4.6 Air Quality Setting

4.6.1 Introduction

California's diverse topography and meteorology combined with population pressure make it one of the most complex environments for monitoring air quality and emissions. Vegetation management activities proposed by this program have the potential to generate emissions identified by the State of California as pollutants of concern, which fall under the jurisdiction of federal, state and local air quality regulatory environment.

4.6.2 Regulatory Framework

Federal

Federal Clean Air Act

The Federal Clean Air Act of 1963 (amended several times, most recently in 1990) requires the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for air pollutants or air pollutant groups that pose a threat to human health or welfare. The Federal standards are two tiered; primary standards – designed to protect public health; and secondary standards – designed to protect the environment, such as visibility, damage to property, soil, vegetation, etc. Tables 4.6.5 and 4.6.6 lists the air pollutants and the federal ambient air quality standards.

The EPA has established NAAQS for six criteria pollutants: ozone, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead, particulate matter, and carbon monoxide (CO). Two separate standards have been set for particulate matter, one for particulate matter 10 microns or less in diameter (PM_{10}), the other for particulate matter 2.5 microns or less in diameter (PM2.5).

Ambient air quality standards are set to address both short-term and long-term air quality impacts on human, animal, and other biotic and abiotic receptors. They are applied to measurements of ambient air quality; that is, the combination of all pollutants from all sources found at monitoring points. Given these considerations, ambient air quality standards can be considered benchmarks for significant adverse cumulative effects of air pollutants.

Air basins that have not violated an ambient air quality standard are considered to be in attainment for that standard. Conversely, air basins with recorded violations of an NAAQS are classified as non-attainment areas for that pollutant. For certain pollutants such as PM10, California has more stringent standards than those set by EPA. Consequently, an air basin may be classified as a non-attainment area for the state PM10 standard while it is in attainment for the federal PM10 standard.

Once an air basin has been classified as non-attainment for the NAAQS, the responsible district must prepare State Implementation Plan (SIP) describing the specific steps that will be taken to bring them into compliance. These steps primarily include rules and regulations to limit emissions from targeted stationary and mobile sources. The Federal Clean Air Act contains specific time frames by which the NAAQS must be met; otherwise, federal sanctions can be imposed.

Air Quality Setting

EPA Interim Air Quality Policy on Wildland and Prescribed Fires

The EPA does not directly regulate the use of fire within a State. The EPA's authority is to enforce the requirements of the Clean Air Act (CAA). In 1998, the EPA issued an interim policy addressing public health and welfare impacts caused by wildland and prescribed fires that are managed for resource benefits.

The policy recommends that states develop a voluntary Smoke Management Program (SMP), which must be certified by the EPA. Once the SMP is certified and implemented, the EPA will allow two days per year in excess of the NAAQS for PM2.5 attributable to prescribed burning without declaring the airshed out of attainment. On the third violation, the area will be designated out of attainment, the Smoke Management Program will become mandatory, and a SIP must then be prepared.

(SMPs) – Smoke Management Programs

The purpose of SMPs are to mitigate the nuisance and public safety hazards posed by smoke intrusions into populated areas; to prevent deterioration of air quality and NAAQS violations; and to address visibility impacts in mandatory Class I Federal areas. Some strong indications that an area needs a SMP are: (1) citizens increasingly complain of smoke intrusions; (2) the trend of monitored air quality values is increasing (approaching the daily or annual NAAQS for PM2.5 or PM10) because of significant contributions from fires managed for resource benefits; (3) fires cause or significantly contribute to monitored air quality that is already greater than 85 percent of the daily or annual NAAQS for PM2.5 or PM10; or (4) fires in the area significantly contribute to visibility impairment in mandatory Class I Federal areas (EPA 1998).

If a smoke management plan is not developed, and burning activities are found to contribute to particulate concentrations above the NAAQS, EPA will force development and implementation of a mandatory smoke management plan and may re-designate these areas as non-attainment, which then imposes requirements for emission reductions (McMahon, 1999).

State

California Clean Air Act

The California Clean Air Act of 1988 differs from the Federal Clean Air Act in that no sanctions or specific timelines for attainment of the California Ambient Air Quality Standards (CAAQS) have been established. The CAAQS (Table 4.6.7) were enacted in response to the need for new air quality requirements which are more protective of public health. California has also set standards for some pollutants that are not addressed by federal standards. This act requires air quality attainment at the earliest practicable date, and reasonable progress must be made each year. Similar to the Federal Clean Air Act, the California Clean Air Act requires that attainment plans be prepared for designated non-attainment areas.

The California Air Resources Board (CARB), which oversees both State and Federal air pollution control programs in California, has divided the state into air basins (Table 4.6.1; Figure 4.6.1). Authority for air quality management within each basin has been given to local Air Pollution Control

Districts, which regulate stationary source emissions and develop local non-attainment plans within their jurisdiction.

CARB is also responsible for the regulation of air toxins and developed a comprehensive California Air Toxics Program (CATP) in the early 1980s, guided by the Toxic Air Contaminant Identification and Control Act (AB1807; Tanner, 1983). The CATP establishes the process for the identification and control of toxic air contaminants and includes provisions to make the public aware of significant toxic exposures and for reducing risk. The primary regulatory mechanisms are “airborne toxic control measures” (ATCMs). Each ATCM is codified under Title 17 of the California Code of Regulations (17 CCR).

The CARB is also responsible for specifying each day of the year as a permissive burn day, or a no-burn day for each air basin or other specified area. These decisions determine when agricultural and prescribed wildland burning may occur based on weather and air quality conditions. For permission to burn, however, individuals are required to contact their local air quality management district, which has information on local conditions, including fire danger.

Table 4.6.1
Air Quality Districts by Air Basin

Air basin	Districts		Air basin	Districts
Great Basin Valley	Great Basin Unified AQMD		Sacramento Valley	Butte APCD
Lake County	Lake APCD			Colusa APCD
Lake Tahoe	El Dorado APCD			Feather River AQMD
	Placer APCD			Glenn APCD
	Antelope Valley APCD			Placer APCD
	Kern APCD			Sacramento Metro AQMD
	Mojave Desert AQMD			Shasta APCD
	South Coast AQMD			Tehama APCD
Mountain Counties	Amador APCD			Yolo-Solano AQMD
	Calaveras APCD		Salton Sea	South Coast AQMD
	El Dorado APCD			Imperial County APCD
	Mariposa APCD		San Diego	San Diego APCD
	Northern Sierra AQMD		San Francisco Bay Area	Bay Area AQMD
	Placer APCD		San Joaquin Valley	San Joaquin Valley Unified AQMD
	Tuolumne APCD		South Central Coast	San Luis Obispo APCD
North Central Coast	Monterey Bay Unified AQMD			Santa Barbara APCD
North Coast	Mendocino APCD			Ventura APCD
	North Coast Unified AQMD		South Coast	South Coast AQMD
	Northern Sonoma AQMD			
Northeast Plateau	Lassen APCD			
	Modoc APCD			
	Siskiyou APCD			

Air Quality Setting

Figure 4.6.1 – Air basins within California

Attainment status

The California Health and Safety Code section 39607(e) requires the CARB to establish and periodically review area designation criteria which provide the basis for the ARB to designate areas of the State as under "Attainment", "Non-Attainment", or "Unclassified" for the State standards. Non-attainment areas are then given a ranking of severe, serious or moderate.

The EPA makes National area designation for the five criteria pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM10. Federal law requires states to submit recommendation on area designations based on monitoring results for EPA approval.

The following categories are used for both State and Federal designations.

- **Unclassified–**a pollutant is designated unclassified if the data are incomplete and do not support a designation of attainment or non-attainment;
- **Attainment–**a pollutant is designated attainment if the State standard for that pollutant was not violated at any site in the area during a three-year period;
- **Non-attainment–**a pollutant is designated non-attainment if there was at least one violation of a State standard for that pollutant in the area; and
- **Non-attainment/transitional–**is a subcategory of the non-attainment designation. An area is designated non-attainment/transitional to signify that the area is close to attaining the standard for that pollutant.

Tables 4.6.5 and 4.6.6 show the attainment status for each California air basin (State and Federal Standards) with regard to common pollutants of public concern. The air quality standards are listed in Table 4.6.7. Many of the air basins across southern California, Mountain Counties, and the Lake Tahoe air basin are in non-attainment for ozone and particulate matter (PM_{10}). All of the air basins are in attainment for the NO_2 standard except the South Coast Air Basin, which is a non-attainment area for the federal and state NO_2 standard.

Local

The CARB has delegated much of its air pollution control authority to local air pollution control districts and air quality management districts. California's 15 local air basins are identified in Figure 4.6.1. For certain air basins covering more than one county, a unified Air Quality Management District (AQMD) has been formed to manage air quality issues throughout the basin. In other multi-county air basins, individual districts' Air Pollution Control District (APCD) manage air quality in only a single county.

When a region falls outside of attainment, individual air districts or groups of air districts prepare air quality management plans designed to bring an air basin into compliance with relevant ambient air quality standards. Those plans, which are submitted to the CARB for approval, usually contain an emission inventory and a list of rules proposed for adoption. The districts regulate emissions from stationary sources while the State regulates emissions from mobile sources such as cars and trucks.

Each air quality district maintains its own air quality rules and regulations, including specific regulations regarding open burning. Open burning regulations encompass both agricultural burning and prescribed wildland burning. The air quality district controls emissions by limiting the acreage per day that can be burned and requiring a permit from the applicable air district. All open burning is restricted only to burn days permitted by the CARB. The CARB uses information on existing air quality conditions and meteorological predictions to determine whether to allow burning and the volume of burning it will allow. However, each air district, fire control agency, or burning permit agency has the authority to be more restrictive than the CARB to avoid air quality impacts.

4.6.3 Pollutants of Concern

Ozone

Ozone (O_3) is a colorless gas with a pungent odor. High ozone concentrations exist naturally in the stratosphere. Ozone forms in the atmosphere when hydrocarbon and oxides of nitrogen (NO/NO_2), pre-cursor emissions, react in the presence of sunlight. Ozone within the stratosphere is considered beneficial as it filters ultraviolet radiation; it is also a highly reactive oxidant that has damaging effects upon materials, plants, and human health at the earth's surface.

Ozone is a regional pollutant, influenced primarily by meteorology and terrain for its formation. It is the chief component of urban smog. Low wind speeds or stagnant air, coupled with warm temperatures and cloudless skies provide for the optimum conditions. As a result, summer is generally the peak O_3 season.

Air Quality Setting

Ozone levels are measured at established monitoring sites within each air basin. The State standard for acceptable levels of O_3 is 0.09 PPM for one hour (Table 4.6.7). When this level is exceeded in any monitored site, the entire day is tallied as a “non-attainment day.”

Statewide, O_3 levels and non-attainment days have been decreasing. However, O_3 levels remain high among the air basins traditionally known to have higher levels, such as the South Coast, San Joaquin Valley, and Mojave Desert air basins. Although days of non-attainment are very low or non-existent within the Great Basin Valley, Lake County, Lake Tahoe, North Coast, and the Northeast Plateau air basins, ozone still remains a chronic stress even in levels below the state standard. See California Air Resources Board ADAM database.

Ambient ozone concentrations are known to cause adverse health effects. Ozone enters the human body through the respiratory system causing irritation and discomfort, making breathing more difficult and reduces the respiratory ability to remove inhaled particles and fight infection. Ozone has also been known to cause significant damage to crops, forestland and other ecosystems.

Inhalable Particulate Matter (PM10 and PM2.5)

Particulate matter can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as sulfur and nitrogen oxides undergo chemical reactions in the atmosphere. Primary PM consists of carbon (soot) — emitted from cars, trucks, heavy equipment, forest fires, and burning waste — and crustal material from unpaved roads, stone crushing, construction sites, and metallurgical operations.

Secondary PM forms in the atmosphere from gases. Some of these reactions require sunlight and/or water vapor. Secondary PM includes:

- Sulfates formed from sulfur dioxide emissions from power plants and industrial facilities
- Nitrates formed from nitrogen oxide emissions from cars, trucks, and power plants
- Carbon formed from reactive organic gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

PM10 refers to particles with an aerodynamic diameter ten microns or smaller. PM10 is a major air pollutant that consists of tiny solid or liquid soot, dust, smoke, fumes, or mist particles that is a known cause of visibility reduction. The size of the particles allows them to enter the air sacs deep in the lungs where they may be deposited, and can be especially harmful to people with existing vascular or respiratory illness, the aged and the very young. The PM10 data are reported as 24-hour average concentrations in ug/m3.

PM10 includes a subgroup of finer particles, PM2.5 (particulate matter 2.5 microns or smaller). PM2.5 particles pose an increased health risk because they can deposit deep in the lungs and contain substances that are particularly harmful to human health. The EPA created national PM2.5 standards in 1997. The standards include an annual standard set at 15 micrograms per cubic meter, based on the 3-year average of annual mean PM2.5 concentrations and a 24-hour standard of 65 micrograms per cubic meter, based on the 3-year average of the 98th percentile of 24-hour concentrations.

4.6.4 Sources of Pollutants

The primary source of air quality emissions due to implementing the VTP will be smoke from prescribed fire or pile burning. Fuel combustion results in emissions of gaseous air pollutants, such as CO, Reactive Organic Gases (ROGs), SO_2, and NOx. Emissions from fire result in both PM10 and gaseous emissions, although PM10 emissions are the most significant effect. The chemistry of the fuel as well as the efficiency of combustion governs the physical and chemical properties of the resulting smoke from fire. Air quality impacts due to fire emissions are affected more by weather patterns than by quantities of fuel consumed

Table 4.6.2 breaks down the average annual emissions due to wildfire by air basin for 2008 (CARB, 2008). The Mountain counties, North Coast, Sacramento Valley and San Joaquin Valley experience the most heavily impacted air quality due to wildfire. Wildfire season is predominately late summer, early fall during which air quality already experiences increased ground level ozone pollution, dense smoke from wildfires during this time can exacerbate the problem.

Table 4.6.2
Average Annual Emissions from Wildfires in California (2008) in tons/yr.

	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5
GREAT BASIN VALLEYS AIR BASIN	339	212	3,073	110	33	332	321	274
LAKE COUNTY AIR BASIN	4,964	3,154	45,140	1,529	471	4,851	4,661	3,953
LAKE TAHOE AIR BASIN	37	26	343	11	4	37	37	29
MOJAVE DESERT AIR BASIN	3,811	1,391	34,657	1,033	318	3,635	3,493	2,964
MOUNTAIN COUNTIES AIR BASIN	15,914	8,939	144,668	4,431	1,365	15,242	14,647	12,428
NORTHEAST PLATEAU AIR BASIN	8,526	5,022	77,486	2,628	810	8,326	8,001	6,789
NORTH CENTRAL COAST AIR BASIN	1,748	394	15,881	544	168	1,708	1,643	1,394
NORTH COAST AIR BASIN	15,764	3,424	143,314	5,004	1,544	15,491	14,885	12,633
SACRAMENTO VALLEY AIR BASIN	15,199	4,442	138,171	4,391	1,354	14,658	14,089	11,954
SALTON SEA AIR BASIN	485	307	4,413	128	40	460	442	376
SAN DIEGO AIR BASIN	5,522	3,380	50,217	1,540	475	5,296	5,088	4,318
SAN FRANCISCO BAY AREA AIR BASIN	1,982	529	18,016	591	183	1,924	1,851	1,570
SAN JOAQUIN VALLEY AIR BASIN	13,954	8,833	126,841	3,873	1,194	13,355	12,837	10,892
SOUTH CENTRAL COAST AIR BASIN	4,803	2,847	43,676	1,354	416	4,614	4,435	3,763
SOUTH COAST AIR BASIN	6,592	3,964	59,937	1,814	558	6,304	6,059	5,143

Table 4.6.3 illustrates projected annual average emission for various fuel management activities in comparison to emissions from wildfire. Overall, prescribed fire emission account for less than 1% of TOG, ROG, NO_x, and SO_x emissions. Forest Management emissions are projected from data only from the San Joaquin Valley. These activities show the highest emission values, with 4.13% of total

CO emissions and 1.12% of overall PM emissions.

Table 4.6.3
2005 Estimated Annual Average Emissions (Tons / Day) and Percent of Total State Emissions (10-yr Average)
Source: Air Resources Board website, http://www.arb.ca.gov/ei/emissiondata.htm

	TOG		ROG		CO		NOX		SOX		PM		PM10		PM2.5	
		%		%		%		%		%		%		%		%
Range Improvement	39.59	0.47	22.56	0.48	309.40	1.90	3.88	0.12	----	----	45.69	1.07	44.89	1.82	42.57	3.95
Forest Management (San Joaquin Valley only)	43.57	0.52	24.82	0.53	671.48	4.13	2.05	0.06	0.02	0.01	47.39	1.12	45.76	1.86	40.51	3.75
Weed Abatement	6.56	0.08	3.74	0.08	40.92	0.25	1.4	0.04	0.18	0.06	5.76	0.14	5.66	0.22	5.38	0.50
Wildland Fire Use	74.35	0.88	47.31	1.02	675.87	4.16	20.30	0.62	6.26	1.92	97.42	2.30	68.19	2.77	57.87	5.36
Wildfires	273.00	3.25	128.39	2.76	2,481.73	15.27	79.38	2.41	24.46	7.50	361.97	8.53	253.38	10.28	215.01	19.93
Total Statewide Daily Emissions	8,410.04		4,655.18		16,247.35		3,298.77		326.38		4,244.70		2,465.41		1,078.90	

Figures 4.6.2 – 4.6.4 Illustrate emissions related to prescribed fire activity in comparison to other baseline pollutants. The category of prescribed burning encompasses the following categories: range improvement, forest management, wildland fire use, weed abatement, non-agricultural open burning, and other miscellaneous prescribed fire activities. These numbers tend to over-estimate the percent emission as they are including Wildland Fire Use (WFU) in the values. WFU incidents are lightning ignitions that become managed fires – and should not be included in prescribed fire emission totals.

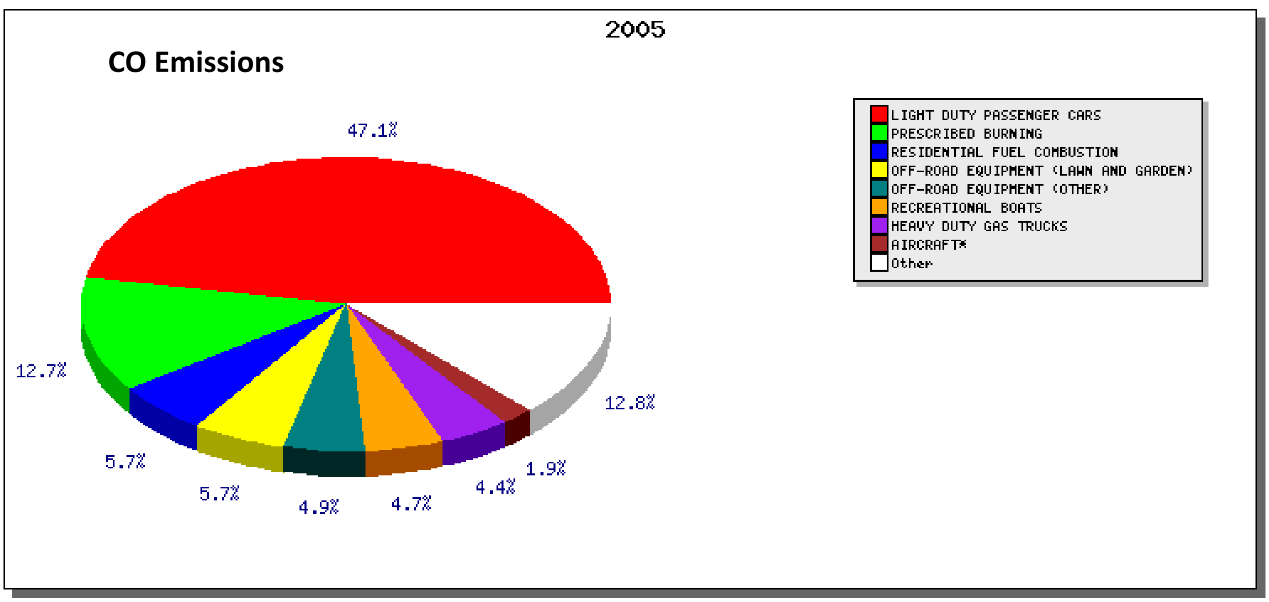

Figure 4.6.2 Carbon Monoxide (CO) Emissions (ARB, 2005)

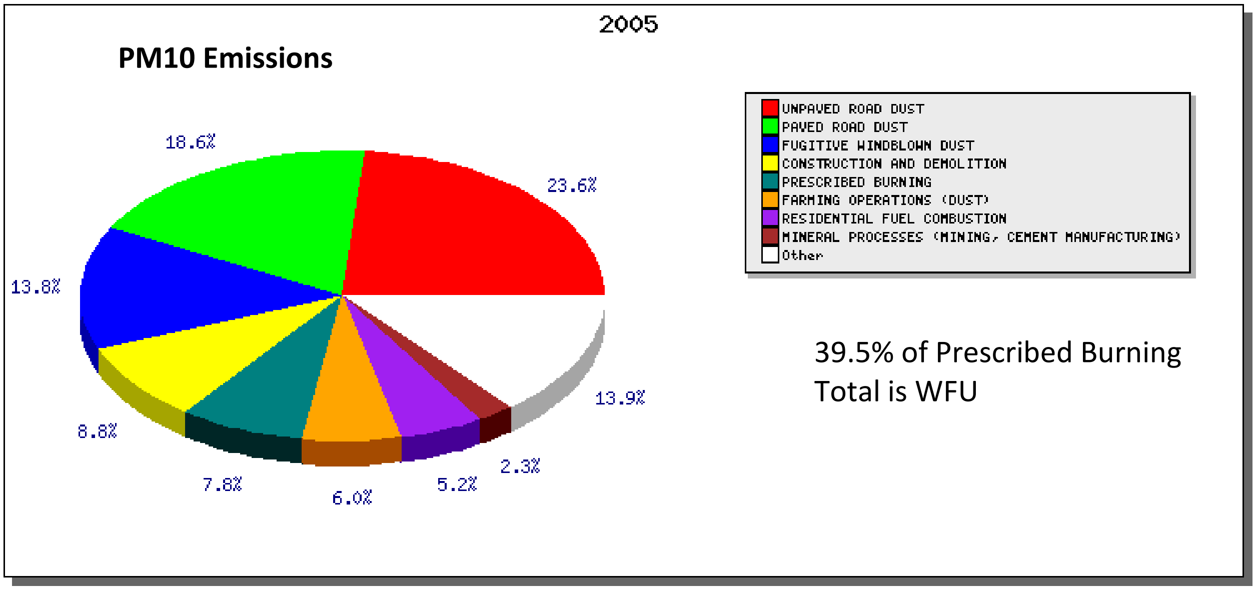

Figure 4.6.3 Estimated PM10 (Particulate Matter) emissions (Source: ARB, 2005)

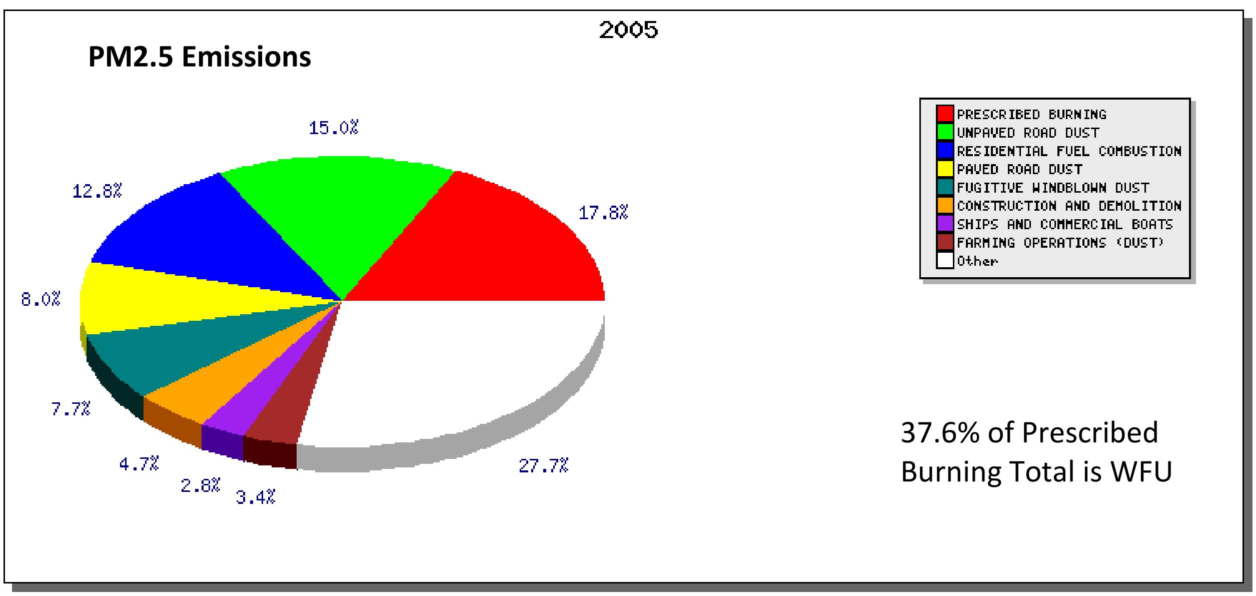

Figure 4.6.4 Estimated PM2.5 (Particulate Matter) emissions (Source: ARB, 2005)

4.6.5 Management

Since the late 1990s there has been general change in land management across the country that acknowledges unnatural fuel densities are contributing to increasing unplanned fire hazards, and that there is a growing need to restore wildland ecosystems to their healthy natural state. Annual treatment targets for all Federal land management agencies increased to more than 5 million acres per year nationally by 2005 (EPA, 1998). The Healthy Forests Restoration Act (HFRA) of 2003 recognizes the national need to increase hazardous fuel reduction on lands at risk from wildland fire or insect and disease epidemics and provides mechanisms to expedite treatments on State, Tribal and private lands. With the increase in the number of treated acres comes an increased need to protect air quality and visibility values.

4.6.6 Visibility

Atmospheric visibility is affected by scattering and absorption of light by particles and gases. Particles and gases in the air can obscure the clarity, color, texture and form of what we see. Fine particles most responsible for visibility impairment are sulfates, nitrates, organic compounds, elemental carbon (or soot), and soil dust. Sulfates, nitrates, organic carbon, and soil tend to scatter light, whereas elemental carbon tends to absorb light. Fine particles (PM2.5) are more efficient per unit mass than coarse particles (PM10 and larger) at causing visibility impairment (Sanberg et al., 2002).

California has 29 Mandatory Class I Federal areas (Figure 4.6.5) that need to be taken into consideration for compliance with the 1977 amendments to the Clean Air Act. Visibility, in the context of scenic Class I vistas, refers to the clarity with which distant objects are perceived. Mandatory Class I Federal lands include all national wilderness areas exceeding 500 acres. Visibility is affected by pollutant concentrations, the viewing angles, relative humidity, cloud characteristics, and other physical factors such as color contrast between objects (EPA, 2001). Class I areas can be considered “smoke sensitive areas” and impacts from prescribed fire may need to be specifically addressed in alternatives, as almost no change from current air quality is allowed from new sources.

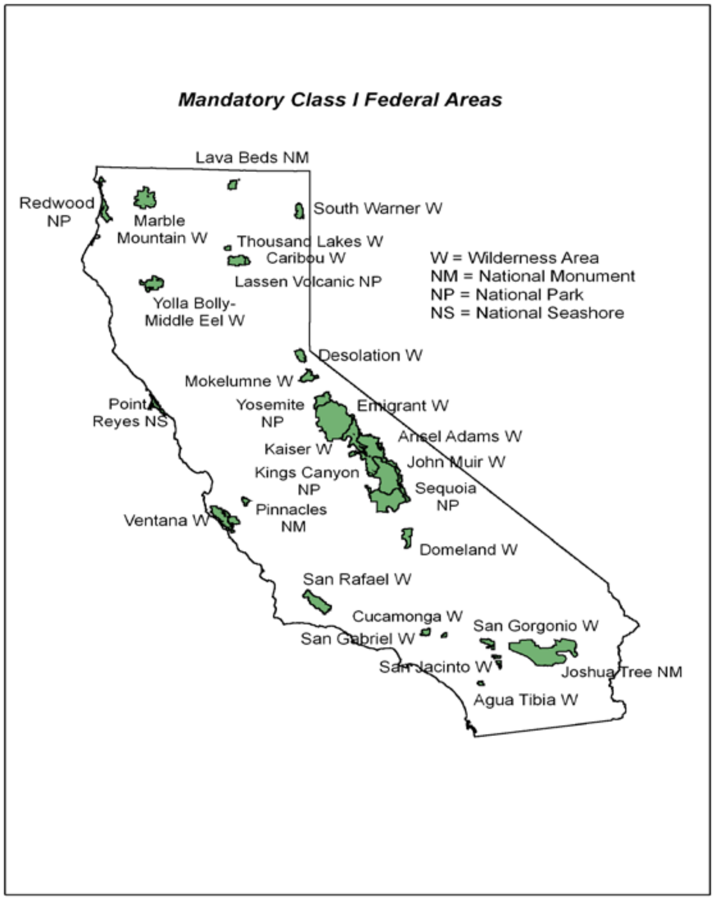

Figure 4.6.5. Mandatory Class 1 Federal Areas

4.6.7 Emissions Reduction

When the use of fire is selected as the best means to accomplish management goals, there are two general types of control options for air pollutant emissions: those that reduce the total amount of emissions, and those that reduce the impact of emissions on smoke-sensitive areas. The components and quantity of emissions from prescribed burning depend in part on the types of fuels burned, their moisture content, and the temperature of combustion.

The approaches fall into four categories and their applicability varies by fuel type: (1) minimize the area burned, (2) reduce the fuel loading in the area to be burned, (3) reduce the amount of fuel consumed by the fire, and (4) minimize emissions per ton of fuel consumed (EPA, 1998).

Reducing the area burned includes mechanical treatments and reduction of fuel loading, chemical treatments or burning a subset of a larger area. Reduction of fuel loading includes mechanical fuel removal, more frequent burning or burning during a time of year when less fuel is present.

Reducing fuel consumption can decrease emissions by reducing fireline intensity, crown and foliage scorch, and cambrium injury, thus reducing flora and fauna mortality. This can be accomplished by burning when there is a high fuel-moisture content (Table 4.6.4), using equipment that creates a mass ignition and by completing rapid mop-up.

Increasing combustion efficiency can shift the majority of consumption away from the smoldering phase and into the more efficient flaming phase. This can be accomplished by burning fuels in piles or windrows, using backing fires, completing rapid mop-up and mass ignitions with a shortened fire duration. (Peterson and Leenhouts, 1997).

Table 4.6.4
Emission Factors in lbs/ton of Fuel Consumed by Fuel Component for Wet, Moderate, and Dry Burn Conditions (http://www.arb.ca.gov/ei/areasrc/onehtm/one9-3.htm) TNMHC = Total Non-Methane Hydrocarbons.

	PM10			PM2.5			CO			CH_4		
Fuel component	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry
Litter, wood 0-1 in	9.3	9.3	9.3	7.9	7.9	7.9	52.4	52.4	52.4	2.1	2.1	2.1
Wood 1-3 in	14.0	14.0	14.0	11.9	11.9	11.9	111.4	111.4	111.4	4.5	4.5	4.5
Wood 3+ in	26.6	21.6	19.1	22.5	18.3	16.2	268.9	205.8	174.4	10.8	8.2	7.0
Herb, shrub, regen	25.1	25.1	25.1	21.3	21.3	21.3	249.2	249.2	249.2	10.0	10.0	10.0
Duff	28.2	30.4	30.4	23.9	25.8	25.8	288.6	316.1	316.1	11.5	12.6	12.6
Canopy fuels	25.1	25.1	25.1	21.3	21.3	21.3	249.2	249.2	249.2	10.0	10.0	10.0
	TNMHC			NH_3			NOx			SO_2		
Fuel component	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry
Litter, wood 0-1 in	3.7	3.7	3.7	0.5	0.5	0.5	8.2	8.2	8.2	2.5	2.5	2.5
Wood 1-3 in	7.8	7.8	7.8	1.1	1.1	1.1	8.0	8.0	8.0	2.5	2.5	2.5
Wood 3+ in	18.8	14.4	12.2	2.7	2.1	1.7	7.3	7.6	7.7	2.2	2.3	2.4
Herb, shrub, regen	17.4	17.4	17.4	2.5	2.5	2.5	7.4	7.4	7.4	2.3	2.3	2.3
Duff	20.2	22.1	22.1	2.9	3.2	3.2	7.2	7.1	7.1	2.2	2.2	2.2
Canopy fuels	17.4	17.4	17.4	2.5	2.5	2.5	7.4	7.4	7.4	2.3	2.3	2.3

4.6.8 Smoke Management

The purpose of smoke management techniques is to minimize the impacts of smoke on urban and residential areas, heavily-used recreation areas, Class I areas, and other sensitive areas. Methods available include meteorological scheduling for good atmospheric dispersion, pre-ignition modeling of downwind particulate concentration, active-phase smoke monitoring, and choosing conditions that encourage cloud scavenging (Radke and Ward, 1991).

The application of best available control measures (BACM) for prescribed fire is a required element of State Implementation Plans for PM10 non-attainment areas that are significantly impacted by prescribed fire smoke (EPA, 1992).

When a burn plan is completed for a project it should include the following smoke management components:

- Actions to minimize fire emissions – The steps taken prior to the burn and actions that will be taken after the burn to reduce air pollutant emissions.
- Evaluate smoke dispersion – Fire prescriptions submitted prior to the day of the fire must specify minimum requirements for the atmospheric capacity for smoke dispersal such as minimum surface and upper level wind speeds, desired wind direction, minimum mixing height, and dispersion index.
- Public notification and exposure reduction procedures – Actions that will be taken to notify populations and authorities at sensitive receptors, including those in adjacent jurisdictions, prior to the fire. The plan should also identify contingency actions that will be taken if smoke intrusions occur.
- Air quality monitoring – The plan should identify how the effects of the fire on air quality at sensitive receptors, and visibility in mandatory Class I Federal areas will be monitored.

4.6.9 California Climate and Meteorology

The climate of California is classified as Mediterranean. Such areas typically have certain common characteristics:

- warm to hot summers and mild winters
- a moderate marine influence throughout the year, more impacting in coastal areas
- most of the year's precipitation concentrated during winters, whereas summers in lower elevations are nearly or completely dry
- extended periods of sunny weather and few clouds

Fire is a natural component of Mediterranean ecosystems. On most days, the sea breeze blowing onshore produces a marine influence. Fires that start under these circumstances can usually be controlled. Under certain conditions, however, brush and forest fires can turn into disastrous conflagrations that ravage wide areas (McCutchan, 1977).

A severe heat wave accompanied by very low humidity greatly increases fire hazard, and this pattern is a prominent climatic feature. Heat waves in California that cause fire danger occur when a subtropical high-pressure system persists over the Great Basin, causing high surface temperatures and low humidity accompanied by strong and gusty winds.

Hot, dry summers reduce fuel moisture and increase the potential for fires. Most fires in California occur during late summer and early fall. The fire season is often longer and more extreme in Southern California because of "Santa Ana" winds. These winds are caused by high pressure areas in the continental interior (Oregon, Nevada, Utah, and Arizona). High pressure can be "trapped" in the interior while low pressure is present in the Central Valley or offshore California. Strong winds then flow through the mountain passes from desert regions. As they move downslope, the winds accelerate, heat, and become extremely dry. Severe forest fires often occur under Santa Ana conditions. Santa Ana winds occur most frequently from September through December and in March.

Wind affects fire behavior and the dispersal of smoke produced by fires. Along with the major seasonal Pacific westerlies, winds also follow daily patterns that play an important role in the mountain regions. These patterns result from air density differences brought about by solar heating during the day and radiative cooling at night. Two types of diurnal cycle winds are land-to-sea breezes and mountain-to-valley winds.

Land-to-sea breezes occur because land heats and cools more quickly than water. Onshore breezes typically occur during the daytime when the warm air over the land mass rises and cool ocean air moves onshore to replace it. At night, the situation reverses and the breeze moves offshore, from the cooling land to the warmer ocean.

Mountain-to-valley breezes form in a similar way. Solar heating of the higher elevation land during the day creates a rising mass of warm air, which tends to move upslope following the terrain. At night, the air flow is reversed as radiation cools the land and chills the air above it. This cooled air drops down into the lowlands from the higher slopes.

Wind direction and intensity during prescribed burns and wildfires are important because air quality is poorest immediately adjacent to and downwind of such fires. Fires near populated areas may pose an increased risk of air quality–related health problems.

Meteorology and Smoke Dispersion

Air resource characteristics are reflective of each air basin’s specific airflow traits, physiographic features, and pollution emission sources. Additional factors that affect air quality in forest and rangelands are geographic location and seasonal variations. Atmospheric conditions that create temperature inversions and permit air masses to remain stagnant for long periods allow the airborne concentrations of smoke and other pollutants to increase. These conditions aggravate air pollution over urban, industrial, and agricultural areas. Air pollution is occasionally aggravated by daily and seasonal wind patterns. Sea-to-land breezes remove pollution from coastal areas during the day as cold, dense air moves onshore, but push it back during the night as the land breeze gently flows offshore.

Mountain-to-valley breezes may also distribute smoke. At night, the air drains downslope, but during the day winds reverse and blow upslope, carrying the polluted air. Mountain areas may become smoky in late afternoon or early evening for this reason. By morning, however, cold, dense nighttime air has traveled downslope and polluted valleys and mountain basins. This may cause ground-level inversions to form as the land radiates heat. Closed mountain basins or valleys, such as the Tahoe Basin and Yosemite Valley, are areas with high smoke potential.

Higher air quality is typically found in the northern, higher elevations, and more remote portions of the State typically associated with forest and rangeland areas, distant from urban centers of pollution production/emissions.

Table 4.6.5
Air Quality Attainment Status (State Standards)

	OZONE - State	PM 10 - State	PM 2.5 - State	CO - State	NO2 - State	SO2 - State	Pb - State	H2S - State
GREAT BASIN VALLEYS AIR BASIN		N	A		A	A	A	
Alpine County	U			U				U
Inyo County	N			A				A
Mono County	N			A				A
LAKE COUNTY AIR BASIN	A	A	A	A	A	A	A	A
LAKE TAHOE AIR BASIN	N	N	A	A	A	A	A	U
MOJAVE DESERT AIR BASIN	N	N			A	A	A	
County portion of federal Southeast	N							
Remainder of Air Basin	U							
Kern County (portion)				U				U
Los Angeles County (portion)				A				U
Riverside County (portion)				U				U
San Bernardino County (portion)				A				
Searles Valley								N
Remainder of County								U
MOUNTAIN COUNTIES AIR BASIN					A	A	A	
Amador County	N	U		U				
City of Sutter Creek								N
Remainder of County								U
Calaveras County	N	N		U				U
El Dorado County	N	N		U				U
Mariposa County	N			U				U
Nevada County	N	N		U				U
Placer County	N	N		U				U
Plumas County	U	N		A				U
Portola Valley			N					
Remainder of Air Basin			U					
Sierra County	U	N		U				U
Tuolumne County	N	U		A				U
NORTH CENTRAL COAST AIR BASIN	N	N	A		A	A	A	U
Monterey County				A				
San Benito County				U				
Santa Cruz County				U				
NORTH COAST AIR BASIN	A		U		A	A	A	
Del Norte County				U				U
Humboldt County				A				A
Mendocino County				A				U
Sonoma County (portion)		A		U				

Remainder of Air Basin		N						
Trinity County				U				U
NORTHEAST PLATEAU AIR BASIN			U	U	A	A	A	U
Siskiyou County	NT	A						
Remainder of Air Basin	U	N						
SACRAMENTO VALLEY AIR BASIN		N			A	A	A	U
Butte County			N	A				
Colusa County	NT		A	U				
Glenn County	NT			U				
Placer County			A	A				
Sacramento County			N	A				
Shasta County				U				
Solano County				A				
Sutter County	NT		A	A				
Remainder of Air Basin	N		U					
Yuba County	NT		A	U				
SALTON SEA AIR BASIN	N	N		A	A	A	A	U
SAN DIEGO AIR BASIN	N	N	N	A	A	A	A	U
SF - BAY AREA AIR BASIN	N	N	N	A	A	A	A	U
SAN JOAQUIN VALLEY AIR BASIN	N	N	N		A	A	A	U
Fresno County				A				
Kern County (portion)				A				
Kings County				U				
Madera County				U				
Merced County				U				
San Joaquin County				A				
Stanislaus County				A				
Tulare County				A				
SOUTH CENTRAL COAST AIR BASIN	N	N		A	A	A	A	
San Luis Obispo County			A					A
Santa Barbara County			U					A
Ventura County			N					U
SOUTH COAST AIR BASIN	N	N	N		N	A	A	U
Los Angeles County (portion)				A				
Orange County				A				
Riverside County (portion)				A				
San Bernardino County (portion)				A				

Note: A = Attainment; N = Non-Attainment; U = Unclassified

Table 4.6.6
Air Quality Attainment Status (Federal Standards)

	National Attainment					
	PM10	PM2.5	CO	NO2	SO2	O3
Great Basin Valleys						
Alpine County	U	U/A	U/A	U/A	U	U/A
Inyo County	U	U/A	U/A	U/A	U	U/A
Mono County	U	U/A	U/A	U/A	U	U/A
Lake County	U	U/A	U/A	U/A	U	U/A
Lake Tahoe	U	U/A	U/A	U/A	A	U/A
Mountain Counties						
Amador County	U	U/A	U/A	U/A	U	N
Calaveras County	U	U/A	U/A	U/A	U	N
El Dorado County	U	U/A	U/A	U/A	U	N
Mariposa County	U	U/A	U/A	U/A	U	N
Nevada County	U	U/A	U/A	U/A	U	N
Placer County	U	U/A	U/A	U/A	U	N
Plumas County	U	U/A	U/A	U/A	U	U/A
Sierra County	U	U/A	U/A	U/A	U	U/A
Tuolumne County	U	U/A	U/A	U/A	U	N
North Central Coast						
Monterey County	U	U/A	U/A	U/A	U	U/A
San Benito County	U	U/A	U/A	U/A	U	U/A
Santa Cruz County	U	U/A	U/A	U/A	U	U/A
North Coast						
Del Norte County	U	U/A	U/A	U/A	U	U/A
Humboldt County	U	U/A	U/A	U/A	U	U/A
Mendocino County	U	U/A	U/A	U/A	U	U/A
Sonoma County (North)	U	U/A	U/A	U/A	U	U/A
Trinity County	U	U/A	U/A	U/A	U	U/A
Northeast Plateau						
Modoc County	U	U/A	U/A	U/A	U	U/A
Lassen County	U	U/A	U/A	U/A	U	U/A
Siskiyou County	U	U/A	U/A	U/A	U	U/A
Sacramento Valley						
Butte County	U	N	U/A	U/A	U	N
Colusa County	U	U/A	U/A	U/A	U	U/A
Glenn County	U	U/A	U/A	U/A	U	U/A
Placer County	U	U/A	U/A	U/A	U	N
Sacramento County	N	N	U/A	U/A	U	N

Shasta County	U	U/A	U/A	U/A	U	U/A
Sutter County	U	N	U/A	U/A	U	U/A
Tehama County	U	U/A	U/A	U/A	U	U/A
Yolo County	U	U/A	U/A	U/A	U	N
Yuba County	U	N	U/A	U/A	U	U/A
San Diego County	U	U/A	U/A	U/A	A	N
San Francisco Bay Area						
Alameda County	U	N	U/A	U/A	A	N
Contra Costa County	U	N	U/A	U/A	A	N
Napa County	U	N	U/A	U/A	A	N
Marin County	U	N	U/A	U/A	A	N
San Francisco County	U	N	U/A	U/A	A	N
San Mateo County	U	N	U/A	U/A	A	N
Solano County	U	U/A	U/A	U/A	U	N
Sonoma County (South)	U	N	U/A	U/A	A	N
Santa Clara County	U	N	U/A	U/A	A	N
San Joaquin Valley						
Fresno County	A	N	U/A	U/A	U	N
Kern County (West)	A	N	U/A	U/A	A	N
Kings County	A	N	U/A	U/A	U	N
Madera County	A	N	U/A	U/A	U	N
Merced County	A	N	U/A	U/A	U	N
San Joaquin County	A	N	U/A	U/A	U	N
Stanislaus County	A	N	U/A	U/A	U	N
Tulare County	A	N	U/A	U/A	U	N
South Central Coast						
San Luis Obispo County	U	U/A	U/A	U/A	U	U/A
Santa Barbara County	U	U/A	U/A	U/A	U	U/A
Ventura County	U	U/A	U/A	U/A	A	N
South Coast						
Los Angeles	N	N	U/A	U/A	A	N
Orange	N	N	U/A	U/A	A	N
Riverside (East)	N	N	U/A	U/A	A	N
Southeast Desert Basin						
Kern County (East)	U	U/A	U/A	U/A	U	N
Los Angeles County (Northeast)	U	U/A	U/A	U/A	A	N
Riverside County (East)	N	U/A	U/A	U/A	U	U/A
San Bernardino County	N	U/A	U/A	U/A	U	N

Note: A = Attainment; N = Non-Attainment; U = Unclassified

Table 4.6.7
Air Quality Standards

Ambient Air Quality Standards Applicable in California								
		Average Time	Standard, as parts per million		Standard, as micrograms per cubic meter		Violation Criteria	
Pollutant	Symbol		California	National	California	National	California	National
Ozone	O_3	8 hours[a]	N/A	0.08	N/A	160	N/A	If 3-year average of annual third-highest daily 8-hour maximum exceeds standard
		1 hour	0.09	0.12	180	235	If exceeded	If exceeded on more than 3 days in 3 years
Carbon monoxide	CO	8 hours	9.0	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	N/A	7,000	N/A	If exceeded	N/A
Nitrogen dioxide	NO_2	Annual average	N/A	0.053	N/A	100	N/A	If exceeded
		1 hour	0.25	N/A	470	N/A	If exceeded	N/A
Sulfur dioxide	SO_2	Annual average	N/A	0.03	N/A	80	N/A	If exceeded
		24 hours	0.04	0.14	105	365	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	N/A	655	N/A	N/A	N/A
Hydrogen sulfide	H_2S	1 hour	0.03	N/A	42	N/A	If equaled or exceeded	N/A
Vinyl chloride	C_2H_3Cl	24 hours	0.010	N/A	26	N/A	If equaled or exceeded	N/A
Inhalable particulate matter	PM10	Annual geometric mean	N/A	N/A	30	N/A	If exceeded	N/A
		Annual arithmetic	N/A	N/A	N/A	50	N/A	If exceeded

Ambient Air Quality Standards Applicable in California								
		Average Time	Standard, as parts per million		Standard, as micrograms per cubic meter		Violation Criteria	
Pollutant	Symbol		California	National	California	National	California	National
		mean						
		24 hours	N/A	N/A	50	150	N/A	If exceeded on more than 1 day per year
Fine particulate matter	PM2.5	Annual arithmetic mean*	N/A	N/A	N/A	15	N/A	If spatial average exceeded on more than 3 days in 3 years
		24 hours*	N/A	N/A	N/A	65	N/A	If exceeds 98th percentile of concentrations in a year
Sulfate particles	SO_4	24 hours	N/A	N/A	25	N/A	If equaled or exceeded	N/A
Lead particles	Pb	Calendar quarter	N/A	N/A	N/A	1.5	N/A	If exceeded no more than 1 day per year
		30 days	N/A	N/A	1.5	N/A	If equaled or exceeded	N/A

Notes: All standards are based on measurements at 25°C and 1 atmosphere pressure.
National standards shown are the primary (health effects) standards.
N/A = not applicable.

* New standards effective July 1997. Eight-hour ozone standard replaces 1-hour standard after compliance with the 1-hour standard has been attained.

A = Attainment – The state standard for the pollutant was not violated at any site in the area for a three year period.

N = Non-attainment – At least 1 violation of a state standard occurred.

T = Transitional – Subcategory of non-attainment. An area is close to attaining the standard for a pollutant.

U = Unclassified – Data is incomplete and does not support a designation

Air basins classified as non-attainment areas have at least one area within that basin that has shown a violation of the relevant ambient standard.

Source: California Air Resources Board 2006 (http://www.arb.ca.gov/desig/adm/adm.htm)

* CDF/USDA combined wildfire emissions.

Sources: California Air Resources Board 2005