APPENDIX 4:
CUMULATIVE IMPACTS FROM GREENHOUSE GAS EMISSIONS

January 2026

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Purpose and Introduction

This Appendix 4 to the *Guidance for Greenhouse Gas Impact Assessments under the Montana Environmental Policy Act* (Guidance Document) provides a review of cumulative impacts from greenhouse gas (GHG) emissions to document existing research, examine cumulative impacts from GHG emissions in greater detail than the main body of the guidance document, and provide Montana-specific context for evaluating these impacts in Montana Environmental Policy Act (MEPA) analyses.

Cumulative impacts are defined as “the collective impacts on Montana's environment of the proposed action when considered in conjunction with other past, present, and future actions related to the proposed action by location or generic type” (§ 75-1-220(4), Montana Code Annotated [MCA]). Related future actions must also be considered when these actions are under concurrent consideration by any state agency through pre-impact statement studies, separate impact statement evaluation, or permit processing procedures (§ 75-1-208(11), MCA).

In the context of GHG emissions, cumulative impacts refer to the combined contribution of a proposed action's GHG emissions with emissions from other past, present, and related future actions to global atmospheric GHG concentrations, and the resulting effects on Montana's environment. Unlike traditional pollutants that have localized effects, GHGs are well-mixed in the global atmosphere, meaning emissions from any source contribute to global atmospheric concentrations regardless of their geographic origin. The cumulative impact analysis includes a review of all state and nonstate activities that have occurred, are occurring, or will occur that contribute GHG emissions and may have impacted or may impact climate-sensitive resources in Montana.

The key to an effective cumulative GHG impact analysis is using reasonable and rational boundaries that will result in a meaningful and realistic evaluation of impacts. Establishing appropriate spatial boundaries (e.g., hydrologic unit codes, wildlife management units, subbasins, and viewsheds) and temporal boundaries (e.g., life of project, mid-century, and end-century) is useful to determine the extent of the cumulative impact of GHG emissions.

Cumulative Emission Sources in Montana

This section describes how to use three different resources to place project-level GHG emissions in context with other past, present, and related future actions to support cumulative impact analysis under MEPA. These tools help establish baseline conditions and identify local, state, and sector-specific GHG emissions that may be relevant to the cumulative impact analysis. The U.S. Environmental Protection Agency (EPA) State Inventory Tool (SIT) provides a sector-based statewide GHG emissions inventory, while the EPA’s Facility Level Information on Greenhouse

Gases Tool (FLIGHT) is a facility-based reporting tool for facilities that emit more than 25,000 metric tons of CO_2e per year. The 2023 Bureau of Land Management (BLM) Specialist Report (BLM 2024) quantifies the GHG emissions from federal fossil fuel production in Montana from current and future projects. These resources provide different, but complementary, approaches to evaluating GHG emissions in Montana for MEPA cumulative impact assessments.

EPA SIT for Montana

The EPA SIT is an interactive spreadsheet model designed to help states develop and update inventories of GHG emissions and sinks (EPA 2025). It enables users to estimate emissions in 11 industry-level modules (Agriculture; CO_2 from Fossil Fuels; Coal; Electricity Consumption; Industrial Processes; Land Use, Land-Use Change, and Forestry (LULUCF); Mobile Combustion; Natural Gas and Oil; Solid Waste; Stationary Combustion; and Wastewater) using an Excel Macro Worksheet file format for each module and a Synthesis Tool module to consolidate the emissions results. The methodologies and sectors covered align with those in the U.S. GHG Inventory and use emission factors from the Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2024a). The EPA SIT provides default data for each state for the most recent years of available data but allows for state-specific customizations in the modules. As of the date of this guidance, the SIT (updated January 2025) has default emissions data updated through 2022. This tool provides the statewide emissions context for project-level cumulative impact assessments.

The Montana Department of Environmental Quality (DEQ) updated Montana's statewide GHG emissions using the EPA SIT with updated LULUCF, stationary combustion, and mobile combustion data. This update resulted in a total state-level emissions estimate of 51.04 million metric tons per year of CO_2e (MMT/year CO_2e) for 2022, as shown in Table 1. Energy emissions steadily increased over the three-year period with a change of 11 percent from 2020 to 2022, while agriculture GHG emissions steadily decreased and exhibit a -13 percent change from 2020 to 2022. Both the industrial process and waste sectors' emissions were consistent throughout the three-year period. LULUCF emissions vary each year with a high of approximately 10 million MMT/year CO_2e in 2020, a low of 5 MMT/year CO_2e in 2021, and 7 MMT/year CO_2e in 2022. Copies of the DEQ's updated EPA SIT files are available upon request. Figure 1 shows the breakdown of Montana's GHG emissions in 2022, with the highest contributor being the Energy sector (62 percent), followed by Agriculture (20 percent), and LULUCF (14 percent). Industrial Processes account for 3 percent of the state's emissions, and Waste contributes only 1 percent of the statewide GHG emissions.

Table 1. Montana's statewide CO_2e emissions from the EPA SIT tool.

Emissions (million metric tons of CO_2e)	2020	2021	2022	2020-2022 Average
Energy	28.66	30.81	31.94	30.47
CO_2 from Fossil Fuel Combustion	26.03	28.20	29.35	27.86
Stationary Combustion	0.17	0.19	0.22	0.19
Mobile Combustion	0.10	0.11	0.11	0.11
Coal Mining	0.42	0.44	0.43	0.43
Natural Gas and Oil Systems	1.93	1.87	1.83	1.88
Industrial Processes	1.41	1.42	1.42	1.42
Agriculture	11.55	10.95	10.00	10.84
Land Use, Land-Use Change, and Forestry	10.03	5.00	7.00	7.34
Waste	0.67	0.68	0.68	0.68
Municipal Solid Waste	0.57	0.58	0.58	0.58
Wastewater	0.10	0.10	0.10	0.10
Indirect CO_2 from Electricity Consumption	6.37	7.47	7.68	7.18
Gross Emissions	**52.32**	**48.87**	**51.04**	**50.74**

Note: Emissions from Electricity Consumption are not included in totals to avoid double counting with Fossil Fuel Combustion estimates.

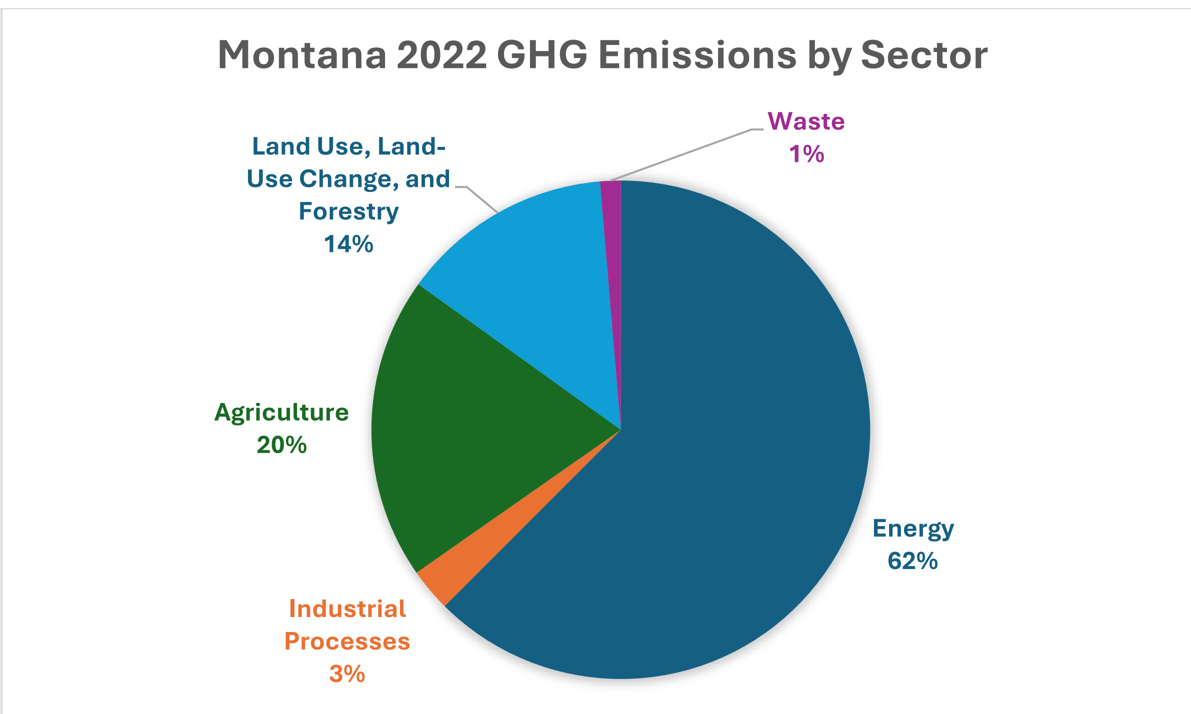

Figure 1. Montana's 2022 GHG emissions from the EPA SIT tool, categorized by industry.

BLM Specialist Report (2023)

The 2023 BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends (hereafter, BLM Specialist Report; BLM 2024) provides lifecycle GHG emission estimates for existing and projected federal fossil fuel production in Montana. This includes emissions from extraction, processing, transport, and combustion of federal minerals extracted from federal lands. Emissions related to existing coal, oil, and gas production in Montana, as well as for permit-approved production and potential leases, are summarized in Tables 2, 3, and 4 for coal, oil, and gas, respectively.

Production and associated carbon dioxide equivalent (CO_2e) emissions from Montana in 2023 are presented along with projections for a 12-month period and for the typical production life for existing and projected development. Production and emissions estimates for potential leases for oil and gas projects are also included in the BLM Specialist Report (BLM 2024). The BLM Specialist Report provides projected emissions for approved federal fossil fuel production that can address the "other past, present, and future actions related to the proposed action by location or generic type" portion of the cumulative impacts definition under MEPA.

Table 2. GHG emissions (Mt of CO2e) for existing and projected federal coal production within Montana.

Type	Production (short tons)	Extraction Emissions	Processing Emissions	Transport Emissions	Combustion Emissions	Total Emissions
Existing Leases (2023 only)	9,207,466	0.1271	0.0344	0.4155	21.56	22.14
Existing Leases (12-month projection)	7,679,027	0.2385	0.0287	0.3465	17.98	18.6
Existing Leases (LOP projection)	104,800,024	3.2553	0.3918	4.7296	245.45	253.83

Source: BLM 2024.

Notes: Mt = Megatonnes; LOP = life of project, meaning the cumulative GHG emissions over the typical production life for existing and projected development.

Table 3. GHG emissions (Mt of CO2e) for existing and projected federal oil production within Montana.

Type	Production (bbl)	Extraction Emissions	Processing Emissions	Transport Emissions	Combustion Emissions	Total Emissions
Existing Leases (2023 only)	2,406,734	0.1775	0.1223	0.0242	1.04	1.37
Existing Leases (12-month projection)	2,061,924	0.1521	0.7047	0.0207	0.89	1.17
Existing Leases (LOP projection)	23,667,900	1.7459	1.2023	0.2382	10.26	13.45
Approved Permits (12-month projection)	688,028	0.0508	0.0349	0.0069	0.3	0.39

Type	Production (bbl)	Extraction Emissions	Processing Emissions	Transport Emissions	Combustion Emissions	Total Emissions
Approved Permits (LOP projection)	2,221,931	0.1639	0.1129	0.0224	0.96	1.26
Potential Leases (12-month projection)	2,439,372	0.1799	0.1239	0.0245	1.06	1.39
Potential Leases (LOP projection)	7,877,755	0.5811	0.4002	0.0793	3.42	4.48

Source: BLM 2024.

Notes: Mt = Megatonnes; bbl = barrels; LOP = life of project.

Table 4. GHG emissions (Mt of CO2e) for existing and projected federal gas production within Montana.

Type	Production (Mcf)	Extraction Emissions	Processing Emissions	Transport Emissions	Combustion Emissions	Total Emissions
Existing Leases (2023 only)	8,713,604	0.0494	0.0169	0.1085	0.47	0.65
Existing Leases (12-month projection)	7,602,986	0.0431	0.0147	0.0947	0.41	0.57
Existing Leases (LOP projection)	96,338,166	0.546	0.1866	1.1997	5.25	7.18
Approved Permits (12-month projection)	811,987	0.0046	0.0016	0.0101	0.04	0.06
Approved Permits (LOP projection)	3,553,363	0.0201	0.0069	0.0443	0.19	0.26
Potential Leases (12-month projection)	2,878,863	0.0163	0.0056	0.0359	0.16	0.21
Potential Leases (LOP projection)	12,598,286	0.0714	0.0244	0.1569	0.69	0.94

Source: BLM 2024.

Notes: Mt = Megatonnes; Mcf = million cubic feet; LOP = life of project.

These estimates provide baseline and projected federal mineral emissions data for Montana's fossil fuel production for 2023 and in the short term (12 months). The biggest federal fossil fuel contributor to Montana's GHG emissions is fossil fuel combustion, with more coal-related emissions than oil and gas. Montana's 2023 federal coal emissions total 22.14 megatons (Mt) CO_2e, with 12-month projections totaling 18.6 Mt CO_2e. The BLM Specialist Report (BLM 2024) also provides life-of-project emissions estimates with 30-year decline curves, which for Montana federal coal projects totals 253.83 Mt CO_2e.

The BLM Specialist Report estimates projected emissions on both a short-term and long-term timeline. The short-term emissions estimates are based on reasonably foreseeable development trends seen in leasing and production statistics while the long-term emissions estimates are based on the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) analysis of energy market dynamics (BLM 2024). These estimates are designed to provide relevant verified information that is intended to fully account for GHG emissions from BLM authorizations to develop the federal mineral estate (BLM 2024).

These data can establish the federal mineral contribution to Montana's cumulative emissions baseline for MEPA cumulative impact assessments and may be particularly relevant when evaluating proposed actions involving federal mineral development or located near existing federal mineral operations.

Facility Level Information on Greenhouse Gases Tool (FLIGHT)

The EPA FLIGHT provides GHG emissions data from large facilities that emit more than 25,000 metric tons of CO_2e per year (EPA 2024b). This tool includes public information from facilities in nine industry groups that directly emit large quantities of GHGs, as well as suppliers of certain fossil fuels, reported under the EPA's Greenhouse Gas Reporting Program (GHGRP). FLIGHT can provide baseline facility-level GHG emissions data to identify and quantify emissions from existing and past industrial sources within Montana, enabling agencies to establish the cumulative emissions baseline against which to assess a proposed action's additional contribution in cumulative impact analyses.

Montana's large facility GHG emitters reported in FLIGHT from 2019 to 2023 are provided in Table 5. The highest total GHG emissions were recorded in 2019, with a large decrease in emissions in 2020. Total GHG emissions from major sources in the years following the pandemic have been steadily increasing since 2020.

Table 5. Facility GHG emissions (metric tons CO2e) from 2019-2023 for large facilities located in Montana.

	Emissions (metric tons of CO_2e)				
Facility Name	**2019**	**2020**	**2021**	**2022**	**2023**
Colstrip	14,277,559	8,340,434	10,035,340	10,740,663	10,967,111
Phillips 66 Billings Refinery	966,133	940,006	976,787	834,083	967,045
CHS Inc Laurel Refinery	979,598	976,385	934,398	1,013,794	918,021
Yellowstone Energy Limited Partnership	852,198	871,923	804,628	791,799	830,005
Par Montana, LLC Billings Refinery	726,587	661,227	712,571	621,037	719,769
Hardin Generating Station	212,250	73,621	692,184	730,172	663,072
Colstrip Energy Ltd Partnership	380,050	373,440	491,021	439,647	474,565
Calumet Montana Refining, LLC	311,235	299,723	283,600	260,293	427,371
Dave Gates Generating Station	153,664	126,595	174,370	254,471	330,090
Ash Grove Cement Company – Montana City	301,601	320,046	316,495	342,055	323,958
Graymont Western U.S. Inc. Indian Creek	322,197	304,550	320,028	318,796	276,271
Trident	277,001	251,350	305,309	299,006	250,489
Billings City Landfill	112,979	117,906	132,607	137,524	143,249
Culbertson Station	66,168	25,841	51,892	82,391	137,957
Western Sugar Cooperative	109,378	104,364	117,000	113,595	122,996

	Emissions (metric tons of CO_2e)				
Facility Name	2019	2020	2021	2022	2023
Montana Waste Systems - Highplains Sanitary Landfill	73,539	78,011	80,756	83,945	85,786
Basin Creek Plant	76,921	28,344	59,476	69,263	55,610
Gallatin County Logan Landfill	42,027	45,078	47,120	51,204	55,531
Weyerhaeuser Nr- Columbia Falls	35,995	33,020	35,530	36,382	40,706
Rec Silicon	33,499	31,006	32,620	32,753	35,245
Lewis & Clark County Landfill	29,810	31,113	32,419	33,857	34,916
Malteurop North America Inc	31	27,301	30,481	29,063	29,063
Cabin Creek Compressor Station	29,901	22,471	28,283	23,967	28,933
Missoula Landfill	28,316	30,692	18,347	22,770	27,790
Northwestern Energy/GTS	25,356	25,210	25,524	26,051	26,289
Hiland Partners Bakken Gathering Plant	22,545	18,263	-	27,967	26,275
Crusoe Energy Systems - Kraken CDP	-	-	-	35,923	22,915
Lewis & Clark	352,646	317,241	90,127	882	10,054
Northwestern Energy, SD LDC	7,164	7,155	7,191	7,211	7,329
Northwestern Energy NE LDC	4,121	4,071	4,050	3,827	3,835
Sidney Sugars Incorporated	96,553	126,731	109,977	110,570	2,690
Total	**20,907,022**	**14,613,118**	**16,950,131**	**17,539,038**	**18,022,021**

Source: EPA FLIGHT (2024b).

Note: The data were reported to the EPA by facilities as of August 16, 2024.

FLIGHT can be used to identify and quantify emissions from other GHG-emitting facilities in a county, planning area, or in specific sectors to address the "other past, present, and future actions related to the proposed action by location or generic type" aspect of the cumulative impacts definition. However, FLIGHT provides historical emissions data only; agencies will need to use other methods or make reasonable assumptions to project future emissions from these facilities for cumulative impact analyses. The tool is particularly useful for identifying existing large emission sources in the vicinity of proposed actions and understanding emission trends from major industrial facilities. The tool does not provide sufficient information to determine if facilities are currently fully operational and therefore require additional facility knowledge to extrapolate to present day and beyond. For example, the Sidney Sugars facility is no longer permitted for operation. Similarly, Colstrip Units 1 and 2 shut down in 2020, meaning that future maximum emissions will align with post-2020 levels, and emissions from 2019 are no longer attainable under standard operational conditions.

Cumulative Climate Change Impacts in Montana

This section provides a compilation of scientific information that agencies may use when describing the cumulative impacts of GHG emissions on Montana's environment. These resources help establish the scientific foundation for understanding how a proposed action's GHG emissions, when combined with other past, present, and related future emissions, contribute to climate change impacts affecting Montana. Agencies can use these sources to characterize baseline climate conditions, document observed trends, and describe projected cumulative impacts of climate change on Montana in their cumulative impact analyses.

BLM Specialist Report (2023)

The BLM Specialist Report (BLM 2024) provides descriptions of climate science and climate trends, including climate forcing and feedback, past and present climate impacts, and projected climate change including in Montana. This is a useful resource for agencies as it provides relevant science-based descriptions of the physical processes that have caused changes in climate throughout Earth's history as well as the recent human-induced, post-industrial era climate change.

The BLM Specialist Report (BLM 2024) summarizes the Fourth National Climate Assessment (NCA4) observed climate trends for Montana as described in the "Northern Great Plains" region, which also includes North Dakota and South Dakota. Key observed changes in the region include:

- An increase in temperature by approximately 1.4°C (2.5°F), with nine of the hottest years in Montana occurring since 1981, and larger temperature increases in winter and spring.
- The growing season in Northern Great Plains region has lengthened by as much as 30 days due to rising temperatures.
- While Montana does not have a clear long-term trend in precipitation, the snowpack in the state has shown a significant decrease since 1955.
- Rising temperatures have dried out soils in Montana's forests, contributing to tree mortality and increasing the risk of forest fires and insect outbreaks in Montana's forests.

The BLM Specialist Report (BLM 2024) also provides a description of the projected climate trends from NCA4. Under the intermediate emissions scenario (RCP 4.5[1]), temperatures are projected to increase by 1.1-2.2°C (2°-4°F) above pre-industrial average temperatures by mid-century, whereas a high emissions scenario (RCP 8.5) could lead to a temperature increase over 5.6°C (10°F) by 2100. Warming is projected to occur throughout all seasons, but would be highest during the summers, leading to increased drought and heatwaves, reduced mountainous snowpack, and variable changes in water availability. Precipitation is projected to increase by approximately 10 percent to 30 percent by 2100, with less precipitation falling as snow under the RCP 8.5 high emissions scenario. Summer rainfall is projected to range from no change under the RCP 4.5 lower emissions scenario to a 10 percent to 20 percent decrease under RCP 8.5 by mid-century. Despite this variation in projected precipitation changes, models show an increase in the number of intense precipitation events (events exceeding 1 inch of

[1] See the Appendix 2 on Secondary Impacts from GHG for further discussion of RCP and SSP scenarios.

rainfall per day). Furthermore, despite projected decreases in hail days, models project a 40 percent increase in hail damage potential due to larger hail in spring months by 2050 under RCP 8.5. While intense precipitation events are expected to increase, the warmer temperatures projected throughout the century will increase evaporative demand, resulting in more severe and frequent droughts.

Fifth U.S. National Climate Assessment

Montana is included in the Northern Great Plains region in the Fifth National Climate Assessment (NCA5), which also encompasses Wyoming, North Dakota, South Dakota, and Nebraska. This region is characterized by variable climate and extreme weather, both of which will compound with climate change.

NCA5 states that the annual average temperature in the region has increased by 0.9°-1.4°C (1.6°-2.6°F) since 1900, and warm nights (nights with a minimum temperature of 21°C [70°F] or higher) have become more common in Montana, despite once being a rare occurrence (Knapp et al. 2023). Since 1985, the number of very cold days (days with a maximum temperature of -18°C [0°F] or lower) has been lower than the long-term average (Knapp et al. 2023).

Montana has seen a decrease in peak streamflow, a proxy for flooding, from 1961 to 2020 as well as a decrease in snow water equivalent (the amount of liquid water in snow) in the mountainous high elevations of the state (Knapp et al. 2023). While overall annual precipitation is anticipated to remain relatively stable across the Northern Great Plains region, NCA5 projects changes in the timing and form of precipitation, with more intense storm events projected for all seasons, and especially during spring (Knapp et al. 2023).

Drought is projected to increase in the region, with more frequent localized droughts by 2040 and more widespread droughts by 2070 under intermediate to very high climate scenarios (RCP 4.5, RCP 6.0, RCP 8.5). Evapotranspiration, the combined loss of water from the land through soil evaporation and plant transpiration, is a critical component of the water budget and can significantly impact drought conditions. Projected warming will increase evapotranspiration, leading to drier soils later in the growing season and making summer droughts more likely than spring droughts (Knapp et al. 2023). Multiple future climate scenarios indicate that moderate, severe, and extreme droughts will occur approximately 10 percent more frequently by 2050 and 20 percent more frequently by 2100 (Knapp et al. 2023). Climate models predict a decrease in soil moisture throughout the summer, with the largest decreases in the mountainous western portion of Montana. A decrease in soil moisture would increase vegetative stress, thereby leading to reduced plant growth in crops, forests, and other vegetation, and increasing the wildfire vulnerability (Knapp et al. 2023).

Driven by rising temperatures and decreasing relative humidity, fire potential in the Northern Great Plains region containing Montana is expected to increase under future climate change, particularly during summer and autumn. The fire season is also expected to lengthen. Increased evapotranspiration and higher drought risk elevate the likelihood of large fires. Historical trends already demonstrate this pattern with the Northern Great Plains experiencing a 213 percent increase in large grassland wildfires from 128 between 1985 and 1995 to 273 between 2005 and 2014, with the total burned area rising by 350 percent in the western ecoregions (Knapp et al. 2023). From the 1970s to the 2000s, the number of wildfires increased by 889 percent and the length of the fire season increased by 85 days in western Montana and Wyoming forests, primarily caused by lightning strikes rather than human activity (Knapp et al. 2023). Historically, snow cover prevented winter wildfires and increased fuel moisture during snowmelt, followed by spring precipitation. However, early spring snowmelt has been correlated with increased fire activity, and the number of snow cover days declined from 1950 to 2010, increasing wildfire activity due to earlier fuel drying, which can also lead to changes in flash flooding and debris flow following fire events (Knapp et al. 2023).

The projected increases in wildfire activity can impact human health, with Montana already experiencing the highest per capita rate of deaths attributable to wildfire smoke in the country (Knapp et al. 2023). Rising average temperatures will also be accompanied by both an increase in heat-related deaths as well as increased risk from vector-borne diseases such as West Nile virus. Furthermore, these health risks can compound during summer months when wildfire and drought are more common, leading to magnified risk from wildfire smoke, heat, and poor water quality.

Sixth Assessment Report of the Intergovernmental Panel on Climate Change

The Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) provides the most comprehensive global scientific assessment of climate change and helps place Montana's climate vulnerabilities in international context. Montana falls within the mid-latitude, semi-arid regions as well as the Western North America region described in AR6. For temperature extremes, AR6 projects that the annual hottest day temperature will increase most (1.5 to 2 times the global warming level) in some of these mid-latitude, semi-arid regions like Montana (IPCC 2023). AR6 also identifies that this region is vulnerable to significant drought risks with medium to high confidence (IPCC 2023).

Regarding projected changes in snow and glaciers, AR6 states that the anticipated warming will lead to the loss of seasonal snow cover and mountain glaciers (IPCC 2023), such as those found throughout western Montana. For agricultural systems, changes are expected to vary globally. While there has been an increase in overall agricultural productivity, climate change has reduced this growth rate in agricultural productivity over the past 50 years globally, with related negative crop yield impacts mainly recorded in mid- and low latitude regions (which includes Montana).

Importantly for cumulative impact assessments, AR6 emphasizes that some changes due to past and future GHG emissions and warming temperatures are irreversible on centennial to millennial time scales, especially changes to the ocean, ice sheets and sea level (IPCC 2023).

Montana-Specific Assessments

This section discusses Montana-specific resources to support agencies in analyzing the impacts of climate change on Montana (including changes in the environment and public health resulting from GHG-induced climate change). These state-level assessments provide detailed baseline conditions, observed trends, and projected impacts that can support cumulative impact analysis under MEPA.

2017 Montana Climate Assessment

The 2017 Montana Climate Assessment (2017 assessment; Whitlock et al. 2017), authored by researchers at Montana State University and the University of Montana, compiles pertinent and peer-reviewed research about climate change impacts in Montana. The assessment was developed in response to requests from citizens and organizations in Montana seeking timely, relevant information on climate change, including historical variability, past trends, and future projections of impacts on key economic sectors. The 2017 assessment focuses on climate trends and their effects on three crucial sectors in Montana: water, forests, and agriculture. The report establishes both baseline conditions (observed climate) and projected climate trends for all regions of the state. This comprehensive baseline information is valuable for MEPA cumulative impact assessments. As a headwaters state feeding Columbia and Missouri river basins, Montana's climate changes affect water supply across a third of the continental United States.

Regional Climate Characteristics

Montana's Continental Divide creates distinct climate regions, with the western part of the state receiving twice as much precipitation (22 to 30 inches) as the eastern part (12 to 14 inches; Whitlock et al. 2017). The mountainous western region has a climate similar to that of the interior Pacific Northwest, with relatively mild winters, cool summers, and precipitation throughout the year. The valleys in this region often exhibit fog, low clouds, and inversions (Whitlock et al. 2017). In contrast, the prairies of Montana’s eastern region are characterized by semi-arid continental climate conditions, with warm summers, cold winters, and less overall precipitation (Whitlock et al. 2017). The 2017 assessment divides Montana into seven climate regions: Western, Southwestern, North Central, Central, South Central, Northeastern, and Southeastern. The report provides the 1981-2010 average seasonal temperature and precipitation for all seven climate regions, which can be used by agencies to establish baseline climate conditions for proposed actions in specific regions. Furthermore, the 2017 assessment provides decadal rates of change for the average annual temperatures and precipitation for all seven climate regions as well as documented changes in Montana's climate extremes.

Observed Climate Changes

The 2017 assessment reports that Montana has warmed 2.0-3.0°F (1.1-1.7°C) between 1950 and 2015, with winter and spring experiencing the most warming at 3.9°F (2.2°C; Whitlock et al. 2017). Additionally, warm days increased by 2.0 percent and cool nights decreased by 4.6 percent between 1951 and 2010. While Montana holds the continental United States' record for coldest temperature (-70°F at Rogers Pass in 1954), such extremes are becoming less likely (Whitlock et al. 2017). There has been no significant change in annual precipitation since 1950, but winter precipitation decreased by 0.9 inch while spring precipitation increased by 1.3-2.0 inches in eastern Montana (Whitlock et al. 2017). The growing season in Montana has lengthened, with an observed increase of 12 days between 1951 and 2010 (Whitlock et al. 2017). This is primarily attributed to an earlier start of spring and longer summers, consistent with the increase in warm days and decrease in cool nights (Whitlock et al. 2017). Crow Tribal elders report observable changes including milder winters, reduced snowfall, earlier spring events, and impacts on traditional foods (Whitlock et al. 2017).

Future Climate Projections

The 2017 assessment uses two RCP scenarios to describe future climate projections for Montana: a stabilization scenario (RCP 4.5) where GHG emissions peak around 2040, and a higher emissions scenario (RCP 8.5) with continued increases in GHG emissions. By mid-century, temperatures are projected to increase by 4.5-6.0°F (2.5-3.3°C); by end-of-century, increases of 5.6-9.8°F (3.1-5.4°C) are projected depending on emission scenarios (Whitlock et al. 2017). These modeled state-level changes in temperature are larger than the average changes projected both globally and nationally. There is high agreement among climate models that temperatures will continue rising and moderate agreement on precipitation increases. Days above 90°F are expected to increase dramatically, especially in eastern Montana (up to 54 additional days by end-of-century under the high emissions scenario; Whitlock et al. 2017). Frost-free days are projected to increase by 30 to 70 days by the end of the century, with western Montana seeing the largest increases (Whitlock et al. 2017). Annual precipitation is expected to increase across the state, with winter, spring, and fall getting wetter but summers becoming drier. Spring precipitation increases are expected to be largest in southern Montana, with summer decreases greatest in the central and southern regions of the state. Northwestern Montana is expected to see the largest precipitation increases, while eastern regions will experience the greatest temperature increases (Whitlock et al. 2017). There is high confidence in temperature projections, but precipitation changes show more variability between climate models, especially for extreme events such as consecutive dry days (Whitlock et al. 2017).

Longer growing seasons and changing precipitation patterns will significantly impact Montana's agricultural productivity and practices.

2021 Climate Change and Human Health in Montana Report

The 2021 Climate Change and Human Health in Montana report (2021 report) is a special report of the Montana Climate Assessment that provides comprehensive data on Montana's current health profile, including county-level vulnerability assessments for heat exposure, population demographics, and existing health disparities (Adams et al. 2021). This baseline health information can serve as the foundation for evaluating how additional GHG emissions might compound existing health risks in cumulative impact assessments. The 2021 report establishes direct causal relationships between climate change (driven by GHG emissions) and health outcomes in Montana, including heat-related illness, respiratory impacts from wildfire smoke, water-related diseases, and mental health effects, thereby providing the scientific foundation to support analysis of health impacts in Montana from cumulative GHG emissions.

The 2021 report addresses various climate-related hazards to health, including direct health impacts from heat, air quality and respiratory health, water-related health risks, vector-borne and infectious diseases, food security, social impacts and vulnerable populations, economic challenges, and adaptation needs.

Heat-Related Health Impacts

The 2021 report identifies extreme heat as the leading weather-related cause of death in the country, causing heat exhaustion, heat stroke, and worsening of chronic conditions (Adams et al. 2021). Heat exposure can increase the risks of respiratory diseases, cardiovascular issues, and kidney disease (Adams et al. 2021). Workers in agricultural or construction industries are most at risk for heat-related death due to the physical demands of their jobs and the direct exposure to heat (Adams et al. 2021).

Air Quality and Respiratory Impacts

Wildfires exacerbated by climate change are projected to become a consistent summer event and lead to poorer air quality and visibility across Montana (Adams et al. 2021). Particulate matter (PM) is one of the primary pollutants from wildfire activity, which can create harmful breathing conditions, especially for those sensitive to air quality (e.g., elderly, children, people with heart or lung diseases, and those who are pregnant). Increased CO_2 levels combined with longer growing seasons will also lead to increased pollen production, which can worsen symptoms of allergies and asthma (Adams et al. 2021).

Water-Related Health Risks

Although changes in flooding throughout the state are difficult to predict, the combination of earlier snowmelt and intense precipitation events can potentially increase flooding risk, which endangers Montana citizens and can contaminate water supplies (Adams et al. 2021). Additionally, flooding can lead to gastrointestinal disease and provide breeding grounds for water-borne, food-borne, and mold-related illnesses (Adams et al. 2021). Extended droughts can also drastically affect populations as they will deplete public and private water sources, especially for communities that rely on surface water and shallow groundwater for drinking water (Adams et al. 2021). The projected reduction in late-season water availability will affect both irrigation and utility-level water sources (Adams et al. 2021). Drought conditions will also challenge agriculture, potentially reducing food availability (Adams et al. 2021). Climate change may also reduce the availability of wild game, fish, and subsistence plants as traditional food sources are particularly vulnerable to environmental changes (Adams et al. 2021).

2020 Montana Climate Solutions Plan

The 2020 Montana Climate Solutions Plan (2020 plan; State of Montana 2020) developed by the Montana Climate Solutions Council was created to provide recommendations for preparing Montana's citizens for climate impacts, reducing GHG emissions, fostering innovation and economic development, and supporting Montana's communities. The 2020 plan established the Montana Climate Solutions Network to coordinate climate information sharing and build community capacity across state, local, tribal, and university partners. The 2020 plan provides a summary of observed climate impacts, including temperature increases of 2-3°F since 1950, earlier snowmelt, and increased wildfire risks (State of Montana 2020). The 2020 plan identifies specific climate vulnerabilities across key sectors (agriculture, water resources, forests, and tourism) and explains how cumulative GHG emissions translate into measurable impacts such as reduced snowpack, altered streamflow, and increased wildfire frequency (State of Montana 2020).

The 2020 plan documents how specific industries, such as agriculture, are particularly vulnerable to climate change because extreme weather events (e.g., flooding, wildfire, blizzards, hailstorms, and drought) can decimate crops (State of Montana 2020). Furthermore, the increase in the number of warm and hot days will also increase water demand for most crops, limit grain development, and increase heat stress on livestock (State of Montana 2020). Additionally, rising temperatures throughout this century will reduce snowpack, leading to lower streamflow and less reliable irrigation water availability during the end of the growing season (State of Montana 2020).

Interactive Climate Data Tools

In addition to the climate assessments described above, several interactive online tools provide agencies with direct access to climate data, projections, and visualizations that can support analysis of cumulative climate change impacts. These tools offer the advantage of providing location-specific climate information that can be tailored to the geographic area and timeframe relevant to a proposed action. The tools described below enable agencies to access high-resolution climate projections, visualize observed climate trends, and generate maps and graphics that can be incorporated directly into MEPA documents. These resources are particularly valuable for quantifying and illustrating how cumulative GHG emissions translate into specific climate impacts at state, county, and local scales relevant to MEPA assessments.

National Climate Change Viewer

The U.S. Geological Survey (USGS) National Climate Change Viewer (NCCV) visualizes scientifically rigorous, high-resolution climate projections that directly link GHG emission scenarios to environmental outcomes for any state, county, and USGS Hydrologic Units (HUC4 and HUC8). The advantage of this resource is that agencies can access statistically downscaled high-resolution climate projections from the Climate Model Intercomparison Program (CMIP) that are specific to the county or hydrologic region in which the MEPA project will occur. The NCCV can visualize projections from multiple GHG emission scenarios (SSP2-4.5, SSP3-7.0, SSP5-8.5 for CMIP6; RCP4.5, RCP8.5 for CMIP5; and total global warming levels of 1.5, 2, and 3°C) and can show how different cumulative GHG pathways translate into specific climate impacts across Montana.

Users can customize both geographic and temporal parameters for analysis. Along with the geographic location, the user can specify the timeframe for analyzing different climate variables: annual, seasonal, or monthly data. The climate variables that can be visualized include mean temperature, maximum temperature, minimum temperature, precipitation, runoff, snow, soil storage, and evaporation deficit. The user can choose from 1 of 23 climate models, as well as multiple multimodel averages to visualize results. The NCCV can display climate projections for 2025-2049, 2050-2074, and 2075-2099. The data can be displayed as a line graph (Climograph) over a year or as an ensemble time series showing model agreement for the selected climate variable over a 100-year timeframe. Importantly for MEPA documentation, the viewer allows users to download summary reports of the time series in PDF format or .csv files to support cumulative impact analysis and documentation.

Climate Indicator Map Explorer

The EPA Climate Indicator Map Explorer visualizes climate impacts across Montana's geography, showing how GHG emissions have manifested as measurable environmental changes at state and regional scales. For example, the user can zoom into the Montana state boundaries and toggle on/off various datasets related to climate impacts (e.g., weather and climate, snow and ice, health and society, and ecosystems). Within the weather and climate map layer, users can reveal/hide high and low temperature map layers, river flooding data, rates of temperature and precipitation change, and changes in drought. Note that not every map layer has data available for every state. For instance, there is no heat wave data available for Montana at the time of the publication of this appendix. This tool can display multiple climate indicators on a single map (e.g., rise in temperature and trends in snowpack) to illustrate related climate risks and how these indicators interact with each other. Furthermore, the spatial resolution of the available data allows for highlighting effects within specific regions of the state, such as the area of a proposed action under MEPA.

For cumulative impacts analysis, the EPA Climate Indicator Map Explorer can be used to establish baseline conditions and document observed changes in climate to date due to collection of historical data displayed in the map. Much of the data in the tool span from the 20th century to the present day. This tool is useful for trend analyses to demonstrate how cumulative GHG accumulation translates to progressive environmental changes. It allows the user to overlay multiple climate indicators to show interconnected impacts (e.g., temperature + drought + wildfire risk). This state-level data can help agencies assess cumulative impacts within Montana's boundaries while considering regional patterns of climate change.

Summary

Agencies can describe baseline GHG and climate conditions and analyze cumulative GHG impacts by using multiple complementary data sources and assessment tools described in this appendix. For quantifying cumulative emissions, agencies can leverage the EPA SIT for Montana-wide sectoral emissions, the EPA FLIGHT database for large facility emissions, and BLM’s federal fossil fuel GHG projections for federal mineral extraction activities. For understanding cumulative climate impacts, the climate assessments from IPCC AR6, NCA5, and Montana-specific studies provide the scientific framework linking cumulative emissions to environmental changes affecting Montana’s environment. Additionally, the interactive climate data tools enable agencies to access location-specific projections and visualizations that can be directly incorporated into MEPA documentation.

Together, this appendix provides agencies with information on multiple data sources and approaches that can be used to support cumulative impact assessments under MEPA. These combined resources enable agencies to establish baseline conditions, quantify cumulative emissions, and analyze how cumulative GHG emissions translate into impacts relevant to Montana’s environment.

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