 1978 regulations in 2020, followed closely by the relatively modest Phase I revisions in 2022 that largely sought to reincorporate certain provisions from the 1978 regulations and comprehensive revisions to the statute itself in 2023 that statutorily incorporated several concepts from the 2020 regulations. The key changes in CEQ's Phase II include:

- Threshold Determinations: CEQ's Phase II redefines several key terms that affect agencies' threshold determination regarding the proper level of analysis under NEPA for the proposed action (e.g., a finding of no significant impact [FONSI], EA, or environmental impact statement [EIS]).

- Recent NEPA Amendments: CEQ's Phase II includes and builds upon new provisions added to NEPA under the FRA, including timelines for when agencies can "tier" to an existing programmatic analysis and provisions regarding agencies' use of categorical exclusions (CEs).

- Environmental Justice (EJ): CEQ's Phase II includes several requirements that agencies consider, analyze, or mitigate impacts to "communities with environmental justice concerns," including impacts to the rights of Tribal Nations, when implementing NEPA. The proposal would also adopt a definition of environmental justice consistent with President Biden's recent executive order on Revitalizing Our Nation's Commitment to Environmental Justice for All, and strengthen community consultation and engagement processes.

The May 2024 CEQ guidance, effective July 1, 2024, includes the following guidance:

- Sets deadlines and page limits for environmental reviews

- Requires designation of lead agency and sets expectations for lead, joint lead, and cooperating agencies

- Expands use of programmatic environmental reviews

- Allows agencies to adopt other agencies' CEs

- Requires analysis of the adverse effects of no action

- Requires documents to be prepared with professional integrity, including scientific integrity, and use reliable data and resources

- Establishes roles when applicants and contractors are involved

- Updates definitions, including major federal action

- Creates more flexible methods to establish CEs

- Expands the use of programmatic reviews and tiering

- Adds clarity on supplementation and reevaluation of EISs and EAs

- Clarifies adoption of EISs, EAs, and CE determinations

- Clarifies that agencies may prepare a "mitigated FONSI"

11.3 GREENHOUSE GASES IN NEPA

The May 2024 CEQ guidance, effective July 1, 2024, also includes the following NEPA guidance related to GHGs:

- Quantify a proposed actions and alternatives reasonably foreseeable GHG emissions (including direct and indirect emissions).

- Provide context for the GHG emissions associated with a proposed action and alternatives.

- Analyze reasonable alternatives, including those that would reduce GHG emissions relative to baseline conditions, and identify available mitigation measures to avoid, minimize, or compensate for climate effects.

- Consider the effects of climate change on a proposed action.

11.4 MONETIZED IMPACTS FROM GREENHOUSE GAS EMISSIONS

The "social cost of carbon," "social cost of nitrous oxide," and "social cost of methane"—together, the "social cost of greenhouse gases" (SC-GHG)—are estimates of the monetized damages associated with incremental increases in GHG emissions in a given year. However, they do not constitute a complete cost-benefit analysis nor do the SC-GHG numbers present a direct comparison with other impacts analyzed in this document. SC-GHG is only useful as a measure of the benefits of GHG emissions reductions to inform agency decision-making.

For federal agencies, the best currently available estimates of the SC-GHG are the interim estimates of the social cost of carbon dioxide, methane, and nitrous oxide developed by the Interagency Working Group (IWG) on the SC-GHG. The IWG's SC-GHG estimates are based on complex models describing how GHG emissions affect global temperatures, sea level rise, and other biophysical processes; how these changes affect society through, for example, agricultural, health, or other effects; and monetary estimates of the market and nonmarket values of these effects. One key parameter in the models is the discount rate, which is used to estimate the present value of the stream of future damages associated with emissions in a particular year. A higher discount rate assumes that future benefits or costs are more heavily discounted than benefits or costs occurring in the present (i.e., future benefits or costs are

a less significant factor in present-day decisions). The current set of interim estimates of SC-GHGs have been developed using three different annual discount rates: 2.5%, 3%, and 5% (IWG on Social Cost of Greenhouse Gases 2021).

To address uncertainty in the estimates, the IWG recommends reporting four SC-GHG estimates in any analysis. Three of the SC-GHG estimates reflect the average costs from the multiple simulations at each of the three discount rates. The fourth value represents higher-than-expected economic impacts from climate change. Specifically, it represents the 95th percentile of impacts estimated, applying a 3% annual discount rate for future economic effects. This is a low-probability but high-impact scenario and represents an upper bound of impacts within the 3% discount rate model.

Select estimates are published in the Technical Support Document (IWG 2021), and the complete set of annual estimates are available on the Office of Management and Budget website (Office of Management and Budget 2021).

The SC-GHGs associated with estimated emissions from future potential development of lease parcels are calculated and reported on a lease-sale level. The SC-GHGs are also disclosed at the APD level. These estimates would represent the present value (from the perspective of the current year) of future market and nonmarket costs associated with CO_2, CH_4, and N_2O emissions from potential well development and operations and potential end use. These estimates are calculated based on IWG estimates of social cost per metric ton (t) of emissions for a given emissions year (for the life of the lease/project) and BLM estimates of emissions in each year.

11.5 PSD AND TITLE V

GHGs became regulated pollutants on January 2, 2011, under the PSD and Title V Operating Permit Programs because of their contribution to global climate change effects. These gases absorb energy emitted from Earth's surface and re-emit a larger portion of the heat back to Earth, rather than allowing the heat to escape into space, than would be the case under more natural conditions. The EPA GHG Tailoring Rule (40 C.F.R. §§ 51, 52, 70, et al.) set initial emissions thresholds for PSD and Title V permitting based on carbon dioxide equivalent (CO_2e). These thresholds apply to stationary sources that emit greater than 100,000 tons CO_2e per year (e.g., power plant, or landfill, etc.) or modifications of major sources with resulting emissions increase greater than 75,000 tons CO_2e per year. However, it is important to note that PSD requirements only apply to GHG emissions from sources that are otherwise required to obtain a PSD permit because they have the potential to emit large amounts of conventional pollutants.

In addition to the Tailoring Rule, the EPA requires reporting of GHGs from facilities with stationary sources that emit 25,000 t CO_2e per year or more in the United States. The Mandatory Reporting Rule (40 C.F.R. § 98, Subpart C) does not require control of GHGs; it only requires that sources above the threshold levels monitor and report emissions. Facilities used for injecting CO_2 for geological sequestration must report net emissions regardless of quantity (40 C.F.R. § 98, Subpart RR). This provides a basis for future EPA policy decisions and regulatory initiatives regarding GHGs. Section 2 of the BLM Specialist Report provides additional regulations and policies for GHGs (BLM 2024a).

11.6 EXECUTIVE ORDERS

EOs and memoranda issued to address the climate crisis have focused on GHG emission reductions and increased renewable energy production. The following is a summary of two of the EOs.

EO 13990, issued on January 25, 2021, focuses on protecting public health and directs all executive departments and agencies to immediately commence work to confront the climate crisis with the goal to improve public health and the environment. Two key directives in this EO are 1) the establishment of an IWG tasked with developing and promulgating costs for agencies to apply during cost-benefit analysis and 2) the rescission of the CEQ draft guidance entitled "Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions" (Federal Register 84:30097). The EO also directs the DOI Secretary to place a temporary moratorium on all oil and gas activities in the Arctic National Wildlife Refuge, revokes the permit for the Keystone XL pipeline, and requires all agency heads to review any agency activity under the prior administration to ensure compliance with the current administration's environmental policies.

EO 14008, issued on January 27, 2021, directs the executive branch to establish climate considerations as an element of U.S. foreign policy and national security and to take a government-side approach to the climate crisis. This EO reaffirms the decision to rejoin the Paris Agreement and commit to environmental justice and new clean infrastructure projects, establishes a National Climate Task Force and puts the United States on a path to achieve net-zero emissions by no later than 2050. Specific directives for the DOI and the BLM include increasing renewable energy production on public land and waters, performing a comprehensive review of potential climate and other impacts from oil and natural gas development on public land, establishing a civilian climate corps, and working with key stakeholders to achieve a goal of conserving at least 30% of the nation's lands and waters by 2030.

12 GREENHOUSE GAS EMISSIONS

Current ongoing global climate change is caused, in part, by the atmospheric buildup of GHGs, which may persist for decades or even centuries. The buildup of GHGs, such as CO_2, CH_4, N_2O, and fluorinated gases since the start of the industrial revolution has substantially increased atmospheric concentrations of these compounds compared to historical background levels. Because GHGs circulate freely throughout Earth's atmosphere, climate change is a cumulative global issue.

Common air emissions related to oil and gas activities include CO_2, CH_4, and N_2O. Other industries emit more potent GHGs, including several fluorinated species of gases, such as HFCs, PFCs, and SF_6. CO_2 is emitted from the combustion of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products and as a result of other chemical reactions (e.g., manufacture of cement). The production and transport of coal, natural gas, and oil emit CH_4, which can also be emitted from coal-mining operations, naturally occurring coal CH_4 seepages, releases/leaks from the oil and gas industry, livestock and other agricultural practices, and the decay of organic waste in municipal solid waste landfills. Agricultural and industrial activities emit N_2O, as well as combustion of fossil fuels and solid waste. Fluorinated gases are powerful GHGs that are emitted from a variety of industrial processes and are often used as substitutes for ODS (i.e., chlorofluorocarbons [CFCs], hydrochlorofluorocarbons [HCFCs], and halons), but typically not from oil and gas operations. SF_6 is the most potent (highest radiative efficiency) GHG known and is typically used as an insulator in circuit breakers, gas-insulated substations, and switchgear used in the transmission system to manage the high voltages carried between power-generating stations and customer load centers.

The impact of a given GHG on global warming depends both on its RF and how long it lasts in the atmosphere. Each GHG varies with respect to its concentration in the atmosphere and the amount of outgoing radiation absorbed by the gas relative to the amount of incoming radiation it allows to pass through (i.e., radiative forcing). Different GHGs also have different atmospheric lifetimes. Some, such as CH_4, react in the atmosphere relatively quickly (on the order of 12 years); others, such as CO_2, typically

last for hundreds of years or longer. Climate scientists have calculated a factor, known as the global warming potential (GWP), for each GHG that accounts for these effects.

The GWP is used as a conversion factor to convert a mixture of different GHG emissions into CO_2e. The larger its GWP, the more the specific gas warms the earth as compared to CO_2. The BLM uses the 100-year time horizon for GWPs in most report metrics, to be consistent with the scientific and regulatory communities that develop climate change assessments and policy. The 100-year GWP was adopted by the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol and is now used widely as the default metric by researchers and regulators (BLM 2024a; UNFCC 2021).

Updated GWPs were reported in the 2021 *IPCC Sixth Assessment Report Global Warming Potentials* (AR6) (IPCC 2021) as the level of scientific understanding increased and include the assessment reports of its three working groups, three special reports, a refinement to the methodology report, and the synthesis report. The synthesis report is the last of the AR6 products, released in March 2023. Section 8.3 of the BLM Specialist Report summarizes AR6 details.

GWP values account for changes in radiative properties, atmospheric lifetimes, and indirect contributions of the different gases. The atmospheric lifetimes and GWPs for the major GHGs over the 20-year and 100-year time horizons are listed below in Table 60. CO_2 has a GWP of 1, and for the purposes of analysis, a GHG GWP is generally standardized to O_2, or the equivalent amount of CO_2 mass the GHG would represent. Section 3.4 of the BLM Specialist Report provides additional details on GWPs.

Table 60. AR6 Global Warming Potentials

Greenhouse Gas	GWP Values for 20-Year Time Horizon	GWP Values for 100-Year Time Horizon
Carbon dioxide (CO_2)	1	1
Methane (CH_4)	Fossil origin – 82.5 Nonfossil origin – 79.7	Fossil origin – 29.8 Nonfossil origin – 27.0
Nitrous oxide (N_2O)	273	273
Select hydrofluorocarbons (HFCs)	–	HFC-32 – 771 HFC-134a – 4,144
Sulfur hexafluoride (SF_6)	–	–

Sources: IPCC (2021).

12.1 NATIONAL GREENHOUSE GAS EMISSIONS BY SECTOR

It is useful to compare the relative and absolute contributions to climate change of different GHG emissions, as well as emissions from different regions/countries or sources/sectors. There are several different metrics that can be used for this comparison. A GHG emissions inventory is used to identify and quantify the anthropogenic GHG emissions from different regions/countries or sources/sectors. Using the GWP concept, GHG emissions are often reported in terms of CO_2e.

To meet the obligations of the UNFCCC, the EPA publishes a national inventory of U.S. GHG emissions and sinks on an annual basis (EPA Inventory) (EPA 2024r). The lowest GHG emissions since reporting began, 6,026.0 million metric tons (or megatonnes) (Mt) of CO_2e, occurred in 2020, and the peak GHG

emissions, 7,477.4 Mt CO_2e, occurred in 2005. The largest source of GHG emissions from human activities in the United States is from burning of fossil fuels for electricity, heat, and transportation. Total gross U.S. emissions have decreased by 3.0% from 1990 to 2022; down from a high of 15.2 percent above 1990 levels in 2007. The latest national GHG emissions are for calendar year 2022, in which total gross U.S. GHG emissions were reported at 6,343.2 Mt CO_2e, represents an increase of approximately 0.2% from the previous year corresponding to an increase of 14.4 Mt CO_2e from 2021 to 2022. Net emissions (including sinks) were 5,489.0 Mt CO_2e. Net emissions increased by 1.3% from 2021 to 2022 and decreased by 16.7% from 2005 levels. Between 2021 and 2022, the increase in total greenhouse gas emissions was driven largely by an increase in CO_2 emissions from fossil fuel combustion across most end-use sectors due in part to increased energy use from the continued rebound of economic activity after the height of the coronavirus (COVID-19) pandemic. The CO_2 emissions from fossil fuel combustion increased by 1.0%, CO_2 emissions form natural gas use increased by 5.2%, and CO_2 emissions from petroleum increased by 0.9% from 2021 to 2022. Carbon sequestration in the Land Use, Land-Use Change, and Forestry (LULUCF) sector offset 14.5% of total emissions in 2022 (EPA 2024r). Figure 5.4 in Section 5.3 of the BLM Specialist Report provides an illustration of U.S. GHG emissions (Mt/year) from fossil fuel combustion between 1990 through 2022 (BLM 2024a).

Section 5.3, Table 5-1 of the BLM Specialist Report further breaks down GHG emissions by major source category and shows GHG trends from 1990 to 2022. The pollutant categories reported in the annual inventory report include CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and nitrogen trifluoride (NF_3); source categories vary for each pollutant. The primary GHG emitted by human activities in the United States was CO_2, representing approximately 79.7% of total 2022 GHG emissions on a GWP-weighted basis. The largest source of CO_2 and of overall GHG emission in 2022 was fossil fuel combustion (4,699 Mt). CH_4 emissions from all sectors (760.8 Mt) accounted for 11.1% of U.S. emissions in 2022. The major sources of CH_4 include natural gas systems, enteric fermentation and manure management associated with domestic livestock, and decomposition of wastes in landfills. N_2O emissions accounted for 6.1% of total GHG emissions in 2022 (398.8 Mt). The agricultural sector including fertilizers and soil management and manure management was the largest source of N_2O emissions (BLM 2024a).

The energy sector includes three different subcategories—coal mining, natural gas and petroleum systems, and fossil fuel combustion. The emissions itemized under the coal mining and natural gas and petroleum systems subcategories include emissions for all U.S. sources in each of the categories and are not differentiated by mineral ownership (i.e., federal, state, or private minerals). In 2022, GHG emissions from coal mining subcategory were 46.1 Mt, a decrease of 2.1% from the previous year (BLM 2024a). The coal mining sector includes emissions from underground mining, surface mining, and post-mining activities. In 2022, GHG emissions from the natural gas and petroleum systems subcategory were 271.3 Mt, a decrease of 4.2% from the previous year. The natural gas and petroleum systems sector includes emissions from oil and gas exploration, production, and processing, as well as other sources. In 2022, the total GHG emissions from the fossil fuel combustion subcategory were 4,699.4 Mt, up 1.0% from the previous year. The fossil fuel combustion sector includes emissions from the use of fossil fuels in transportation, electricity generation, industry, and residential use. Approximately 82% (5,199.8 Mt) of the total emissions were from the energy sector, primarily fossil fuel combustion for transportation and electricity generation (BLM 2024a).

12.2 GLOBAL, NATIONAL, STATE, AND COUNTY GREENHOUSE GAS EMISSIONS

Global and national annual GHG emissions and projections, as well as state annual GHG emissions are discussed in Section 5.0 of the BLM Specialist Report (BLM 2024a). The global, national, and state annual gross GHG emissions are presented in Table 61. Global emissions were obtained from the Emissions

Database for Global Atmospheric Research (EDGAR) (EDGAR 2024). National emissions are from the EPA Inventory (EPA 2024r) and Section 5.3, Table 5-1, of the BLM Specialist Report. State emissions for 2022 are from the EPA interactive tool, the Greenhouse Gas Inventory Data Explorer (EPA 2024s). State emissions for 1990, 2005, and 2017 through 2021 are available in Table 5-2, Section 5.5 of the BLM Specialist Report. Note that national- and state-level data are not yet available for 2023.

Table 61. Annual Global, National, and State Gross GHG Emissions (CO₂e) in Megatonnes (Mt) for 2022

Area	2022
Global	53,786
Global Fossil Fuel CO_2	38,522.0
United States	6,343.2
U.S. Fossil Fuel CO_2	4,699.4
New Mexico	76.77
New Mexico Fossil Fuel CO_2	46.74
Oklahoma	134.29
Oklahoma Fossil Fuel CO_2	82.11
Kansas	112.29
Kansas Fossil Fuel CO_2	59.27
Texas	856.67
Texas Fossil Fuel CO_2	594.82

Sources: Tables 5-1 and 5-2 in BLM (2024a); EDGAR (2024); EPA (2024r, 2024s [retrieved 9/16/2024]).

County-level GHG emissions information for New Mexico is available in the 2020 NEI and from the EPA Facility Level Information on GHG Tool (FLIGHT) (EPA 2023k, 2024t). The NEI includes emissions data for mobile sources, prescribed fires, and wildfires, whereas the FLIGHT tool includes emissions data for major industrial facilities. Although emissions data for FLIGHT are updated annually, the 2020 reporting year is shown here to match the 2020 NEI data. The combined county-level anthropogenic GHG emissions from the NEI and FLIGHT datasets are provided in Table 62. At the county level, emissions information is not readily available for residential, commercial, agriculture, and fugitive sources, but these sources account for the difference in state and county total emissions shown in Table 61 and Table 62. Detailed emissions from all source types for each county are also provided in Appendix A.

Table 62. County-Level GHG Emissions (CO₂e) for the 2020 Reporting Year

County	Data Source	CO_2 (t)	CH_4 (t)	N_2O (t)	20-year Total CO₂e (t)	100-year Total CO₂e (t)
Chaves	NEI	384,360	30	6	**388,360**	**386,802**
	FLIGHT	84,247	40	48	**100,651**	**98,543**
Total		**468,607**	**30**	**54**	**613,868**	**610,774**
Eddy	NEI	607,292	59	6	**1,231,284**	**1,197,081**
	FLIGHT	844,135	649	1,222	**676,468**	**674,254**

County	Data Source	CO$_2$ (t)	CH$_4$ (t)	N$_2$O (t)	20-year Total CO$_2$e (t)	100-year Total CO$_2$e (t)
Total		**607,292**	**708**	**1,228**	**4,985,031**	**4,855,493**
Lea	NEI	671,095	42	7	951,197	947,621
	FLIGHT	4,162,410	1,940	2,327	1,801,179	1,703,262
Total		**4,833,505**	**42**	**2,334**	**291,660**	**287,630**
McKinley	NEI	942,776	68	10	25,325	24,797
	FLIGHT	760,371	1,858	3,251	1,086,609	1,082,134
Total		**942,776**	**1,926**	**3,261**	**39,583**	**38,740**
Rio Arriba	NEI	284,211	76	4	827,552	820,271
	FLIGHT	21,223	10	12	35,952,691	33,902,872
Total		**305,434**	**76**	**16**	**172,499**	**170,204**
Sandoval	NEI	1,076,013	85	13	35,320	34,582
	FLIGHT	32,530	16	21	388,360	386,802
Total		**1,108,543**	**85**	**34**	**100,651**	**98,543**
San Juan	NEI	812,711	138	13	613,868	610,774
	FLIGHT	14,220,175	38,896	67,852	1,231,284	1,197,081
Total		**812,711**	**39,034**	**67,865**	**676,468**	**674,254**
Roosevelt	NEI	168,213	44	3	4,985,031	4,855,493
	FLIGHT	29,251	14	18	951,197	947,621
Total		**168,213**	**58**	**21**	**1,801,179**	**1,703,262**

Sources: EPA (2023k, 2024t)

12.3 NATIONAL GREENHOUSE GAS EMISSIONS GREENHOUSE GAS REPORTING PROGRAM (FLIGHT)

The Greenhouse Gas Reporting Program (GHGRP) is codified by regulation (40 C.F.R. § 98) and requires reporting of GHG data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO_2 injection sites in the United States. In total, 41 categories are covered by the program. Facilities are generally required to submit annual reports under 40 C.F.R. § 98 if:

- GHG emissions from covered sources exceed 25,000 t CO_2e per year.

- Supply of certain products would result in over 25,000 t CO_2e of GHG emissions if those products were released, combusted, or oxidized.

- The facility receives 25,000 t or more of CO_2 for underground injection.

The reported data are usually made available to the public in October of each year. It should be noted that the GHGRP does not represent total U.S. GHG emissions but provides facility-level data for large sources of direct emissions, thus representing most of U.S. GHG emissions. The GHGRP data collected

from direct emitters represent about half of all U.S. emissions. When including GHG information reported to the GHGRP by suppliers, emissions coverage reaches approximately 85% to 90% (EPA 2024u). The EPA Inventory contains information on all GHG emissions sources and sinks in the United States (EPA 2024r). For more information, please visit https://www.epa.gov/ghgreporting.

12.3.1 COMPRESSOR ENGINES AND STATIONS (MIDSTREAM) REPORTED GREENHOUSE GAS EMISSIONS

Compressor engines link the natural gas pipeline infrastructure that transports natural gas from its source to points of consumption. Table 63 shows the GHG emissions from transmission compressor stations and gas plants for each state where BLM NMSO has mineral estate (from FLIGHT). Some gas plants and compressor stations emissions may not be reported to FLIGHT because emissions from the plant or station do not exceed EPA GHG reporting threshold. Additionally, there are gathering compression stations that are not considered "point sources" under the Mandatory Reporting Rule, which are instead reported under the oil and gas gathering and boosting industry segment.

Table 63. 2022 Midstream GHG from Gas Plants and Compressor Stations

State	Number of Reporting Transmission Compressor Stations	Total GHG Emissions from Reporting Compressor Stations (Mt CO_2e)	% U.S. Total Reported Compressor Station GHG Emissions	Number of Reporting Gas Plants	Total GHG Emissions from Reporting Gas Plants (Mt CO_2e)	% U.S. Total Reported Gas Plant GHG Emissions
New Mexico	17	0.74	2.11%	24	3.6	6.10%
Texas	112	5.9	16.86%	208	27	45.76%
Oklahoma	20	0.54	1.54%	45	2.5	4.24%
Kansas	22	0.60	1.71%	5	0.70	1.19%

Source: EPA (2024t). Data accessed September 17, 2024. Selected Petroleum and Natural Gas Systems and Natural Gas Transmission/Compression for Transmission Compressor Station values. Total United States GHG Emissions from Reporting Compressor Stations is 35 Mt CO_2e. Selected Petroleum and Natural Gas Systems and Natural Gas Processing for Gas Plants values. Total United States GHG Emissions from Reporting Gas Plants is 59 Mt CO_2e.

Emissions from the United States oil and gas "point sources," which include natural gas processing, natural gas transmission and compression, onshore natural gas transmission pipelines, natural gas local distribution companies, underground natural gas storage and liquified natural gas storage, totaled 109 Mt CO_2e in 2022, which was about 4.04% of the total 2,695 Mt CO_2e emissions reported to EPA for the United States in 2022 (EPA 2024t). Emissions from the onshore oil and gas gathering and boosting segment, which includes compressor stations, meter stations, gathering pipelines, and other miscellaneous midstream oil and gas support facilities, totaled 86 Mt CO_2e in 2022 (EPA 2024t).

12.3.2 REFINERIES (MIDSTREAM) REPORTED GREENHOUSE GAS EMISSIONS

Crude oil produced throughout the BLM NMSO area of operations is transported by pipeline and/or tanker truck to refineries where the oil is processed into various types of fuel. Table 64 shows the GHG emissions from refineries in each BLM NMSO state.

Table 64. 2022 Greenhouse Gas Emissions from Refineries

State	Number of Reporting Refineries	Total GHG Emissions from Reporting Refineries (Mt CO_2e)	% U.S. Total Reported Refinery GHG Emissions
New Mexico	3	0.79	0.48%
Texas	31	55.0	32.73%
Oklahoma	5	4.4	2.48%
Kansas	3	3.2	1.88%

Source: EPA (2024t).

There are three refineries in New Mexico: one in Jamestown (Gallup Refinery), one in Artesia, and one in Lovington. Kansas has three refineries, Oklahoma has five refineries, and Texas has 31 refineries. Transportation and processing of crude oil and petroleum products result in emissions of various HAPs, criteria pollutants, and GHGs. In 2022, GHG emissions from refineries (total of 135 reporting) accounted for 164 Mt CO_2e emitted, which is 6.09% of the 2022 total 2,695 Mt CO_2e emissions reported to EPA (EPA 2024u).

12.3.3 OTHER MAJOR INDUSTRIES GENERATING GREENHOUSE GAS EMISSIONS

Potash mining is another major industry in the BLM CFO area. The two potash minerals mined in New Mexico are sylvite (potassium chloride) and langbeinite (potassium-magnesium sulfate). The minerals are mined from two underground mines and one solution mine which involve Federal potassium leases in southeastern New Mexico. Potash production produces emissions of various HAPs, criteria pollutants, and GHGs. In 2015, potash mines in southeastern New Mexico emitted 97,140 t of CO_2e collectively. This is 0.002% of total U.S. GHG emissions (EPA 2023k). In 2016, CO_2e emissions decreased significantly, as some facilities discontinued reporting GHG emissions for valid reasons: operations had ceased, operations were changed such that a process or operation no longer meets the "Definition of Source Category," the entire facility or supplier was merged into another facility or supplier that already reports to the GHGRP, the facility reported emissions or quantity of GHG supplied of less than 15,000 t CO_2e for 3 consecutive years, or the facility reported emissions or quantity of GHG supplied of less than 25,000 t CO_2e for 5 consecutive years. Thus, in 2019 the emissions from Intrepid Potash reported only 8,109 t CO_2e, which is 0.0001% of total U.S. GHG emissions. As of 2021, 0 t of CO_2e were reported.

Coal mining and coal-fired power generation are major industries in San Juan County, New Mexico. Coal production produces emissions of various HAPs, criteria pollutants, and GHGs. In 2022, the San Juan Mine reported 0.37 Mt CO_2e, whereas data for the Navajo Mine were not available. In 2022, underground coal mining in the United States contributed 26.5 Mt CO_2e, which is 0.42% of total United States GHG emissions (EPA 2024u).

The 2020 NEI data for San Juan County include emissions from the San Juan Generating Station near Waterflow, New Mexico, and the Four Corners Power Plant on Navajo Nation land in Fruitland, New Mexico. Both were PSD major sources subject to BART requirements to comply with the Regional Haze Rule. Two electric generating units (EUs) at the San Juan Generating Station were shut down in December 2017, and new selective catalytic reduction (SRD) technology was installed on the two remaining EGUs. The 2020 NEI data take into account the EGU shutdowns and the new SCR system technology; subsequently, the San Juan Generating Station was closed in September 2022, removing all EGUs associated with this facility. Two EGUs have been shut down at the Four Corners Power Plant, and

the remaining two EGUs had SCR technology installed in 2018. The shutdown of San Juan Generating Station and two EGUs at the Four Corners Power Plant and the installation of SCR technology at the Four Corners Power Plant are expected to result in significant emissions reductions.

In Texas, EGUs in O_3 nonattainment areas (Beaumont-Port Arthur, Dallas-Fort Worth and Houston-Galveston-Brazoria) are required to limit NO_x emissions from utility boilers, auxiliary steam boilers, stationary gas turbines, and duct burners under 30 T.A.C. § 117(c). The Texas-proposed regional haze SIP did not require BART-eligible EGUs to install controls because the State of Texas determined the impact of each plant's emissions did not significantly degrade visibility in a Class I area or facilities had already reduced emissions or shut down units. On December 16, 2014, the EPA proposed to partially disapprove the Texas regional haze SIP and also proposed a Federal Implementation Plan to require SO_2 emissions reductions at 15 Texas BART-eligible sources.

In Oklahoma, Tulsa Public Service Company of Oklahoma retired one coal-fired EGU in Oologah, Oklahoma, and installed a dry sorbent injection system on a second coal-fired EGU in April 2016. A second EGU will be shut down by December 31, 2026, to meet the requirements of the Regional Haze Rule. In 2016, SO_2 emissions were reduced by 78%, and NO_2 emissions were reduced by 81%.

In 2011, EPA disapproved the Oklahoma SIP revision plan for controls at the Oklahoma Gas and Electric Sooner and Muskogee Units and the American Electric Power (AEP)–Public Service Company of Oklahoma (PSO) Northeastern Plant Units 3 and 4. The EPA determined that dry scrubber control technology was needed at these units to meet Regional Haze Rule requirements. The disapproval was challenged by the State of Oklahoma, upheld by the courts, and has been appealed to the Supreme Court by the State of Oklahoma. Oklahoma submitted a SIP revision in 2013 that was approved by EPA in March 2014, which revises the BART determination for AEP-PSO Units 3 and 4. The revised determination includes short-term compliance with emissions limits, shut down of one of the units by April 16, 2016, and shut down of the other unit by December 31, 2026.

In Kansas, emissions at four coal-fired EGUs were significantly reduced as a result of the Regional Haze Rule. At the Kansas City Power and Electric La Cygne Power Plant, an SCR system was installed on both units, and air scrubbers were installed. These actions resulted in an 83% reduction in NO_x emissions and an 82% reduction in SO_2 emissions. Installing low-NO_x burners and switching to natural gas combustion at the Westar Energy Jeffrey Energy Center coal-fired EGUs resulted in an 82% reduction in NO_x emissions and a 34% reduction in SO_2 emissions. In addition, EPA has issued final carbon pollution standards for power plants that set CO_2 limits for new gas-fired combustion turbines and CO_2 emission guidelines for existing coal, oil and gas-fired steam generating units, securing important climate benefits and protecting public health (NSPS TTTTa).

13 CLIMATE CHANGE PROJECTIONS

13.1 REPRESENTATIVE CONCENTRATION PATHWAYS

Section 8.0 of the BLM Specialist Report provides information on projected climate change. Section 8.1 of the BLM Specialist Report discusses four global emissions scenarios known as representative concentration pathways (RCPs), which are used by climate scientists in projection analyses. The RCPs are not fully integrated scenarios of climate feedback, policy, emissions limits, thresholds, or socioeconomic projections but rather a consistent set of cumulative emissions projections out to year 2100 of only the components of RF that are meant to serve as input for climate and atmospheric chemistry modeling. By

2050, the magnitude of projected climate change is substantially affected based on which of the four scenarios is considered. More details are in Section 8.1 of the BLM Specialist Report.

13.2 SHARED SOCIOECONOMIC PATHWAYS

Section 8.2 of the BLM Specialist Report discusses the range of "pathways," collectively known as the Shared Socioeconomic Pathways (SSPs), that examine how global society, demographics, and economics might influence future climate impacts, vulnerabilities, adaptation, and mitigation over the next century. The RCPs and SSPs are meant to complement each other. The RCPs set pathways for GHG concentrations and the potential amount of RF and warming the world may experience by the end of the century. The SSPs explore how reductions in emissions will, or will not, be achieved and can therefore be thought of as potential mitigation alternatives. The SSPs were used to inform the latest round of climate modeling that was incorporated into AR6 and are discussed in more detail in Section 8.2 of the BLM Specialist Report.

13.3 GLOBAL CLIMATE CHANGE PREDICTIONS

The EIA provides long-term (2020–2050) world energy and emissions projections in its International Energy Outlook (IEO). As of June 2024, the most recent IEO that contains CO_2 emissions data is the IEO2023, released in October 2023. The IEO provides several different scenarios to forecast future energy needs and associated carbon emissions. The reference case reflects current trends and relationships among supply, demand, and prices in the future and is a reasonable baseline case to compare with cases that include alternative assumptions about the future energy system. Details regarding the IEO reference case assumptions for global energy consumption, natural gas consumption, petroleum growth, and global energy-related CO_2 emissions are provided in Section 5.2 of the BLM Specialist Report. Although aggregate CO_2 emissions from the energy sector are projected to continue to rise, the carbon intensity of future energy sources (i.e., the amount of CO_2 emissions produced per unit of energy used) is projected to decrease, indicating that sources of energy that do not produce CO_2 emissions (e.g., renewables) will comprise a larger portion of meeting future energy demands. Figure 5-3 of the BLM Specialist Report, which are EIA IEO graphs, shows some of the historical and projected energy and emissions estimates derived from global fossil fuel use.

13.4 REGIONAL CLIMATE CHANGE PREDICTIONS

The following climate change discussion summarizes information from the BLM Specialist Report regarding the fourth national climate assessment (NCA4) and NOAA state climate summaries for New Mexico, Kansas, Oklahoma, and Texas. Section 8.4 of the BLM Specialist Report provides more details on state climate summaries. Figure 8-4 in the BLM Specialist Report provides projected temperature changes for the presented states relative to a low- and high-emissions scenario (RCPs 4.5 and 8.5) analyzed by the NCA. Section 8.5 of the BLM Specialist Report discusses the effects of climate change on public health and safety.

Climate modeling suggests that average temperatures in the New Mexico region may rise by 4°F to as much as 12°F by the end of the twenty-first century, depending on the emissions scenario. Although projections of annual precipitation are uncertain, more precipitation falling as rain is very likely to occur as temperatures increase (BLM 2024a).

The U.S. Bureau of Reclamation (Reclamation) et al. (2013) made the following projections through the end of the twenty-first century for the Upper Rio Grande Basin (southern Colorado to south-central New Mexico) based on the current and predicted future warming:

- There will be decreases in overall water availability by one-quarter to one-third.

- The seasonality of stream and river flows will change with summertime flows decreasing.

- Stream and river flow variability will increase. The frequency, intensity, and duration of both droughts and floods will increase.

The Reclamation *West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment* also noted that reduction in water is expected to make environmental flows in the Upper Rio Grande system more difficult to maintain and reduce the shallow groundwater available to riparian vegetation (Reclamation et al. 2013). Both effects have implications for the habitat of fish and wildlife in the Upper Rio Grande Basin riparian ecosystems. A USFS assessment of 117 species of birds, reptiles, amphibians, and mammals along the Middle Rio Grande in New Mexico (Friggens et al. 2013, as cited in Reclamation et al. 2013) projected decreasing availability of riparian habitat and loss of mature trees due to fire and disease, which would directly and indirectly affect many species of birds and mammals. Most evaluated species were projected to experience negative effects from climate change; however, a few species that are considered generalists and highly adaptable, such as coyotes, jackrabbits, some lizards, and road runners, may benefit from conversion of the riparian area associated with the Rio Grande to a more sparsely vegetated and drier habitat (Friggens et al. 2013, as cited in Reclamation et al. 2013).

Observed temperatures are generally within the envelope of model simulations of the historical period (Figure 9-3 in Reclamation et al. 2013). Historically unprecedented warming is projected during the twenty-first century. Less warming is expected under a lower emissions future, where the average daily maximum temperature could rise by as much as 6°F, in contrast to the higher emissions scenario that could lead to average daily maximums that are 11°F warmer than the historical record.

Texas, Oklahoma, and Kansas are part of the Great Plains region, which will see increases in temperatures and more frequent drought in the future. Temperature increases and precipitation decreases will stress the region's primary water supply, the Ogallala Aquifer. Seventy percent of the land in this area is used for agriculture. Threats to the region associated with climate change include:

- pest migration as ecological zones shift northward,

- increases in weeds, and

- decreases in soil moisture and water availability (Reclamation et al. 2013).

13.4.1 STATE CLIMATE CHANGE TRENDS AND PREDICTIONS

NOAA National Centers for Environmental Information released its climate summaries by state in 2022. The key messages bulleted below in Sections 13.4.1.1 through 13.1.1.4 represent climate summary information for each state within the BLM NMSO area of operations. More detailed climate discussions for each state can be found through the State Climate Summaries webpage (NOAA 2022b). Section 4.4 of the BLM Specialist Report also discusses the climate change indicators, impacts, and trends, authorizations including NOAA precipitation and temperature data, specific to states where the BLM conducts most of its fossil fuel (BLM 2024a).

13.4.1.1 NEW MEXICO

- Average annual temperature has increased by almost 2°F since the beginning of the twentieth century, and the number of extremely hot days and warm nights has also increased. Historically unprecedented future warming is likely.

- The summer monsoon rainfall, which provides much needed water for agricultural and ecological systems, varies greatly from year to year and future trends in such precipitation are highly uncertain.

- Droughts are a serious threat in this water-scarce state. Drought intensity is projected to increase, and snowpack accumulation is projected to decrease, which will pose a major challenge to New Mexico environmental, agricultural, and human systems. Wildfire frequency and severity are projected to increase in New Mexico (Frankson, Kunkel, Stevens, and Easterling 2022).

13.4.1.2 OKLAHOMA

- Average annual temperature has increased by about 0.6°F since the beginning of the twentieth century. Winter warming has been characterized by the much below average occurrence of extremely cold days since 1990. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

- Precipitation can vary greatly from year to year in this region of transition from humid to semi-arid conditions. Extreme precipitation events are projected to increase, which may increase the risk of flooding and associated increases in soil erosion and non-point-source runoff into streams and lakes.

- The agricultural economy of Oklahoma makes the state particularly vulnerable to droughts, several of which have occurred in recent years. Higher temperatures will increase the rate of soil moisture depletion, leading to an increase in the intensity of naturally occurring future droughts (Frankson, Kunkel, Stevens, Champion, Stewart, and Nielsen-Gammon 2022).

13.4.1.3 KANSAS

- Average annual temperature has increased about 1.5°F since the beginning of the twentieth century, with greater warming in the winter and spring than in the summer and fall. The number of very cold nights has been much below average since 1990. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

- Precipitation has varied greatly from year to year in this region of transition from humid conditions in the east of the state to semi-arid conditions in the west. Projected increases in winter precipitation and decreases in summer precipitation may result in both beneficial and negative impacts.

- The agricultural economy of Kansas makes the state vulnerable to droughts and heat waves, several of which occurred in the 1930s, 1950s, and in recent years. Projected increases in temperatures may increase the intensity of future droughts. The frequency of wildfire occurrence and severity is also projected to increase in Kansas (Frankson, Kunkel, Stevens, Easterling, Lin, Shulski, Umphlett, and Stiles 2022).

13.4.1.4 TEXAS

- Mean annual temperature has increased by almost 1.5˚F since the beginning of the twentieth century. Under a higher emissions pathway, historically unprecedented warming is projected during this century, with associated increases in extreme heat events.

- Although projected changes in annual precipitation are uncertain, increases in extreme precipitation events are projected. Higher temperatures will increase soil moisture loss during dry spells, increasing the intensity of naturally occurring droughts.

- Future changes in the number of landfalling hurricanes in Texas are difficult to project. As the climate warms, increases in hurricane rainfall rates, storm surge height due to sea level rise, and the intensity of the strongest hurricanes are projected (Runkle, Kunkel, Nielson-Gammon, Frankson, Champion, Stewart, Romolo, and Sweet 2022).

13.5   NEW MEXICO GREENHOUSE GAS TRENDS

Overall, total New Mexico statewide gross GHG emissions are expected to decrease (Energy and Environmental Economics, Inc. [E3] 2020). The *New Mexico Greenhouse Gas (GHG) Emissions Inventory and Forecast* (E3 2020) projects the following for year 2030 in New Mexico for emissions produced within the state (i.e., production-based emissions):

- Gross GHG emissions of 96.6 Mt CO_2e—an increase of 22% relative to 2005 and a decrease 15% relative to 2018. New Mexico emissions are more than twice the national average of GHG emissions per capita. High per-capita emissions for New Mexico are largely the result of a GHG-intensive oil and gas industry, which makes up a significant portion of overall GHG emissions profile.

- Top sources of GHG emissions: transportation fuel use (15.4 Mt CO_2e,), electricity generation (12.9 Mt CO_2e,), and oil and gas (fugitive and fuel emissions) (32.5 Mt CO_2e). Transportation fuel and electricity generation decreased over 2005 estimates, but oil and gas increased.

- Approximately 43 Mt of CO_2e are projected as a result of oil and natural gas production, processing, transmission, and distribution. This is 44.5% of the gross New Mexico emissions, a slight decrease compared with the relative contribution of oil and gas production in 2018, (53.0%), and an increase compared with the relative contribution of oil and gas production in 2005 (25.0%).

All scenarios see a significant rise in emissions from 2005 to 2018, as well as a significant drop from 2018 to 2023, driven primarily by the NSPS for the oil and gas sector (E3 2020). Additional projections of emissions for New Mexico, Texas, Oklahoma, and Kansas are found in Section 7 of the BLM Specialist Report (Figure 7-1 and 7-2), which is discussed in more detail in Sections 16.1 and 16.2 of this report.

13.6   CUMULATIVE CLIMATE CHANGE SUMMARY

Existing conditions of climate change in any given location are the result of numerous complex factors, both natural and human caused. Natural factors contributing to the current condition of air resources include existing climate resulting from long-term atmospheric weather patterns, soil types, and vegetation types. Anthropogenic factors contributing to the current condition of air resources include long-term human habitation, growing human populations, transportation methods and patterns, recreational activities, economic patterns, and the presence of power plants and other industrial

sources. The presence of natural resource (primarily oil and natural gas) extraction and processing on some BLM lands also impacts air quality and GHG emissions.

The EIA 2023 Annual Energy Outlook (EIA 2023) projects energy consumption increases through 2050 as population and economic growth outweighs efficiency gains. As a result, U.S. production of natural gas and petroleum and liquids will rise amid growing demand for exports and industrial uses. U.S. natural gas production increases by 15% from 2022 to 2050. However, renewable energy will be the fastest-growing U.S. energy source through 2050. As electricity generation shifts to using more renewable sources, domestic natural gas consumption for electricity generation is expected to decrease by 2050 relative to 2022. As a result, energy-related CO_2 emissions are expected to fall 25% to 38% below the 2005 level, depending on economic growth factors. Further discussion of past, present, and projected global and state GHG emissions can be found in Chapter 5 of the Annual GHG Report (BLM 2024a).

13.7   PARIS AGREEMENT AND GLOBAL CARBON BUDGET DISCUSSION

The United States has established an economy-wide target of reducing its net GHG emissions by 50% to 52% below 2005 levels in 2030 in its national determined contribution (NDC) under the Paris Agreement (UNFCCC 2021). This goal is also included in *The Long-Term Strategy of the United States, Pathways to Net-Zero Greenhouse Gas Emissions by 2050* (U.S. Department of State and the U.S. Executive Office of the President 2021). Net GHG emissions include both anthropogenic and natural emissions of GHGs, as well as removals by sinks (e.g., carbon uptake by forests). To develop the NDC, the National Climate Task Force performed an analysis of potential and measured impacts of various policies and measures (both potential and existing) at all levels of government and in all relevant sectors. This analysis was conducted using input from all federal government agencies, as well as other stakeholders, such as scientists, activists, local and state governments, and various local institutions. For the industrial sector, the NDC outlines that the U.S. government will support research and implementation of very low- and zero-carbon industrial processes and products, including introducing these products to market. The U.S. government will also incentivize carbon capture and the use of new sources of hydrogen for powering industrial facilities. The net emissions (including sinks) in 2005 were 6,635 Mt CO_2e (UNFCCC 2021); therefore, the 2030 net emissions are estimated to be 3,348.15 Mt CO_2e. So far, the United States is anticipated to have met and surpassed the 2020 target of 17% reduction in net economy-wide emissions below 2005 levels and is broadly on track to meet the 2025 goal of 26% to 28% emissions reductions below 2005 levels (U.S. Department of State and the U.S. Executive Office of the President 2021).

Carbon neutrality, or net-zero emissions, is maintaining a balance between emitting and absorbing GHGs from the atmosphere. On a global scale, carbon neutrality would result in atmospheric concentrations of GHGs reaching an equilibrium, which could stabilize climate change and limit global warming. Under the 2015 Paris Agreement, countries agreed to cut GHG emissions with the goal of holding the increase in the global average temperature to well below 2 degrees Celsius (°C) above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels to avoid some of the more dire consequences associated with climate change.

Annually, the United Nations Environment Programme (UNEP) publishes an emissions gap report, which provides an assessment of how actions and pledges of countries affect global GHG emissions trends and how these trends compare to emissions trajectories that are consistent with long-term goals for limiting global warming (UNEP 2023). Specifically, the emissions gap is the difference between GHG emissions levels consistent with limiting global warming to 1.5°C or 2.0°C and the emissions levels consistent with current reduction commitments by member nations. By 2030, the UNEP estimates that to limit warming to 2.0°C or 1.5°C, global annual emissions should be approximately 41 GtCO$_2$e and 33 GtCO$_2$e,

respectively. Based on the most optimistic current emissions pledges, the global emissions gap in 2030 would be 11 $GtCO_2e$ above the 2.0°C warming goal and 19 $GtCO_2e$ above the 1.5°C warming goal. By 2050, the UNEP estimates that to limit warming to 2.0°C or 1.5°C, global annual emissions should be approximately 20 $GtCO_2e$ and 8 $GtCO_2e$, respectively. Based on the most optimistic current emissions pledges, the global emissions gap in 2050 would be 1 $GtCO_2e$ above the 2.0°C warming goal and 13 $GtCO_2e$ above the 1.5°C warming goal. The UNEP emissions gap report does not account for the recent passage of the Inflation Reduction Act. The Inflation Reduction Act formalizes an economy-wide policy, while continuing federal oil and gas leasing over the next 10 years, which puts the United States within reach of meeting the 2030 emissions target (Rhodium Group 2022). Additionally, the U.S. Department of Energy (DOE) stated that, "While [Federal] oil and natural gas leasing provisions may lead to some increase in GHG pollution in 2030, those possible increases are dwarfed around 35-to-1 by the net estimated pollution reduction associated with the two laws [Inflation Reduction Act and Bipartisan Infrastructure Law]" (DOE 2022). Note that whereas the Inflation Reduction Act specifically mentions oil and gas leasing but not APDs, leasing is a commitment of resources and development is a foreseeable outcome of the lease. Carbon budgets have not yet been established on a national or subnational scale, primarily due to the lack of consensus on how to allocate the global budget to each nation, and as such the global budgets that limit warming to 1.5°C or 2.0°C are not useful for BLM decision-making as it is unclear what portion of the budget applies to emissions occurring in the United States.

Table 9-1 of the BLM Specialist Report provides an estimate of the potential emissions associated with BLM fossil fuel authorizations in relation to IPCC carbon budgets. The BLM uses the long-term estimates of federal fossil fuel (oil, gas, and coal) emissions that were developed from the EIA 2023 AEO. The projected annual emissions are added over the remaining time frame until the global emissions budget is estimated to be exhausted to show the portion of the budget that is consumed by federal emissions. The BLM-estimated emissions include direct emissions as well as transport and downstream combustion emissions. It is important to note that this comparison of BLM-estimated emissions from fossil fuel authorizations to global carbon budgets does not portray the full picture of carbon flux (amount emitted vs. amount stored/sequestered/offset) on public lands. Section 9.1 of the BLM Specialist Report provides information on carbon neutrality and carbon budgets.

14 GREENHOUSE GAS ANALYSIS AND METHODOLOGIES

As stated, the BLM Specialist Report presents the estimated emissions of GHGs attributable to fossil fuels produced on land and mineral estate managed by the BLM. Fossil fuel extraction, construction, and operation (well development), and processing and end-use production activities all contribute to air pollutants and GHG emissions in the BLM FFO and CFO areas, especially San Juan, northwest Sandoval, Eddy, Lea, and Chaves Counties, as well as in parts of Oklahoma, Kansas, and Texas. This includes midstream sources from the natural gas compressor stations and pipelines, gas plants, and petroleum refining as well as final downstream end-use by the consumer. Coal mining is also occurring in the BLM FFO and OFO areas. Potash mining in the BLM CFO area also contributes to air contaminant and GHG emissions.

The BLM Specialist Report contains estimates of both direct and indirect (including downstream combustion) emissions from BLM-authorized fossil fuel development on the federal mineral estate for the three primary GHGs of concern (CO_2, CH_4, N_2O). In addition, the estimated emissions are aggregated at different scales for comparison with emissions reports and inventories completed by other entities at state, national, and global scales and for relevant industrial sectors.

The term direct is used to describe emissions from fossil fuel mineral development and production-related activities authorized by the BLM that typically take place on leased acres of the federal mineral estate. Direct emissions could result from a variety of activities, such as lease exploration, access road construction, well pad or coal mine development, well drilling and completions, recurring maintenance and production equipment operations, and site reclamation.

Indirect emissions occur as a consequence of the authorized action and can include activities such as the processing, transportation, and any end-use combustion of the fossil fuel mineral products. They are a consequence of the produced fossil fuels but occur downstream from the point of production on federal lands and/or are outside of BLM approval authority. End-use emissions make up most of GHG emissions related to federal energy resource development. The sum of the direct and indirect GHG emissions from fossil fuel mineral production is also known as a life cycle assessment (LCA).

The emissions estimates are also presented at two cumulative scales: geographic and temporal. The geographic cumulative scale is the entire onshore federal mineral estate managed by the BLM. The temporal cumulative scales include estimated emissions from total federal onshore mineral production projected for the next 12 months, the life-of-project emission estimates associated with the 12-month projections, and the long-term emissions from the portion of energy demand estimated to be met from the federal mineral estate out to year 2050 using data from the Energy Information Administration. The estimates provide a baseline to compare emissions from BLM-authorized development with those of the broader economy (national and global) and illustrate the degree to which federal fossil fuel mineral development contributes to projected GHG emissions and therefore to climate change.

To account for the full LCA, estimates of projected emissions are included on both a short-term and long-term basis: in which the short-term estimates are based on RFD trends derived from leasing and production statistics, and the long-range estimates are based on the analysis of energy market dynamics developed by the EIA in its AEO report. Together, the estimates are designed to provide relevant, well-supported, and factual information that is intended to fully account for GHG emissions from BLM authorizations to develop the federal mineral estate (BLM 2024a).

Section 6.1 of the BLM Specialist Report contains emission factors and production data applying a combination of published LCA data, other studies and statistics, and assumptions for each fossil fuel type. In general, this means that the total federal GHG burden on the environment is best described by the end use, or downstream combustion portion of the disclosed accounting, plus any fugitive emissions that result from fossil mineral processes prior to end use. Some of the referenced LCA sources contain estimates for systemic losses of CH_4 (i.e., fugitive emissions), such that when these data are available the BLM back-calculates the fugitive losses from the direct emissions to more fully provide transparency for emissions resulting from BLM-authorized development.

The end-use phase emissions for coal, oil, and gas (assumed combustion) are estimated using EPA emissions factors from Tables C-1 and C-2 of 40 C.F.R. § 98, Subpart C, as shown in Tables 6-2, 4-7, and 4-9 of the BLM Specialist Report. The EPA factors were chosen to represent the downstream portion of these life-cycle emissions since they provide a relatively straightforward basis for estimating the consumption of each fuel for which the actual downstream transformation or use is relatively unknown compared to the assumptions and specificity used in the referenced LCA data.

Fossil fuel production is the primary input used in the LCA methodology and generally in this report. The BLM is using data and statistics from the EIA and the DOI Office of Natural Resources Revenue (ONRR), both of which provide production accounting services for domestic fossil fuel minerals to estimate report year emissions on a fiscal year basis (when such data exist). Details on the coal, oil, and gas emission factors are in Sections 6.2, 6.4, and 6.5 of the BLM Specialist Report. Table 65 through Table 68 presents emissions data from reasonably foreseeable projects involving federal fossil fuel production and authorizations from BLM NMSO area of operation.

Table 65. Emissions from Reasonably Foreseeable Projected 12-Month Projects Federal Fossil Fuel Production and Authorizations in New Mexico

BLM-Authorized	Direct Mt CO_2e/year	Indirect Mt CO_2e/year	Combustion Mt CO_2e/year	Total Mt CO_2e/year	Life-of-Project Mt CO_2e
Existing Federal Production					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	25.86	21.34	151.99	199.19	1,697.00
Gas	9.53	24.19	91.6	125.32	1,147.84
Total	**35.39**	**45.53**	**243.59**	**324.51**	**2,844.84**
Permitted but Not Yet Developed Oil, Gas, and Coal Leases					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	20.94	17.28	123.07	161.29	494.81
Gas	5.62	14.27	54.06	73.95	235.17
Total	**26.56**	**31.55**	**177.13**	**235.24**	**729.98**
Potential New Leases in the Next 12 Months					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	3.25	2.68	19.09	25.02	76.76
Gas	0.87	2.22	8.39	11.48	36.48
Total	**4.12**	**4.90**	**27.48**	**36.50**	**113.24**
Total Projected Emissions By Mineral Type					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	50.05	41.3	294.15	385.5	720.95
Gas	16.02	40.68	154.05	210.75	405.48
Total	**66.07**	**81.98**	**448.2**	**596.25**	**1,126.43**

Sources: BLM (2024a) (Information can be found in the Appendix [2023 Report Year Database] link provided at the base of BLM 2024a or at https://docs.google.com/spreadsheets/d/1-HZHErAx_eukxFZV1pP7zClnD5W_0KwaC0eaRm1z1HU/edit?gid=1786309511#gid=1786309511 - 'Emis' tab).

Table 66. Emissions from Reasonably Foreseeable Projected 12-Month Projects Federal Fossil Fuel Production and Authorizations in Kansas

BLM-Authorized	Direct Mt CO$_2$e/year	Indirect Mt CO$_2$e/year	Combustion Mt CO$_2$e/year	Total Mt CO$_2$e/year	Life-of-Project Mt CO$_2$e
Existing Federal Production					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.00	0.03	0.03	0.57
Gas	0.01	0.03	0.13	0.17	2.86
Total	**0.01**	**0.03**	**0.16**	**0.2**	**3.43**
Permitted but Not Yet Developed Oil, Gas, and Coal Leases					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.00	0.00	0.00	0.00
Gas	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Potential New Leases in the Next 12 Months					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.00	0.02	0.02	0.10
Gas	0.00	0.00	0.02	0.02	0.11
Total	**0.00**	**0.00**	**0.04**	**0.04**	**0.21**
Total Projected Emissions By Mineral Type					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.00	0.05	0.05	0.10
Gas	0.01	0.03	0.15	0.19	0.37
Total	**0.01**	**0.03**	**0.2**	**0.24**	**0.47**

Sources: BLM (2024a) (Information can be found in the Appendix [2023 Report Year Database] link provided at the base of BLM 2024a or at https://docs.google.com/spreadsheets/d/1-HZHErAx_eukxFZV1pP7zClnD5W_0KwaC0eaRm1z1HU/edit?gid=1786309511#gid=1786309511 - 'Emis' tab).

Table 67. Emissions from Reasonably Foreseeable Projected 12-Month Projects Federal Fossil Fuel Production and Authorizations in Texas

BLM-Authorized	Direct Mt CO$_2$e/year	Indirect Mt CO$_2$e/year	Combustion Mt CO$_2$e/year	Total Mt CO$_2$e/year	Life-of-Project Mt CO$_2$e
Existing Federal Production					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.01	0.01	0.05	0.07	1.06
Gas	0.21	0.53	1.99	2.73	34.19
Total	**0.22**	**0.54**	**2.04**	**2.8**	**35.25**

BLM-Authorized	Direct Mt CO_2e/year	Indirect Mt CO_2e/year	Combustion Mt CO_2e/year	Total Mt CO_2e/year	Life-of-Project Mt CO_2e
Permitted but Not Yet Developed Oil, Gas, and Coal Leases					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.22	0.18	1.29	1.69	10.53
Gas	0.08	0.2	0.75	1.03	4.54
Total	**0.3**	**0.38**	**2.04**	**2.72**	**15.07**
Potential New Leases in the Next 12 Months					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.02	0.01	0.11	0.14	0.92
Gas	0.01	0.01	0.06	0.08	0.39
Total	**0.03**	**0.02**	**0.17**	**0.22**	**1.31**
Total Projected Emissions By Mineral Type					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.25	0.2	1.45	1.90	3.55
Gas	0.30	0.74	2.8	3.84	7.38
Total	**0.55**	**0.94**	**4.25**	**5.74**	**10.93**

Sources: BLM (2024a) (Information can be found in the Appendix [2023 Report Year Database] link provided at the base of BLM 2024a or at https://docs.google.com/spreadsheets/d/1-HZHErAx_eukxFZV1pP7zClnD5W_0KwaC0eaRm1z1HU/edit?gid=1786309511#gid=1786309511 - 'Emis' tab).

Table 68. Emissions from Reasonably Foreseeable Projected 12-Month Projects Federal Fossil Fuel Production and Authorizations for Oklahoma

BLM-Authorized	Direct Mt CO_2e/year	Indirect Mt CO_2e/year	Combustion Mt CO_2e/year	Total Mt CO_2e/year	Life-of-Project Mt CO_2e
Existing Federal Production					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.40	0.04	0.25	0.69	3.55
Gas	0.06	0.16	0.6	0.82	9.65
Total	**0.46**	**0.2**	**0.85**	**1.51**	**13.2**
Permitted but Not Yet Developed Oil, Gas, and Coal Leases					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.02	0.01	0.12	0.15	0.47
Gas	0.02	0.05	0.17	0.24	0.95
Total	**0.04**	**0.06**	**0.29**	**0.39**	**1.42**

BLM-Authorized	Direct Mt CO_2e/year	Indirect Mt CO_2e/year	Combustion Mt CO_2e/year	Total Mt CO_2e/year	Life-of-Project Mt CO_2e
Potential New Leases in the Next 12 Months					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.02	0.01	0.1	0.13	0.4
Gas	0.01	0.03	0.14	0.18	0.79
Total	**0.03**	**0.04**	**0.24**	**0.31**	**1.19**
Total Projected Emissions By Mineral Type					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.44	0.06	0.47	0.97	1.5
Gas	0.09	0.24	0.91	1.24	2.39
Total	**0.53**	**0.3**	**1.38**	**2.21**	**3.89**

Sources: BLM (2024a) (Information can be found in the Appendix [2023 Report Year Database] link provided at the base of BLM 2024a or at https://docs.google.com/spreadsheets/d/1-HZHErAx_eukxFZV1pP7zClnD5W_0KwaC0eaRm1z1HU/edit?gid=1786309511#gid=1786309511 - 'Emis' tab).

14.2 COAL, OIL AND GAS PRODUCTION

Estimates of production (or downstream/end-use) GHG emissions are dependent on projected oil and gas production volumes. The BLM does not direct or regulate the end use of produced oil and/or gas. The challenge for estimating downstream emissions comes with understanding when and how oil and gas would be distributed and used for energy. It can be reasonably assumed that oil and gas produced on leases would be combusted primarily for electricity generation, transportation, industry, agriculture, commercial, and residential uses. From this assumption, the BLM provides potential GHG emissions estimates using currently available GHG emissions data. Section 6.2 (Coal) Table 6-6 (Federal Coal Production (tons)), Section 6.4 (Crude Oil) Table 6-9 (Federal Oil Production (bbl)), and Section 6.5 (Natural Gas) Table 6-11 (Federal Gas Production (Mcf)) of the BLM Specialist Report presents emissions for year 2023 from BLM coal, crude oil, and gas leasing authorizations, which are based on ONRR records of actual coal, oil, and gas production (BLM 2024a). These tables show the ONRR production data from the United States, federal, and BLM NMSO area of operation, total U.S. coal, oil, and gas production (federal and non-federal) to illustrate the percentage of federal coal relative to the U.S. total (percent U.S. total) and the percentage of federal coal, oil, and gas that comes from the various federal producing states (percent federal). The end-use phase emissions for coal, oil, and gas (assumed combustion) are shown in BLM Specialist Report Tables 6-2, 6-8, and 6-10 and ONRR production data.

14.3 UNCERTAINTIES OF GREENHOUSE GAS CALCULATIONS

Section 6.8 of the BLM Specialist Report discusses uncertainties that could impact the GHG estimates. The BLM acknowledges that operational diversity, product variations, and broad geographic distribution of the federal mineral estate introduces some uncertainty into the simplifying assumptions and approximation methodologies used to estimate emissions for the BLM Specialist Report, which could have relatively small impacts, while other uncertainties could have a larger impact on the estimates. The best available data were used and presented for the emissions estimates in this report, and as new information becomes available, the BLM will continue to improve and revise its emission estimates,

methodologies, and assumptions as appropriate. Ultimately, these estimates are subject to many influences that are largely beyond BLM practical control. Section 6.8 of the BLM Specialist Report discusses these uncertainties in more detail.

15 OIL AND GAS SINGLE-WELL GHG EMISSIONS

15.1 FIELD OFFICE

15.1.1 FARMINGTON FIELD OFFICE

The GHG single-well emission factors in Table 69 use the same methodology discussed in Section 7.1.1.

Table 69. BLM FFO/RPFO Horizontal Single-Well GHG Emissions

Phase	Total Emissions (metric tons per year)			
	CO_2	CH_4	N_2O	CO_2e
Single-well construction/ development phase	1,607.50	0.66	0.013	1,630.72
Single-well operation phase	937.31	5.40	0.002	1,099.03
Single-well total	**2,544.81**	**6.06**	**0.015**	**2,729.75**

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

Max Emissions from Oil and Gas Scenarios - Single Well Emissions in the San Juan Basin

15.1.2 PECOS DISTRICT OFFICE

The GHG single-well emission factors in Table 70 use the same methodology discussed in Section 7.1.2.

Table 70. BLM PDO Horizontal Single-Well GHG Emissions

Phase	Total Emissions (metric tons per year)				
	CO_2	CH_4	N_2O	100-yr CO_2e	20-yr CO_2e
Single-well construction/ development phase	1,686.74	0.45	1.34E-02	1,703.89	1,727.76
Single-well operation phase	358.51	1.41	2.18E-03	401.07	475.28
Single-well total	**2,045.25**	**1.86**	**1.56E-02**	**2,104.96**	**2,203.05**

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

15.1.3 OKLAHOMA FIELD OFFICE

The GHG single-well emission factors in Table 71 use the GHG Lease Sale Tool default emissions for a deep oil/high gas scenario.

Table 71. BLM OFO Horizontal Oil Single-Well GHG Emissions

Phase	Total Emissions (metric tons per year)			
	CO_2	CH_4	N_2O	CO_2e
Single-well construction/ development phase	1,767.4	1.01	0.014	1,801.32
Single-well operation phase	1,113.7	16.86	0.003	1,616.95
Single-well total	**2,881.1**	**17.87**	**0.017**	**3,418.27**

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

16 GHG EMISSIONS AND PROJECTIONS FROM BLM-AUTHORIZED ACTIONS

The estimates presented here provides direct and indirect GHG emission estimates for the existing federal fossil fuel production. Existing emissions estimates show the GHGs emitted from the assumed consumption of each fossil fuel based on production statistics from the previous fiscal year for all producing wells and mines. The projected emissions include both short- and long-term estimates based on the methodologies discussed in Chapter 6 of the BLM Specialist Report.

16.1 SHORT TERM

Table 7-1 (Federal Coal Emissions - 2023 [Mt]) of the BLM Specialist Report presents the emissions from coal production on the federal mineral estate in fiscal year (FY) 2023, which result from multiplying the representative emission factors from Tables 6-1 (Coal Production Emissions Factors and Statistics), 6-3 (Derived Downstream Coal Emissions Factors), and 6-4 (Coal Transport Emissions Factors) in the BLM Specialist Report by the state-specific shipping and production data contained in Tables 6-5 (Coal Transport Data) and 6-6 (Federal Coal Production [tons]). The short-term emissions projections (12-month and life-of-project) from reasonably foreseeable coal production in the eight states where federal coal is presently being produced are also included in the BLM Specialist Report as Table 7-2 (Federal Coal Emissions - Projected 12-Months [Mt]) and Table 7-3 (Federal Coal Emissions - Projected Short-Term Life-of-Project [Mt]).

Table 7-4 (Federal Oil Emissions - Held-By-Production Lands 2023 [Mt]) of the BLM Specialist Report shows the FY 2023 held-by-production emissions from oil production on the federal mineral estate. The emissions are calculated by multiplying the emission factors from Tables 6-8 (GHG Emissions Factors for Federal Oil Production [tonnes/bbl]) of the BLM Specialist Report by the state-specific production amounts from emission factors Table 6-9 (Federal Oil Production [bbl]) of the same report.

Table 7-11 (Federal Gas Emissions - Held-By-Production Lands 2023 [Mt]) of the BLM Specialist report shows the FY 2023 held-by-production emissions from gas production on the federal mineral estate. The emissions are calculated by multiplying the emission factors from Table 6-10 (GHG Emissions Factors for Federal Gas Production [tonnes/Mcf]) of the BLM Specialist Report by the state-specific production amounts from Table 6-11 (Federal Gas Production [Mcf]). These estimates include emissions from the full oil and gas life cycle, including emissions arising from activities outside of BLM jurisdiction (such as emissions associated with refining and processing). The emissions from oil and gas projected APD approvals and leasing within the next 12-months on both a maximum annual and life-of-project basis are also included in the BLM Specialist Report. Figure 29 through Figure 32 shows an annualized timeline of the projected short-term life-of-project CO_2e emissions from existing producing wells and

projected wells from new APDs and Leasing (12 months) for each state within the BLM NMSO area of operation (Figure 7-1 of the BLM Specialist Report). Figure 7-1 of the BLM Specialist Report also shows the cumulative sum of all the state series (i.e., the federal sum), which is also displayed in the BLM Specialist Report Table 7-18 (Federal Summary - Projected Short-Term Life-of-Project Emissions [Mt]).
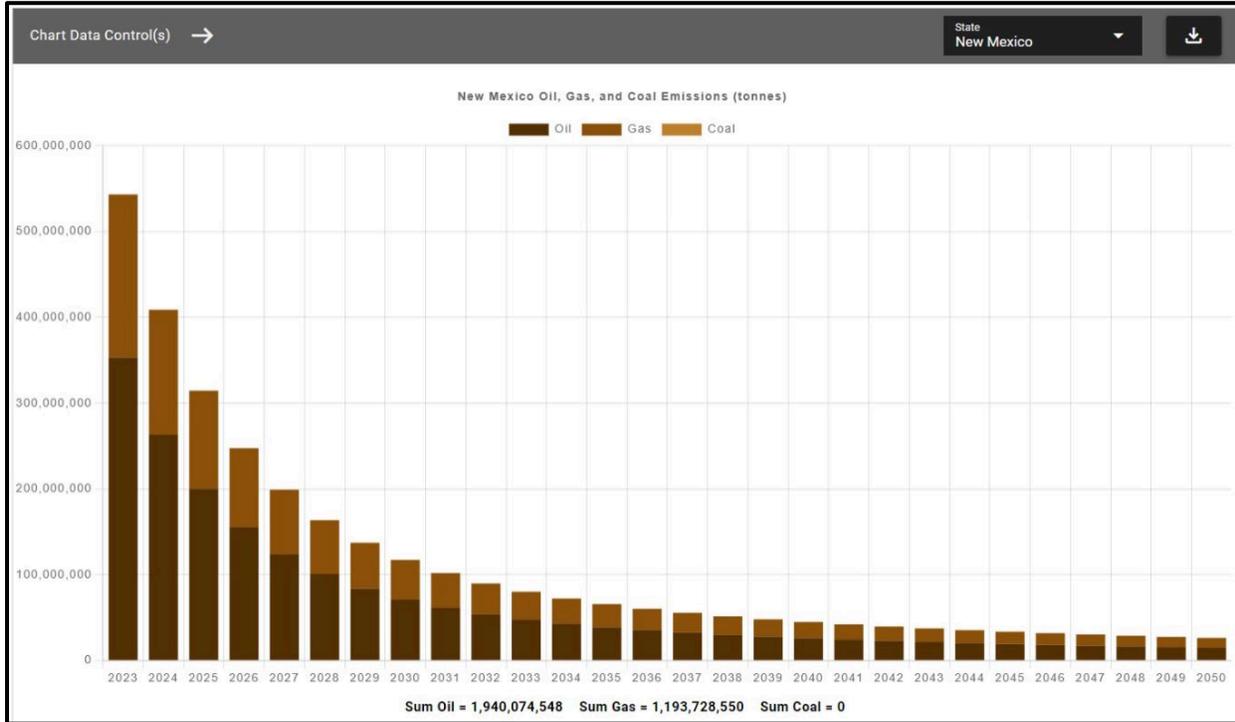
Figure 29. Projected New Mexico oil, gas, and coal CO$_2$e emissions (metric tons) (BLM 2024a).
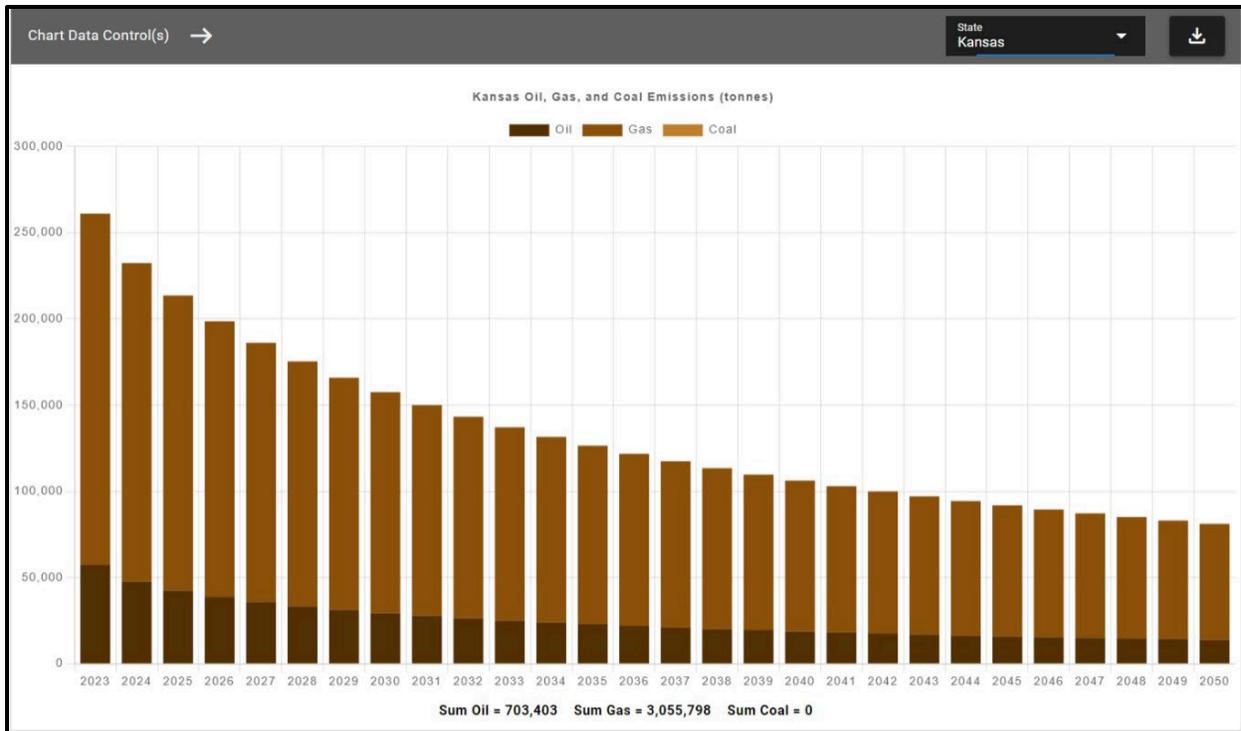
Figure 30. Projected Kansas oil, gas, and coal CO$_2$e emissions (metric tons) (BLM 2024a).
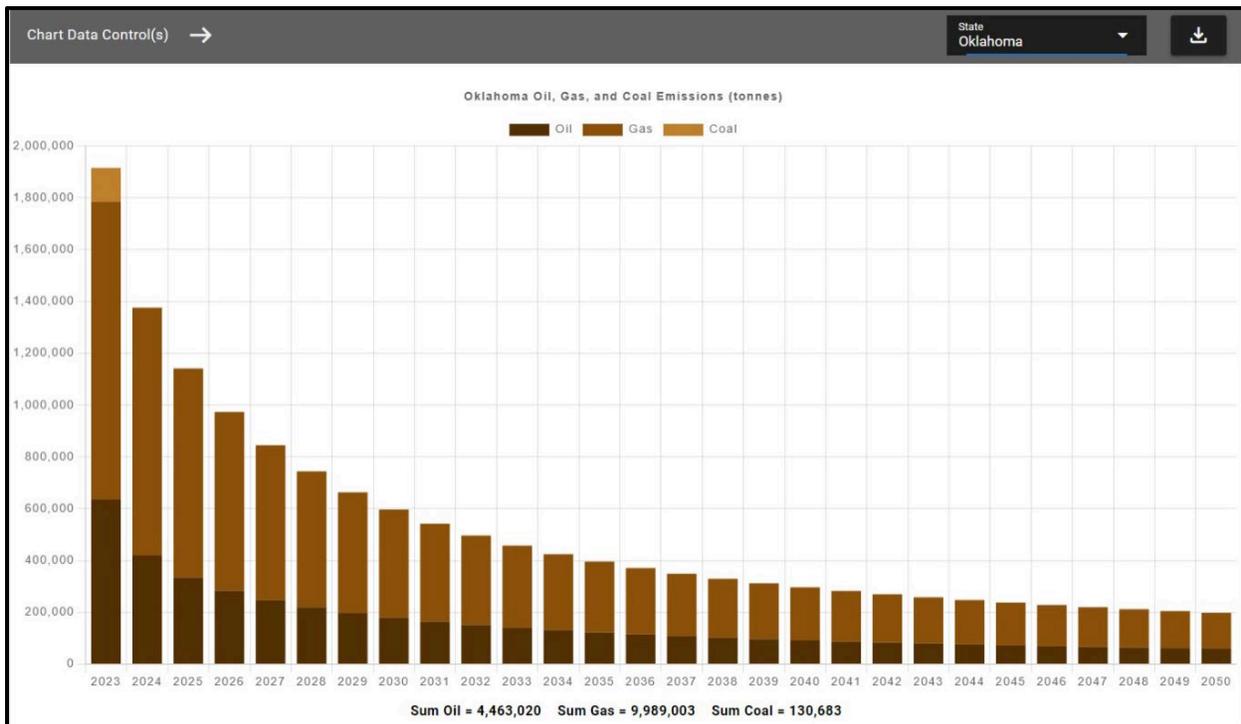
Figure 31. Projected Oklahoma oil, gas, and coal CO$_2$e emissions (metric tons) (BLM 2024a).
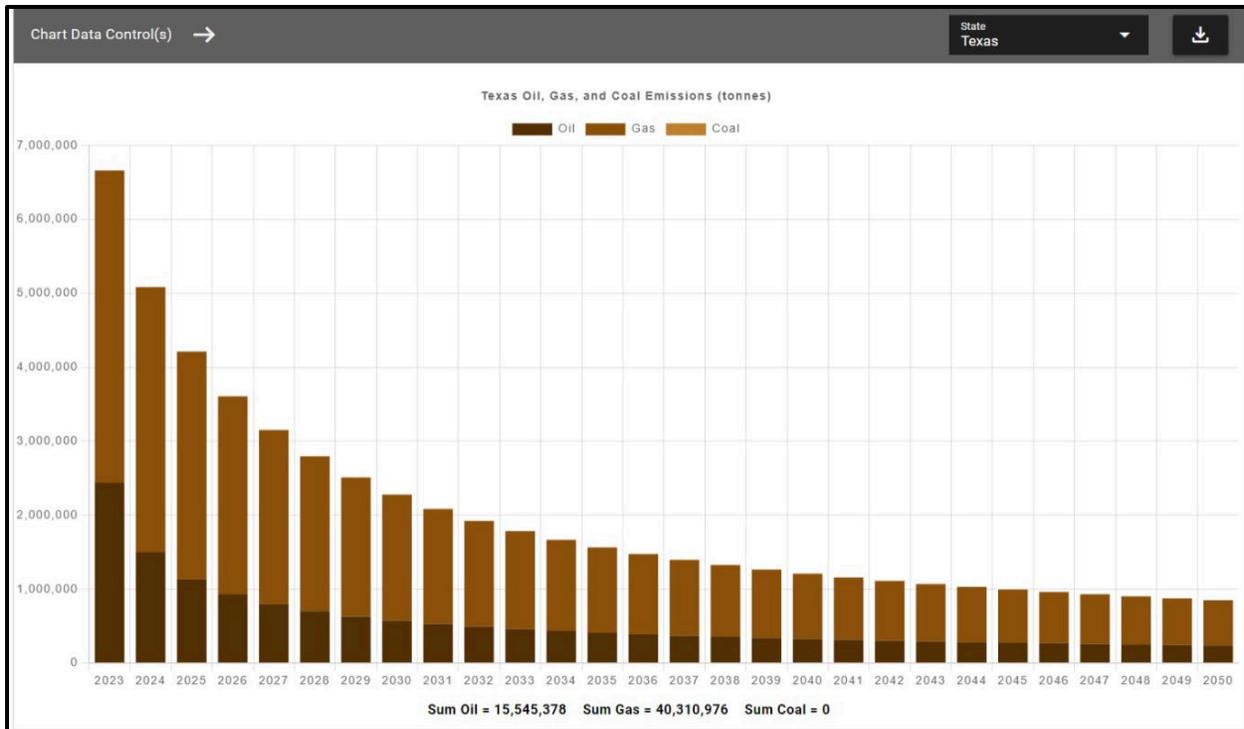
Figure 32. Projected Texas oil, gas, and coal CO₂e emissions (metric tons) (BLM 2024a).

16.2 LONG-TERM PROJECTED TRENDS

The BLM Specialist Report also discusses long-term projected annual trends in federal fossil fuel production, energy values, and GHG emissions to year 2050 based on data obtained from the EIA AEO report (EIA 2023). The BLM Specialist Report provides access to most of the AEO cases, as these explore a variety of market conditions, including varying production, price, and overall economic growth rates, and the AEO scenario selection controls in Figure 7-2 (Long-Term Onshore Federal Mineral Emissions [Mt CO_2e]) of the BLM Specialist Report can be used to view the projected emissions from federal fossil fuel production. Table 7-19 of the BLM Specialist Report provides the long-term cumulative sums of production, energy values, and GHG emissions projected out to year 2050 for the AEO reference case. At the national level, these long-term projections estimate that there will be emissions of 17,264 Mt CO_2e from federal oil and gas combined, and 24,845 Mt CO_2e from all federal fossil fuel minerals (oil, gas, and coal) (see Table 72 below and Table 7-19 of the BLM Specialist Report). GHG emissions for future projections for all growth scenarios is available in the BLM Specialist Report (BLM 2024a).

Table 72. Estimated Projected or "Long-Term" Oil and Gas GHG Emissions from Federal Leases

Area	Oil (Mt CO₂e per year)	Gas (Mt CO₂e per year)	Coal (Mt CO₂e per year)	Total (Mt CO₂e per year)
BLM Total	8,640	8,624	7,982	25,246
New Mexico	6,759	4,460	-	11,219
Oklahoma	11	28	-	39
Kansas	1	6	-	7

Area	Oil (Mt CO_2e per year)	Gas (Mt CO_2e per year)	Coal (Mt CO_2e per year)	Total (Mt CO_2e per year)
Texas	2	91	-	93

Source: BLM (2024a) (Information can be found in the Appendix [2023 Report Year Database] link provided at the base of BLM 2024a or at https://docs.google.com/spreadsheets/d/1-HZHErAx_eukxFZV1pP7zClnD5W_0KwaC0eaRm1z1HU/edit?gid=1786309511#gid=1786309511 - 'eia' tab column AJ).

The projections made from the 2023 AEO data show that fossil fuel mineral development on federal land accounts for approximately 14.41% of total U.S. GHG emissions by 2050 (reference case). The difference in federal emissions on an absolute basis between the high and low AEO projection scenarios is approximately 7,717 Mt CO_2e over the entirety of the projection period, or about 296.8 Mt CO_2e on an annual average basis. The difference (or delta) between the cumulative short-term emissions previously described and the long-term emissions estimates can be thought of as the level of additional development that could be authorized to sustain the existing federal fraction of production over the longer term. Similarly, if the short-term emissions exceed a longer-term scenario, then the delta can be thought of as the amount of reduction required to attain the outlook forecast. In all cases, the EIA clearly explains that the AEO scenario projections are not predictions of what will happen, but rather they are modeled projections of what may happen given certain assumptions (BLM 2024a).

17 GHG EMISSIONS ANALYSIS

17.1 CLIMATE IMPACT MODELING

Section 9.3 of the BLM Specialist Report discusses the BLM use of reduced complexity climate models (RCMs) for the purposes of obtaining potential gross scale (e.g., perturbations from global climatic means) earth system responses that could be attributable to the federal decision scope over which the BLM has purview. The feasibility of other models such as Earth System Models (ESMs) and Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) are also discussed. The BLM Specialist Report uses the projected emissions for each of the long-term onshore federal mineral emissions for 12 AEO cases (Figure 7-2 of the BLM Specialist Report) and conducted MAGICC runs evaluating potential contributions to global climate change and related values for the two climate change projection scenarios that most closely approximate or frame the desired outcomes of the Paris Climate Accord. Tables 9-3 and 9-4 of the BLM Specialist Report present the MAGICC modeling results for each baseline scenario and for the modified AEO "high oil price" case and the AEO "low oil and gas supply" case. The model results show that regardless of the global climate change projection scenario and the pathway that federal fossil fuels emissions follow, federal minerals emissions are predicted to have minimal impacts to future global climate change through the end of the century. Section 9.3 of the BLM Specialist Report provides additional information regarding the MAGICC modeling and results (BLM 2024a).

17.2 NATURAL GAS SYSTEMS AND PETROLEUM SYSTEMS

Within the fossil fuel combustion sector in 2022, the contribution by fuel type shows that petroleum represents 44.5% of the fuel type, natural gas 36.3%, and coal 19.1% as shown in Section 3.1 Table 3-5 of the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2024r).

The EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2024r) describes "Natural Gas Systems" and "Petroleum Systems" as two of the major sources of U.S. GHG emissions. The inventory identifies the major contributions of natural gas and petroleum systems as total CO_2 and CH_4 emissions. Natural gas and petroleum systems do not produce noteworthy amounts of any other GHGs.

Within the category of "Natural Gas Systems," the EPA identifies emissions occurring during distinct stages of operation, including field production, processing, transmission and storage, and distribution. "Petroleum Systems" sub-activities include production field operations, crude oil transportation and crude oil refining. Within Natural Gas Systems and Petroleum Systems, the BLM has authority to regulate those field production operations that are related to oil and gas measurement and prevention of waste (via leaks, spills, and unauthorized flaring and venting).

Total GHG emissions (CH_4, CO_2, and N_2O) from natural gas systems in 2022 were 209.7 Mt CO_2e, a decrease of 17% from 1990, and a decrease of 0.3% from 2021, both primarily due to decreases in CH_4 emissions. Of the overall GHG emissions (209.7 Mt CO_2e), 83% is CH_4 emissions as expressed as CO_2e (173.1 Mt CO_2e), 17% is CO_2 emissions (36.5 Mt), and less than 0.1% is N_2O emissions as expressed as CO_2e (0.15 Mt CO_2e) (EPA 2024r).

CH_4 and CO_2 emissions from natural gas systems include those resulting from normal operations, routine maintenance, and system upsets. Emissions from normal operations include natural gas engine and turbine uncombusted exhaust, flaring, and leak emissions from system components. Routine maintenance emissions originate from pipelines, equipment, and wells during repair and maintenance activities. Pressure surge relief systems and accidents can lead to system upset emissions. In the EPA reported data, emissions of N_2O from flaring activities are included, with most of the emissions occurring in the processing and production segments. Note that in the EPA reported data, CO_2 emissions exclude all combustion emissions (e.g., engine combustion) except for flaring CO_2 emissions.

Section 3.7 of the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks provides a characterization of the six emission subcategories of natural gas systems: exploration, production (including gathering and boosting), processing, transmission and storage, distribution, and post-meter (EPA 2024r). Each of the segments is described, and the different factors affecting CH_4, CO_2, and N_2O emissions are discussed.

Total GHG emissions (CH_4, CO_2, and N_2O) from petroleum systems in 2022 were 61.6 Mt CO_2e, an increase of 4% from 1990, primarily due to increases in CO_2 emissions. Since 2021, total emissions from petroleum systems decreased by 15%. Of the overall GHG emissions (61.6 Mt CO_2e), 22.0 Mt are CO_2 emissions, 39.6 Mt CO_2e are from CH_4 emissions, and 0.05 Mt CO_2e are from N_2O emissions from petroleum systems in 2022. In 2022, U.S. oil production was 163 percent higher than in 2010 and 7 percent higher than in 2021 (EPA 2024r).

CH_4 emissions from petroleum systems are primarily associated with onshore and offshore crude oil production, transportation, and refining operations. During these activities, CH_4 is released to the atmosphere as emissions from leaks, venting (including emissions from operational upsets), and flaring. CO_2 emissions from petroleum systems are primarily associated with crude oil production and refining operations. Note that in the EPA reported data, CO_2 in the petroleum systems emissions exclude all combustion emissions (e.g., engine combustion) except for flaring CO_2 emissions. All combustion CO_2 emissions (except for flaring) are accounted for in the fossil fuel combustion category. Emissions of N_2O from petroleum systems are primarily associated with flaring.

Section 3.6 of the GHG Annual Sinks provides a characterization of the four emission subcategories of petroleum systems: exploration, production (including well drilling, testing, and completion), production, crude oil transportation, and crude oil refining. Each of the segments is described and the different factors affecting CH_4, CO_2, and N_2O emissions are discussed.

Table 73 displays GHG emissions (CO_2, CH_4, and N_2O) related to natural gas systems, petroleum systems, and coal mining; CO_2 emissions listed represent CO_2 emissions that are not otherwise captured in the "fossil fuel combustion" category. The natural gas and petroleum subsectors are the stages of production outlined in the table below.

Table 73. 2022 GHG Emissions for Oil and Gas Subsectors and Coal Mining

Sector	Subsector	2022 GHG Emissions (Mt CO₂e)				% of U.S. Total Gross GHGs
		CO₂	CH₄[1]	N₂O	Total Gross GHGs	
U.S. Total		**5,053.0**	**702.4**	**389.7**	**6,343.2****	**100%**
Natural Gas Systems	Total	36.5	173.1	0.2	209.7	3.31%
	Exploration[2]	***	0.2	***	0.2	0.00%
	Production field operations	8.6	89.7	***	98.3	1.55%
	Onshore production	NA	46.2	NA	NA	NE
	Offshore production	NA	0.6	NA	NA	NE
	Gathering and boosting[3]	NA	42.8	NA	NA	NE
	Processing	26.7	15.1	***	41.8	0.66%
	Transmission and storage	1.2	39.6	***	40.7	0.64%
	Post-meter	***	13.4	NO	13.4	0.21%
	Distribution	***	15.2	NO	15.3	0.24%
Petroleum systems	Total	22.0	39.6	***	61.6	0.97%
	Exploration[2]	0.3	0.1	0.0001	0.4	0.01%
	Production field operations	18.8	38.6	0.04	57.4	0.90%
	Crude oil transportation	*	0.2	NE	0.2	0.00%
	Crude refining	2.9	0.7	0.008	3.6	0.06%
Coal mining	–	2.5	43.6+	NE	46.1	0.73%

Source: EPA (2024r), Table 2-1.

* Does not exceed 0.05 MMT CO2 .

** Indicates that the total U.S. GHG emissions value includes U.S. emissions of four additional minor classes of GHGs not listed here (HFC, PFCs, SF₆, and NF₃).

*** Does not exceed 0.05 MMT CO2 Eq.

NE = Not estimated; NO = Not occurring; NA = Not Applicable

+ Does not include data from abandoned coal mines.

[1] These values represent CH_4 emitted to the atmosphere. CH_4 that is captured, flared, or otherwise controlled (and not emitted to the atmosphere) has been calculated and removed from emission totals.

Exploration includes well drilling, testing, and completions.

Gathering and boosting includes gathering and boosting station routine vented and leak sources, gathering pipeline leaks and blowdowns, and gathering and boosting station episodic events.

In summary, CO_2 is produced during the burning of fossil fuels to run internal combustion engines that may be used in drilling, transportation, pumping, and compression. CO_2 may be a significant component of natural gas, especially coal-bed CH_4, and is vented during field operations or processing. CO_2 is also used in enhanced oil production processes and may be released or escape to the atmosphere during those processes. CH_4 is the primary component of natural gas and is released to the atmosphere during both oil and gas production either intentionally during production when it cannot be captured, or accidentally through leaks and fugitive emissions.

Emissions from production (including gathering and boosting) accounted for 52% of CH_4 emissions and 23% of CO_2 emissions from natural gas systems in 2022. Emissions from gathering and boosting and pneumatic controllers in onshore production accounted for most of the production segment CH_4 emissions in 2022. Within gathering and boosting, the largest sources of CH_4 are compressor exhaust slip, compressor venting and leaks, and tanks. Flaring emissions account for most of the CO_2 emissions from production, with the highest emissions coming from flare stacks at gathering stations, miscellaneous onshore production flaring, and tank flaring. CH_4 emissions from production increased by 38% from 1990 to 2022, due primarily to increases in emissions from pneumatic controllers (due to an increase in the number of controllers, particularly in the number of intermittent bleed controllers) and increases in emissions from compressor exhaust slip in gathering and boosting. CH_4 emissions decreased 3% from 2021 to 2022 due to decreases in emissions from pneumatic controllers and liquids unloading. CO_2 emissions from production increased by approximately a factor of 2.6 from 1990 to 2022 due to increases in emissions at flare stacks in gathering and boosting and miscellaneous onshore production flaring and decreased 8% from 2021 to 2022 due primarily to decreases in emissions at flare stacks in miscellaneous onshore production flaring and tank venting. Nitrous oxide emissions from production were 36.9 times higher in 2022 than in 1990 and 17.5 times higher in 2022 than in 2021. The increase in N2O emissions from 1990 to 2022 and from 2021 to 2022 is primarily due to increases in emissions from condensate tank flaring (EPA 2024r).

Production emissions account for 86% of the total CO_2 emissions (including leaks, vents, and flaring) from petroleum systems in 2022. The principal sources of CO_2 emissions are associated gas flaring, miscellaneous production flaring, and oil tanks with flares. In 2022, these three sources together accounted for 96% of the CO_2 emissions from production. In 2022, CO_2 emissions from production were 3.1 times higher than in 1990, due to increases in flaring emissions from associated gas flaring, miscellaneous production flaring, and tanks. Overall, in 2022, production segment CO_2 emissions decreased by 8% from 2021 levels primarily due to decreases in associated gas flaring in the Williston Basin and oil tanks with flares. Production emissions accounted for 84% of the total N_2O emissions from petroleum systems in 2022. The principal sources of N_2O emissions are oil tanks with flares and associated gas flaring, accounting for 90% of N_2O emissions from the production segment in 2022. In 2021, N_2O emissions from production were 8 times higher than in 1990 and were 3.5 times higher than in 2021 (EPA 2024r).

Distribution system CH_4 emissions in 2022 were 70% lower than 1990 levels and 1% lower than 2021 emissions. Annual CO_2 emissions from this segment are less than 0.1 Mt CO_2e across the time series. CH_4 emissions from the post-meter segment accounted for approximately 8% of emissions from natural gas systems in 2022. Post-meter CH_4 emissions increased by 65% from 1990 to 2022 and increased by less than 3% from 2021 to 2022, due to increases in the number of residential houses using natural gas and

increased natural gas consumption at industrial facilities and power plants. CO_2 emissions from post-meter account for less than 0.01% of total CO_2 emissions from natural gas systems.

18 MITIGATION

Section 10.0 of the BLM Specialist Report discusses various forms of mitigation, including controlling (best management practices [BMPs]), preventing emissions, and offsetting emissions (carbon sequestration, plugging orphaned and abandoned wells, energy substitution, carbon capture, compensatory mitigation). In addition to controlling or preventing emissions, strategies to offset emissions could be used to align BLM decision-making with the goal of achieving net-zero emissions by 2050. Much of the current policy on mitigating emissions in the United States comes from individual states and municipalities, as well as market forcing that results when institutions move assets and future investments away from fossil fuel projects (BLM 2024a).

The EPA Natural Gas STAR Program was established in 1993 to identify and share information on cost-effective ways to mitigate methane emissions from oil and gas operations demonstrating that it is possible to achieve important reductions in methane emissions while also enhancing safety, improving performance, increasing natural gas supplies, and saving money (EPA 2024v). These reductions can help to control not only GHGs but also VOCs, which contribute to O_3 formation. Each year, partners would submit annual reports documenting their previous year's CH_4 emission reduction activities. In 2022, EPA transitioned the Natural Gas STAR Partnership, ending the partnership agreements and annual reporting elements of the program, while retaining a focus on technology transfer and stakeholder engagement. EPA continues to collaborate with operators through the Natural Gas STAR Program providing a framework for technical support and stakeholder engagement, as well as sharing information on the EPA Natural Gas STAR website about opportunities for reducing methane emissions from the oil and gas industry. Since the inception of the program cumulative through 2020, partners have eliminated 1.72 trillion cubic feet of CH_4 emissions by implementing 150 cost-effective technologies and practices.

The Natural Gas STAR Methane Challenge Program is a voluntary program founded by the EPA in 2016 in collaboration with oil and natural gas companies. The program recognizes companies that make specific and transparent commitments to reduce CH_4 emissions. Throughout the course of this partnership, more than 70 companies from all segments of the industry—production, gathering and boosting, transmission and storage, and distribution—were program partners. Given recent regulatory efforts in the oil and gas sector and the passage of the Inflation Reduction Act providing a new approach for methane reduction, EPA ended the Methane Challenge Partnership at the end of 2023, following publication of the sixth and final Methane Challenge Report for Calendar Year 2022 data (Reporting Season 2023) (EPA 2024w). In addition, as part of the Inflation Reduction Act, a new program called the Methane Emissions Reduction Program has been started. The Methane Emissions Reduction Program will provide $1.36 billion in financial and technical assistance through multiple funding opportunities, establishes a Waste Emissions Charge for methane, and requires EPA to revise the GHGRP subpart W regulations for the oil and gas sector.

The BLM has two infrared cameras that are being used to detect leaks and fugitive emissions. BLM inspectors carry these cameras into the field and have been able to alert operators of equipment requiring repair or maintenance. At this time, the cameras are being used in an advisory rather than a regulatory role.

Cumulatively, it is expected that future levels of criteria pollutant, VOC, HAP, and GHG emissions related to oil and gas operations would be lower than current levels due to the aforementioned factors.

However, there will be increases in emissions associated with reasonably foreseeable oil and gas development and future potential development of leases.

Although it is beyond the scope of this report to detail the wide range of mitigation strategies available, it must be noted that, for the most part, these strategies must be applied on a case-by-case basis at the project level.

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20 APPENDICES

20.1 APPENDIX A NATIONAL EMISSIONS INVENTORY (NEI)

20.2 APPENDIX B AIRTOXSCREEN RESULTS

20.3 APPENDIX C CLIMATE NORMALS, WIND ROSES, AND TRENDS

20.4 APPENDIX D MAJOR SOURCES (NEI)