USFS REGION 1
Eastside National Forests
AIR QUALITY ASSESSMENT

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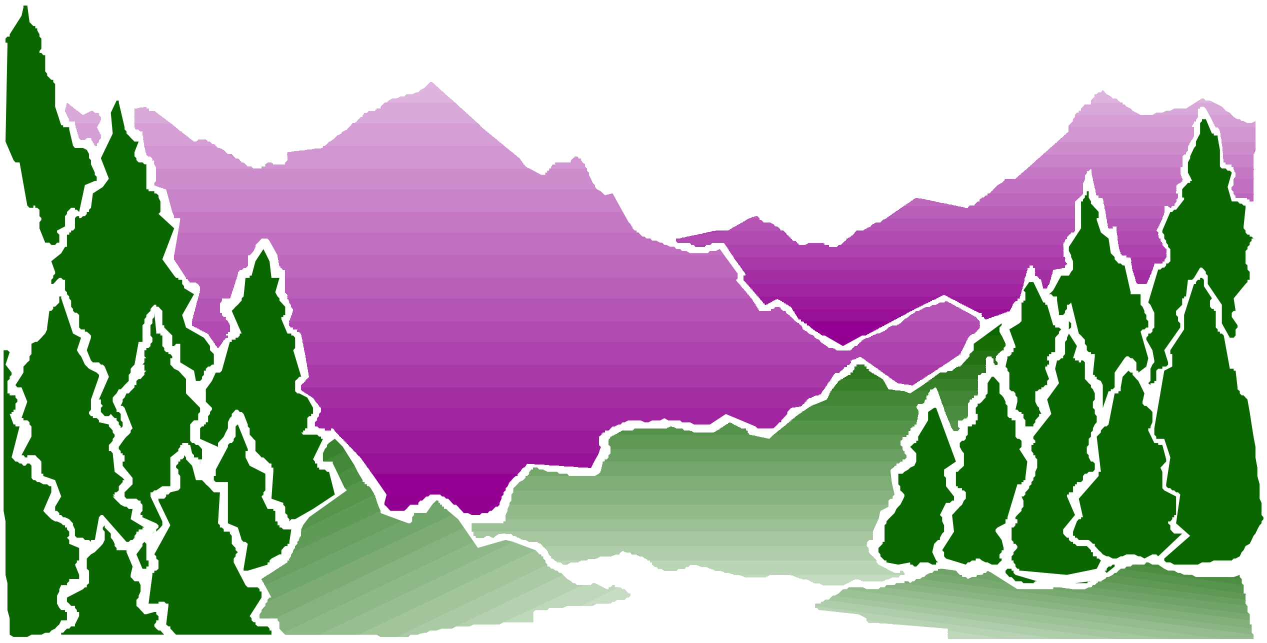


TABLE OF CONTENTS

PURPOSE AND USE OF ASSESSMENT

The purpose of this assessment is to identify Eastside Forests air quality issues, air quality conditions, air pollution sources, monitoring sites, summarize known information, and to advise Forest managers on the Lewis and Clark, Helena, Beaverhead, Deerlodge, Gallatin, and Custer NF's on air quality issues. This assessment is focused on air quality issues associated with the Eastside National Forests and subsequent AMS and Forest Plan revisions. The assessment should also be useful in planning, NEPA documents, facilitating air quality information exchange.

LEGAL FRAMEWORK

THE FEDERAL CLEAN AIR ACT

The basic framework for controlling air pollutants in the United States is mandated by the 1970 Clean Air Act (CAA), as amended in 1999 and 1990. The CAA was designed to "protect and enhance" air quality. The primary means by which this is to be accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value." Stringent requirements are therefore established for areas designated as "Class I" attainment areas. Class I areas include Forest Service and Fish and Wildlife Service wilderness areas over 5,000 acres that were in existence before August 1977, and National Parks in excess of 6,000 acres as of August 1977. Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels.

Another requirement of the CAA (as amended) is that new major stationary sources or major modifications of existing stationary sources must first receive a "Prevention of Significant Deterioration" (PSD) permit from the appropriate air regulatory agency before construction or modification of these sources can be accomplished. A major source is one that limits over 100 or 250 tons/yr of a pollutant, depending on the type of source. PSD provisions are aimed at protecting and enhancing the air quality in Wilderness areas and other locations of special scenic, recreational, historic, or natural value. Before the construction of certain new air pollution sources is approved, the new-source proponents must apply for and receive a PSD permit for the appropriate air regulatory agency. In Montana Class I areas have been delegated the PSD permit program by the Environmental Protection Agency (EPA). PSD permit applicants must demonstrate that the proposed facility will: (1) not violate national or state ambient air quality standards, (2) use Best Available Control for sources subject to PSD, (3) not violate either Class I or II increments for sulfur dioxide, nitrogen oxides, or particulates, and (4) not cause or contribute to an adverse impact on AQRV's in any Class I area.

Regulations

The Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for specific pollutants emitted in significant quantities throughout the country that may be a danger to public health and welfare. These pollutants are called criteria pollutants. The NAAQS are designed to protect human health and the public welfare from the adverse effects of these criteria pollutants. The CAA defines public welfare effects to include, but not be limited to, "effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being".

The following table lists the National Ambient Air Quality Standards. Montana has adopted some more stringent standards on certain pollutants.

POLLUTANT	TIME PERIOD	FEDERAL (NAAQS)	STANDARD TYPE	MONTANA (MAAQS)
Carbon Monoxide	Hourly Average 8-Hour Average	35 ppm[a] 9 ppm[a]	Primary Primary	23 ppm[b] 9 ppm[b]
Fluoride in Forage	Monthly Average Grazing Season	- - - -	- - - -	50 µg/g[c] 35 µg/g[c]
Hydrogen Sulfide	Hourly Average	- -	- -	0.05 ppm[b]
Lead	90-Day Average Quarterly Average	- - 1.5 $\mu g/m^3$[c]	- - Prim. & Sec.	1.5 $\mu g/m^3$[c] - -
Nitrogen Dioxide	Hourly Average Annual Average	- - 0.053 ppm [3d]	- - Prim. & Sec.	0.30 ppm[b] 0.05 ppm[e]
Ozone	Hourly Average 8-Hour Average	0.12 ppm[f] 0.08 ppm[g]	Prim. & Sec. Prim. & Sec.	0.10 ppm[b] - -
PM -10	24-Hour Average Annual Average	150 $\mu g/m^3$[k] 50 $\mu g/m^3$[l]	Prim. & Sec. Prim. & Sec.	150 $\mu g/m^3$[k] 50 $\mu g/m^3$[l]
PM-2.5 (in litigation)	24-Hour Average Annual Average	65 $\mu g/m^3$[m] 15 $\mu g/m^3$[n]	Prim. & Sec. Prim. & Sec.	- - - -
Settleable Particulate	30-Day Average	- -	- -	10 g/m^2[c]
Sulfur Dioxide	Hourly Average 3-Hour Average 24-Hour Average Annual Average	- - 0.50 ppm[a] 0.14 ppm[a,i] 0.03 ppm[d]	- - Secondary Primary Primary	0.50 ppm[h] - - 0.10 ppm[b,j] 0.02 ppm[e]
Visibility	Annual Average	- -	- -	3×10^{-5}/m[e]

[a] Federal violation when exceeded more than once per calendar year.
[b] State violation when exceeded more than once over any 12 consecutive months.
[c] Not to be exceeded (ever) for the averaging time period as described in the state and/or federal regulation.
[d] Federal violation when the annual arithmetic mean concentration for a calendar year exceeds the standard.
[e] State violation when the arithmetic average over any four consecutive quarters exceeds the standard.
[f] Applies only to NA areas designated before the 8-hour standard was approved in July, 1997. Mt. has none.
[g] Fed. violation when 3-year average of the annual 4th-highest daily max. 8-hour concentration exceeds the standard.
[h] State violation when exceeded more than eighteen times in any 12 consecutive months.
[i] The federal standard is based upon a calendar day (midnight to midnight).
[j] The state standard is based upon 24-consecutive hours (rolling).
[k] State and federal violation when more than one expected exceedance per calendar year, averaged over 3-years.
[l] State and Federal violation when the 3-year average of the arithmetic means over a calendar year at each monitoring site exceed the standard.
m Federal violation when 3-year average of the 98th percentile values at each monitoring site exceed the standard.
[n] Federal violation when 3-year average of the spatially averaged calendar year means exceed the standard.

Non-Attainment Areas and New Source Review

Areas where the National Ambient Air Quality Standards are exceeded are considered non-attainment areas. If a major new air pollution source is to be located in a non-attainment area, that source is subject to the New Source Review PM_{10} instead of the PSD process. The New Source Review is designed to allow a net air quality improvement in the area even after the proposed source begins operation. The proposed source must undergo an analysis of alternative sites, sizes, production, processes, and control techniques. Proposed sources must also determine that the benefits of the source outweigh the environmental and social costs. The non-attainment areas in the vicinity of the Eastside Forest are all cities and include: Butte for $PM_{10,}$ East Helena for SO_2, Billings for SO_2 and CO, Laurel for SO_2, and Great Falls for CO (carbon monoxide).

Regional Haze Proposed Regulations

Visibility impairment is a basic indicator of pollution concentrations in the air. Visibility has been recognized as a major air quality concern for many years. Visibility variation occurs as a result of the scattering and absorption of light by particles and gases in the atmosphere. Without pollution effects, a natural visual range is approximately 140 miles in the West and 90 miles in the East.

The EPA has determined that regional variation in visibility effects needs to be addressed. As a result, the EPA proposed Regional Haze Regulations for Protection of Visibility in National Parks and Wilderness Areas in 1997. These regulations are intended to improve visibility, or visual air quality, in more than 150 important natural areas across the country. These areas include many of the best known national parks and wilderness areas, such as, the Grand Canyon, Yellowstone, and Yosemite.

The proposed regulations, which are revisions to the existing 1980 visibility rules, address visibility impairment in the form of regional haze. These regulations will protect specific areas of concern, known as Class I areas. The Clean Air Act defines mandatory Class I areas as national parks over 6000 acres, wilderness areas over 5000 acres, and national memorial parks over 5000 acres.

The proposed regional haze regulations apply to all States, including those States that do not have any Class I areas. Pollution that occurs in those states may or may not contribute to impairment in other states or Class I areas, but must be accounted for.

The Regional Haze regulations propose “ presumptive reasonable progress targets” for improving visibility in each Class I area. The progress targets are described in terms of deciviews, a measure for describing perceived changes in visibility. For example, a deciview of zero represents pristine conditions. For most views in Class I areas the average person considers a change of one deciview perceptible. In this proposal, EPA is requesting that every 3 years, States review progress in each Class I area in relation to the area’s relevant progress targets. In addition, States are required to revise their implementation plans for visibility within 12 months of promulgation of the rule.

OTHER LAND MANAGEMENT ACTS

The Wilderness Act of 1984 (16 USC 1131 et seq.) defines wilderness as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain . . . an area of undeveloped Federal Land retaining its primeval character and influence . . . which is protected and managed so as to preserve its natural conditions (16 USC 1131(c)). The Wilderness Act also states that wilderness areas will be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use. The Eastside Forests area includes 7 Class I areas and 2 Class II Wilderness areas.

Eastside National Forests area Class I and Class II areas

Area	Acres	Management Agency	Class
Bob Marshall Wilderness	1,019,356	Lewis & Clark NF, Helena NF	1
Scapegoat Wilderness	239,936	Helena NF	1
Great Bear Wilderness	285,771	Lewis & Clark NF	
Gates of the Mountains Wilderness	28,936	Helena NF	1
Anaconda-Pintler Wilderness	158,656	Beaverhead-Deerlodge NF	1
Absaroka-Beartooth Wilderness	930,584	Gallatin NF	2
Lee Metcalf Wilderness	140,594	Gallatin NF, Beaverhead NF	2
Northern Cheyenne Reservation	436,947	Northern Cheyenne tribe	1
Yellowstone NP Park	2,718,159	NPS	1
Red Rock Lakes Fish & Wildlife Refuge	44,963	USFWS	1
TOTAL CLASS I ACREAGE	4,932,724		
TOTAL CLASS II ACREAGE	1,071,178		

In addition, Eastern Montana includes 2 mandatory Class I areas (Medicine Lakes Wilderness and UL Bend Wilderness) and a designated Class I area (Fort Peck Indian Reservation).

POLICIES AND DIRECTION

Forest Service air resource management responsibilities derive from the Clean Air Act and amendments, National Forest Management Act (NFMA), Wilderness Act, and National Environmental Policy Act (NEPA). Primary responsibilities include:

1. Protect NFS lands from adverse air pollution impacts
2. Manage NFS emissions in accordance with national and local air quality standards
3. Protect AQRVs, including visibility, in Class I areas

The Forest Service air quality responsibilities derive from protective requirements of Class I areas and associated air quality values (AQRVs) as well as several Class II Wilderness areas. The Forest Service multiple use output mandates and targets, however, result in several sources of emissions such as prescribed fire, wildfire, road dust, and emissions from permitted activities such as mines, oil and gas exploration and development, and ski areas. Air quality management in the Forest Service, therefore, requires a balance of sustaining resource productivity while conserving ecosystems and protecting Wilderness areas.

CURRENT AND POTENTIAL IMPACTS ON EASTSIDE FORESTS AIR QUALITY

Pollution sources that potentially affect all areas in the Eastside Forests include industrial sources, wildfires, prescribed burning, agricultural burning, residential and business development, and vehicle emissions. The level of concern varies by area and the following discussion reflects the current level of understanding.

Industrial Emissions

A listing of all stationary sources in Montana in the vicinity of the Eastside Forests with permitted emissions greater than 100 tons/yr is contained in Appendix 1. Particulates are the major source of air pollution in Montana**.**

Sulfur dioxide is also a pollutant of concern in Montana. Four areas in the vicinity of the Eastside Forests where SO_2 from industrial point sources is an issue: Billings/Laurel, East Helena, Colstrip, and Great Falls.

In Great Falls, the primary source of SO_2 in the Montana Refining petroleum refinery. As the result of dispersion modeling performed in support of a permit application by Montana Refining potential exceedances of the SO_2 NAAQS were identified.

Seven major $S0_2$ sources in the Billings/Laurel area include the Exxon oil refinery, Conoco oil refinery, Montana Power coal fired electric power generating facility, Western Sugar beet factory, Yellowstone Energy Limited Partnership coke fired cogeneration power plant, Montana Sulphur and Chemical sulfur recovery facility, and the Cenex oil refinery. Sulfur dioxide emissions in the Billings/Laurel area have declined over the last 6 years due to a number of factors including industrial controls added as part of SIP requirements, plants operating at less than full capacity, and industrial process changes to meet sulfur and diesel fuel regulations. However, subsequent monitoring networks for SO_2 have shown the area to be in compliance with National Ambient Air Quality Standards (MAAQS). In 1997 the Montana Board of Health and DEQ negotiated new emission limits on all of the SO_2 emitting sources and require continuous emissions monitors on most stacks for compliance determinations.

East Helena is a non-attainment area for SO_2 due primarily to the ASARCO lead smelter. The smelter has installed an acid plant and modified stacks to reduce SO_2 emissions. Data from monitors in the immediate vicinity of the smelter has shown exceedance but no violations of the NAAQS or MAAQS for PM_{10} but consistent violations of the lead NAAQS standards. A SIP is being prepared to reduce lead emissions.

Nitrogen dioxide (NO_2) is not a pollutant of major concern in the Eastside Forests area. Point sources of NO or NO_2 in Montana include coal fired power plants, natural gas compressor stations, and oil refineries (Appendix 1). Data submitted by the Colstrip Power Company has shown no violations of the NAAQS or MAAQS for NO_2.

Oil, Gas, Mineral Development

No active oil and/or gas wells currently exist on National Forest managed lands in Montana. Scattered dry holes in the southwestern part of Montana but there is currently no active production. The area is ranked as very low, low or moderate potential for petroleum occurrence.

The Beartooth RD on the Custer NF is in the vicinity of some oil and gas production including a small (7 wells) shut-in oil field and about 800 wells in approximately 50 fields in Carbon, Stillwater, and Park

Counties. The Beartooth District is ranked low to high potential for petroleum potential. The Reasonably Foreseeable Development Scenario for the Beartooth Leasing EIS predicted 4 wells might be drilled on the Beartooth front over a 15 year period.

In the Ashland area about 350 coal bed methane gas wells are proposed in the vicinity of the Custer NF. Just south in Wyoming about 150-200 coal bed methane wells are proposed, primarily on BLM land.

Scattered drilling, both productive and dry holes, has occurred around the Lewis and Clark Forest island units including the Highwoods, Big and Little Belts, Crazy, Castle, and Big Snowy Mountains. The areas are ranked as very low, low and some moderate potential for petroleum occurrence.

Scattered well drilling has occurred along the Rocky Mountain Front. Except for the gas production at Blackleaf Field, most have been dry holes. The area is rated as high for the potential occurrence of petroleum especially gas. Leasing is not currently allowed on the Lewis & Clark NF portion of the Rocky Mountain Front. (Information on the potential rankings is from Lewis & Clark NF Oil and Gas Leasing FEIS Appendix B and the Helena NF Oil and Gas Leasing FEIS Appendix E). There have been thousands of wells drilled since the early 1900's on the Sweetgrass arch which stretches from the Canadian border through Shelby and Conrad. The western most production from the fields associated with the arch is approximately 24 to 30 miles east of the Rocky Mountain Ranger District.

Wildfires and Prescribed Burning

Fire management effects on air quality is an issue throughout the West, as there has been many discussions on prescribed fire and wildland fire impacts on air quality, visibility and public health. The following was taken from the Public Advisory Committee Final Report from the Grand Canyon Visibility Transport Commission. It includes background, a discussion on management alternatives, and the Commissions Proposed Recommendations.

Fire Emissions and Visibility

Fire has played a major role in the development and maintenance of most ecosystems of the West. The long-term future of the West is dependent on healthy ecosystems that are capable of sustaining natural processes and human uses.

An increase of accumulated forest fuels in the West has occurred because of past land management practices, including decades of fire suppression. Evident ecosystem changes include increasing tree densities, disrupted nutrient cycling, and altered forest structure. As a result, wildfires are becoming larger in size, unnaturally destructive, and more dangerous and costly to control. In 1994, wildfire burned 3.1 million acres in the West and cost $1 billion dollars in direst suppression costs while causing firefighter deaths and serious human health impacts. Rectifying this problem will take years and is a basic responsibility of wise land stewardship. Fire is an essential component of most natural systems, and perpetuation of fire at a level required to maintain ecosystem processes is necessary. The natural role of fire in the wildland/urban interface must also be addressed to protect life and property. A substitute for fire and its natural role has not been found in many ecosystems. The objective of future prescribed fire programs is to cooperatively meet land management, human health and visibility objectives.

Emissions form fire (wildland and prescribed) are an important episodic contributor to visibility-impairing aerosols, including organic carbon, elemental carbon, and particulate matter (PM2.5). Agricultural burning emissions and their effects have been identified as a concern, but have not been quantified due to lack of data. All types of fire (prescribed fire and agricultural burning) must be addressed equitably as part of a visibility protection strategy. This may require state legislation in some cases.

Wildfire impacts are increasingly uncontrollable or unmanageable, due to excessive fuel loads, except through the application of prescribed fire and/or mechanical means, such as brush removal and logging. Field experience has shown that prescribed fire can reduce the size, frequency, and intensity of wildland fires. Areas that have been treated with prescribed fire demonstrate much less burning in the tops of trees and a slowing of wildfire spread. Prescribed fire therefore promotes better fire control, predictable fire effects and allows for management of emissions as compared to wildfire.

The future use of prescribed fire and the restoration of fire in its natural role with natural fuel loadings will provide sustainable ecosystems where environmental and human health impacts can be managed. This future desired situation contrasts with the current adverse public health impacts and permanent damage to natural resources and property from wildfires. Wildfires are causing exceedences of ambient air quality standards and air quality-triggered community evacuations with greater frequency. Prescribed fire programs will influence future wildfire in many locations of the West. However, infrequent large-scale fore replacement wildfire will still occur naturally in some vegetation types.

Land managers employ emission reduction and smoke management techniques to reduce air quality impacts of prescribed fire. Current smoke management techniques take into account the timing and location of burns so that impacts on human health are reduced. These techniques can be expanded to reduce current and future impacts on visibility. Emission reduction techniques can also be utilized to reduce the quantity of emissions from a prescribed burn. The appropriateness and effectiveness of emission reduction techniques vary based on vegetation type, burn objectives, location, other environmental constraints such as water quality, and funding. Effective agricultural smoke management programs have been developed in some states using similar measures.

Utilization of mechanical treatments such as logging or firewood sales to remove fuels will be necessary in some areas prior to prescribed burning. The potential use of mechanical treatments is limited, however, since large areas of the West are not physically available due to inaccessibility, slope or soil sensitivity. Significant emission reductions from mechanical treatment would only occur in timber areas. Administrative constraints, such as wilderness or habitat protection, also impose limitations. Approximately 30% of the total timber area has the potential to be treated using mechanical methods. In areas where mechanical treatments are used alone, some level of prescribed fire treatment may still be necessary. Mechanical treatment cannot replace the natural role of fire in ecosystem health and sustainability processes.

In order to address the fuels problem and ensure adequate protection of visibility in the West, funds will need to be greatly increased. With the development of increased prescribed fire programs, it is crucial to fund smoke management programs that protect public health and visibility, while meeting the underlying land management objectives and air quality standards.

The following proposed recommendations from the Grand Canyon Visibility Transport Commission could also apply to the Eastside Forests. If the EPA, states, state and federal land management agencies implement recommendations, they will have implications on prescribed fire use in the Eastside Forests.

1. Plan for the visibility impacts of smoke.

The commission recommends that the EPA require all federal, state, tribal, and private prescribed fire programs to incorporate smoke effects in planning and application by the year 2000.

2. Implement emissions tracking system for all fire activities.

Consistent emissions tracking system for prescribed fire, wildfire, and agricultural burning should be implemented region-wide.

3. Improve integrated assessment of emissions.

Federal, state, tribal and private land managers, in conjunction with relevant regulatory agencies and interested parties, should improve the current integrated assessment of emissions from prescribed fire, wildfire and agricultural burning by 1999. The assessment should:

a) Identify specific areas where fire activities have or could have an adverse impact on health and visibility;

b) identify areas where mechanical treatments could substantially reduce emissions and subsequent impacts on health and welfare;

c) In the areas identified, assess the feasibility of biomass utilization (woody material use), market development, and non-statutory administrative barriers; and

d) Assess meteorological information needs, air quality monitoring needs, smoke dispersion model needs, interstate planning needs, wildfire/prescribed fire trade-offs (economics, air quality and other resource effects), and emission factor research (vegetation/fuels and effects of emission reduction techniques).

4. Enhance smoke management programs.

The Commission recommends the development and implementation of criteria and requirements for the use of enhanced smoke management programs (including alternative management practices) and emission reduction strategies in the identified areas. Such programs should consider factors of efficiency, economics, law, land management objectives, and reduction of visibility impacts. States, tribes, state and federal land management agencies and private parties should create and implement smoke management programs that address public health, visibility and land management objectives by the year 2000, using the results of the assessment listed in Recommendation #3.

5. Develop cooperative funding mechanisms.

The Commission supports the development of cooperative funding mechanisms between burners and regulatory agencies to implement increased smoke management programs and integrated assessment costs.

6. Promote public education programs.

The Commission supports the creation of a public education program regarding the role of fire in air quality to be undertaken by land managers and other interested governmental and private groups.

7. Establish annual emission goals for fire programs.

The Commission recommends that annual emission goals for all fire programs, where appropriate, be established by the year 2000. These goals will be set to minimize emission increases from such programs to the maximum extent feasible. States, tribes, state and federal land management agencies and their private sector counterparts will establish the goals cooperatively.

8. Remove administrative barriers to the use of alternatives to burning.

The Commission recommends that the federal land management agencies and their state, tribal, local and private counterparts identify and remove non-statutory administrative barriers to emission reduction strategies by the year 2000, to the maximum extent feasible. In removing such barriers, the Commission intends that subsequent actions will be undertaken consistent with applicable laws and regulations.

Prescribed Fire

Prescribed fire has been used to meet resource objectives for land management agencies for many years. Objectives of these prescribed fires have been primarily for hazard reduction and site preparation on timber sales, range and wildlife habitat improvement, etc. Increasing issues involving forest health, ecosystem management, and wildfire suppression costs has generated an increasing emphasis on reducing natural fuels on federal lands. By moving funds from wildfire suppression budgets to natural fuels treatment budgets federal land management agencies have set a goal of treating 3.5 million acres by the year 2000. Prescribed fire will be the tool most likely used to treat a majority of these acres.

The Eastside Forests land management agencies will be involved in this national emphasis to reduce natural fuel loadings in their ecosystems with greatly accelerated programs of prescribed fire. Prescribed fire areas will be treated during various weather conditions throughout the year. Some of the projects are stand replacing burns, which will be executed during late summer or early fall. Other burns will be executed during the spring before green-up or late in the fall before the first snows arrive. These figures may change as windows of opportunity change with weather and drought conditions.

Wildland Fire Use for Resource Benefit (Prescribed Natural Fires)

All of the units within the Eastside Forests manage their lands or a portion of them for natural fires to burn under prescribed conditions allowing natural processes to occur. Yellowstone and Grand Teton National Parks have Fire Management Plans that allow these processes to occur within designated wilderness areas. Many of the Forests will be revising or have revised their respective Land Management Plans, after these revisions incorporating the National Fire Policy Forests will be able to manage wildland fires for resource benefit once Fire Management Plans are approved. With these approved plans in both wilderness and non-wilderness lands, an increase of natural fires managed for resource benefit will occur within the Eastside Forests. Management of these fires may occur during the entire fire season and be of varying magnitude.

The following Wilderness Areas currently have approved Fire Management Plans:

Wilderness Area	**National Forests**
Lee Metcalf	Gallatin and Beaverhead NF’s
Absaroka-Beartooth	Shoshone, Custer and Gallatin NF’s
Bob Marshall	Lewis and Clark, Flathead, and Lolo NF’s
Scapegoat	Helena and Lolo NF’s
Anaconda Pintler	Beaverhead, Deerlodge, and Bitterroot NF’s

With the increase in prescribed fire and wildland fire use in the Eastside Forests, smoke management will become an important factor in the success of the fire management program. Becoming pro-active in working with state and local air quality agencies on air quality issues and smoke management regulations will be essential in a successful program. The land management agencies in the Eastside Forests have been or are becoming involved with the state air quality divisions and becoming partners in air quality partnerships in their respective regions. Many states are updating or working on finalizing their State

Implementation Plans (SIP); some of the federal land management agencies are represented from units in the Eastside Forests.

Smoke Impacts and Health Effects Prescribed Fire

It is becoming evident that smoke has had health impacts on employees that have been involved in prescribed fire. The Missoula Technology and Development Center (MTDC) has ongoing research studying the health effects smoke has on employees involved in prescribed and wildfires. The MTDC is publishing newsletters on the research and methods and equipment that reduce the exposure to smoke. When possible efforts should be made to assist with the MTDC in their research and provide equipment and methods that reduce exposure to smoke on our employees when involved in prescribed fire or wildland fires.

MONITORING EFFORTS AND SUMMARY OF KNOWN INFORMATION

NADP

The National Atmospheric Deposition Program (NADP) was initiated in 1978 to monitor geographic and temporal trends in the chemical composition of rain and snow (wet deposition), with the primary purpose of acid rain benchmark monitoring. The NADP program currently consists of 200 sites, including 5 sites in the Eastside Forests. Table 1 lists average (1990-1998) wet deposition chemistry of the 6 NADP stations in the vicinity of the Eastside Forests. The pH and mg/L columns are concentrations in 9 year averages. The kg/Ha column of annual loading rates for SO_4 (sulfate) and $N0_3$ (nitrate) factor in precipitation in order to calculate total wet deposition. Table 1 results are very similar to Gibson (1990) and Saunders (1991) of the Natural Resource Ecology Lab, which calculated wet deposition rates for Colorado, Wyoming, Idaho, and Montana for the 1985-1989 period.

Table 1. 1990-1998 Wet Deposition Chemistry of NADP Sites Upwind and in the Vicinity of the Eastside Forests.

Site/Management agency	pH	S04	N03	NH4	S04	N03	Pcp	elev
		mg/L			kg/Ha		cm	meters
WY08 – Yellowstone NP Tower Falls	5.39	.39	.55	.14	1.59	2.24	41	1912
MT97 – Bitterroot NF Lost Trail Pass	5.35	.21	.31	.05	1.6	2.3	102	2114
MT05 –Glacier NP West Glacier	5.12	.32	.39	.07	2.8	3.3	86	968
MT07 –Clancy (near Helena)	5.0	.46	.52	.11	1.8	2.1	40	1448
MT00 – Little Bighorn National Monument	5.23	.65	.77	.20	2.1	2.45	32	957
MT13 – Give Out Morgan (Fort Peck)	5.3	.9	.9	.32	2.7	2.7	31	806

In the absence of any man caused air pollution the pH would average around 5.65 due to the solubility of CO2 into carbonic acid in water vapor. Concentrations (mg/L) and deposition (kg/Ha) of the primary acid deposition anions (NO3 – nitrate and SO4 – sulfate) area relatively low. However the relatively elevated levels of SO4 and NO3 at the Clancy and Little Bighorn sites, which may be influenced by Helena area emissions and Billings-Laurel/Colstrip emissions, indicate possible localized increase in acid anions in wet precipitation.

Each of the sites demonstrates a pronounced seasonal trend of lower pH and higher nitrate and sulfate concentrations in the summer. This is at least partially due to more efficient process of photo-chemical transformation of acid deposition precursors (NO2, SO2 to nitric and sulfuric acid) in the summer when the atmosphere is warmer.

Dry Deposition

Dry deposition is the transfer (or flux) of sulfur and nitrogen compounds from the atmosphere to either terrestrial or aquatic sinks. Within the EASTSIDE FORESTS, dry deposition is monitored near Yellowstone Lake in Yellowstone National Park (site #408). The two sites are part of an EPA-administered 67 site nationwide Clean Air Status and Trends Network (CASTNet), formerly known as the National Dry Deposition Network. The Yellowstone Lake site was established in June 1996 and is jointly operated by the EPA and NPS under an interagency agreement.

The CASTNet dry deposition stations measure:

- Atmospheric concentrations of sulfate nitrate, ammonium, sulfur dioxide, and nitric acid;
- Continuous ambient ozone levels;
- Meteorological conditions required for calculating dry deposition rates.

Dry deposition rates are calculated using atmospheric concentrations, meteorological data and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), which is considered the nation's primary source for wet deposition data. Together the wet and dry deposition databases provide the necessary information to estimate trends in total atmospheric deposition. In conjunction with information on ecosystem health, these results will ultimately be used to determine the effectiveness of emission reductions in curtailing the environmental effects associated with acidic and other forms of atmospheric deposition (USEPA, 1999).

The most recent dry deposition data summary for measurements taken from 1987 to 1995 is found in USEPA (1998). The report analyzes data from the eastern states, where the database is the largest and longer term. The dry deposition data for the western sites is not yet available.

Lakes

Water quality in lakes is a very diagnostic indicator of air quality changes since lake chemistry can be highly influenced by atmospheric deposition. This is particularly true in poorly buffered alpine lakes where limited watershed size and limited soil development does not allow much buildup of dissolved bicarbonates which buffer acidic compounds. The Greater Yellowstone Area has a large number of highly sensitive lakes, particularly in the Wind River and Beartooth ranges which have extensive area of alpine, cirque, Precambrian granitic type lakes.

The USFS Region 1 (Montana and Northern Idaho) has about Wilderness 1749 lakes of which 49% occur in the Eastside Forests including 641 lakes in the Absaroka Beartooth Wilderness , 111 lakes in the Lee Metcalf Wilderness. 91 lakes in the Anaconda Pintler Wilderness, and 13 in the Bob Marshall and Scapegoat Wilderness areas. Sampling has been done in a 3 phase approach.

- Phase 1 includes measuring pH, alkalinity, conductivity, and documenting watershed factors (geology, vegetation, and drainage characteristics) to determine lake sensitivity to atmospheric induced chemical change.
- Phase 2 consists of a more comprehensive chemical analysis (major cations and anions).
- Phase 3 "benchmark monitoring" includes some additional chemical parameters and some biological parameters.

The lake monitoring has documented a wide range of lake sensitivities in R1, controlled primarily by weatherability and alkalinity generation potential of bedrock parent material. The Beartooth mountains parent material is Precambrian crystalline, metamorphic, and belt series with granite gneiss, amphibolite, and subordinate meta-sedimentary rocks intruded by many Precambrian mafic dikes. The Precambrian rocks are also intruded by numerous silica dikes and plugs of Tertiary and possibly Cretaceous age, and in the western edge of the Beartooth uplift, overlain by small patches of Tertiary volcanic rocks.

Sampling of lakes in the Absaroka-Beartooth Wilderness has been done by the USFS in cooperation with Yellowstone Ecosystem Studies including 35 phase 2 lakes in 1993, 19 in 1994, and 14 in 1995. The phase 2 monitoring was focused on identifying lakes with the lowest ANC (acid neutralizing capacity). Lakes in the Beartooth plateau have generally similar chemistry characteristics with the primary differences attributable to elevation and the degree of soil and vegetation development. The highest lakes sampled are all well above timberline (>10,000 feet) with very little soil development.

Acid neutralizing capacity (ANC) is the sum of base cations minus the sum of acid anions, comparable to alkalinity in calcium dominated systems. Average ANC in the Absaroka Beartooth lakes sampled during 1993-1995 was 64 ueq/L with a standard deviation of 44.4 ueq/L. The ANC ranged from 10.7 ueq/L in unnamed lake T8SR17ESWS31 to 307 ueq/L in Pine Creek Lake, which is actually in the Absaroka range. The 10.7 ueq/L reading is the 2nd lowest measured ANC of any lakes in USFS R1. All of the Beartooth range lakes monitored have ANC <200 ueq/L (which is generally considered a threshold for acid sensitivity). In 1995, the last year of Phase 2 monitoring, 21% of the lakes had ANC <25 ueq/L, which the USFS R1 screening workshop defined as a threshold for extreme sensitivity (Stanford, et.al. 1997).

Twin Island lake and Stepping Stone lakes were selected as the Absaroka Beartooth Wilderness phase 3 lakes. The phase 3 monitoring consists of intensive chemical monitoring to provide a long term benchmark to evaluate trends in acid deposition and other atmospheric related changes in lake ecosystems. The other phase 3 lakes in USFS Region 1 include 2 in the Cabinet Mountains Wilderness and 2 in the Selway Bitterroot Wilderness. All of the phase 3 lakes, including Twin Island and Stepping Stone, are being calibrated for acid deposition sensitivity with the MAGIC/WAND model (Model of Acidification of Groundwater in Catchments/with Aggregated Nitrogen Dynamics) The MAGIC/WAND model calibrates lake chemistry to atmospheric deposition and watershed/soil/hydrology factors. This enables a prediction of lake chemical response to potential upwind changes in emissions. The model is extremely useful in PSD analysis.

The Lee Metcalf Wilderness, which is in the Madison range, has 111 lakes in 2 units (Spanish Peaks and Taylor-Hilgard). Parent material in the Spanish Peaks unit includes granite, gneiss, shist, amphibolite, pegmatite, and basic dike rocks. Localized variation in rock and mineral composition has a major effect on lake chemistry. Sampling in the Spanish Peaks unit occurred in 1985 (28 lakes) and 1994 (11 lakes). Both data sets are comparable for 4 lakes, which were sampled both years. The ANC in 1994 ranges from 67.8 ueq/L in Jerome Rocks lake #3 to 357.8 ueq/L in Thompson lake. Average ANC is 232 ueq/L. Most of the lakes sampled in the Spanish Peaks are not highly sensitive to atmospheric deposition when compared to Beartooth range lakes.

The 13 lakes in the Eastside Forests parts of the Bob Marshall and Scapegoat Wilderness areas have watersheds generally dominated by Paleozoic and Mesozoic limestone/sandstone/shale geology with high ANC's (averaging 811 ueq/L in the Bob Marshall Wilderness). These lakes are not vulnerable to acid deposition under any reasonable acid deposition scenario.

The Anaconda Pintler Wilderness had 100 lakes, 91 on Eastside Forests. In 1992,39 of the APW lakes were sampled as part of the NRDA/CERCLA program. ANC averaged 429.4 ueq/L with a range of 17.5 ueq/L in Buck lake to 1461 ueq/L in Johnson lake. Parent material in the APW is very complex with mostly sedimentary Middle Proterozoic (Precambrian) and Paleozoic age, igneous granodiorite to granite of Cretaceous to Tertiary age. The APW 1992 monitoring included sediment cores from 8 lakes to evaluate metal contamination in lake sediments exposed to the old Anaconda smelter. Some of the APW lakes had slightly elevated levels of lead, zinc, cadmium, and copper in lake sediments These elevated levels were marginal exceedances of biological metal water quality criteria but correspond to identify mineralized zones in the APW rather than distance from the old Anaconda smelter.

Visibility

Visibility is usually characterized by the visual range (the greatest distance that a large black object can be seen against a viewing background) expressed in kilometers (km) or light extinction (the sum of light scattering and absorption per unit distance) expressed in inverse megameters (Mm^{-1}). Natural Rayleigh scatter from air molecules and suspended atmospheric aerosol particles causes this base light extinction of 10 Mm^{-1}. A visual range of 391 km signifies the best possible visibility, corresponding to a light extinction of 10 Mm^{-1}. These two characteristics are inversely related and neither is linear with respect to increases or decreases in perceived visual air quality. Therefore, a third visibility characterization, the deciview (dv) was derived and used to index a constant fractional change in extinction or visual range. High (the best) visibility is signified by low deciview values.

Scientists and technical professionals most commonly use the light extinction coefficient (or commonly just “extinction”) over the other two visibility characteristics. Extinction is directly calculated from light transmittance measurements or even derived as a “reconstructed extinction” from measured particle concentrations. In this report, the primary visibility characterization provided is extinction, either measured or reconstructed.

Visibility monitoring in the Eastside Forests area has been most extensively done in Yellowstone NP. As part of the *Interagency Monitoring of Protected Visual Environments* (IMPROVE) network, visual air quality in Yellowstone NP has been monitored since 1988 using an aerosol sampler, transmissometer, and camera. Visibility in YNP has been excellent and fairly stable during the period of record. Visibility reduction from natural levels at Yellowstone NP, like many rural western areas, is largely due to sulfate, organics, and soil. Historically, visibility varies with patterns in weather, winds (and the effects of winds on coarse particles) and smoke from fires. No information is available on how the distribution of visibility conditions at present differs from the profile under "natural" conditions, but the cleanest 20% of the days probably approach natural conditions. Smoke from frequent fires is suspected to have reduced pre-settlement visibility below current levels during some summer months. Current SVR (standard visual range in km) has varied from 108km to 138km (Peterson et.al. 1998). Acheson (1993) has documented SVR for the Cabinet Mountains Wilderness and Bob Marshall Wilderness in Western Montana. For the Eastside Forests 90% SVR (visibility better 10% of the time) is estimated at 150 km and 50% SVR is estimated at 250 km. Scott Copeland (1999) has estimated SVR for 3 Wilderness areas, which are partially on the Eastside Forests:

Wilderness Area	10% SVR	50% SVR	90% SVR
Bob Marshall Wilderness	97 km	178 km	249 km
Scapegoat Wilderness	93 km	164 km	218 km
Anaconda-Pintler Wilderness	84 km	166 km	274 km

Additional IMPROVE sites are being installed in 2000 at Hogback Lookout on the Helena NF and at the Monture Guard Station (Lolo NF) to monitor visibility conditions in the vicinity of the Gates of the Mountains and Scapegoat Wilderness areas.

Pollution Exposure Index

The USFS R1 contracted with Sue Ferguson, Atmospheric Scientist with the Pacific Northwest Station in Seattle to do a Pollution Exposure Index (PEI) assessment of the USFS Region 1 and surrounding areas including the Eastside Forests (Ferguson and Rorig, 1998). The PEI is an index based on monthly averaged emission concentrations from industrial stacks, winds at different elevations, and mixing heights. ARCINFO® was used to plot the monthly locations of stationary air pollution sources with emissions greater than monthly threshold levels (1.25 t/m TP, 3 t/m SOx, 3 t/m NOx, and 3 t/m NH3). Steering winds at 3 different vertical levels (surface, 850 mb for heights between about 1640 and 6500 feet above ground surface, and 700 mb for elevations above 6500 feet above ground level) were identified for each source by month factoring in appropriate mixing heights and a dispersion index. The resulting pollution trajectories were plotted by vertical level per pollutant parameter per season and are contained in Ferguson and Rorig, 1998.

The results indicate that pollution exposure of the Eastside Forests is generally low since the largest sources of industrial emissions in the Rocky Mountains and North West are north or south of the airflow patterns through the Eastside Forests.

Figure 2 includes representative pollution trajectories for nitrogen and sulfur oxides at various seasons and elevations (Ferguson and Rorig, 1998).

Most of the industrial emissions from point sources in Washington, Oregon, and Western Montana well dispersed before impacting the Eastside Forests. The primary industrial sources in Central and Eastern Montana (Helena smelter, Billings refinery, and Colstrip power plant) generally disperse to the east with limited exposure to the Eastside Forests). The most exposed area in the Eastside Forests to industrial emissions are parts of the Big Belt Mountains downwind from Helena which are slightly impacted by the Helena and East Helena area stationary sources.

Figure 1a. Pollution Exposure Index representative trajectories.

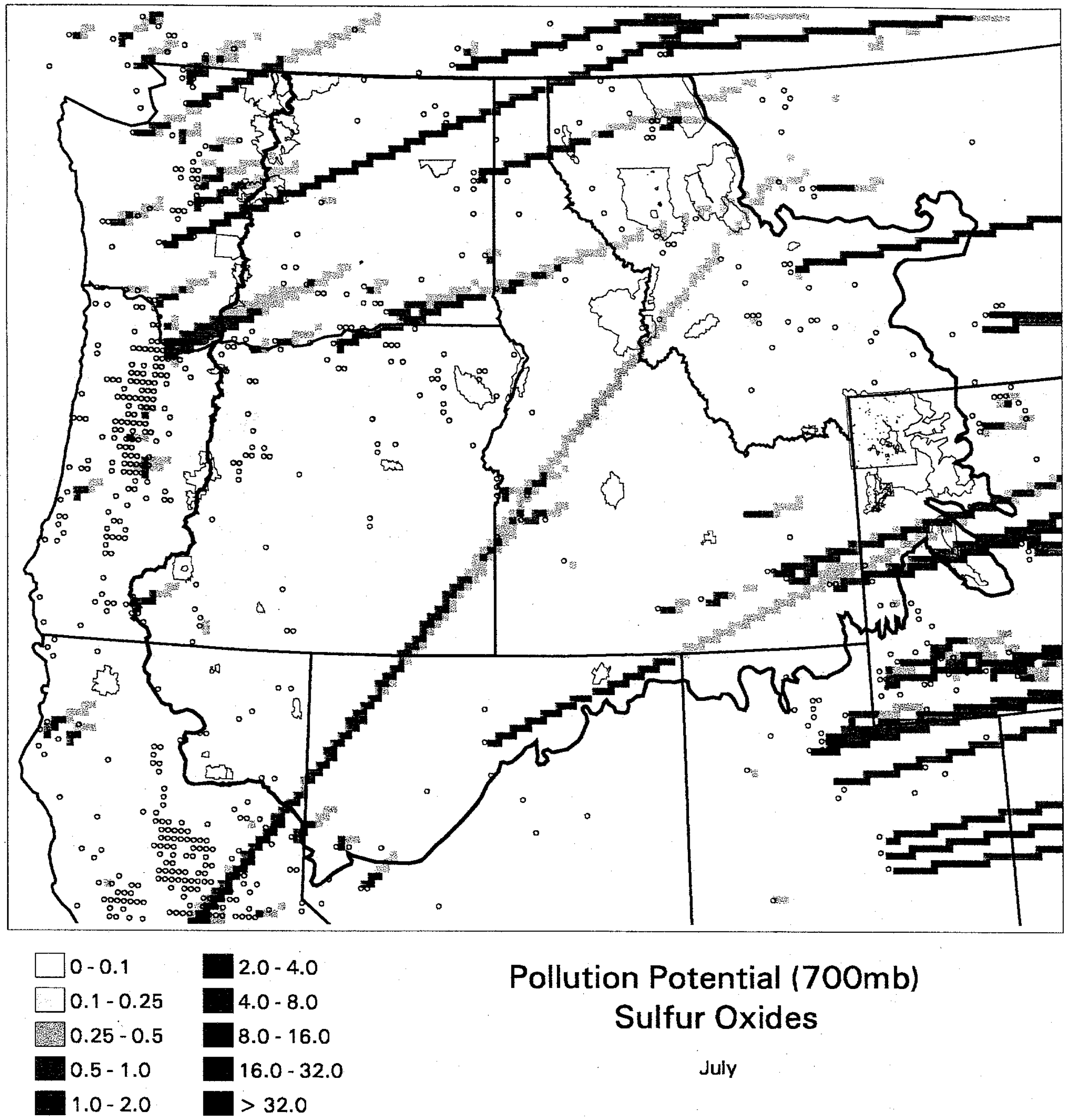
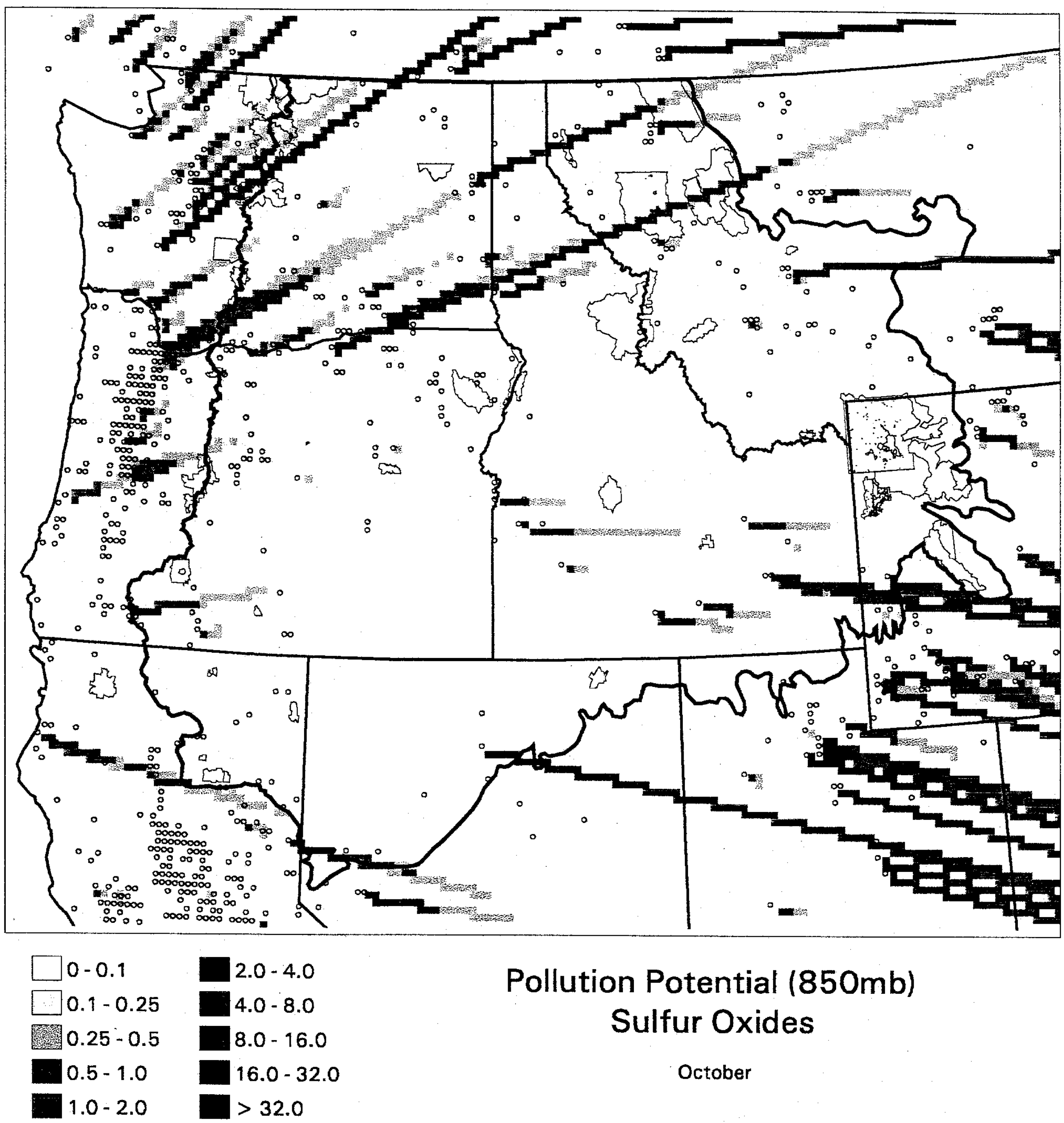


Figure 1b. Pollution Exposure Index representative trajectories.


0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 8.0
8.0 - 16.0
16.0 - 32.0
> 32.0
Pollution Potential (850mb)
Sulfur Oxides
October

Ozone

The only continuous ozone monitoring station in the Eastside Forests area is located in Yellowstone NP. NPS (1998) reports that maximum hourly ozone concentrations at Tower Junction between 1987 and 1994 ranged between 61 and 98 parts per billion which are well low the NAAQS for Ozone. The mean daytime 7-hour ozone concentration during the growing season ranged between 41 and 45 parts per billion. Another indicator that can be useful to assess ozone exposures of plants is SUM60 which is the sum of all hourly ozone concentrations equaling or exceeding 60 parts per billion. The SUM60 exposure index at Yellowstone NP ranged between 363 and 11,376 between 1987 and 1994 which is much lower that for national parks in highly polluted areas where SUM60 exposure indexed have been measured as high as 100,000. The continuous ozone analyzer at Yellowstone NP was moved to the Lake area in 1995.

Snowpack Chemistry

The chemical composition of annual snowpack has been shown to be a composite record of atmospheric deposition of airborne pollutants throughout winter and has also been used to identify nearby emission sources. The U.S. Geological Survey (USGS) has been monitoring the chemical composition of annual snowpacks in Colorado since the mid-1980s (Ingersoll et al, 1997). Elevated levels of pollutants from atmospheric deposition held in seasonal snowpacks have been indicated by chemical concentrations of species associated with watershed acidification (including nitrate and sulfate) at alpine and subalpine sites.

In 1993, the USGS began annually monitoring chemicals in the snowpack throughout a network of 50 to 60 sites in the Rocky Mountain region of the United States that includes 12 sites in the vicinity of the East Side Forests and an additional 7 sites in Yellowstone National Park. Eastside Forest sites include Kings Hill (Lewis and Clark NF), Mount Belmont, Cement Gulch Divide, Spring Gulch, and Grassy Mountain (Helena NF), Lionshead, Sunlight Creek, Big Sky, and Daisy Pass (Gallatin NF), Red Mountain, Joseph Pass, and Monida Pass (Beaverhead NF). The USGS currently is drafting reports containing data on the levels of key acidic compounds found in snowpacks throughout the Rocky Mountain region. Snowmelt chemistries from this network of mountainous locations established normal, or background levels of acidic ions deposited in the seasonal snowpack. In addition to normal chemical concentrations present in the region, elevated levels of pollutants in a given area are readily identifiable. Thus, emissions of chemical compounds such as ammonium, nitrate, and sulfate from local anthropogenic sources are discernible from normal background levels.

Preliminary information indicates slightly elevated ammonia levels at Lionshead (possibly from snowmobile emissions), and slightly elevated sulfate levels at Spring Gulch, Cement Gulch divide that may be attributable to Helena area sources. Ingersoll (1998), found increased snowpack concentrations of ammonium, nitrate, sulfate, benzene, and toluene in Yellowstone NP. Concentrations, however, decreased rapidly with distance from roadways.

General Meteorology

Topography of the Greater Yellowstone area ranges from rolling foothills to steep rugged glaciated mountain peaks. The climate is influenced by prevailing westerly winds and two seasonal maritime systems. At lower elevations precipitation may be as little as 20 inches annually, while at higher elevations precipitation may exceed 40 inches annually. Average annual temperatures range between 30 and 40° F, but may approach 45° F in lower valleys. Monthly mean surface winds are shown in Figure 2 (Fegurson, 1998). Some general meteorological information for Montana is available from the Montana DEQ (2000).

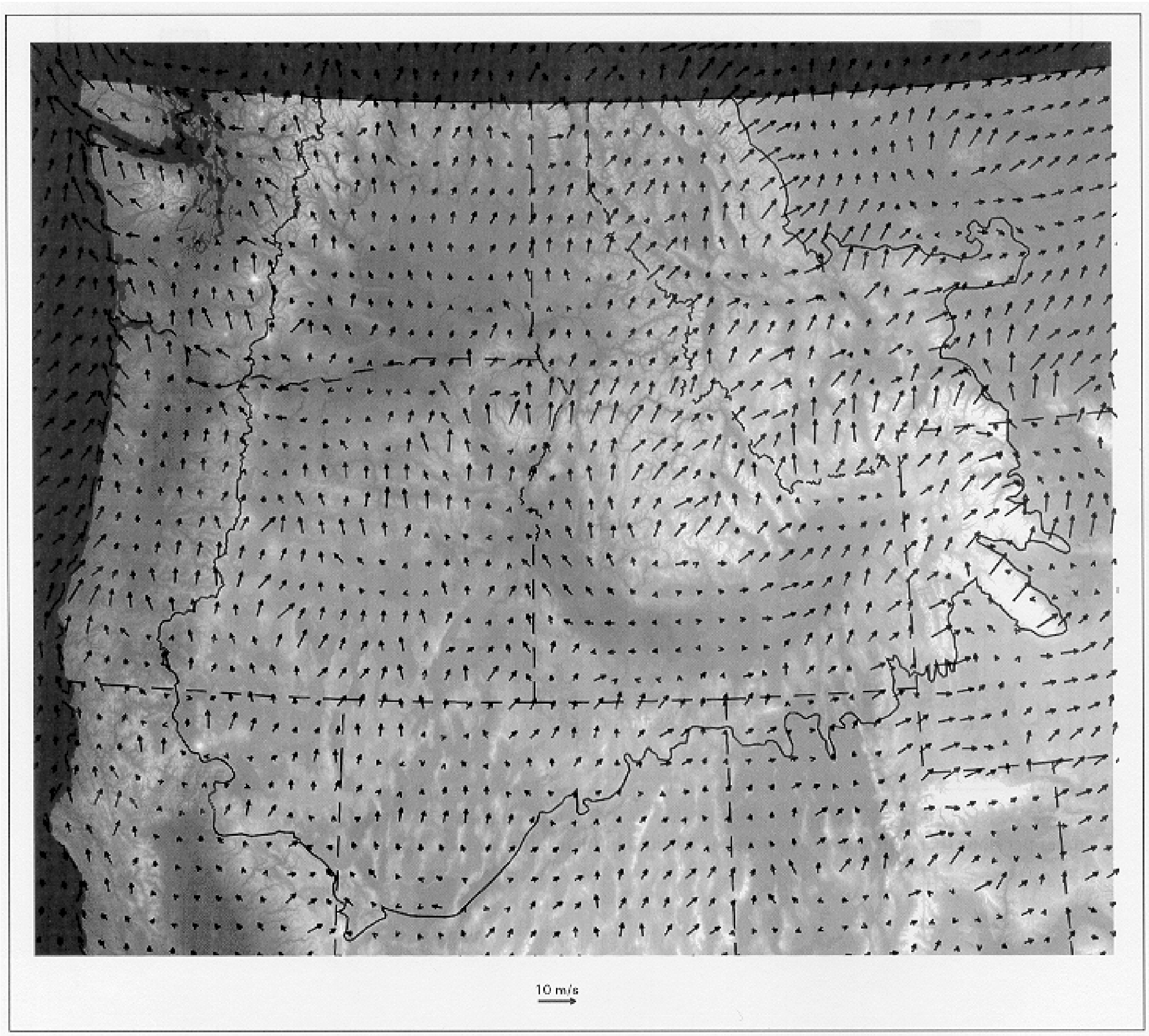
In South Central Montana, including portions of the Helena and Deerlodge NF's. the diverse nature of the terrain and climate can result in variable dispersion characteristics. Mountainous terrain can provide shelter from prevailing winds and severely limit wind on one area while funneling high winds into other areas. Temperature inversions, which trap pollutants, are common in this region throughout the year but the depth, duration, and intensity vary widely from the mountains to the plains. Inversions on the plains seldom persist past noon and are usually shallow and weak. Inversions on the plains seldom persist past noon and are usually shallow and weak. Inversions in the mountainous areas are usually much stronger and deeper and can persist for several days during the fall and winter. Low level wind speed and direction patterns in the mountains are affected by terrain and generalizations or comparisons to any existing measurements at other sites are not very practical. Wind patterns in the non-mountainous portions in South Central Montana have prevailing winds from the west and southwest.

In Central Montana, including the Highwood, Bear Paw, and Little rocky areas of the Lewis and Clark NF, the climatological regime dominated by warm dry summers interrupted by occasional Chinooks. Dispersion potential in Central Montana is generally excellent due to persistent and often very strong winds.

In Southwestern Montana, including the Beaverhead, Deerlodge, Gallatin, and portions of the Custer NF's, the mountainous terrain substantially impacts the weather patterns. Precipitation is often limited to the higher mountains while the valleys remain arid and relatively dry. Winds along the mountaintops are frequent and during the fall and winter can persist for days at a time. Occasional severe inversions can be several thousands of feet deep and very strong allowing almost no dispersion of pollutants. This allows even small emission sources to produce localized areas of poor air quality.

Eastern Montana, including the Ashland and Camp Crook Districts of the Custer NF, has weather typical of the northern Great Plains with hot dry summers and cold dry winters. Chinooks occur but are not as frequent as in Central Montana. Precipitation totals are generally low with thunderstorms producing a significant of the total precipitation. The wind patterns can be characterized by existing offsite measurements and are usually westerly. Dispersion in Eastern Montana is excellent. Shallow and short lived inversions are frequent in the southern part of Eastern Montana.

Figure 2. 30 year average of monthly-mean surface winds in January form Air Quality Climate in the Columbia River Basin (Ferguson, 1998).



NEEDS AND RECOMMENDATIONS

Eastside Forests

1. In general air quality in the vicinity of the Eastside Forests is excellent. Relatively limited emission sources, which are concentrated around great Falls, Helena, Billings/Laurel and Colstrip are dispersed by generally prevailing westerly airflow with robust dispersion.

2. Localized areas of inversions, primarily in valley location, pose the main areas of pollutant and health concerns within Eastside Forests. All of the non-attainment areas in the vicinity of the Eastside Forests are municipalities. The Montana DEQ is working with industries in the non-compliance areas through SIP's and other regulatory tools to achieve compliance.

3. Air resource monitoring in the vicinity of the Eastside Forests (visibility, lakes, acid deposition) has documented generally excellent visibility and lake chemical condition. Eastside Forest scenic vistas and lakes are quite vulnerable to degradation from anthropogenic air pollution sources, however.

4. Increased use of fire activity, such as broadcast and prescribed burns, is the primary source of potential changes in Eastside Forest emissions. The primary potential increase in industrial emissions is from oil and gas drilling and production, especially coalbed methane in SE Montana.

Recommended Management Actions

1. Coordinate with the Montana DEQ to constrain oil and gas and other cumulative industrial emissions to comply with NAAQS, PSD increments, and AQRV thresholds (visibility and lake chemistry) in the Eastside Forests Wilderness areas.

2. Continue to coordinate with the Montana DEQ and the EPA in meeting all air quality regulatory requirements in Eastside Forest projects or permitted emissions such as from fire activity, road dust, or vehicle/equipment emissions.

3. Implement recommendations from the Grand Canyon Visibility Transport Commission to deal with smoke emissions from prescribed burning and wildfires in the Eastside Forests. These include: plan for smoke visibility impacts, implement emission tracking system for all fire activities, improve integrated assessment of emissions and establish annual emission goals, enhance smoke management programs with cooperative funding mechanism, promote public education programs, and remove administrative barriers to the use of alternatives to burning.

4. The Eastside Forests should continue to participate in the GYACAP (Greater Yellowstone Area Clean Air Partnership) group which functions primarily as a technical advisory group to the GYCC (Greater Yellowstone Coordinating Committee). The GYACAP is also a useful forum to collaborate with Montana, Idaho, and Wyoming DEQ’s on air quality issues and regulations, exchange air quality information, and to coordinate air quality monitoring.

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Appendix 1 US EPA - AIRSData

Eastside Forests area Montana, Air Pollution Sources

Pollutant Emissions in Tons Per Year										
Facility	City	County	CO	NO2	PB	PM10	PT	SO2	VOC	Industry Type
Westmoreland Resources	Hardin	Big Horn Co	281	280		432	906	31	20	Bituminous Coal And Lignite(1977)
Spring Creek Coal	Decker	Big Horn Co	311	333		244	946	29	31	Bituminous Coal And Lignite(1977)
Decker Coal Company	Decker	Big Horn Co	381	372		483	1868	40	25	Bituminous Coal And Lignite(1977)
Ocean Energy Inc., Blaine County #1	Chinook	Blaine Co	187	1846		4		1	107	Natural Gas Transmission
Continental Lime	Townsend	Broadwater Co	147	388		100	134	180	8	Lime
Montana Refining	Great Falls	Cascade Co	49	90		14	20	845	309	Petroleum Refining
Conoco Inc.	Great Falls	Cascade Co							180	Petroleum Bulk Stations & Terminals
Williston Basin - Little Beaver	Baker	Fallon Co	164	254		0	0	0	11	Natural Gas Transmission
Williston Basin - Cabin Creek	Baker	Fallon Co	377	516		4	4	0	59	Natural Gas Transmission
Williston Basin - Baker Compressor Sta.	Baker	Fallon Co	118	185		0		0	7	Natural Gas Transmission
Holnam, Inc.	Three Forks	Gallatin Co	22	327	0.1	213	339	52	1	Cement, Hydraulic
Cenex, Inc. Cut Bank/Big Sky Pipeline	Cut Bank	Glacier Co							237	Petroleum Bulk Stations & Terminals
Ash Grove Cement	Clancy	Jefferson Co	23	732	0.5	148	257	207	2	Cement, Hydraulic
Golden Sunlight Mine	Whitehall	Jefferson Co	414	520		886	1927	40	30	Gold Ores
Montana Tunnels Mine	Jefferson City	Jefferson Co	285	374		460	990	41	25	Gold Ores
Asarco Incorporated	East Helena	Lewis And Clark Co	5	19	17.3	102	176	11007	0	Primary Nonferrous Metals, Nec
Williston Basin - Vida Station	Vida	Mc Cone Co	47	201		0	0	0	11	Natural Gas Transmission
Luzenac America - Yellowstone Mine	Cameron	Madison Co	39	49		59	127	5	3	Minerals, Ground Or Treated
Holly Sugar Corporation	Sidney	Richland Co	179	262	0	166	227	47	25	Beet Sugar
Mdu - Lewis & Clark Station	Sidney	Richland Co	83	652	0	11	93	861	10	Electric Services
Knife River Corporation	Savage	Richland Co	20	14		65	132	2	1	Bituminous Coal And Lignite(1977)

Montola Growers, Inc.	Culbertson	Roosevelt Co	1	3		10	34	0	102	Shortening And Cooking Oils
Western Energy	Colstrip	Rosebud Co	491	394		1886	3886	57	28	Bituminous Coal And Lignite(1977)
Colstrip Energy Ltd. Partnership	Colstrip	Rosebud Co	1	782	1.8	31	50	1217	7	Electric Services
Mpc - Colstrip Units #1 & #2	Colstrip	Rosebud Co	877	8998	0.1	69	1056	9749	102	Electric Services
Big Sky Coal Company	Colstrip	Rosebud Co	177	197		181	713	21	16	Bituminous Coal And Lignite(1977)
Mpc - Colstrip Units #3 & #4	Colstrip	Rosebud Co	2116	24429	0.2	177	2241	5275	247	Electric Services
Montana Resources	Butte	Silver Bow Co	388	462		847	1727	50	30	Copper Ores
Stillwater Mining Company	Nye	Stillwater Co	111	129		85	117	2	5	Metal Ores Nec
Mpc - Telstad Field, Station 033	Shelby	Toole Co	18	112		0	0	0	37	Natural Gas Transmission
Williston Basin - Fort Peck Station	Nashua	Valley Co	65	162		1	1	0	15	Natural Gas Transmission
Williston Basin - Saco	Saco	Valley Co	177	201		1	1	0	22	Natural Gas Transmission
Western Sugar	Billings	Yellowstone Co	207	350		45	231	106	15	Beet Sugar
Conoco	Billings	Yellowstone Co	188	761		106	253	560	793	Petroleum Refining
Cenex	Laurel	Yellowstone Co	234	931		118	122	2974	753	Petroleum Refining
Exxon Co Usa	Billings	Yellowstone Co	770	734		178	392	5825	1259	Petroleum Refining
Montana Sulfur & Chemical	Billings	Yellowstone Co	337	52		2	2	3636	2	Industrial Inorganic Chemicals
Mpc - J.E. Corette Plant	Billings	Yellowstone Co	122	902	0.1	67	863	1473	14	Electric Services
Yellowstone Energy Limited Partnership	Billings	Yellowstone Co	44	485		19	65	1907	9	Electric Services

CO = Carbon Monoxide NO2 = Nitrogen Dioxide PB = lead PM10 = particulates < 10 microns

NO2 = Nitrogen Dioxide PT = Total Particulate SO2 = Sulfur Dioxide VOC = Volatile Orgnanic Compounds