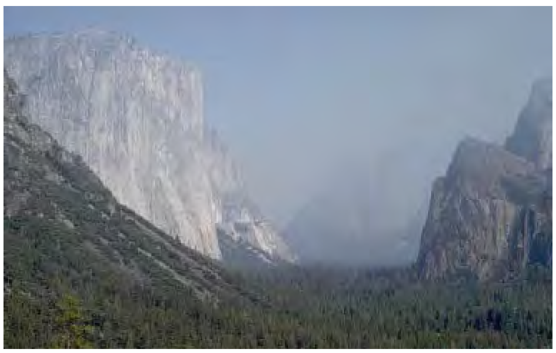
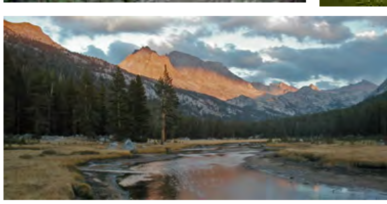
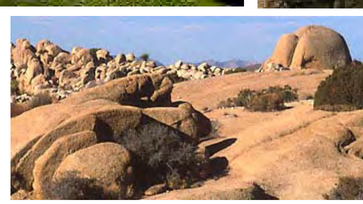
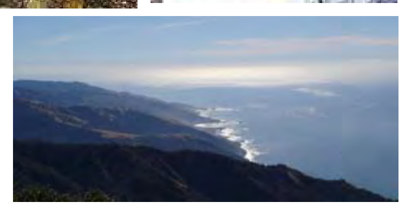
CALIFORNIA REGIONAL HAZE PLAN







California Environmental Protection Agency

Air Resources Board

Final

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This document has been drafted by the staff of the California Air Resources Board for public review and comment in partial satisfaction of the requirements of the federal Regional Haze Rule, 40 CFR 51.300 et seq.

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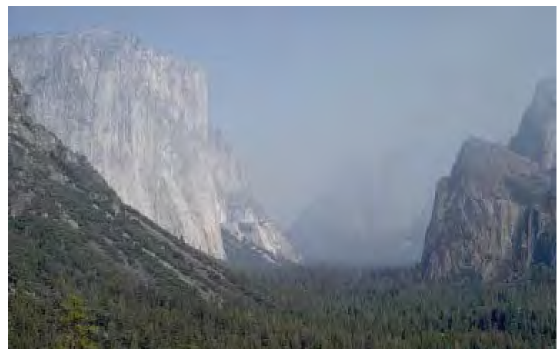
EXECUTIVE SUMMARY

Good visibility is essential to the enjoyment of national parks and scenic areas throughout the United States. Pollution in the atmosphere, from both natural and human-caused sources, can degrade visibility resulting in what is known as regional haze. As its name implies, this haze can impact broad regional areas and significantly impair the scenic vistas that are so integral to the wilderness experience. A graphic example of the impacts of impaired visibility is provided in the figure below comparing the view of Half Dome in Yosemite National Park on both good and poor visibility days.



To protect visibility in these national parks and scenic areas, the United States Environmental Protection Agency (U.S. EPA) adopted the Regional Haze Rule in 1999. The Rule lays out specific requirements to ensure improvements in the human-caused components of visibility at 156 of the largest national parks and wilderness areas across the United States. The vast majority of these areas are in the West (118), with 29 in California, including such national treasures as Yosemite and Sequoia National Parks. The Rule sets out a long-term path towards attaining improved visibility, with the goal of achieving visibility which reflects natural conditions by 2064. Unlike State Implementation Plans which require specific targets and attainment dates, the Regional Haze Rule requires States to provide for a series of interim goals to ensure continued progress. This Regional Haze Plan (Plan) addresses the first interim goal period of 2018.

California has a long history of pollution control efforts to address both national and State air quality standards. Due to the unique challenges faced in California, our pollution control programs have gone far beyond what has been achieved on a national level. As a result, California has made tremendous progress in reducing emissions and improving air quality. Most recently, California has also embarked on a landmark program to address climate change. Visibility improvement is an additional aspect of environmental protection in California that is benefiting from California's stringent air pollution control efforts addressing a broad spectrum of program areas.

This Plan sets forth California's visibility goals and represents California's element of a broader western regional effort to assess the visibility improvement that is expected to occur through 2018. Due to the regional nature of haze, multi-state planning organizations were established to provide for coordinated technical planning and consultation. The Western Regional Air Partnership (WRAP) serves this function in the west. The WRAP membership includes 15 western states, federal land management agencies, tribes, and U.S. EPA. California has worked extensively with the WRAP over the last five years in preparing this Plan. Technical tool development, emission inventories, and air quality modeling have been conducted on a regional basis by the WRAP to support the efforts of all of the western states. This has ensured that there is a common basis for the building blocks of planning efforts both now and in the future. The WRAP has also provided a forum for consultation amongst member states and with federal land managers that has fostered the cooperative approach for defining future visibility goals.

The technical analysis conducted by the WRAP has shown that by 2018 visibility will improve in all areas of the West. However, the greatest improvements will occur in California. This enhanced rate of progress can be attributed to California's unique and technology-forcing control programs for ozone and particulate matter that are reflected in California's strategy for achieving the 2018 visibility goals. While continuing progress will occur, work conducted by the WRAP has also highlighted that there are impediments to achieving greater rates of progress in the West, including many locations in California. The WRAP analysis has shown that natural sources contribute significantly to visibility impairment. These sources include wildfires that have become more prevalent in the West, as well as natural plant-based biogenic emissions. In addition, analysis has shown that sources outside of the western region, such as from international shipping, and emissions from Mexico and Asia can provide substantial contributions to visibility impairment. These factors, as well as assessing the cost and feasibility of controls from a regional and national perspective, must be considered in setting appropriate reasonable progress goals.

Nevertheless, California's long-standing emissions control program is providing extensive reductions which establish a reasonable level of progress within this context. For example, California has significantly tightened emission standards for on-road and off-road mobile sources and the fuels that power them. As a result, California's emission control program for on-road motor vehicles is the strongest in the world. Compared to uncontrolled vehicles, passenger cars are now 99 percent cleaner. By 2010, new trucks will be 98 percent cleaner than new pre-1988 models. California has also adopted fuel standards that are more stringent than national requirements including California Reformulated Gasoline, and California Clean Diesel fuel. Our requirements for consumer products have led to significant improvements in the formulation of products ranging from paints to automotive cleaners to personal care products. California has also pioneered programs to provide incentive funding to expedite the replacement of older equipment such as the Carl Moyer program, school bus retrofits, and the goods movement bond program. In addition, California's stationary sources are subject to stringent control requirements and their emission levels are generally far lower than equivalent sources elsewhere in the nation.

Finally, while California's current control measures are the basis for this first set of interim goals and will contribute measurably to visibility improvement by 2018, we are embarking on even more aggressive control programs over the coming years to address further air quality standard requirements. Notably, in 2007 the Air Resources Board adopted a comprehensive Statewide strategy to provide for attainment of the federal 8-hour ozone and PM2.5 standards through a combination of far-reaching technologically feasible and cost-effective measures. Meeting the federal standards in the South Coast and the San Joaquin Valley, the two regions with the most severe air quality problems, will require a 75 percent reduction in NOx emissions from today's levels. The Statewide strategy targets clean-up of in-use heavy duty trucks, off-road sources, and goods movement sources. In addition, California has established air quality standards which are more stringent than the federal standards. The State standards also have long-term planning requirements to ensure they are attained as expeditiously as possible. The scope of these ongoing challenges will ensure that California will continue to be at the forefront of pursuing clean technologies and stringent control approaches far into the future and thus provide ongoing improvements in visibility.

It is also important to note that this Plan is the first of many as we proceed towards 2064. Each state is required to submit a five year progress report, as well as a revised Plan every ten years. These mid-course reviews allow states to evaluate interim progress towards their goals. During development of this Plan, the western states have identified a number of areas that require further evaluation to better inform the goal setting process. As noted previously, natural emissions from wildfires and biogenic sources have been found to play a significant role in visibility impairment in the west. Current estimates of natural conditions appear to underestimate the contributions from these sources. An improved understanding of the role of these sources is therefore needed to more appropriately define the level of future natural visibility that can realistically be achieved. In addition, the western states must continue to work with the federal government and international organizations to reduce the contributions to visibility impairment that come from sources under federal and international control. Updated information on these issues, as well as assessing the additional benefits of new control programs will all be incorporated into future Plan updates.

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1. INTRODUCTION TO THE REGIONAL HAZE RULE REQUIREMENTS

1.1. Purpose of the Plan

To protect visibility in national parks and scenic areas, the United States Environmental Protection Agency (U.S. EPA) adopted the Regional Haze Rule in 1999. The Rule lays out specific requirements to ensure improvements in the anthropogenic components of visibility at 156 of the largest national parks and wilderness areas across the United States. The vast majority of these areas are in the West (118), with 29 in California, including such national treasures as Yosemite and Sequoia National Parks. The Rule sets out a long-term path towards attaining improved visibility, with the goal of achieving visibility which reflects natural conditions by 2064. Unlike State Implementation Plans, which require specific targets and attainment dates, the Regional Haze Rule requires states to establish a series of interim goals to ensure continued progress. This Regional Haze Plan (Plan) addresses the first interim goal period of 2018.

This Plan sets forth California's visibility goals and represents California's element of a multi-state western regional effort to assess the visibility improvement that is expected to occur through 2018. Due to the regional nature of haze, multi-state planning organizations were established to provide for coordinated technical planning and consultation. The Western Regional Air Partnership (WRAP) serves this function in the West. California has worked extensively with the WRAP over the last five years in preparing this Plan. Technical tool development, emission inventories, and air quality modeling have been conducted on a regional basis by the WRAP to support the efforts of all of the western states.

The technical analysis conducted by the WRAP has shown that by 2018 visibility will improve in all areas of the West. However, the greatest improvements will occur in California due to the extensive nature of our control programs to achieve ambient air quality standards which have gone far beyond what has been achieved on a national level. To document the co-benefits of these programs for visibility, and to meet the requirements of the Regional Haze Rule, the Air Resources Board (ARB) has prepared this first Plan for California. The Plan evaluates the nature of the visibility problem at each Class 1 Area in the State, demonstrates the progress that will be achieved in each area by 2018, and describes how this progress is occurring within the framework of California's comprehensive control programs.

1.2. Overview of Visibility and Regional Haze

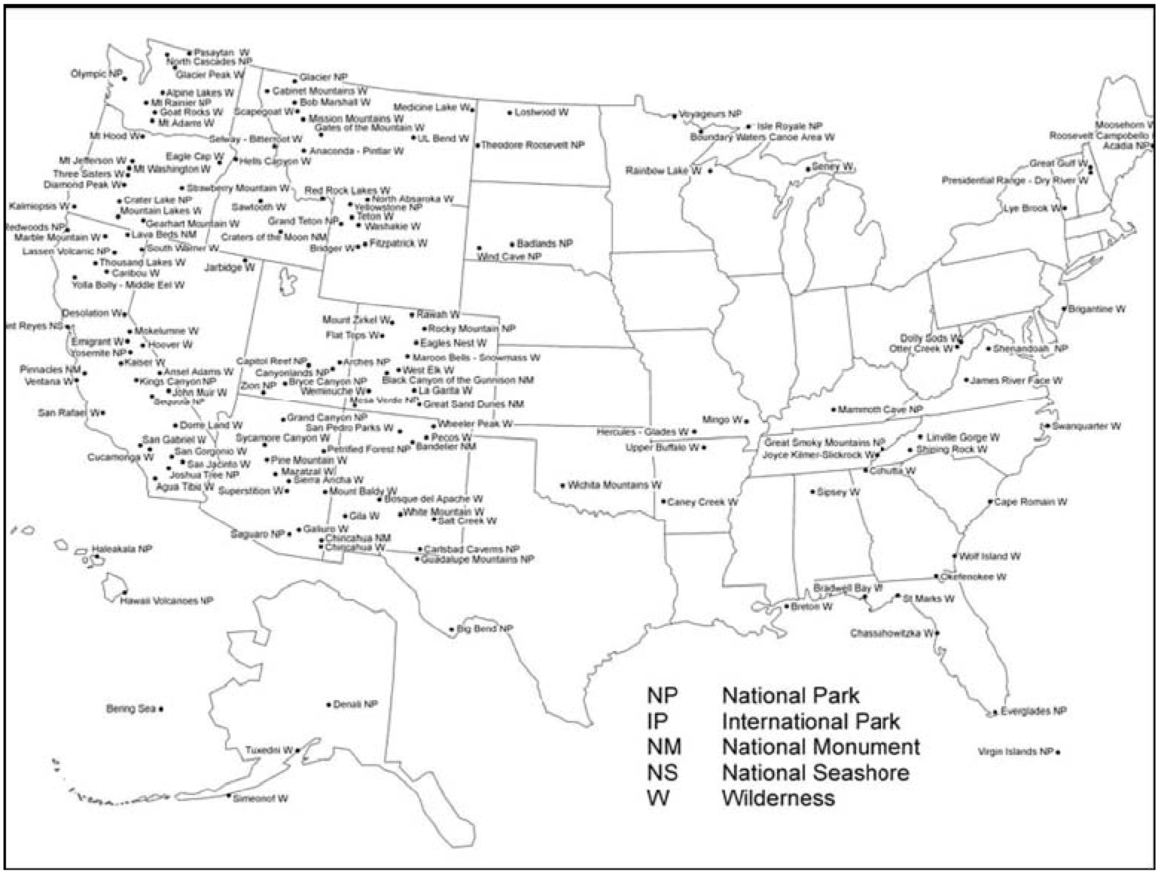
Good visibility is essential to the enjoyment of national parks and scenic areas. Across the United States, regional haze has decreased the visual range in these pristine areas from 140 miles to 35-90 miles in the West, and from 90 miles to

15-25 miles in the East. This haze is composed of small particles that absorb and scatter light, affecting the clarity and color of what humans see in a vista. The pollutants (also called *haze species*) that create haze are measurable as sulfates, nitrates, organic carbon, elemental carbon, fine soil, sea salt, and coarse mass. Anthropogenic sources of haze include industry, motor vehicles, agricultural and forestry burning, and dust from soils disturbed by human activities. Pollutants from these sources, in concentrations much lower than those which affect public health, can impair visibility anywhere. Natural forest fires, biological emissions, sea salt and other natural events also contribute to haze species concentrations. Visibility-reducing particles can be transported long distances from where they are generated, thereby producing regional haze. But when they are transported to and occur in national parks and wilderness areas, the reduced visibility impairs the quality and the value of the wilderness experience.

The national visibility goal set forth in section 169A of the federal Clean Air Act is to remedy existing degraded visibility and prevent future visibility impairment in national parks and wilderness areas. U.S. EPA first promulgated visibility rules in 1980. In July 1999, EPA adopted the Regional Haze Rule to complement and add to the visibility rules. These rules apply to 156 national parks and wilderness areas designated by Congress as “mandatory federal Class 1 Areas” (referred to herein as Class 1 Areas). Figure 1.1 shows that most of these are located in the western states, with 29 Class 1 Areas in California as illustrated in Figure 1.2. California Class 1 Areas span all regions of the State, from Joshua Tree National Park in the south, to Yosemite National Park in the Sierras, and Redwoods National Park on the northern coast.

The Regional Haze Rule sets forth the goal of achieving natural visibility conditions by 2064 in all Class 1 Areas. Along that path, states must establish a series of interim goals to ensure continued progress. The first planning period specifies setting reasonable progress goals for improving visibility in Class 1 Areas by the year 2018. Specifically, the interim goals must provide for improved visibility on the 20 percent of days with the worst visibility, and ensure that there is no further degradation on the 20 percent of days with the best visibility. The intent is to focus on reducing anthropogenic emissions, while achieving a better understanding and quantification of the natural causes of haze.

Figure 1-1 Nationwide Class 1 Areas

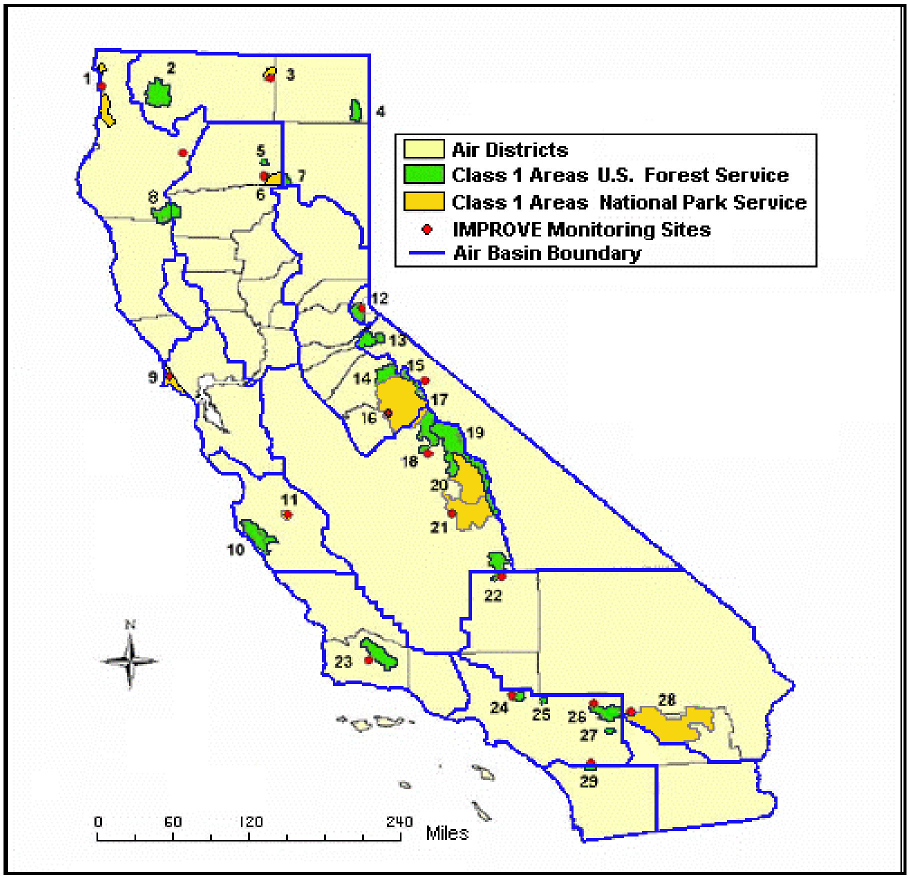


1.3. California and the Federal Regional Haze Rule

California has a long history of pollution control efforts to meet the health-based air quality standards. The numerous federal nonattainment areas within the State, as well as requirements to address more stringent State air quality standards have kept California at the forefront of pollution control. Due to the unique challenges faced in California, our pollution control programs have gone far beyond what has been achieved on a national level. California has also pioneered programs to address issues such as health risk from diesel exhaust, mitigating the impacts from good movement within the State, and most recently climate change. As a result, California has made tremendous progress in reducing emissions and improving air quality.

Visibility improvement reflects an additional aspect of environmental protection in California that benefits from the broad spectrum of programs already underway. Examination of visibility data from a number of sites with long-term monitoring demonstrates that California's control programs are providing visibility benefits. For example, at the San Gorgonio Class 1 Area, a wilderness area just downwind of the South Coast Air Basin, visibility has improved approximately 15 percent between 1990 and 2004, while at Pinnacles National Monument on the Central Coast, visibility has shown an approximately 18 percent improvement over the same time period.

Figure 1-2 California's Class 1 Areas and IMPROVE Monitoring Network



1. Redwood National Park
2. Marble Mountain Wilderness
3. Lava Beds National Monument
4. South Warner Wilderness
5. Thousand Lakes Wilderness
6. Lassen Volcanic National Park
7. Caribou Wilderness
8. Yolla Bolly Middle Eel Wilderness*
9. Point Reyes National Seashore
10. Ventana Wilderness
11. Pinnacles National Monument
12. Desolation Wilderness
13. Mokelumne Wilderness
14. Emigrant Wilderness
15. Hoover Wilderness
16. Yosemite National Park
17. Ansel Adams Wilderness
18. Kaiser Wilderness
19. John Muir Wilderness
20. Kings Canyon National Park
21. Sequoia National Park
22. Dome Land Wilderness*
23. San Rafael Wilderness
24. San Gabriel Wilderness
25. Cucamonga Wilderness
26. San Gorgonio Wilderness
27. San Jacinto Wilderness
28. Joshua Tree National Park
29. Agua Tibia

**also includes land managed by the U.S. Bureau of Land Management*

As noted earlier, this Plan represents California's element of a broader regional effort to improve visibility throughout the West through our participation in the WRAP. The WRAP facilitates the regional planning process and interstate consultation for the western states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. The WRAP established stakeholder-based technical and policy oversight committees to assist in managing the development of regional haze work products. Working groups and forums were also established that included states, tribal representatives, federal agencies, environmental groups, and industry stakeholders. ARB staff actively participated in the research, data analyses, interstate and tribal coordination, and discussions which led to regionally consistent emissions and air quality modeling approaches for addressing regional haze amongst all the western states.

The Regional Haze Rule contains many technical and informational elements which must be included in the Plan. These key elements include:

- Determining baseline and natural visibility conditions,
- Presenting base and future year emission inventories,
- Setting reasonable progress goals for 2018,
- Documenting the strategy to attain these goals,
- Determination of best available retrofit technologies,
- Consultation with states, tribes, and federal land managers,
- Committing to a monitoring strategy, and
- Specifying a timeline for future Plan revisions.

These elements are briefly explained in this Chapter and then detailed in subsequent Chapters of this document. Appendix J outlines the location of all of the elements that must be included in the Plan.

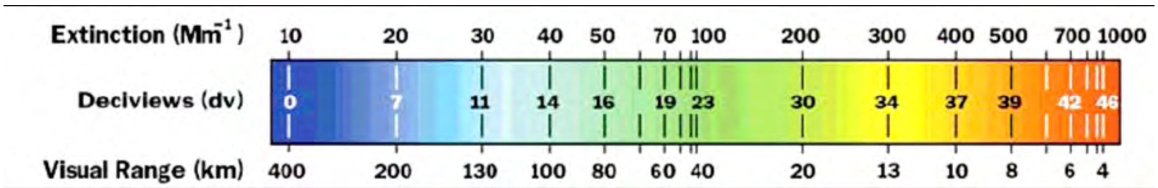
1.3.1. Determining Baseline and Natural Visibility Conditions

For each Class 1 Area in California, the state must describe existing (current) visibility conditions, on the suite of days with the best and worst visibility, for the baseline years of 2000-2004. The state must also establish what the best and the worst visibility would be like under natural conditions during the baseline period, on days when only natural sources affect visibility, without any anthropogenic impairment. Achieving natural conditions for visibility on worst days by 2064 is the overall goal of the Regional Haze Program.

Establishing the link between haze species and visibility impairment is the key to understanding regional haze. The haze species reflect (scatter) and absorb light in the atmosphere, thereby extinguishing light. The amount of light extinction affects visibility or the clarity of objects viewed at a distance by the human eye. The amount and type of haze species in the air can be measured, and the amount of light extinction caused by each one can be calculated, for any location or day, as visibility conditions change from good to poor throughout the year. The specific visibility measurement unit, the deciview (dv), is the natural logarithm of light extinction. The deciview is used in the Regional Haze Rule to track visibility conditions. While the deciview value describes overall visibility levels, light extinction describes the contribution of particular haze species to measured visibility.

The relationship between units of light extinction (Mm^{-1}), haze index (dv), and visual range (km) are indicated by the scale below. Visual range is the distance at which a given object can be seen with the unaided eye. The deciview scale is zero for pristine conditions and increases as visibility degrades. Each deciview change represents a perceptible change in visual air quality to the average person. Generally, a one deciview change in the haze index is likely perceptible by a human regardless of background visibility conditions. This is approximately a 10 percent change in the light extinction reading.

Figure 1-3 Visibility Measurement Scale



As the scale indicates, the deciview value gets higher as the amount of light extinction increases. The ultimate goal of the regional haze program is to reduce the amount of light extinction caused by haze species from anthropogenic emissions, until the deciview level for natural conditions is reached. That would be the deciview level corresponding to emission levels from natural sources only. The haze species concentrations are measured as part of the IMPROVE (**I**nteragency **M**onitoring of **Pro**tected **V**isual **E**nvironments) monitoring network deployed throughout the United States. Seventeen sites are operated in California.

Baseline or current visibility includes haze pollutant contributions from anthropogenic sources as well as those from natural sources using the actual pollutant concentrations measured at the IMPROVE monitors every three days during the period of 2000-2004. The 20 percent highest deciview days (roughly corresponding to the 24 days having the worst visibility) are averaged each year. These five yearly values are then averaged to determine the worst days visibility in deciviews for the 2000-2004 baseline period. The same process is used to get the best day baseline visibility value in deciviews from the annual 20 percent best days over the baseline years.

Natural visibility conditions represent the long-term degree of visibility estimated to exist, in the absence of anthropogenic impairment. Natural events such as wind storms, wildfires, volcanic activity, biogenic emissions from natural plant processes, and even sea salt from sea breezes introduce particles from natural sources that contribute to haze in the atmosphere. Therefore, individual natural events can lead to high short-term concentrations of visibility-impairing pollutants. Establishing the best and worst days under natural conditions represents a statistical normalization of these episodic events over time.

The U.S EPA initially calculated default natural visibility conditions for all Class 1 monitors but allowed states to develop more refined calculations. The Regional Planning Organizations nationwide funded research to refine the methods used to calculate visibility, the results of which were used to calculate the deciview values presented in this Plan. However, a great deal of additional research is underway to continue to better define natural visibility conditions in the western United States. New research is emerging on the increasing prevalence of wildfires in the western United States. The frequency of dust storms and their impact on areas disturbed by human-caused vs. wildlife activities is being investigated, as well as global transport of dust from natural desert storms in Africa and Asia. There is also increased awareness of the biogenic contributions to haze. As research into long-range transport, biogenic emissions, and wildfire cycles continues, we believe that natural condition visibility levels will be adjusted upwards.

Chapter 2 of this Plan describes current visibility conditions in each Class 1 Area as well as the nature of the pollutant species that contribute to the observed levels. Chapter 6 provides further information on the role of natural versus anthropogenic contributions and how that affects the progress that can be expected by 2018.

1.3.2. Statewide Emissions Inventory of Haze-causing Pollutants

As with any air quality analysis, a good understanding of the sources of haze pollutants is critical. The Plan includes emissions for the base year 2002, which represents the midpoint of the 2000-2004 baseline planning period, as well as future projected emissions to the year 2018. This emissions inventory was developed by the WRAP with input from California in order to provide a regionally consistent inventory. Chapter 3 provides information on emissions within California, including both natural and anthropogenic source categories.

1.3.3. 2018 Progress Strategy

The Plan also describes the strategy that provides the necessary emission reductions to achieve the reasonable progress goals established for each Class 1 Area within California, as well as for each Class 1 Area located outside California which may be affected by California emissions. The Regional Haze

Rule requires that the strategy consider ongoing air pollution control programs, measures to mitigate the impacts of construction activities, and smoke management programs. Emissions limitations, control measures, compliance schedules, replacement and retirement schedules, including their enforceability, must also be considered. Given California's need to attain both federal and State standards for pollutants affecting public health, we have a multi-faceted combination of aggressive programs that have been reducing criteria pollutant emissions for many years. California's strategy provides an ambitious and comprehensive basis for setting reasonable progress goals for the purpose of regional haze planning. Chapter 4 describes the measures included in California's 2018 Progress Strategy.

1.3.4. Best Available Retrofit Technology (BART) Requirement

The Best Available Retrofit Technology (BART) requirement implements a federal mandate to retrofit certain very old sources that pre-date the 1977 amendments to the Clean Air Act up to 15 years. The Plan must identify facilities that fall into one of 26 specific source categories, with emission units from the 1962-1977 time period having the potential to emit more than 250 tons per year of any haze pollutant. These emission units are known as BART-eligible sources. If it is demonstrated that the emissions from these sources cause or contribute to visibility impairment in any Class 1 Area, then the best available retrofit technology must be installed.

The determination of BART must take into consideration the costs of compliance, the energy and non-air quality environmental impacts of compliance, any existing pollution control technology in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology. In California, there are a number of facilities that fit the initial BART-eligible criteria. However, because local air districts have adopted stringent measures to reduce criteria pollutants, the vast majority of the older emission units have already been retrofit or suitably controlled. The systematic BART analysis carried out by ARB and the local air districts are detailed in Chapter 5.

1.3.5. Reasonable Progress Goals for 2018

Reasonable progress goals are established by each state for each Class 1 Area as a deciview level to be achieved by 2018, the end of the first planning period. The reasonable progress goals must assure that the worst haze days get less hazy *and* that visibility does not deteriorate on the best days, when compared with the baseline period. WRAP regional air quality modeling was used by the western states to assess future visibility and therefore, provide the context for states to establish reasonable progress goals for their Class 1 Areas.

States must also compare their reasonable progress goals to the level of visibility improvement that would be achieved if perfectly linear progress between the current period and expected natural conditions in 2064 were to occur. This linear rate of progress is known as the uniform glide path. The uniform glide path is not a fixed standard that must be met; instead it simply provides a basis for evaluating the selected 2018 goals. Many factors play into whether the uniform glide path can be achieved in the initial progress period including the cost and feasibility of controls as well as the appropriateness of the level set for natural conditions in 2064. Chapter 4 contains the analysis of control measures leading to California's selection of reasonable progress goals which are described in Chapter 7. Chapter 6 provides information on the WRAP modeling efforts and discussion of natural versus human-caused source contributions.

1.3.6. Required Consultation

Preparation of the Plan and selection of reasonable progress goals requires consultation between states, Federal Land Managers (FLMs), and affected tribes since haze pollutants can be transported across state lines, as well as international and tribal borders. In California, Class 1 Areas are managed primarily by the National Park Service (NPS) and the U.S. Forest Service (USFS.) The ARB has longstanding cooperative relationships with the NPS and the USFS, as well as with other Federal Land Managers within the State. During the preparation of this Plan, ARB formed a Steering Committee with the NPS, the USFS, and the U.S. EPA to discuss the components of the Plan. The draft Plan must be available to the Federal Land Managers at least 60 days before the public hearing on the final Plan. This allows time to identify and address any comments from the Federal Land Managers in the final Plan in advance of the Board hearing.

Participation in the WRAP has fostered a regionally consistent approach to haze planning in the western states and provided a sound mechanism for consultation. Through this process, the western states have agreed upon the overall goals being set for 2018 and the appropriateness of the strategies to achieve these goals for all Class 1 Areas in the region. The consultation process is explained in detail in Chapter 8.

1.3.7. Monitoring Strategy

The Plan also includes a monitoring strategy for measuring, characterizing, and reporting visibility impairment that is representative of all Class 1 Areas within the State. California uses the seventeen IMPROVE monitors whose locations are shown on Figure 1.2. Although there are twenty-nine Class 1 Areas in California, the IMPROVE monitors are located to give a reasonable indication of visibility in the respective regions where some of the Class 1 Areas are close to each other and share a monitor. Chapter 9 explains how California will continue to provide monitoring information for visibility analysis, as well as emissions inventories, as required, to the U.S. EPA.

1.3.8. Mid-Course Review of Progress, Revisions, and Timelines

Following submittal of the initial Plan, and every ten years after that, a revised Plan must be submitted for the following ten year period. In the interim, each state is required to submit a 5-year progress report to the U.S. EPA. Inventory and monitoring data updates, as well as a progress report on emission reductions are prepared for the mid-course review. As in this initial Plan, at the mid-course review, California will also work and consult with other states through a regional planning process.

The mid-course review also allows each state to assess progress towards its reasonable progress goals. As explained in Chapter 4, California's strategy for improving visibility is related to ongoing activities to reduce emissions of criteria pollutants. While the current control measures and incentive programs for stationary, area, and mobile sources contribute measurably to reductions in haze, California is embarking on ever more stringent, far-reaching, and technology-forcing control efforts in the upcoming years to meet further national and State air quality standard requirements. The first mid-course review, anticipated to occur in 2012, will provide an opportunity to reassess progress in light of these continuing programs.

2. VISIBILITY CONDITIONS AT CALIFORNIA CLASS 1 AREAS

2.1 Monitoring Data and Measuring Visibility Conditions

As discussed in Chapter 1, the Regional Haze Rule requires tracking visibility conditions at all Class 1 Areas in deciviews (dv). Deciview levels are not measured directly; they are derived from direct measurement of the haze pollutant species that impair visibility. The measurements are made at 17 IMPROVE monitors in California, assigned to the 29 Class 1 Areas shown in Figure 1-2 in Chapter 1. California used only this monitoring data to determine visibility conditions, so the baseline and current visibility will be the same for Class 1 Areas sharing an IMPROVE monitor. For this first Plan submittal, the 2000-2004 baseline conditions are the reference point against which visibility improvement is tracked. For subsequent Plan updates (in the year 2018 and every 10 years thereafter), these baseline conditions will be used to calculate progress from the beginning of the regional haze program.

Describing the average "Best Days" and "Worst Days" for Natural Conditions (background visibility in the absence of anthropogenic source visibility impairment) and Baseline Conditions (visibility considering all pollution sources) shows the typical range in visibility for each Class 1 Area during the baseline period. The Plan can be understood as a way to continually shrink the gap between worst days of the baseline period and worst days under Natural Conditions by reducing anthropogenic source visibility impairment. Table 2-1 shows the deciview values for the baseline best and worst days at each IMPROVE monitor and describes the hurdle to overcome in bringing the current worst visibility days to that of Natural Conditions at each Class 1 Area. In the future, the best days for the Baseline Conditions must be maintained or constantly bettered in subsequent planning periods.

The Class 1 Areas with the highest baseline deciview levels and therefore the biggest hurdles to overcome to reach Natural Conditions are Agua Tibia Wilderness Area (68 percent reduction), Kings Canyon and Sequoia National Parks (70 percent reduction), and San Gorgonio and San Jacinto Wilderness Areas (67 percent reduction). These Class 1 Areas are all situated at or near the edge of air basins with high density populations, many different land uses, and large interstate transportation corridors.

The Class 1 Areas with the least change needed in deciview level by 2064 are Redwoods National Park (25 percent reduction) and Point Reyes National Park (31 percent reduction). Because these two areas are located within 10 km of the coastline, they are exposed to large concentrations of sea salt, a natural cause of haze that will remain constant into the future. Therefore, the expected Natural Conditions at these two sites are much higher than for sites located further inland and hence the reductions needed to meet natural levels are much less.

Class 1 Areas at higher elevations in the Sierra Nevada such as Desolation Wilderness, Mokelumne Wilderness, and Hoover Wilderness, as well as those in the far northeastern corner of California such as Lava Beds National Monument and the South Warner Wilderness have the lowest deciview levels because these sites tend to be the furthest removed from the most highly urbanized portions of the State. These include the Caribou Wilderness and Thousand Lakes Wilderness in the northern, rural, high terrain areas close to Lassen Volcanic National Park. These sites need an approximately 50 percent reduction from current visibility levels, as measured by deciviews, to achieve Natural Conditions.

The terrain, ecology, land use, and weather patterns around each IMPROVE monitor in California are unique. Emission sources producing haze species or their precursors can have seasonal fluctuations that vary from one area to another. Additionally, after pollutants are emitted from the various sources, their transformation and transport in ambient air is affected by weather patterns. Detailed examination of the resultant ambient air monitoring data does show similarities within definable intra-State regions. These sub-regions are different from each other based on physiographic features, as well as land use patterns. Therefore California has grouped its Class 1 Areas by geographic sub-region, as shown in Table 2-1. This facilitates comparison of different landscapes, meteorological conditions, and the impacts of local and regional emissions. The map in Figure 2-1 illustrates these sub-regions.

Table 2-1 IMPROVE monitors and Visibility at California Class 1Areas

California Class 1 Areas (Visibility Calculated in Deciviews)			Current Conditions (2000-2004 Baseline)		Future Natural Conditions (2064 Goals)		
IMPROVE Monitor (name and elevation in meters)		CLASS 1 AREA(s)	Worst Days	Best Days (maintain in future years)	Natural Worst Days	Deciview Hurdle (baseline to 2064)	Improvement from Current Visibility on Worst Days
NORTHERN CALIFORNIA							
TRIN *(1014 m.)*	Trinity	Marble Mountain Wilderness Yolla Bolly-Middle Eel Wilderness	17.4	3.4	7.9	9.5	55%
LABE *(1460 m.)*	Lava Beds	Lava Beds National Monument South Warner Wilderness	15.1	3.2	7.9	7.2	48%
LAVO *(1733 m.)*	Lassen Volcanic	Lassen Volcanic National Park Caribou Wilderness Thousand Lakes Wilderness	14.1	2.7	7.3	6.8	48%
SIERRA CALIFORNIA							
BLIS *(2131 m.)*	Bliss	Desolation Wilderness Mokelumne Wilderness	12.6	2.5	6.1	6.5	52%
HOOV *(2561m.)*	Hoover	Hoover Wilderness	12.9	1.4	7.7	5.2	40%
YOSE *(1603 m.)*	Yosemite	Yosemite National Park Emigrant Wilderness	17.6	3.4	7.6	10.0	57%
KAIS *(2598 m.)*	Kaiser	Ansel Adams Wilderness Kaiser Wilderness John Muir Wilderness	15.5	2.3	7.1	8.4	54%
SEQU *(519 m.)*	Sequoia	Sequoia National Park Kings Canyon National Park	25.4	8.8	7.7	17.7	70%
DOME *(927 m.)*	Dome Lands	Dome Lands Wilderness	19.4	5.1	7.5	11.9	61%
COASTAL CALIFORNIA							
REDW * *(244 m.)*	Redwood	Redwood National Park	18.5	6.1	13.9	4.6	25%
PORE *(97 m.)*	Point Reyes	Point Reyes National Seashore	22.8	10.5	15.8	7.0	31%
PINN *(302 m.)*	Pinnacles	Pinnacles Wilderness Ventana Wilderness	18.5	8.9	8	10.5	57%
RAFA *(957 m.)*	San Rafael	San Rafael Wilderness	18.8	6.4	7.6	11.2	60%
SOUTHERN CALIFORNIA							
SAGA * *(1791 m.)*	San Gabriel	San Gabriel Wilderness Cucamonga Wilderness	19.9	4.8	7.0	12.9	65%
SAGO *(1726m.)*	San Gorgonio	San Gorgonio Wilderness San Jacinto Wilderness	22.2	5.4	7.3	14.9	67%
AGTI * *(508 m.)*	Agua Tibia	Agua Tibia	23.5	9.6	7.6	15.9	68%
JOSH *(1235 m.)*	Joshua Tree	Joshua Tree National Park	19.6	6.1	7.2	12.4	63%

* *REDW is influenced by transport from the same regions as the Northern California sites, which are different from the regions influencing the other monitors close to the coast. However, sea salt is a major component of haze at Redwoods National Park, characteristic of coastal sites. Also, a sparsely populated coastal mountain range, cresting around 7000 feet, separates REDW from many inland source influences. Therefore REDW is aligned with Coastal sites for analysis purposes.*

SAGA and AGTI are closer to the Pacific Ocean than the other Southern California sites. However, commercial marine shipping, port activities, sources in the Los Angeles Basin, and transport from Mexico impact all the southern sites. Also, sea salt's contribution to haze on worst days at all the southern sites is <0.1%. All the Southern sites are separated from the other sites by transverse mountain ranges and the Antelope Valley, hence their grouping for analysis purposes.

2.2 Haze Species Contributions to Light Extinction

The deciview level describes the visibility, or relative clarity of view, for every day that haze species are measured at a particular IMPROVE monitor. The deciview value for a given day is the natural logarithm of the total light extinction on that day. As air pollution is reduced, light extinction lessens, visibility improves, and the deciview value gets lower. Although the deciview number does not distinguish how much there is of each haze species or where it came from, the fundamental monitoring data which is used to derive deciview levels reveals what causes haze at each monitor. Differences in the key species which contribute to light extinction in different areas of California provide important insights into the sources of haze.

The IMPROVE monitors measure the concentration of six particulate haze species in the PM2.5 size fraction: nitrates, sulfates, organic carbon (OC), elemental carbon (EC), soil, sea salt. The total amount of mass in the PM10-2.5 size fraction is also measured and denoted as coarse mass. Most importantly, each haze species has a different capability to absorb and scatter light, so the measured pollutant concentration must be converted to light extinction to get the true impact or contribution of each haze species to visibility impairment each measured day. The relationship between haze species concentrations and light extinction is described below.

Haze Species Concentration: These are the particulate matter species concentrations that are measured in micrograms per cubic meter (ug/m^3) every three days at each IMPROVE monitor. Since each species does not have the same capability to extinguish light, sometimes a low concentration of one species can have the same effect as a high concentration of another species. For this reason, California has focused on the contribution to light extinction of each species to describe what causes haze at each IMPROVE monitor.

Light Extinction: This is calculated by the Haze Algorithm II equation (see Appendix A) which gives different weight to the concentrations of the various haze species according to their ability to absorb or scatter light and expresses total extinction at the monitor for that day in inverse megameters (Mm^{-1}). Humidity and temperature affect the light extinction strength of some of species. The Haze Algorithm II incorporates these factors into the light extinction calculation, on each day of measurement, as the cold/wet and hot/dry seasons change in California, according to the location of the monitor. The Haze Algorithm II also accounts for Rayleigh scattering by natural gases which contribute a relatively small, constant amount to light extinction at each monitor. For the purpose of determining which haze species drive poor visibility on worst days, the “reconstructed” light extinction for the seven major haze species is used as an analysis tool rather than total extinction. That is because these haze species are the aerosol particles that need to be reduced to improve visibility.

Graphing light extinction for the haze species on the best and worst days shows which species have the most influence on impaired visibility at each monitor.

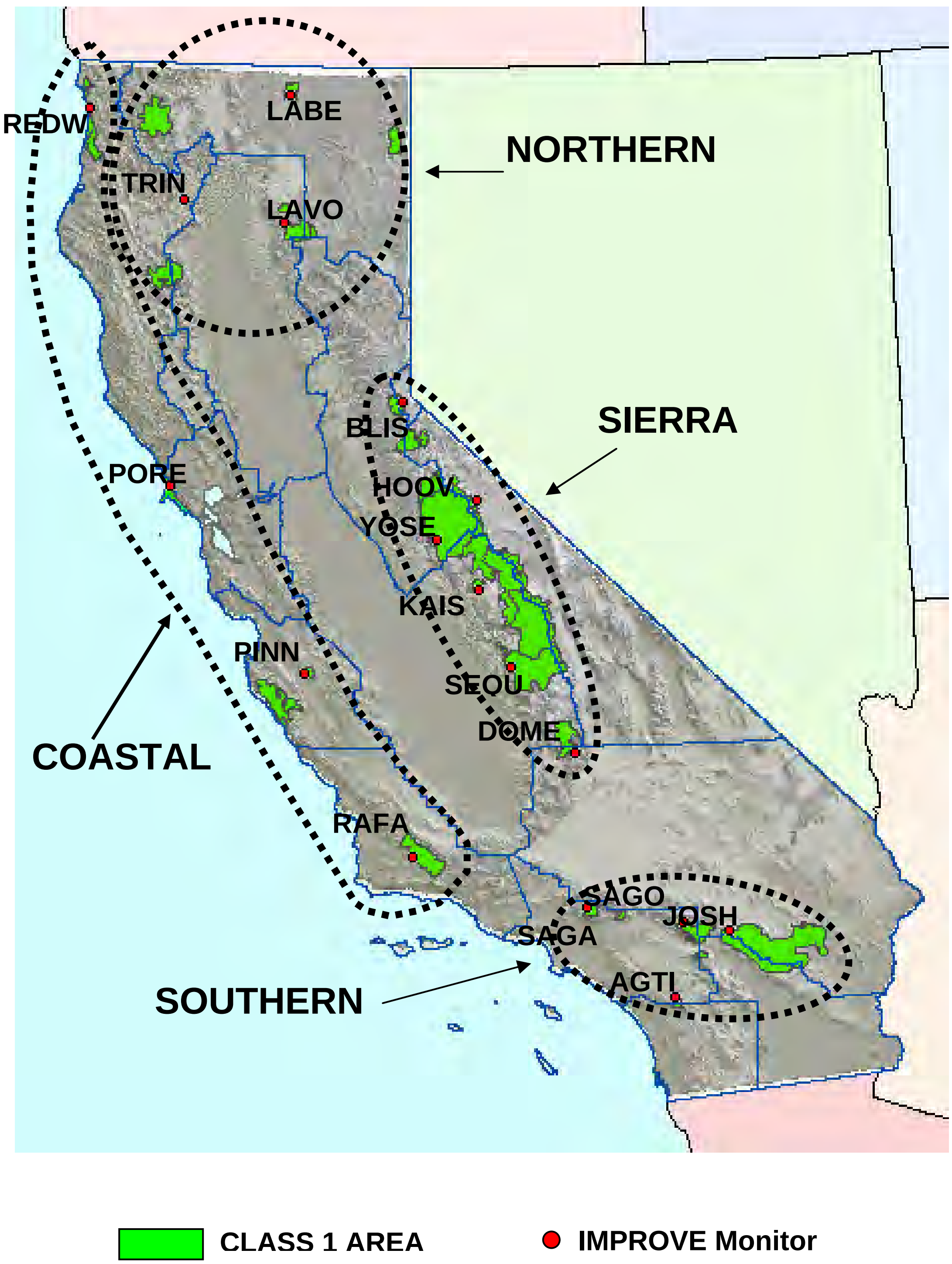
2.3 California's Geographic Sub-regions

California has 15 air basins bounded by physical features, such as topography, that impact local weather patterns and affect inter-basin transport of air pollutants. The four sub-regions for analysis of haze in California reflect consideration of these intra-State air basins as well as the jurisdiction of the thirty-five air districts with regulatory control over stationary sources within them. The haze species that serve as the main drivers of haze on worst days are generally the same for each sub-region because the topography and natural resources of each sub-region affect the way the surrounding areas developed. Factors such as urbanization level and interstate transportation corridors also play into the types of sources within each sub-region. Finally climate, humidity, vegetative cover, and precipitation patterns also influence which haze species predominate during the year. Therefore, the groupings are based on factors beyond simple geographic proximity.

In California, there are four collective geographic areas or sub-regions of the State with similar natural features, land uses, and population densities. Although data from each monitor is fully scrutinized in this Plan, and visibility conditions and Reasonable Progress Goals are determined for each Class 1 Area, using these sub-regions to compare and contrast characteristics reveals a coherent picture of the causes of haze in California. Through understanding the terrain and meteorology of the sub-regions, the impacts of local emissions can begin to be differentiated from long-range transport of emissions. Figure 2-1 represents the four different geographic sub-regions in CA, the Class 1 Areas that fit within them, and their corresponding IMPROVE monitor locations.

Even within the sub-regions there are variations on visibility conditions and what causes haze. However, for the most part, the main "driver" of haze, the species with the greatest contribution to light extinction on worst days, is the same. The relative abundance of these key drivers, as well as their seasonal variability, provides indications of the sources of haze in each sub-region as discussed in this Chapter. In addition, Chapter 6 provides further information through source apportionment analyses linking observed haze levels to specific source regions and source categories. The following sections describe the sub-regions. Summary data of reconstructed light extinction for the baseline worst days for the haze species at the IMPROVE monitors, broken down by geographic areas, are also provided. More detailed information about each Class 1 Area can be found in Appendix B.

Figure 2-1 California's Geographic Sub-Regions



2.3.1 Northern California

The Northern California sub-region encompasses most of the Northeast Plateau Air Basin, the northeastern portion of the North Coast Air Basin, and the northern part of the Sacramento Valley Air Basin. The IMPROVE monitors in this sub-region are LABE (Lava Beds and South Warner Wilderness), LAVO (Lassen Volcanic National Park, Caribou Wilderness, and Thousand Lakes Wilderness), and TRIN (Marble Mountain Wilderness and Yolla Bolly-Middle Eel Wilderness). Emission sources are primarily from rural land uses as there are few small cities and towns. However, the I-5 corridor has considerable traffic, particularly truck traffic. Major rail freight corridors also pass through the region.

Figure 2-2 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Northern California region. The baseline days with the worst air quality are dominated by organic aerosols. Figure 2-3 illustrates the seasonal nature of the species that contribute to haze at Lassen Volcanic National Park in 2002. Organic aerosols peak during the summer months. Evaluation of this data has shown a strong correlation with the incidence of wildfires. For example, in 2002, the Biscuit Fire burned nearly 500,000 acres in the Siskiyou National Forest in the states of Oregon and California. Figure 2-4 provides a satellite image of the Biscuit Fire in 2002 highlighting the broad regional extent of smoke from this fire which impacted Class 1 Areas throughout much of Northern California. Smoke from the smaller Umpqua Complex Area Fires northwest of Crater Lake in Oregon also impaired visibility in both states. In addition to wildfires, natural biogenic emissions from plants play an important role in contributing to elevated organic aerosol levels observed during the spring and summer months.

Figure 2-2 Baseline Conditions for 20 Percent Worst Days: Northern California

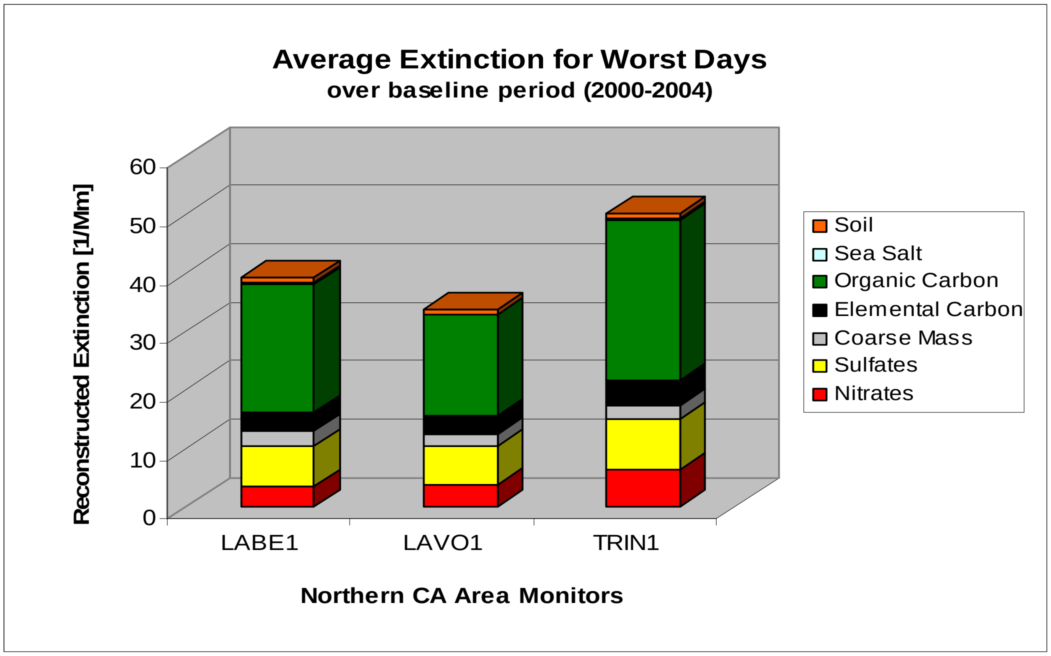


Figure 2-3 Seasonal Variation in Haze Species at Lassen Volcanic NP in 2002

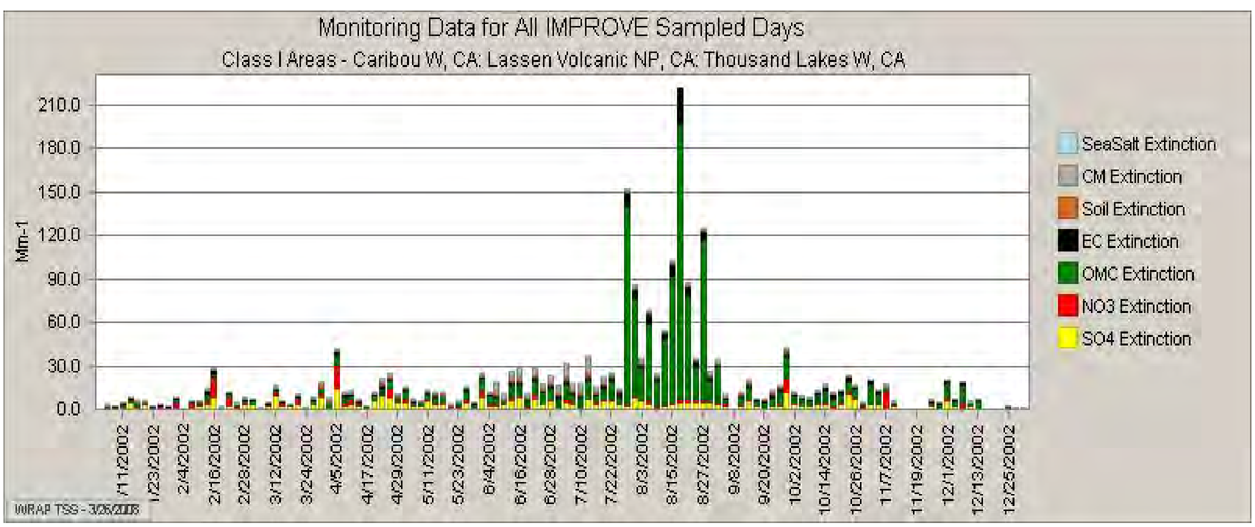


Figure 2-4 Smoke Impacts from the 2002 Biscuit Fire in Siskiyou National Forest

2.3.2   Sierra California

The Sierra sub-region of California encompasses the Sierra Nevada Mountains and foothills, from the Mountain Counties Air Basin, the Lake Tahoe Air Basin, the northern portion of the Great Basin Valleys, and the eastern part of the San Joaquin Valley Air Basin. The IMPROVE monitors representing the Sierra Nevada region are BLIS (Desolation Wilderness and Mokelumne Wilderness) , HOOV (Hoover Wilderness), YOSE (Yosemite National Park and Emigrant Wilderness), KAIS (Ansel Adams Wilderness, Kaiser Wilderness, and John Muir Wilderness), SEQU (Sequoia National Park and Kings Canyon National Park), and DOME (Dome Lands Wilderness). Emissions are primarily from forest biogenic sources, wildfires, transport from the Central Valley, and from the highway and major rail transportation corridors through the mountains.

Figure 2-5 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Sierra sub-region. As with the far Northern California region, the baseline days with the worst air quality are dominated by organic aerosols, with the majority coming from wildfire smoke and biogenic forest emissions. Sulfates and nitrates are also high on the worst case days in the Sierra sub-region, particularly at the SEQU monitor. Figure 2-6 illustrates the seasonal variations in the species that contribute to haze at Sequoia National Park. Nitrate peaks in the winter months, similar to the seasonal variability observed within the San Joaquin Valley. Because the SEQU monitor is at 519 meters, it is exposed to urban, agriculture, and transportation corridor emissions from the San Joaquin Valley to the west of the Park. As a result, the SEQU monitor represents the highest aerosol concentrations and most severe visibility impacts within the Class 1 Areas. Other sites in the Sierra sub-region are at a higher elevation and therefore experience more limited impacts from the San Joaquin Valley, and corresponding greater impacts from wildfires and biogenic emissions, which peak during the summer months.

Figure 2-5 Baseline Conditions for 20 Percent Worst Days: Sierra California

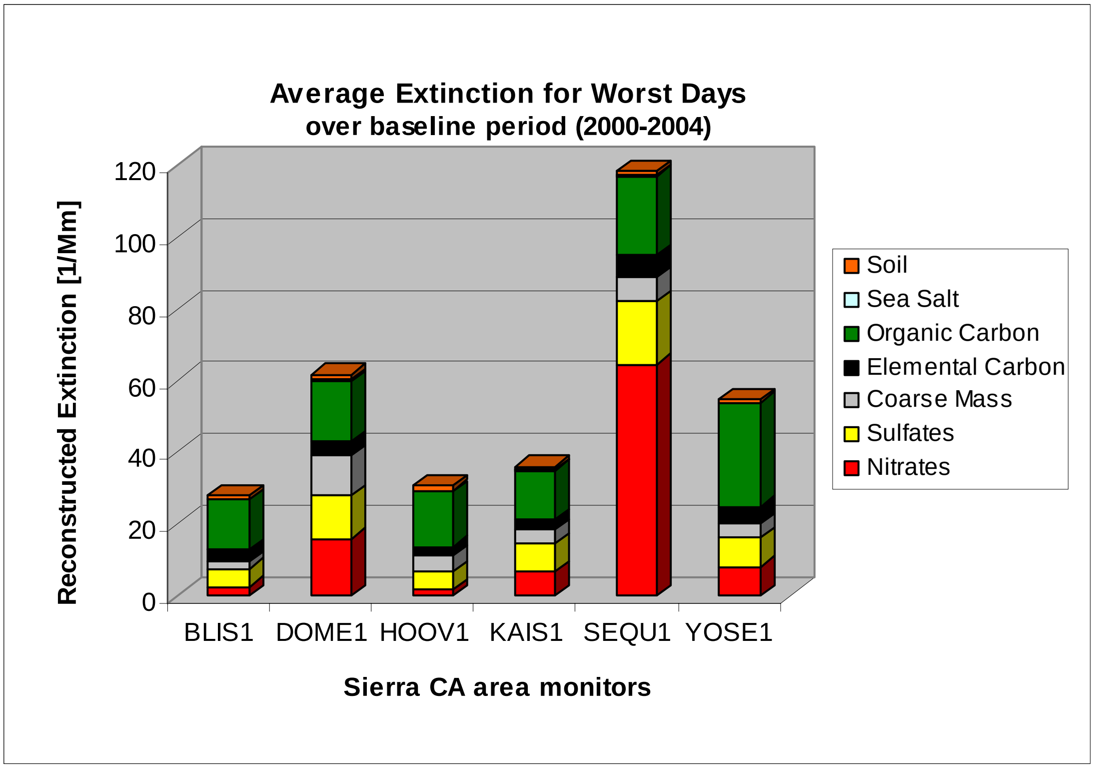
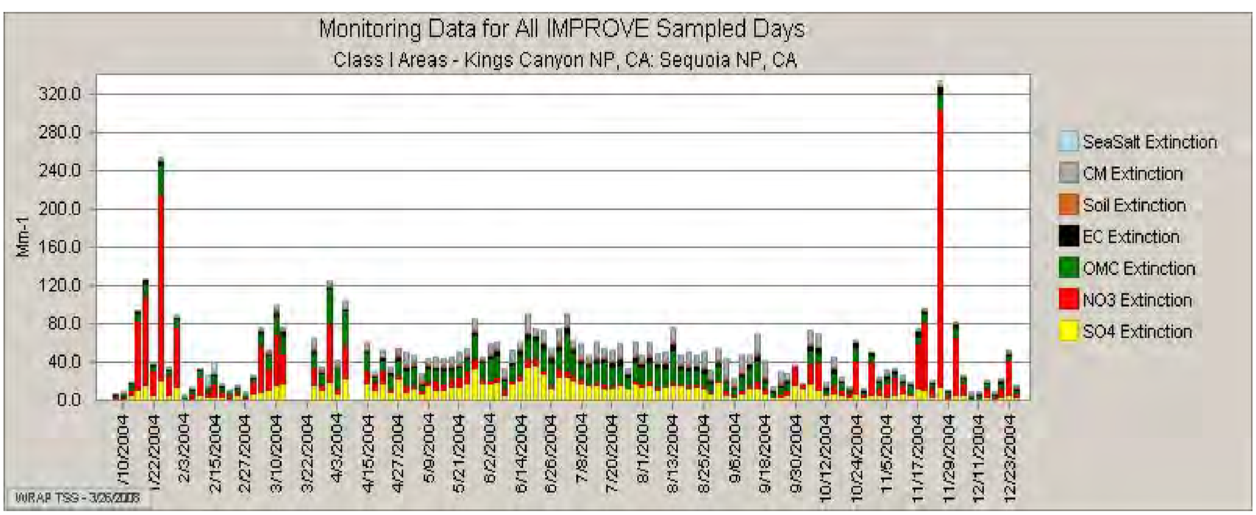


Figure 2-6 Seasonal Variation in Haze Species at Sequoia 2004



2.3.3. Southern California

The Southern California sub-region includes the South Coast Air Basin, the northern portion of the Salton Sea Air Basin, and the central and western portions of the Mojave Desert Air Basin. The IMPROVE monitors representing the Southern California sub-region are AGTI (Agua Tibia), SAGA (San Gabriel Wilderness and Cucamonga Wilderness), JOSH (Joshua Tree National Park), and SAGO (San Gorgonio Wilderness and San Jacinto Wilderness). These areas are located generally downwind of the South Coast Air Basin and therefore, upwind urban emissions are key sources of haze. Emissions from offshore shipping and international transport are also important.

Figure 2-7 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Southern California sub-region. The sites in Southern California have some of the most impaired visibility in the State, with the largest contribution to haze coming from nitrate. Sulfates and organic carbon are also contributors. Due to their proximity to the urban areas of southern California and general transport patterns, urban sources are a major contributor to haze at all of these sites. Elevated sulfate contributions at Agua Tibia in part reflect the fact that this site is closer to the coast, with corresponding impacts from both offshore shipping emissions, as well as natural marine sources of sulfate. It is also the Class 1 Area closest to Mexico and tracer analysis show that AGTI receives the largest impact from Mexican stationary and area source SOx emissions of all the IMPROVE monitors in California. Figure 2-8 depicts the seasonal variation in haze species at San Gorgonio Wilderness. Unlike other areas of the State, there is less of a pronounced seasonal pattern to individual haze species contributions, with high nitrate concentrations occurring throughout the year. Sulfate contributions are slightly higher during the summer months due to greater photochemical production during this time of year. Organic carbon contributions are also slightly higher during the summer, likely reflecting some impacts from wildfires and biogenic sources.

Figure 2-7 Baseline Conditions for 20 Percent Worst Days: Southern California

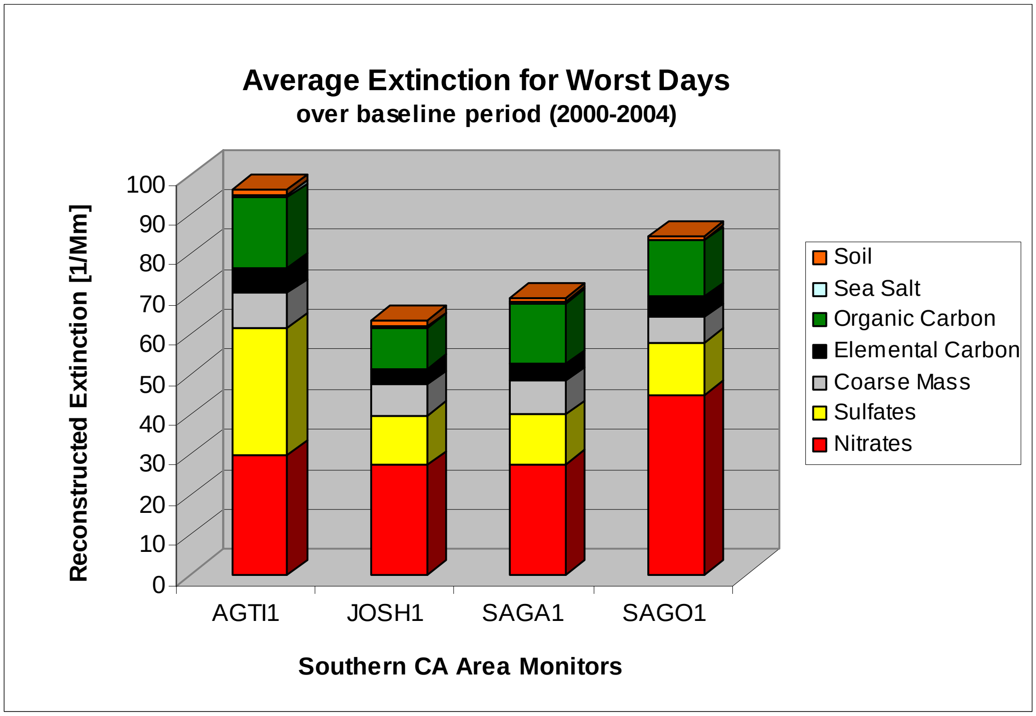
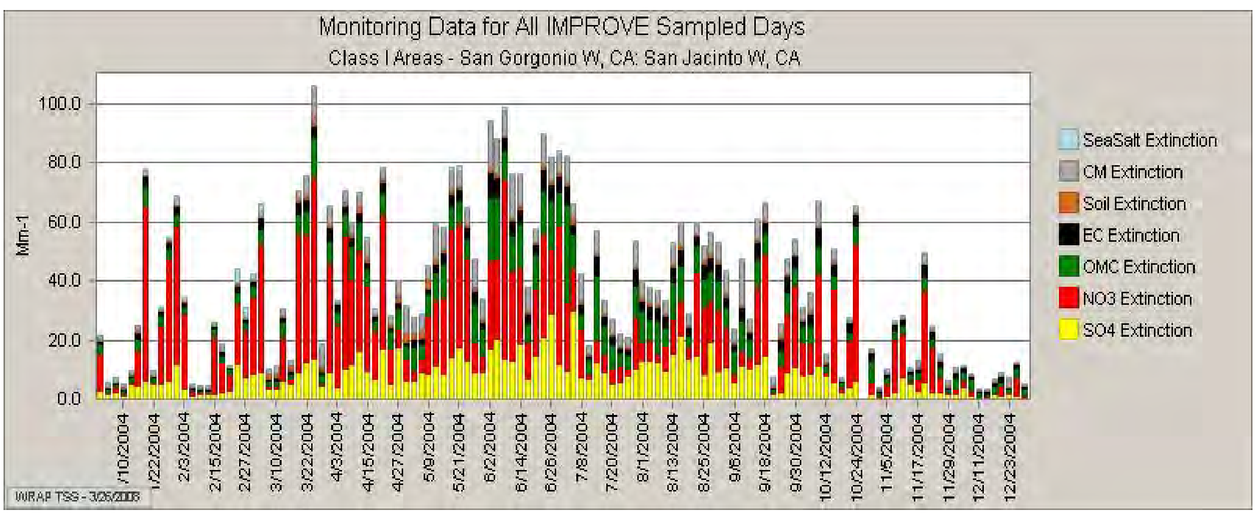


Figure 2-8 Seasonal Variation in Haze Species at San Gorgonio 2004

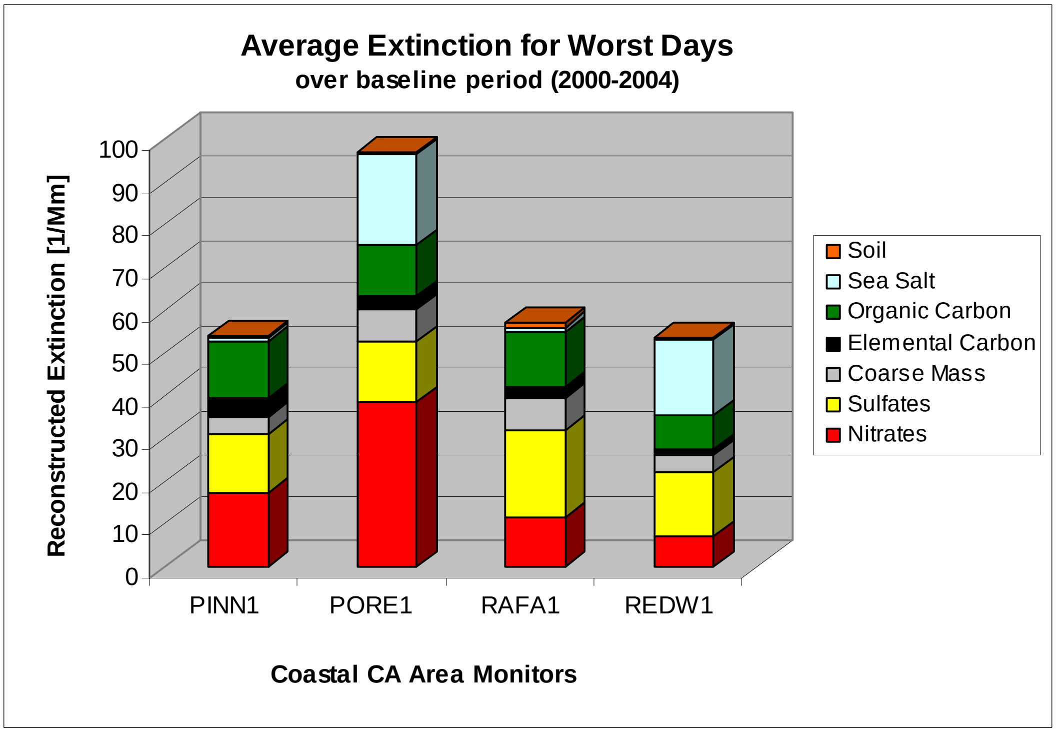


2.3.4 Coastal California

The Coastal sub-region is represented by the IMPROVE monitors close to the Pacific Ocean coastline. Based on population density and climate, there are actually several sub-areas in this California sub-region. The northern tip encompasses the coastal regions of the North Coast Air Basin, effectively separated from far northern inland California by the Trinity Alps. The San Francisco Bay Area Air Basin around Point Reyes, and the Central Coast Air Basins from Monterey to Ventura include Class 1 Areas with similar exposure to emissions species from oceanic and coastal sources, both offshore, and from urban and agricultural uses along the coast. In general, the IMPROVE monitors representing the Coastal California region are REDW (Redwoods National Park), PORE (Point Reyes National Seashore), PINN (Pinnacles Wilderness and Ventana Wilderness), and RAFA (San Rafael Wilderness).

Figure 2-9 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Coastal sub-region. Contributions on the worst days come from sulfates, nitrates, and sea salt. Point Reyes has higher nitrate concentrations as compared to the other coastal monitors. This is partly because of its location close to a significant metropolitan area, immediately southeast of the IMPROVE monitor and because the monitor is downwind, and within a few nautical miles, of a major commercial shipping lane. The sea salt contribution is especially pronounced at REDW and PORE because these two sites are located within 10 km of the coastline, at elevations close to sea level. In contrast, both PINN and RAFA are located further inland, with a lesser influence from sea salt on worst days than on best days. Sea salt is a natural contributor to haze, and as explained earlier in this section will remain constant in the future, resulting in higher natural conditions at these sites as compared to sites further inland.

Figure 2-9 Baseline Conditions for 20 Percent Worst Days: Coastal California



The pattern of sulfate concentration measured at the monitors throughout the year is similar at all the IMPROVE monitors in California. It increases slightly mid-year compared with slightly lower levels during the winter months. Compared with the other sub-regions, the contribution to light extinction from sulfates is generally higher at the coastal sites. Sulfates are the key driver of haze on worst days at the coastal monitors, except on winter worst days at Point Reyes when nitrates predominate.

Figure 2-10 is an example of the seasonal variation of haze species at Redwoods National Park. High sea salt contributions can occur throughout the year. Sulfate, as in other areas, tends to peak during the summer months. Figure 2-11 depicts the seasonal variation in haze species at Point Reyes for comparison purposes as this site displays a distinctly different pattern. Sulfate contributions are fairly similar across the year. Sea salt contributions also show little variability, consistent with the prevailing onshore wind patterns. However, nitrate contributions exhibit a strong wintertime peak. During the winter months, nitrate concentrations build up in the Bay Area under offshore wind patterns, likely leading to the higher observed nitrate contributions at Point Reyes.

Figure 2-10 Seasonal Variation in Haze Species at Redwoods in 2004

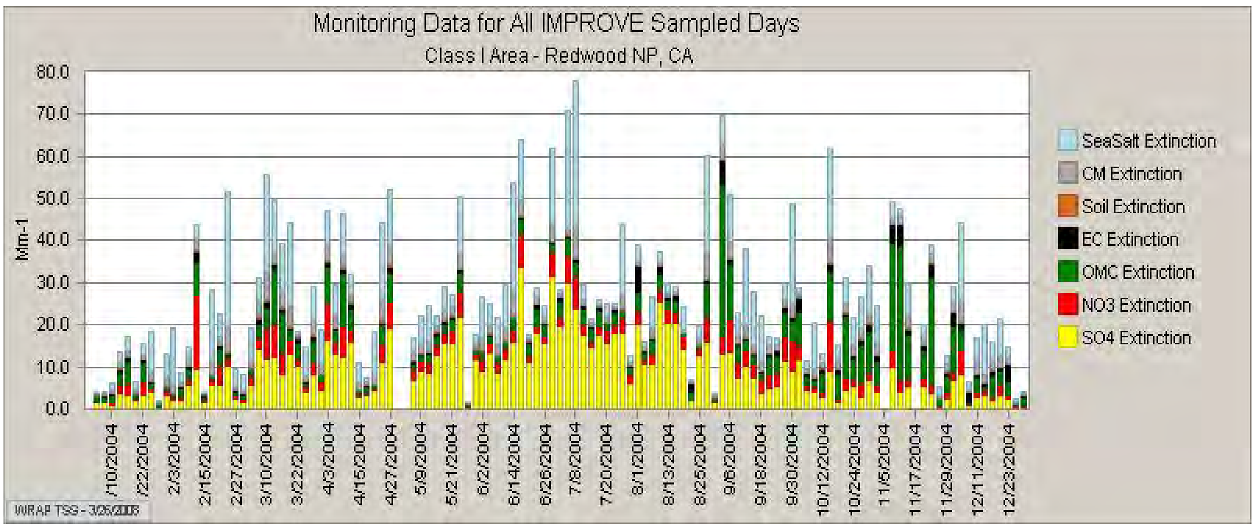
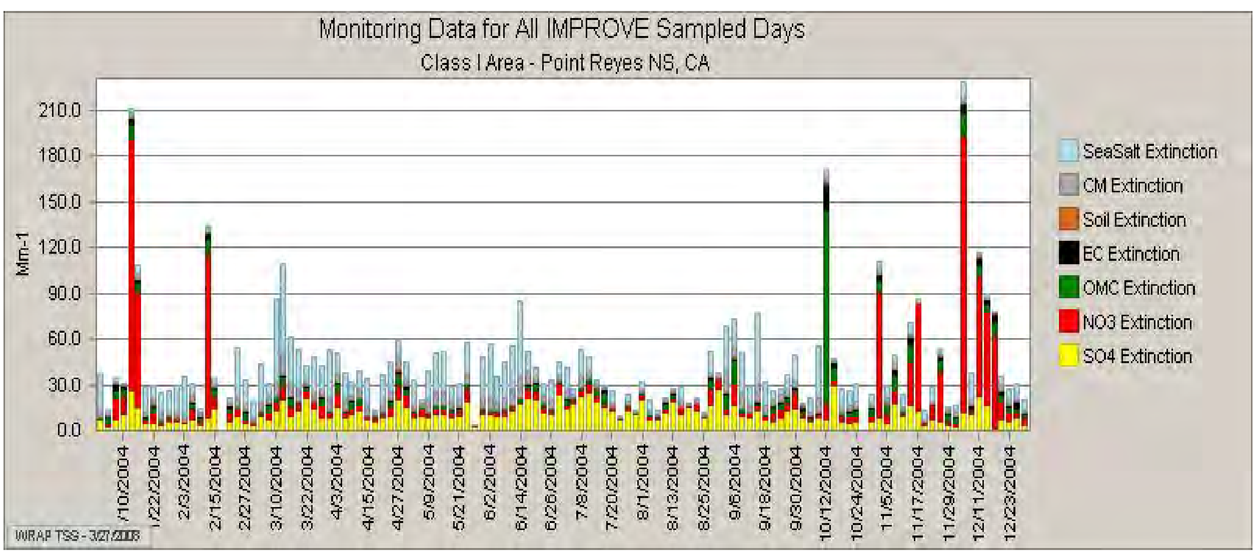


Figure 2-11 Seasonal Variation in Haze Species at Point Reyes in 2004



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3. EMISSIONS INVENTORY

3.1 Background

The ARB, in conjunction with local air districts, develops and maintains a Statewide inventory of emission sources. Because a regional modeling effort was conducted for the Plan, the Western Regional Air Partnership (WRAP), in coordination with the fifteen western states, developed a multi-state emissions inventory to support this work. This inventory was developed for 2002, reflecting the mid-point of the 2000-2004 baseline period. The WRAP 2002 planning inventory includes ARB's submission to the National Emission Inventory (2002 NEI), which reflects rules adopted through 2004. This inventory was then projected to 2018 using information on the growth and control of source categories. For regional continuity on a number of source categories which are primarily of natural origin, and which occur similarly throughout the region, WRAP developed new estimates for sources such as biogenic (plant) emissions, wildfires, and windblown dust.

The WRAP inventory is therefore slightly different from ARB's and does not include several recent updates that the ARB has made since the 2002 NEI submittal. Specifically, ARB recently updated California's mobile source inventory to reflect the impacts of new control measures, new vehicle emission factors, and updated vehicle activity estimates. Nevertheless, the WRAP inventory provides an appropriate regionally consistent basis for this Plan, and ARB updates will be incorporated in subsequent Plan revisions. Information on the WRAP inventory can be found at http://www.wrapedms.org.

3.2 Pollutants Addressed

The emissions inventory used for the Plan begins with the same inventory of criteria pollutants or health-impacting pollutants that is used in planning efforts to meet the National Ambient Air Quality Standards (NAAQS). The sources can be from both natural and anthropogenic activities.

Emissions that contribute to impairing visibility include sulfur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM), both PM10 and PM2.5, volatile organic compounds (VOC), and ammonia (NH3). Not all of these contribute directly to the development of haze, but may undergo chemical reactions in the atmosphere to become haze components. The most pertinent of these species are noted below:

Oxides of Nitrogen (NOx). Fuel combustion is the primary source of nitrogen oxide emissions in the atmosphere. The vast majority of Statewide NOx emissions come from mobile sources. Combustion processes from stationary industrial sources, such as manufacturing, food processing, electric utilities, and petroleum refining, also contribute, with smaller contributions from area-wide sources, such as waste burning and residential fuel consumption. Natural sources, primarily from wildfires, are not a major source of emissions. Nitrate particles, formed when nitrogen oxides react in the atmosphere, particularly with ammonia, are very effective at scattering light and contributing to haze formation.

Oxides of Sulfur (SOx). The mobile source categories of ships and commercial boats are the primary sources of sulfur oxide emissions along the coastline of California. These sources are not included in the California emission totals, but rather are included in a separate Pacific Offshore category developed by the WRAP. Other significant sources include petroleum refining, locomotives, mining, and cement manufacturing. Wildfire emissions, while a source of SOx, are not significant. Sulfate particles are generally formed when sulfur oxides interact with ammonia in the atmosphere. Similar to nitrate, sulfate particles are effective as scattering light and contributing to haze.

Particulate Matter (PM). PM10, also known as Respirable Particulate Matter, is comprised of both Coarse and Fine PM. PM Coarse, the fraction of PM10 larger than 2.5 and smaller than 10 micrometers in diameter, is primarily emitted from activities that suspend dust in the atmosphere, such as traffic on paved and unpaved roads, farming, and construction, as well as windblown dust.

Fine particulate matter, PM2.5 or PM Fine, is directly emitted into the atmosphere in the form of smoke, soot, and dust particles. These particles come from sources as diverse as mobile sources, managed and agricultural burning and residential fireplaces. Natural sources of PM include wildfires and biogenics (plant and animal matter). Sub-categories of Fine PM include Organic (OC) and elemental (EC) carbon particles, both directly emitted into the atmosphere, primarily through combustion processes. The remaining Fine PM comes primarily from dust and other non-combustion activities.

Volatile Organic Compounds (VOC). Incomplete fuel combustion and the evaporation of chemical solvents and fuels contribute to the presence of volatile organic compounds in the atmosphere. These gases are also emitted from natural, biogenic, sources such as plants and trees. VOCs can react and condense in the atmosphere to form organic aerosols which can then contribute to visibility impairment.

Ammonia (NH3). Mobile sources contribute only a small amount of the ammonia in the atmosphere. Most emissions are from livestock operations and fertilizer applications. Natural biogenic sources such as soil and vegetation contribute almost as much ammonia to the atmosphere as livestock operations (about 40 percent). Ammonia can combine with oxides of sulfur and nitrogen in the atmosphere to form ammonium sulfates and ammonium nitrates.

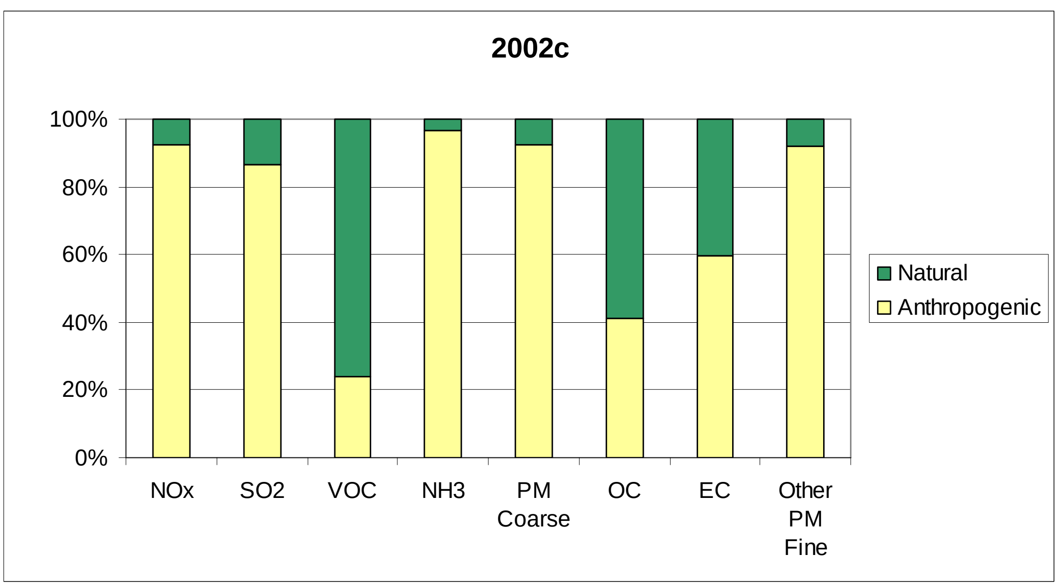
3.3 Statewide Inventory

The overall emissions inventory for the State of California for the 2002 base year is shown in Table 3-1 and Figure 3-1. Statewide, natural, biogenic sources account for a large portion of the emissions for several pollutants such as VOCs, Fine PM, OC, and EC. Biogenics are the largest contributor to natural VOC emissions, while wildfires account for the majority of Fine OC and EC natural emissions. As will be discussed in subsequent chapters, understanding the contributions from natural versus anthropogenic emissions will be important in assessing the level of improvement in future visibility that can be expected to occur. More detailed emissions inventory on a sub-regional basis can be found in Appendix I.

Table 3-1 Overall Emission Source Inventory (Anthropogenic versus Natural Sources)

	Source - Plan 02c (tons/year)	
Species	**Anthropogenic**	**Natural**
NOx	1,127,359	93,043
SO2	62,954	9,840
VOC	908,151	2,890,198
NH3	225,157	7,595
PM Coarse	279,148	23,124
OC Fine PM	64,491	92,097
EC Fine PM	28,397	19,078
Other PM Fine	67,667	5,880

Figure 3-1 2002 Magnitude of Anthropogenic versus Natural Sources



3.4 Emissions Categories

The WRAP inventory for California includes both natural and anthropogenic sources. Anthropogenic sources are composed of the three major categories below:

- **Stationary Sources** – sources which can be identified by name and location, such as general industrial facilities.
  - Stationary sources in the WRAP inventory are noted as Point Sources.
- **Area-wide Sources** - sources that cannot be tied to a single location, such as consumer products and dust from unpaved roads, or small individual sources, such as residential fireplaces.
  - Area sources in the WRAP inventory include the following categories: Area, Road Dust, Fugitive Dust, Wind Blown Dust, and Anthropogenic Fire.
- **Mobile Sources** – sources that use roads to move from one location to another, such as on-road cars, trucks, buses, etc. Off-road mobile sources are those that move from one location to another, but not necessarily via roads, such as boats and ships, off-road recreational vehicles, aircraft, trains, portable industrial and construction equipment, farm equipment, and other easily moved equipment.
  - WRAP mobile source categories include: On-Road Mobile and Off-Road Mobile. Offshore California emissions are reported as part of a separate Pacific Offshore emissions category and are, therefore, not included here.

In addition, a fourth category addresses natural emission sources:

- **Natural Sources** – sources that are not directly human-caused (not anthropogenic) such as biological and geogenic sources, and wildfires.
  - WRAP natural source categories include: Natural Fire and Biogenics (plant emissions).

Table 3-2 provides a breakdown of the emissions of each pollutant into these key categories.

Table 3-2 Individual Pollutants and Source Categories

Species	Stationary (tpy)		Area (tpy)		Mobile (tpy)		Natural (tpy)	
	2002	2018	2002	2018	2002	2018	2002	2018
NOx	104,991	109,514	112,988	112,789	909,380	370,385	93,043	93,043
SO2	42,227	49,632	9,139	10,134	11,588	3,800	9,840	9,840
VOC	54,632	54,631	335,114	594,843	518,405	232,839	2,890,198	2,890,198
NH3	433	0	202,045	193,486	22,679	30,430	7,595	7,595
PM Coarse	10,172	13,700	263,902	291,429	5,075	6,389	23,124	23,124
Fine PM OC	5,515	3,696	44,986	36,777	13,991	15,834	92,097	92,097
Fine PM EC	933	835	5,887	5,503	21,577	12,589	19,078	19,078
Other PM Fine	10,537	12,317	55,005	54,016	2,125	2,929	5,880	5,880

Mobile sources, both on-road and off-road, account for the majority of NOx emissions, approximately 70 percent, with almost 50 percent from on-road and over 20 percent from off-road sources. The mobile source contribution, however, decreases significantly by 2018 with overall NOx emissions dropping by nearly 44 percent. Natural sources contribute less than 10 percent.

Sulfur Dioxide, the most common form of the sulfur oxides, is primarily from anthropogenic stationary/point sources; this is expected to increase slightly by 2018. A little over 10 percent is contributed by biogenic sources. Stringent motor vehicle emissions regulations will decrease the contribution from mobile sources significantly, almost 70 percent by 2018, particularly in the off-road category.

Biogenic sources, consisting of plants, crops, and trees, account for 80 percent of Volatile Organic Compound emissions. This natural emission source is expected to remain constant. Total emissions from anthropogenic sources is expected to decrease, due primarily to mobile source controls.

Ammonia is dominated by area sources, primarily livestock operations, with very little contribution from natural sources. Area sources of ammonia are expected to decrease 4 percent by 2018.

The sources of coarse PM (PM larger than PM2.5 and smaller than PM10) are dominated by fugitive dust sources such as windblown dust and emissions from paved and unpaved roads. Natural contributions are slight and are expected to remain constant. Coarse PM emissions are expected to increase in most other source categories due to population growth.

Fine PM (PM2.5) can be further broken into sub-categories including OC and EC. OC and EC are emitted directly into the atmosphere from combustion sources such as wood burning, mobile sources, and commercial cooking. The primary source of OC and EC are natural fires and these are expected to remain relatively constant. However, mobile source EC decreases significantly in 2018 due to the effects of California’s diesel control program. The remaining portion of Fine PM, or Other Fine PM, is primarily derived from area sources, particularly fugitive dust source categories.

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4. CALIFORNIA 2018 PROGRESS STRATEGY

4.1. Introduction

The Regional Haze Rule requires states to submit a long-term strategy that addresses regional haze visibility impairment for the Class 1 Areas impacted by the emissions from that state. This 2018 Progress Strategy reflects the measures which are included in setting California's reasonable progress goals for the first progress period. The Rule requires that a state's strategy consider emission reductions from on-going control programs as well as specifically consider construction activity mitigation, source retirement and replacement, and smoke management techniques. Due to the severity of our air quality problems, California has long-standing programs to reduce emissions that comprehensively address all of these aspects. While the driver for California's control efforts has been to meet national and State air quality standards and protect public health, the emission reductions achieved also provide significant benefits for visibility. It is within the context of these broader air quality efforts that California is setting our visibility Progress Strategy for the first progress period ending in 2018.

California's 2018 Progress Strategy includes ARB, local air district, and U.S. EPA adopted control measures. Based on a recently updated inventory, between 2002 and 2018, NOx emissions and mobile source PM2.5 go down over 40 percent and 37 percent, respectively, Statewide. These reductions come primarily from ARB's mobile source control program. ARB's aggressive and innovative control measures, which go far beyond federal requirements, define a comprehensive and long-term basis for setting the reasonable progress goals. These measures address the main constituents of California's visibility problem, NOx, SOx, and directly emitted particulate matter emissions, and will have a very significant impact on improving visibility between now and 2018 in all Class 1 Areas throughout the State, as well as areas outside the State that may be impacted by California emissions.

ARB is responsible for controlling emissions from mobile sources (except where federal law preempts ARB's authority) and consumer products, developing fuel specifications, establishing gasoline vapor recovery standards and certifying vapor recovery systems, providing technical support to the districts, and overseeing local district compliance with State and federal law. The Department of Pesticide Regulation is responsible for control of agricultural, commercial and structural pesticides, while the Bureau of Automotive Repair runs the State's Smog Check programs to identify and repair polluting cars on a regular basis.

Local air districts are primarily responsible for controlling emissions from stationary and areawide sources (with the exception of consumer products) through rules and permitting programs. Examples include industrial sources like factories, refineries, and power plants; commercial sources like gas stations, dry cleaners, and paint spray booth operations; residential sources like fireplaces, water heaters, and house paints; and miscellaneous non-mobile sources like emergency generators. Districts also inspect and test fuel vapor recovery systems to check that such systems are operating as certified.

U.S. EPA has the authority to control emissions from mobile sources, including sources all or partly under exclusive federal jurisdiction (like interstate trucks, some farm and construction equipment, aircraft, marine vessels, and locomotives based in this country). U.S. EPA also has oversight authority for State air programs as they relate to the federal Clean Air Act. International organizations develop standards for aircraft and marine vessels that operate outside the U.S. Federal agencies have the lead role in representing the U.S. in the process of developing international standards. The following sections describe the comprehensive suite of measures that comprise the 2018 Progress Strategy for California.

4.2 ARB Control Programs in 2018 Progress Strategy

Statewide, motor vehicle emissions contribute significantly to visibility impairment. For over four decades, ARB has been regulating automotive emissions. Due the severity of the air quality problem in California, ARB has some of the strictest control strategies in the nation. Adopted SIP measures have been developed over the years through the combined efforts of air pollution regulators – with a foundation of ARB's mobile source and fuels programs. ARB has adopted 46 emission-reducing control measures since the approval of the 1994 1-hour ozone SIP. The key focus areas of ARB's control measures are described below.

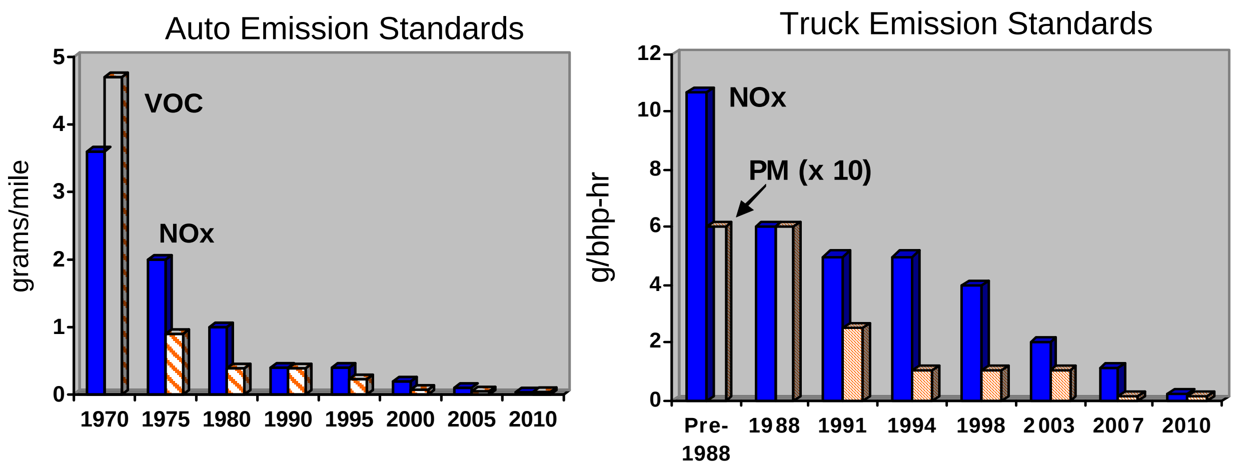
4.2.1 Mobile Sources

Cleaner Engines and Fuels

More than any other pollution control effort, ARB's mobile source program has moved the State's nonattainment areas closer to meeting federal air quality standards. California's ability to adopt vehicle emission standards that are more stringent than national standards has been fundamental to this success. The mobile sector continues to be the heart of the attainment effort with a new focus on vehicles and equipment already in use – the "legacy" or in-use fleet. California has dramatically tightened emission standards for on-road and off-road mobile sources and the fuels that power them. Figure 4-1 and Table 4-1, on the next page, show how dramatically the adopted measures have controlled emissions from new engines for the major categories of mobile sources.

California has led the way in adopting stringent regulations for passenger vehicles. Compared to uncontrolled vehicles, cars are now 99 percent cleaner. A new 1965 car produced about 2,000 pounds of ozone-forming VOC emissions during 100,000 miles of driving. In addition, to controlling vehicles, California has also led the way in reducing smog forming emissions from gasoline. Reformulated gasoline has reduced smog-forming emissions by 15 percent and toxic air emissions by 40 percent. Overall, California's low-emission standards, coupled with reformulated gasoline, have cut that to less than 50 pounds for the average new car today. By 2010, California's standards will further reduce VOC emissions from the average new 2010 car to approximately 10 pounds.

Figure 4-1 California Emission Standards



ARB's first diesel engine regulations went into effect in 1988. Significant gains began with the introduction of California Clean Diesel fuel in 1993. Clean Diesel Fuel significantly reduced PM and SOx. U.S. EPA and ARB worked together to develop and adopt the next phases of on-road diesel engine control, with cleaner fuel in 2006 and even cleaner engines in 2007 that will reduce per-truck particulate matter emissions by another 90 percent. By 2010, new trucks will be 98 percent cleaner than new pre-1988 models, providing needed NOx reductions.

Table 4-1 Impact of Existing Standards and Emission Limits

Source	Controlled Since	Level of Control*
ON-ROAD		
Passenger Cars	1966	**99% in 2006 (VOC + NOx)**
Trucks and Buses	1988	**90% by 2007, 98% by 2010 (NOx) 98% by 2007 (PM)**
Motorcycles	1975	**88% by 2008 (VOC + NOx)**
GOODS MOVEMENT		
Ship Auxiliary Engines (fuel)	2000	**96% (SOx), 83% (PM) by 2010**
Locomotives	1973	**60% in 2005 (VOC+NOx)**
Harbor Craft		**50% in 2004 (NOx)**
Cargo Handling Equipment		**95% by 2011-2012 (VOC+NOx, PM)**
OFF-ROAD SOURCES		
Large Off-Road Equipment	1996	**98% by 2015 (VOC + NOx)**
Personal Water Craft	1990	**88% by 2010 (VOC)**
Recreational Boats	1990	**89% by 2010 (VOC)**
Lawn & Garden Equipment	1990	**82-90% by 2010 (VOC)**
AREAWIDE SOURCES		
Consumer Products	1989	**50 categories controlled 50% (VOC)**

* Level of emissions control compared to uncontrolled source.

Working in concert with the U.S. EPA, standards for goods movement sources have also been cut dramatically. By requiring low-sulfur fuel, SOx emissions from ship auxiliary engines will be cut 96 percent by 2010. New locomotive engines are now 50-60 percent cleaner. Harbor craft emission standards were cut roughly in half. And new cargo handling equipment will be 95 percent cleaner by 2011.

California has also drastically lowered standards for off-road sources, from lawn and garden equipment, to recreational vehicles and boats, to construction equipment and other large off-road sources. From 2010 through 2014, these new off-road sources will be manufactured with 80-98 percent fewer emissions than their uncontrolled counterparts.

ARB has worked closely with U.S. EPA to regulate large diesel, gasoline and liquid petroleum gas equipment – where authority is split between California and the federal government – and by 2014, new large off-road equipment will be 98 percent cleaner. ARB has also made great strides in reducing emissions from the smaller engines under State control, from lawn and garden equipment, to recreational vehicles and boats. From 2010 to 2015, these new off-road sources will be manufactured with 82-90 percent fewer emissions than their uncontrolled counterparts.

Figure 4-2 Mobile Source Emissions in California

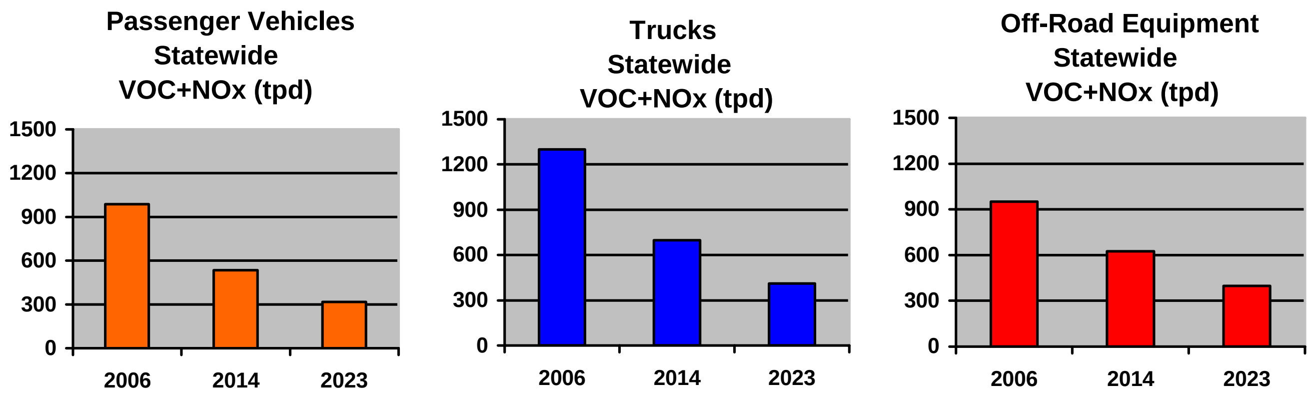
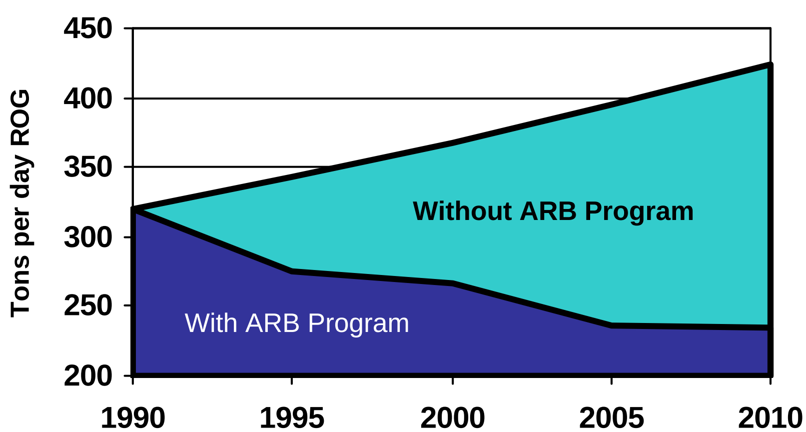


Figure 4-2 above clearly illustrates the benefits of adopted measures to reduce emissions from mobile sources despite significant population growth. The progress has been dramatic.

4.2.2   Consumer Products

ARB has adopted standards to limit emissions from nearly 50 consumer product categories (such as hair sprays, deodorants, and cleaning compounds), as well as over 35 architectural coatings and aerosol paints categories. The Board has adopted and implemented voluntary provisions to offer greater compliance flexibility to consumer product manufacturers while retaining the air quality benefits. Without these actions, VOC emissions from these products would be roughly 60 percent greater in 2010.

Figure 4-3 Consumer Product Emissions in California



4.2.3 ARB Diesel Risk Reduction Plan

An important source of directly emitted PM2.5 is diesel exhaust. The particulate matter from diesel-fueled engines (diesel PM) has been singled out as a particularly harmful pollutant and identified as a toxic air contaminant by ARB in 1998. Nearly 70 percent of the known cancer risk caused by air toxics is attributed to diesel PM. In 2000, ARB adopted a plan to reduce diesel PM emissions 85 percent by 2020, and has since adopted a number of regulatory measures to reduce diesel PM emissions Statewide. Additional measures are under development. Diesel PM control measures in the plan are reducing both direct diesel PM and NOx emissions through a combination of engine retrofits and replacements.

4.2.4 California Incentive Programs

In recent years, regulatory programs have been supplemented with financial incentives to accelerate voluntary emission reductions. Incentive programs like the Carl Moyer Program are both popular and effective. They also help to demonstrate emerging technologies that then can be used to set a tougher emissions benchmark for regulatory requirements. Most of the existing incentive programs are designed to pay for the incremental cost between what is required by regulation and advanced technology that exceeds that level. The incentive programs are publicly funded through fees paid by California vehicle owners as part of their annual registrations, smog inspections or new tire purchases. California is currently investing up to $170 million per year to clean up older, higher emission sources.

The support for clean air incentive funding from Governor Schwarzenegger, the Legislature, and California's voting public is reflected in the passage on November 7, 2006, of the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006. The Bond Act includes $1 billion to accelerate the cleanup of air pollution caused by goods movement activities in California. Recently, ARB appropriated this money to fund emission reductions from activities related to the movement of freight along California's trade corridors. As with Carl Moyer, projects funded under this program must achieve emissions reductions not required by law or regulation.

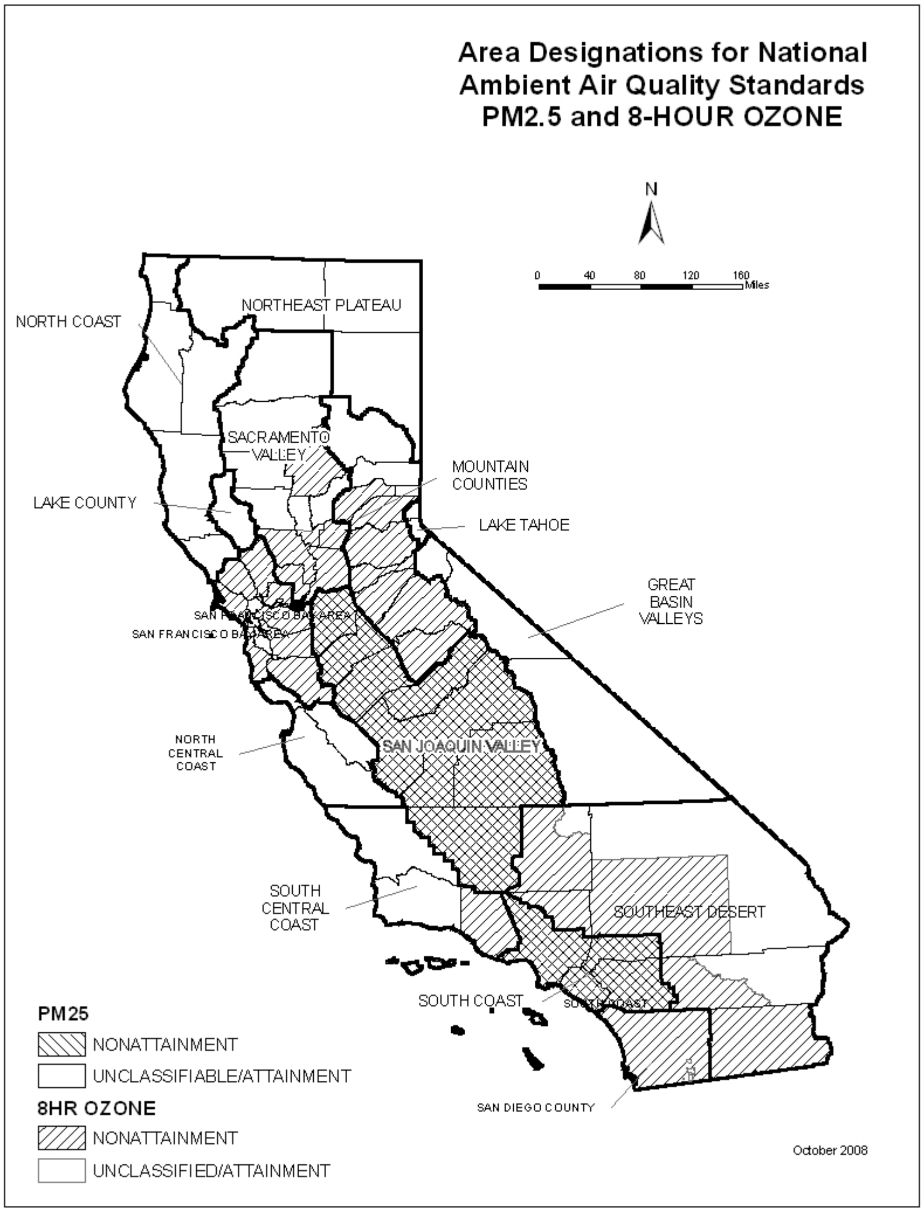
4.3 <u>Local Air District Control Programs in 2018 Progress Strategy</u>

Businesses in California are subject to the most stringent air quality rules in the country. In California, local air districts are responsible for controlling stationary source emissions. Limits on emissions from new sources are addressed through the New Source Review (NSR) program. Our stationary sources are subject to stringent NSR requirements because of ongoing needs to meet federal air quality standards. Local air districts have also adopted a number of innovative rules and programs over the years to help reduce emissions from existing stationary sources. Both the South Coast and the San Joaquin Valley set the benchmark for stationary source controls. For example, South Coast's innovative program, RECLAIM, provides market incentives for companies to use the cleanest possible technologies. In addition, the San Joaquin Valley has adopted a first-of-its-kind indirect source rule that ensures that new developments bear their fair share of the pollution burden. Finally, ARB has over 50 suggested control strategies for stationary sources that many local air districts have adopted.

The reason California has such stringent controls is due to the vast amount of the State that is currently nonattainment for national ambient air quality standards. As shown in Figure 4-4, existing nonattainment areas cover most of the large urban areas in the State. In addition, the State is currently in the process of designating nonattainment areas for the new 8-hour ozone and PM2.5 standards. These new areas potentially include portions of the South Central Coast, Sacramento Valley, and Great Basin Valleys for 8-hour ozone and the San Francisco Bay Area and portions of the Sacramento Valley for PM2.5. Taken together, California's federal nonattainment areas comprise a substantial portion of the State and corresponding Statewide emissions.

In context to the rest of the nation, California reviewed the top 10 facilities in the State for NOx and SOx emissions. For NOx, the facilities are located in the Mojave Desert, Kern County, and the San Francisco Bay Area. On a national level comparison, California's highest emitting NOx-emitting facilities are well controlled with our largest facility ranking 385 nationally. These facilities are all located in federal 8-hour ozone nonattainment areas which are required to have reasonably available control technologies (RACT) on all large facilities. For SOx, the facilities are located in the San Francisco Bay Area, South Coast region, Kern County, San Luis Obispo County, and Santa Barbara County. On a national level, California's largest SOx facility is ranked 469 and is located in the San Francisco Bay Area, a future PM2.5 nonattainment area which will be subject to RACT requirements. Thus, on a national basis, California facilities are lower emitting and are subject to multiple federal requirements ensuring their emissions are well controlled.

Figure 4-4 Ozone and PM2.5 Nonattainment Areas in California



Finally, in addition to federal requirements, California has State ozone and particulate matter standards that are more stringent than the federal standards. As shown in Figure 4-5, 27 local air districts are designated nonattainment for the State ozone standard. Triennially, local air districts that exceed the ozone standard must develop a plan demonstrating that they are making progress towards the standard. These plans are required to include an all feasible measure analysis if they do not show a 5 percent reduction in emissions per year. Each time the all feasible measure analysis is done, the air district must evaluate new rules that have been adopted. In addition, as shown in Figure 4-6, nearly the entire State is designated nonattainment for the State PM10 standards. In 2003, the Legislature passed Senate Bill 656 to initiate a planning process for meeting the State PM10 and PM2.5 standards. This legislation required ARB, in consultation with local air districts, to adopt a list of the most readily available, feasible, and cost-effective control measures that could be implemented by air districts to reduce PM10 and PM2.5. In turn, local air districts were required to adopt implementation schedules of appropriate rules based upon the nature and severity of their PM problem. As a result of all of the ozone and PM requirements, stationary sources in California have some of the strictest controls in the nation.

Figure 4-5 2006 State Ozone Designations

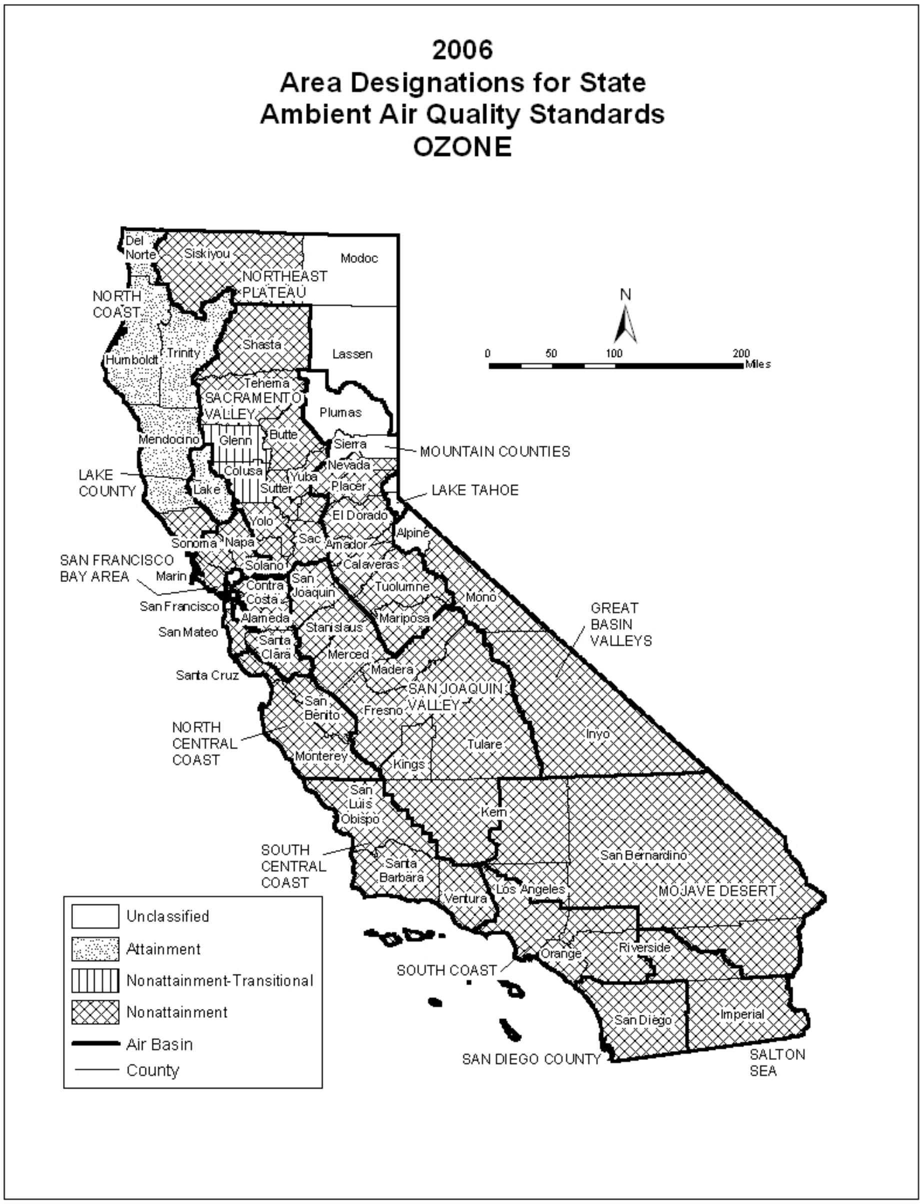
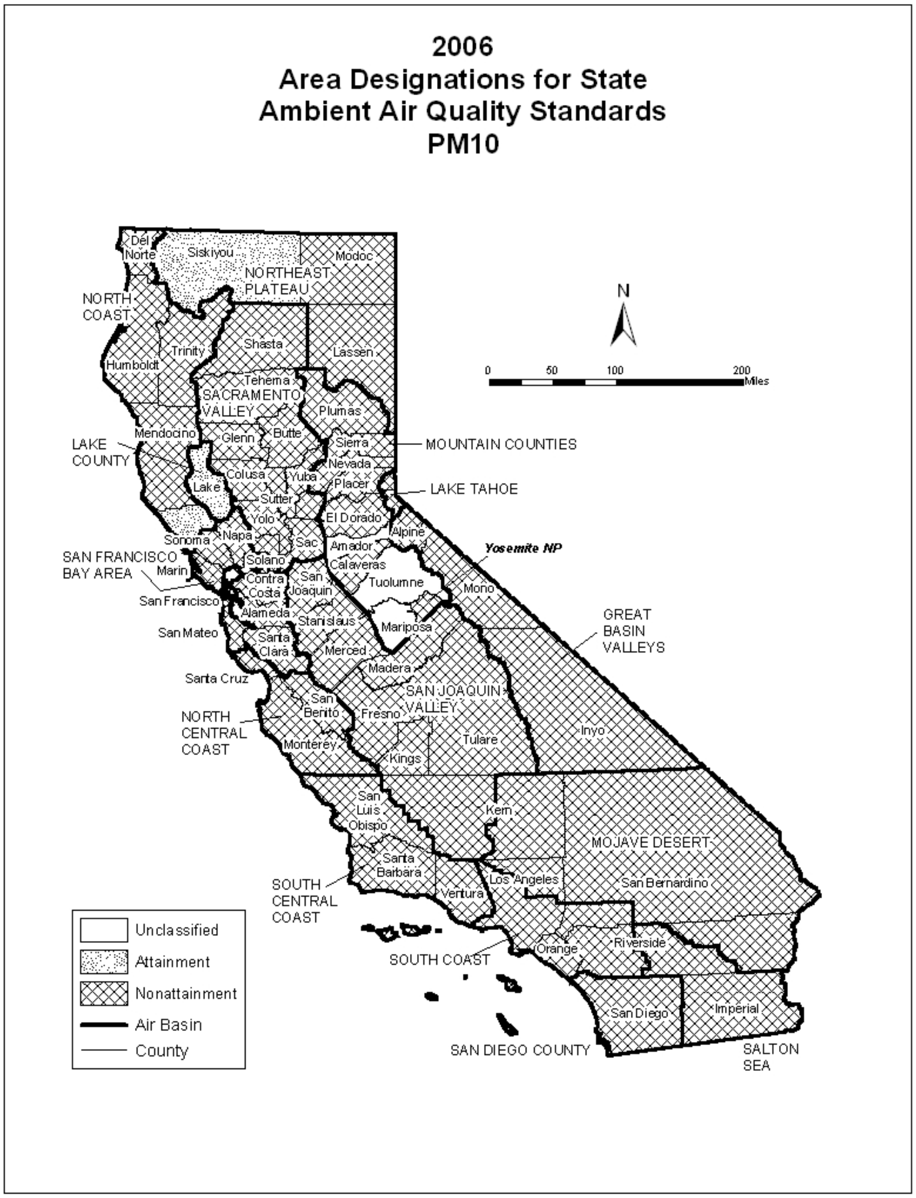


Figure 4-6 2006 State PM10 Designations



4.4 PSD/NSR Permit Programs

In California, new and modified major stationary sources are analyzed under the federal Prevention of Significant Deterioration (PSD) or NSR permitting programs. The PSD permit program applies to pollutants that do not exceed the NAAQS. Among other things, the PSD permit program is designed to protect air quality and visibility in Class 1 Areas by requiring best available control technology (BACT) and involving the public in permit decisions. In California, the responsibility to administer the federal PSD permit requirements is shared by U.S. EPA Region 9 and local air districts. However, U.S. EPA is in the process of re-delegating authority to air districts attaining the federal standards.

For areas with pollutants that do not meet the NAAQS, the NSR permit program administered by the local air districts is applicable. California's NSR program is designed to achieve no net increase in nonattainment pollutants or their precursor emissions for all new or modified major stationary sources. These same pollutants and precursor emissions impact visibility in California. Sources are required to install BACT. Dependent upon their air quality problem, sources are required to mitigate their emission increases after the installation of BACT. Finally, California law does not allow an air district to weaken their NSR program. As stated earlier, California has one of the most stringent NSR programs in the country.

Therefore, California's current PSD and NSR programs ensure that visibility at Class 1 Areas will not be impacted by growth in stationary sources. Figure 4.4 and 4.5 above show the areas of the State violating the federal PM2.5 and ozone standards and provide context for areas subject to NSR or PSD programs. The majority of California Class 1 Areas are located in current or future nonattainment areas.

4.5 Additional Regional Haze Rule Source Considerations

When developing the 2018 Progress Strategy, the Regional Haze Rule requires states to consider in addition to emission reductions from on-going programs, specific measures to mitigate construction activities, source retirement schedules, and smoke management techniques. The 2018 Progress Strategy described above considers all of these. Details regarding construction activity mitigation, source retirement, and smoke management techniques are discussed below.

4.5.1 Construction Activity Mitigation

Due to population growth, construction is an on-going activity throughout the State. In July 2007, ARB adopted a pioneering regulation aimed at reducing diesel and NOx emissions from the State's estimated 180,000 off-road vehicles used in construction, mining, airport ground support and other industries. By 2020, ARB estimates that particulate matter will be reduced by 74 percent and NOx will be reduced by 32 percent compared to current levels. In addition, many air districts have adopted stringent rules to control fugitive dust emissions from construction activities.

4.5.2 Source Retirement

New stationary sources and vehicles are very clean compared to older existing sources and vehicles. However, older sources make up the majority of mobile emissions. In California, mobile sources make up the majority of haze polluting emissions. Therefore, a key focus of California's source retirement strategy is on mobile sources. Several programs are aimed at mobile source retirement. California's Smog Check Breathe Easier Campaign pays motorists $1,000 to permanently retire their high-polluting vehicles rather than repair the vehicle due to smog check inspection failure. These vehicles are taken to one of the State's authorized dismantlers where they are crushed. In addition, local air districts have vehicle retirement programs in which they pay motorists to retire an older vehicle that although it may pass the smog check inspection, may have higher emissions than a newer vehicle.

California has also pursued the retirement of engines used in a variety of activities through the use of incentive funding. These incentive programs have worked hand-in-hand with in-use regulations, providing added emissions benefits. California is currently investing up to $170 million per year to clean up older, higher-emitting sources through the Carl Moyer Program. The $170 million will clean up to 7500 engines with 24 tons per day of surplus NOx emissions achieved.

Finally, as stated previously, California air districts have some of the most stringent stationary source rules in the country. The stringency of these rules results in sources considering the costs of control in comparison to the useful life of the source in determining whether to retire a source.

4.5.3 ARB's Smoke Management Program

California's Smoke Management Program is an important element of the Regional Haze 2018 Progress Strategy. The Program is designed to provide for best management practices for agricultural and prescribed burning and thereby minimize the potential for harmful smoke impacts. The legal basis of the Program is found in ARB's Smoke Management Guidelines for Agricultural and Prescribed burning which was amended in 2000. In 2003, U.S. EPA accepted ARB's certification that the Guidelines met U.S. EPA's Enhanced Smoke Management requirements.

The ARB and the State's 35 local air pollution control districts are responsible for jointly administering the Guidelines. The ARB is responsible for general oversight of the program and also makes daily burn/no burn day decisions for each of the 15 air basins in the State. Air districts are required to adopt comprehensive smoke management programs and regulations to implement and enforce the Guidelines. These smoke management programs contain requirements for:

- Permits for all agricultural and prescribed burns
- Daily burn authorization systems
- Annual reporting of all agricultural and prescribed burning
- Annual or seasonal burn registration for prescribed burns
- Smoke management plans for prescribed burns

Basic information on burn location, types and amounts of material to be burned, and the location of smoke sensitive receptors are required for all burns greater than 10 acres in size. More comprehensive plans are required for the largest burns (greater than 100 acres) including projections of where smoke is expected to travel and contingency actions such as fire suppression or containment to be taken if weather changes or unexpected smoke impacts occur. Class 1 Areas are specifically considered as sensitive receptors in these smoke management plans.

4.6 Four-factor Analysis

The Regional Haze Rule requires the 2018 Progress Strategy to consider four factors in assessing the appropriateness of the strategy for setting reasonable progress goals: the cost of compliance; the time necessary for compliance; the energy and non-air quality environmental impacts of compliance; and the remaining useful life of potential sources. As described below, California's emission reduction program analysis considers the Regional Haze Rule's four-factor analysis. The 2018 Progress Strategy reflects benefits of these analyses for mobile, stationary, and area source reductions.

As shown earlier in Figure 4-4, California has two PM2.5 and fifteen 8-hour ozone nonattainment areas that cover a vast majority of the State. Due to these federal nonattainment areas plus the State ozone and PM planning requirements discussed earlier, the four-factor analysis process has been embodied in California emission reduction strategies for decades. Later on in this chapter, California will discuss the four-factor analysis on a sub-regional basis. Each of the sub-regions includes a combination of both State and federal nonattainment areas ensuring the four factors are considered and emissions will continue to decrease.

4.6.1 Cost of Compliance

Currently, the cost of compliance can be measured by the cost-effectiveness threshold per ton of pollutant reduced throughout the State, up to $24,500/ton and $20,200/ton for NOx and VOC, respectively, for stationary source rules adopted by local air districts. The local air districts calculate this based on local economies and all feasible control measures. Periodically, local air districts update these values based on their needs to meet air quality standards. For mobile source diesel PM, ARB has adopted regulations with cost-effectiveness up to $86,000/ton PM. In addition, ARB's Carl Moyer incentive program sets a maximum cost effectiveness of $16,000/ton for air quality improvement projects.

The magnitude of these cost-effectiveness thresholds reflects both the length of time that California has been pursuing emission reductions and the severity of California's air quality problems. This has led to the need to pursue ever more aggressive controls at greater costs in order to meet State and federal air quality standards. These cost-effectiveness thresholds therefore set a very stringent bar for assessing reasonable controls and stationary sources in California are already required to reduce emissions at a higher cost than elsewhere in the United States.

4.6.2 Time Necessary for Compliance

During the rule development process, both ARB and local air districts consider the time needed to comply with the rule. In general, for new vehicle regulations, ARB considers the time it takes to develop the new technology, ensure the technology is durable, and implement the regulations within the time constraints of new vehicle certification to maximize the emission benefits. Local air districts also allow for time considerations in their rulemaking process to allow for the availability of new technology. Many ARB and air district rules are already considered technology forcing. ARB's 2018 Progress Strategy has taken these factors into consideration in specifying the suite of measures to be included in the Strategy.

4.6.3 Energy and Non-Air Quality Environmental Impacts

The California Environmental Quality Act requires a documented public review of all environmental and energy impacts for all rulemaking actions of State and local agencies in California. This ensures that all projects are assessed for their environmental impacts. These projects range from air quality plans to local construction projects. This review requires a determination of environmental factors that have a potentially significant impact and impacts that are potentially significant unless mitigated. The environmental factors that need to be reviewed are aesthetics, biological resources, hazards and hazardous materials, mineral resources, public services, utilities/service systems, agriculture resources, cultural resources, hydrology/water quality, noise, recreation, mandatory findings of significance, air quality, geology/soils, land use/planning, population/housing, and transportation/traffic.

4.6.4 Remaining Useful Life of any Potentially Affected Sources

When developing regulations, ARB and local air districts consider the useful life of potentially affected sources. The stringency of air district rules results in sources considering the costs of control in comparison to the useful life of the source in determining whether to retire a source or implement new control requirements.

ARB's long-term mobile source strategy has two distinct components – more stringent standards for new engines and clean-up of existing fleets. ARB's Low Emission Vehicle Program, which is a key element in the 2018 Progress Strategy, is ensuring that new vehicles entering the fleet are exceptionally clean. To address existing fleets, ARB has adopted 20 in-use regulations in the last five years to provide for the clean-up of existing fleets. These include requiring use of cleaner fuels, limitations on truck idling, and diesel engine retrofit technologies. The California Legislature has also enabled funding programs to incentivize early retirement of equipment and replace them with lower emissions units. In aggregate, these measures provide a comprehensive basis for supporting California's reasonable progress goals for Regional Haze.

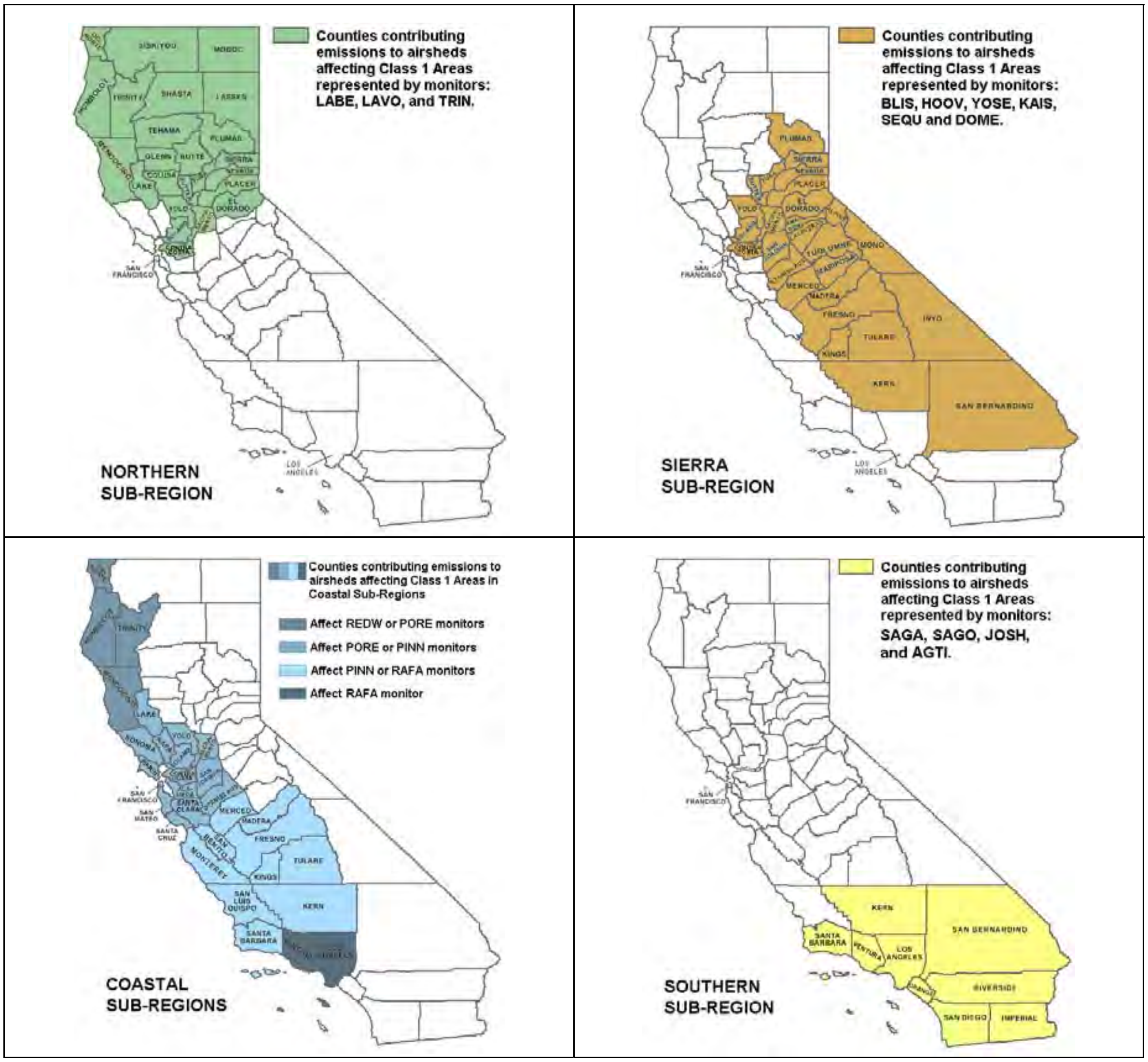
4.7 Regional Analysis of Source Categories

California has 15 air basins bounded by physical features, such as topography, that impact local weather patterns and affect inter-basin transport of air pollutants. The four sub-regions for analysis of haze in California reflect consideration of these intra-State air basins as well as the jurisdiction of the thirty-five air districts with regulatory control over stationary sources within them. The haze species that serve as the main drivers of haze on worst days are generally the same for each sub-region because the topography and natural resources of each sub-region affect the way the surrounding areas developed. Factors such as urbanization level and interstate transportation corridors also play into the types of sources within each sub-region. Finally climate, humidity, vegetative cover, and precipitation patterns also influence which haze species predominate during the year. Therefore, the groupings are based on factors beyond simple geographic proximity.

In developing the 2018 Progress Strategy, California analyzed each sub-region in the State to determine the types of sources affecting visibility in each sub-region and their current level of control, considering the four factors discussed above in section 4.6. The analysis focused on the significant pollutant species driving haze on worst days and source categories that California is able to control, specifically in-State and anthropogenic sources. The analysis reflects the results of existing controls to reduce emissions of ozone and particulate matter precursors that are necessary to meet federal and State health standards in the nonattainment areas of California since all of the State's Class 1 Areas are in one or more of these zones. These reductions demonstrate that the four-factor analysis embedded in California rulemaking is effective in improving visibility.

As discussed in Chapter 2, Class 1 Areas in California are clustered in four sub-regions. The counties whose sources are most likely to impact the Class 1 Areas in the sub-regions are shown in Figure 4-7.

Figure 4-7 Source Regions by Counties in California

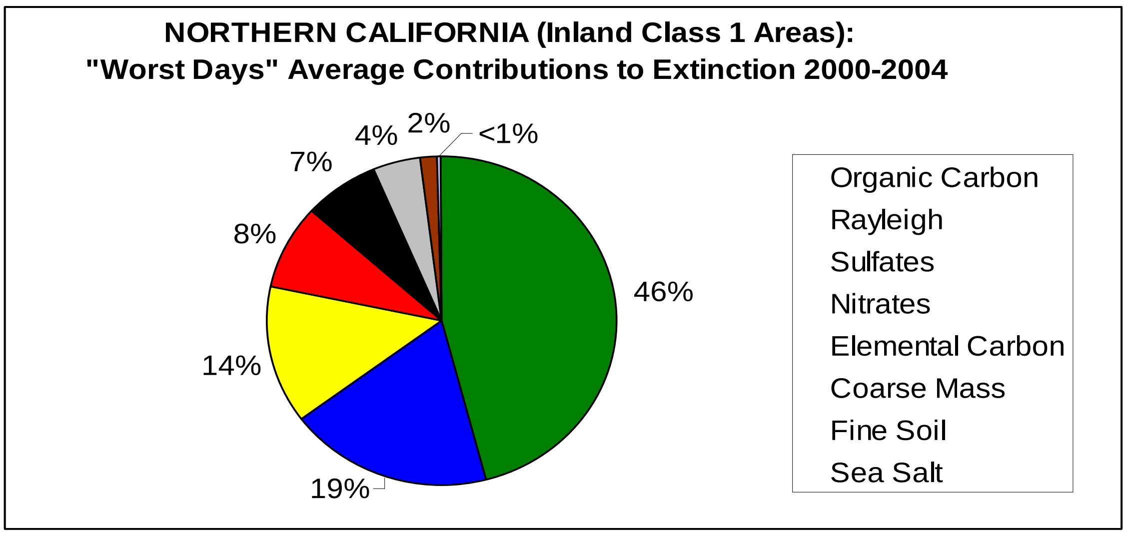


For each sub-region, at least part of each shaded county is in an airshed or air basin where topography and meteorological patterns indicate that the county's emissions influence visibility at the Class 1 Areas in the sub-region. The other counties are in air basins where separating mountain ranges and prevailing winds significantly reduce the influence of their emissions on Class 1 Areas in another sub-region. The emission inventories from the corresponding counties were reviewed, in conjunction with the results of the WRAP's NOx, SOx, and organic aerosol tracer tools, to identify the primary influences on worst day haze from California source categories in each sub-region of the State.

4.7.1 Northern California

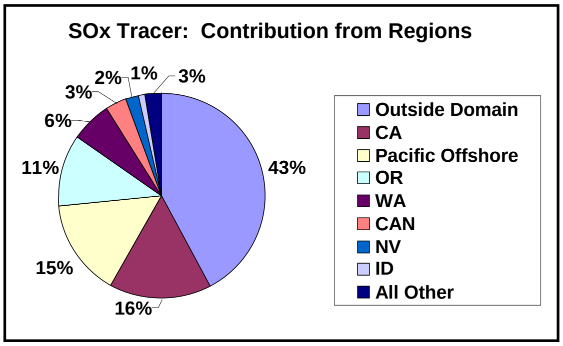
Northern California includes these inland Class 1 Areas: Lava Beds National Park, South Warner Wilderness Area, Lassen Volcanic National Park, Caribou Wilderness Area, Thousand Lakes Wilderness Area, Marble Mountain Wilderness Area, and Yolla Bolly-Middle Eel Wilderness Area. On worst days, organic aerosols drive haze in Northern California, dwarfing the contributions from sulfates and nitrates as shown in Figure 4-8. Rayleigh gas scattering is a natural phenomenon that contributes to haze and is considered "uncontrollable."

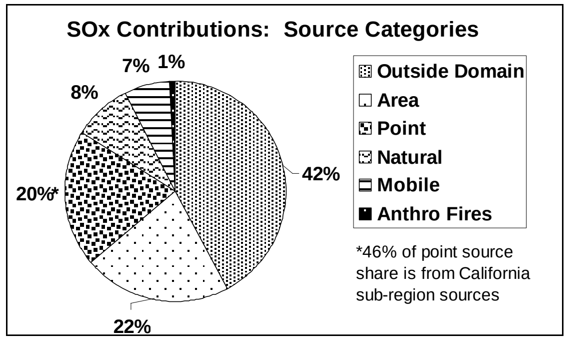
Figure 4-8 Species Contributions to Worst Days (Northern Class 1 Areas)



Source apportionment shows that natural wildfires and biogenic emissions contribute 70 to 80 percent of the organic aerosols on worst days. The balance is primarily from area sources and anthropogenic fires. Existing Statewide measures to reduce area source emissions of organic aerosols have already been discussed earlier. Area sources such as residential wood combustion are being controlled at various levels by air districts in Northern California. California has an EPA-certified enhanced Smoke Management Program, which is the best possible means of controlling anthropogenic smoke. In California, all open burning, including agricultural burning and other prescribed burning, is under shared State and air district jurisdiction. The Northern Region will also see a very slight reduction in anthropogenic emissions of precursor volatile organics from planned mobile source emissions reductions.

Figure 4-9 Worst Days SOx Source Attribution (Northern Class 1 Areas)

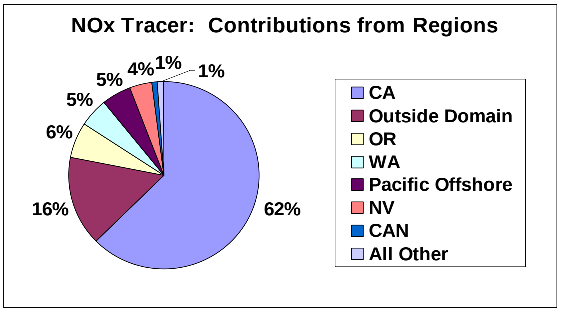


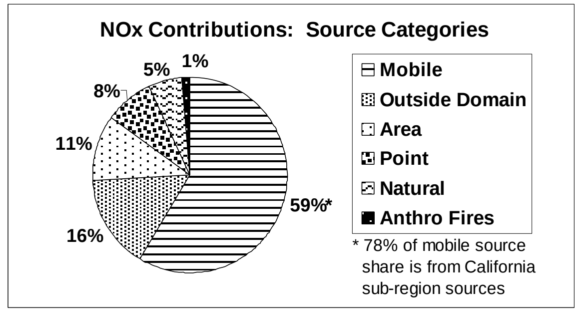


Sulfates are the third largest contributor to light extinction (haze) on worst days in Northern California. Sub-regional sources of SOx were analyzed with respect to their contribution to visibility impairment and existing level of control. The major contributors to sulfates impacting northern inland California Class 1 Areas are sources outside the modeling domain, California sources, and Pacific offshore sources, presumably marine commercial shipping and natural marine emissions. California has already reduced the sulfur content of fuels, which limits SOx emissions from all source categories. The SOx tracer analysis shows that only 16 percent of the sulfates causing worst days haze at Northern California Class 1 Areas come from California sources. Of that, California point sources lead with about 9 percent of the total contribution to light extinction by sulfates. When that amount is converted to visibility impact, the sub-regional California point sources contribute about 1.3 percent of total light extinction on worst days, on average, at Northern California IMPROVE monitors. By comparison, California mobile sources and area sources contribute about 0.4 percent each to total light extinction.

A review of the top 100 SOx-emitting stationary sources in the counties included in the sub-region shows that only eight facilities emitted more than 100 tons per year of SOx in 2006 due to existing controls. The closest source is a BART-eligible facility in Solano County, over 200 kilometers from the nearest Northern California Class 1 Area, Yolla Bolly - Middle Eel Wilderness Area. The facility will be implementing stringent controls to reduce its SOx emissions by more than 90 percent by 2013, which is equivalent to 24 percent of all current point source SOx emissions from the sub-region. The other seven large point sources are in Contra Costa County, even farther south. Existing State and air district rules controlling point sources were developed taking into consideration the cost of compliance, the time necessary for compliance, energy and non-air quality environmental impacts, and the remaining useful life of the source.

Figure 4-10 Worst Days NOx Source Attribution (Northern Class 1 Areas)



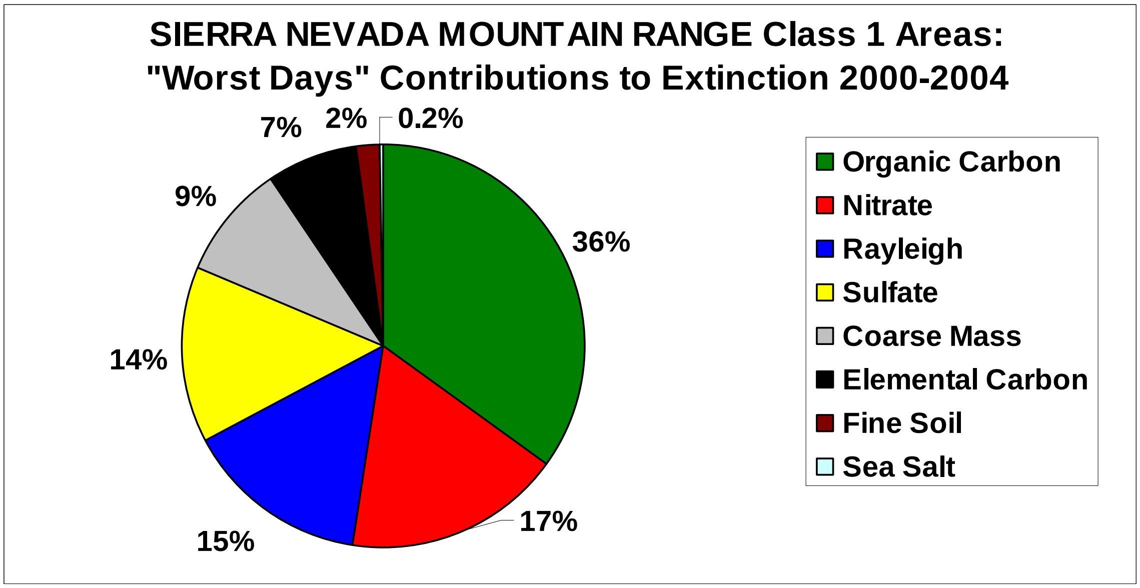


Nitrates are the fourth highest contributor to haze on worst days at Class 1 Areas in the Northern California sub-region. California sources are responsible for 62 percent of the nitrates with the bulk of these from in-State mobile sources. Mobile source NOx emissions from all regions contribute a 59 percent share of the nitrate light extinction in this sub-region. However, on average at all the Northern California monitors, only 3.6 percent of the total light extinction on worst days is due to NOx emissions from California's mobile sources. Moreover, only 0.6 percent and 0.4 percent of the total light extinction on worst days comes from California area and point sources, respectively, according to the WRAP's NOx tracer tool. California anticipates a 40 percent reduction in mobile source emissions by 2018. This reduction, along with those achieved by existing controls in other source categories, delivers more than a 20 percent reduction in nitrate extinction by 2018 at the Northern Class 1 Area monitors. Therefore, progress beyond a uniform 20 percent NOx reduction increment is achieved for the first of five planning periods before 2064.

4.7.2 Sierra California

There are eleven Class 1 Areas in the Sierra Nevada Mountain Range in California: Desolation Wilderness, Mokelumne Wilderness, Hoover Wilderness, Emigrant Wilderness, Yosemite National Park, Kaiser Wilderness, Ansel Adams Wilderness, John Muir Wilderness, Sequoia National Park, King's Canyon National Park and Domelands Wilderness. The air masses moving over the Sierra are similar in content and origin. The slight variations in light extinction at each IMPROVE monitor are influenced by elevation, latitude, vegetative cover, proximity to populated areas and transportation corridors, and position on the windward or leeward side of the crest line. Figure 4-11 shows the average contributions of haze species to light extinction in the baseline years at the six monitoring sites representing the Sierra Class 1 Areas.

Figure 4-11 Species Contributions to Worst Days (Sierra Class 1 Areas)

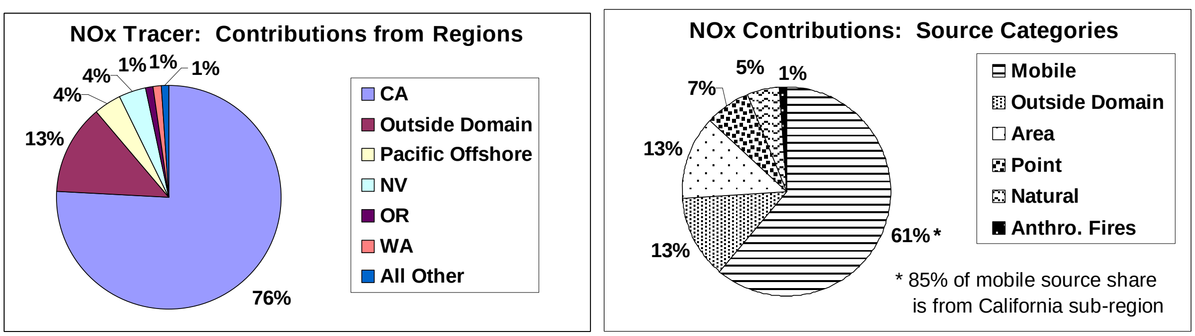


On average, organic aerosols are the predominant cause of haze on worst days, with slight variations in species strength at the representative monitoring sites. The contributions from sulfates and nitrates are stronger at Class 1 Areas closest to urbanized areas and transportation corridors. The influence of coarse mass increases on windy days in the drier, higher Class 1 Areas on the lee side of the Sierra crest. The contribution of elemental carbon increases on days when there are nearby wildfires in the heavily forested areas. Rayleigh scattering exerts more influence at higher elevations when the monitors are located above the mixing layers associated with adjacent populated valleys to the west and dry valleys and desert to the east. Fine soil and sea salt consistently have little impact on visibility throughout the Sierra.

Source apportionment shows that natural wildfires and biogenic emissions contribute more than half to 90 percent of the organic aerosols on worst days in the Sierra Class 1 Areas, with wildfire contributions also coming from out-of-State. The balance of the organic aerosols is from area sources, anthropogenic fire, mobile sources, and point sources. If only the California sources in the four "controllable" categories are considered, their combined share of organic aerosol extinction rarely exceeds 15 percent, primarily from area sources. As in the inland Northern California sub-region, area sources such as residential wood smoke and consumer products are controlled by existing State and local measures. Both local agricultural interests in the Central Valley, immediately west of the Sierra Nevada Range, and State and federal land management agencies, who oversee most of the land in the Sierra and east to the Nevada state line, actively practice smoke management. All open burning, whether by public or private entities, falls under coordinated State and local regulatory control of California's Smoke Management Program.

Currently, organic aerosols from mobile sources and point sources in California contribute about 1percent apiece to total light extinction in the Sierra Class 1 Areas. There will be reductions in mobile source organic aerosol emissions by 2018 under current controls. Although organic aerosols from point sources have marginal impact on visibility, the nonattainment status for both ozone and particulate matter in the Central Valley and the Mountain Counties means that existing controls are constantly evaluated and upgraded for stringency, taking into account the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. For example, the San Joaquin Valley Air Pollution Control District has been nonattainment for both Federal and State ozone and particulate matter health standards. The air district has already implemented control measures that reduce organic matter aerosol precursors from both area and point sources in the key upwind air basin for the Sierra Class 1 Areas.

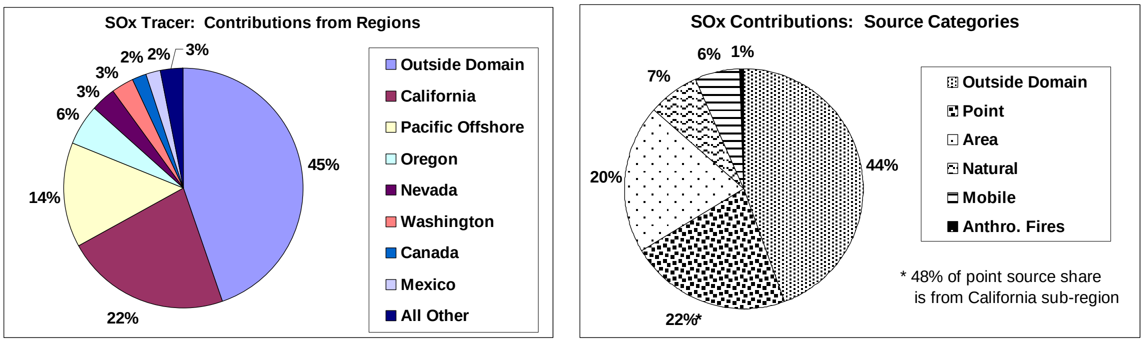
Figure 4-12 Worst Days NOx Source Attribution (Sierra Class 1 Areas)



After organic aerosols, nitrates are the next highest driver of haze on worst days in the Sierra, closely followed by Rayleigh scattering and sulfates. Mobile source NOx emissions from all regions contribute an overwhelming 61 percent share of the nitrate light extinction on worst days in this sub-region. California mobile sources contribute 85 percent of the mobile source category, which equates to about 9 percent of the total extinction on worst days in the Sierra. California anticipates a 60 percent reduction in mobile source NOx emissions in the Sierra sub-region by 2018. Currently, California's area and point sources shares of total light extinction at Sierra Class 1 Areas are minor, about 2 percent and 1 percent, respectively.

Despite predicted population growth in the regional air basins in which the Sierra Class 1 Areas are located, the contribution to nitrates from all categories will decrease by 43 percent by 2018 with existing State and air district controls in place. As noted previously, all air quality rulemaking in California must consider the four factors; cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source, to assure that the most stringent and feasible controls are applied to new and existing sources. Future controls, now in development to attain the new ozone and PM2.5 standards, will further reduce NOx emissions within the planning period. These controls and their potential benefits to visibility will be evaluated during the mid-course review.

Figure 4-13 Worst Days SOx Source Attribution (Sierra Class 1 Areas)



Sulfates are the fourth highest contributor to worst day haze, after natural Rayleigh gas scattering. Major contributors to sulfates impacting Sierra Class 1 Areas are sources outside the modeling domain, as well as from the Pacific Off-Shore region, with a combined contribution of 59 percent. California sources are responsible for about 22 percent of the sulfates reaching the Sierra Class 1 Areas from all regions. Of California's share of sulfates, 48 percent (about half of 22 percent) is from California point sources and about 20 percent (one fifth of 20 percent) from area sources. When converted to visibility impact, the sub-regional California point sources contribute, on average, about 1.5 percent to total light extinction on worst days in the Sierra. California area sources contribute only 0.6 percent to total light extinction on worst days.

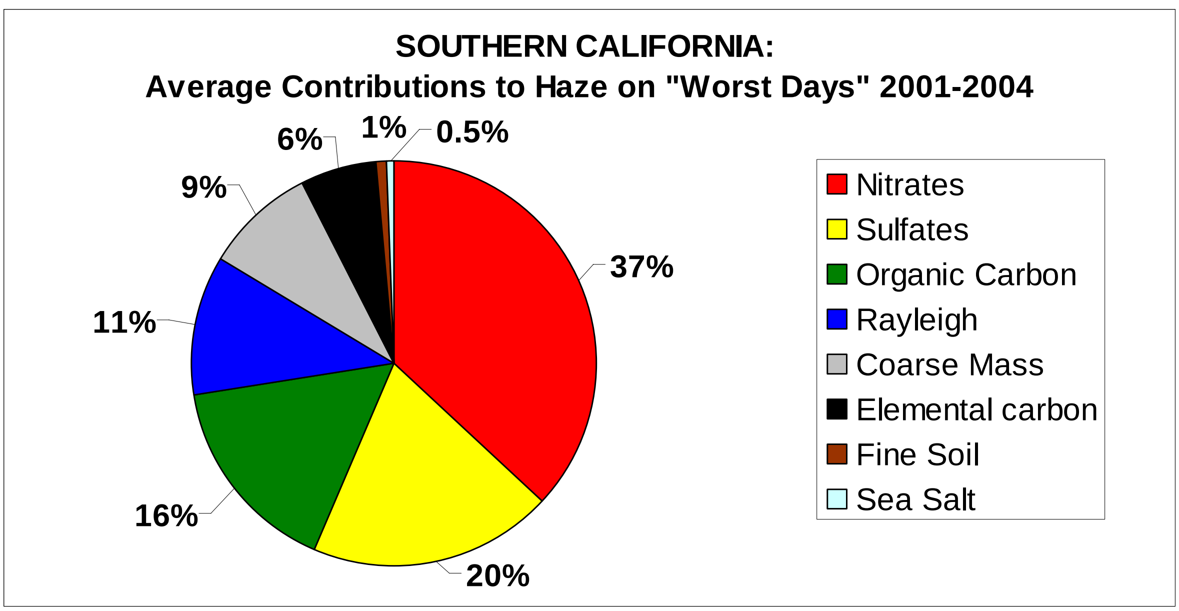
A review of the top 100 SOx-emitting stationary sources in the counties included in the Sierra sub-region shows that 21 facilities emitted more than 100 tons per year of SOx in 2006. All of the sources in the San Joaquin Valley were required to have BACT when they went through New Source Review, because the Valley was nonattainment for PM10. The other sources are in State nonattainment areas for PM and already have considered all feasible measures to improve air quality to benefit health taking into consideration cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. The air districts also require that low-sulfur fuels be used for combustion in stationary sources. State mobile source measures will continue to reduce SOx emissions from traffic on interstate corridors running through and adjacent to the Sierra Class 1 Areas. All of these reductions also benefit visibility.

4.7.3 Southern California

There are six Class 1 Areas in Southern California: San Gabriel Wilderness, Cucamonga Wilderness, San Gorgonio Wilderness, San Jacinto Wilderness, Joshua Tree National Park, and Agua Tibia Wilderness. The Wilderness Areas are located in the mountains ringing the very densely populated Los Angeles Basin. The Route 10 corridor through the mountains funnels air from the Los Angeles Basin into the Coachella Valley and the sparsely populated Mojave Desert that surround Joshua Tree National Park. While airflows from the Basin distribute anthropogenic pollutants across all these Class 1 Areas, natural haze pollutants from geologic and biogenic sources are driven oceanward across the same Class 1 Areas during high velocity Santa Ana wind events. Unique to this part of the State, the hot, dry Santa Ana winds initiate seasonally in the desert every year. They can ignite and fan extensive wildfires throughout the Southern California sub-region spreading smoke throughout Class 1 Areas and nearby urban environments. All Southern Class 1 Areas are also located within 250 kilometers of the Pacific Ocean and Mexico, thereby exposed to transported offshore shipping emissions and international emissions.

Figure 4-14 shows the average contributions of haze species to light extinction in the baseline years at the four monitoring sites representing the Class 1 Areas in the Southern sub-region.

Figure 4-14 Species Contributions to Worst Days (Southern Class 1 Areas)

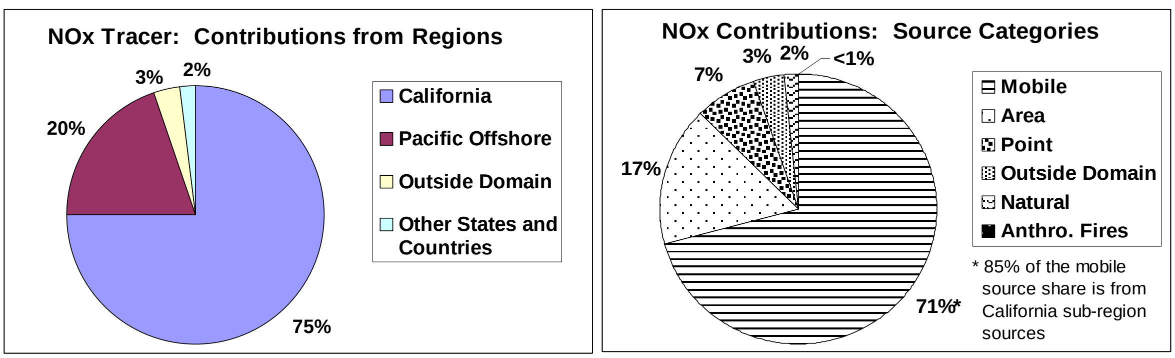


The four-factor analysis targets only the “controllable” sources in this complex mix of anthropogenic and natural emissions in the Southern sub-region. At least 17 million people live within a 50 kilometer radius of this cluster of six Class 1 Areas, with a 40 percent increase in population expected by 2018.

Nevertheless, considerable progress has been made in reducing haze pollutants because all six of the Class 1 Areas are wholly or partially within a federal nonattainment area for ozone or particulate matter, and have been for many years. This area is also nonattainment for the State standards and as such requirements for rulemaking to address these standards have considered on an ongoing basis the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. Therefore, visibility will continue to improve at the Southern Class 1 Areas, because existing stringent controls require offsets for growth from new sources and continual reductions from existing sources.

On average, nitrates are the predominant cause of haze on the worst days in this sub-region. As shown in Figure 4-15, a small portion of the NOx emissions leading to nitrate formation in the Southern sub-region come from natural sources and from anthropogenic sources not within California's jurisdiction.

Figure 4-15 Worst Days NOx Source Attribution (Southern Class 1 Areas)

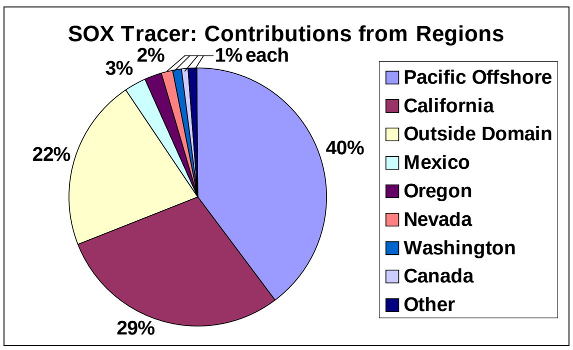


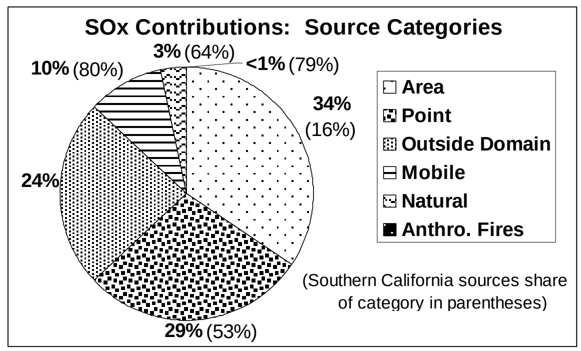
NOx emissions from all the California source categories, taken together, account for about 75 percent of the nitrates. This amounts to about 28 percent of the total light extinction in the Southern Class 1 Areas. Mobile sources, including emissions from commercial marine shipping offshore in the Pacific Ocean, account for the bulk of NOx emissions. NOx emissions from Southern California area and point sources have a lesser role in causing haze, about 3 percent and 2 percent of total light extinction, respectively.

All feasible measures to reduce NOx emissions from stationary sources are required by State law in Southern California. These existing controls which consider cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source in the rule development process include an aggressive local program for continuous, quantifiable reductions at facilities emitting more than four new tons of NOx or SOx per year. The same program requires an analysis of visibility impacts at the six Southern California Class 1 Areas. Area sources are also subject to rigorous prohibitory rules for industrial, commercial, institutional, and residential uses, to limit even minor emissions from each of the very large number of small units and equipment in the densely populated area. While existing air district regulations keep new and existing stationary sources in check, State programs for reducing mobile source NOx emissions from all on-road and off-road mobile source categories, including portable equipment, provide the biggest benefit to visibility.

By 2018, California anticipates a 40 to 50 percent reduction in nitrate-caused light extinction using existing control measures. This calculation takes into account expected growth in area sources, vehicle miles traveled, and point source expansion, which must be offset. Future controls to attain new federal air quality standards to protect health, are anticipated. They will be addressed during the mid-course review.

Figure 4-16 Worst Days SOx Source Attribution (Southern Class 1 Areas)





Sulfates are the second highest cause of light extinction at the Southern California sub-region, when averaged. They are the primary influence at Agua Tibia, and are third highest in the forested mountains of the San Gabriel, Cucamonga, San Gorgonio, and San Jacinto Wilderness Areas where organic matter influence is slightly higher than sulfates on an annual basis. Sulfates increase slightly in hot, dry months at all the monitors, as do organic matter aerosols. The Agua Tibia IMPROVE monitor is at the lowest elevation, directly exposed to air masses containing the marine layer and urban pollution. The other IMPROVE monitors (SAGA, SAGO, and JOSH) are at elevations two to three times higher, above or outside the mixing zone of the urbanized Los Angeles Basin. Nevertheless, the six Class 1 Areas are close enough to be impacted by regional sulfate levels, no matter the location of the initial SOx emissions, because the sulfates subsequently-formed are persistent in the atmosphere.

The tracer analysis shows that SOx emissions come primarily from Pacific offshore sources, largely beyond State or local control. They also come from area, point, and mobile sources in California. These include port activities, interstate freight movements, military bases, and airports with shared federal, State, and local jurisdiction. A review of the top 100 SOx-emitting stationary sources in the Southern sub-region shows that only 19 facilities emitted more than 100 tons per year of SOx in 2006. All must operate at RACT or BACT level, in accordance with the respective air district federal nonattainment status or maintenance plan.

California has already implemented low sulfur fuel requirements for gasoline, diesel, natural gas, and coal used in combustion at stationary and mobile sources through existing State and air district programs. Fuel oil is restricted to emergency use and natural gas is required for routine use in many existing stationary source permits administered by Southern sub-region air districts. Fuel sulfur restrictions apply to area sources via existing prohibitory rules for residential heaters, small boilers, and internal combustion engines.

Anthropogenic SOx emissions originating in California contribute about 6 percent to regional worst day light extinction and are all subject to existing controls. That estimate does not count near-shore marine commercial emissions grouped with all Pacific Offshore sources in the SOx tracer analysis. Projections to 2018 for California mobile, point, and area sources show that sulfate concentrations will decrease from each source category. California will also continue existing efforts to work with Mexico in cooperative agreements to reduce the use of high-emitting vehicles entering the United States with commercial goods.

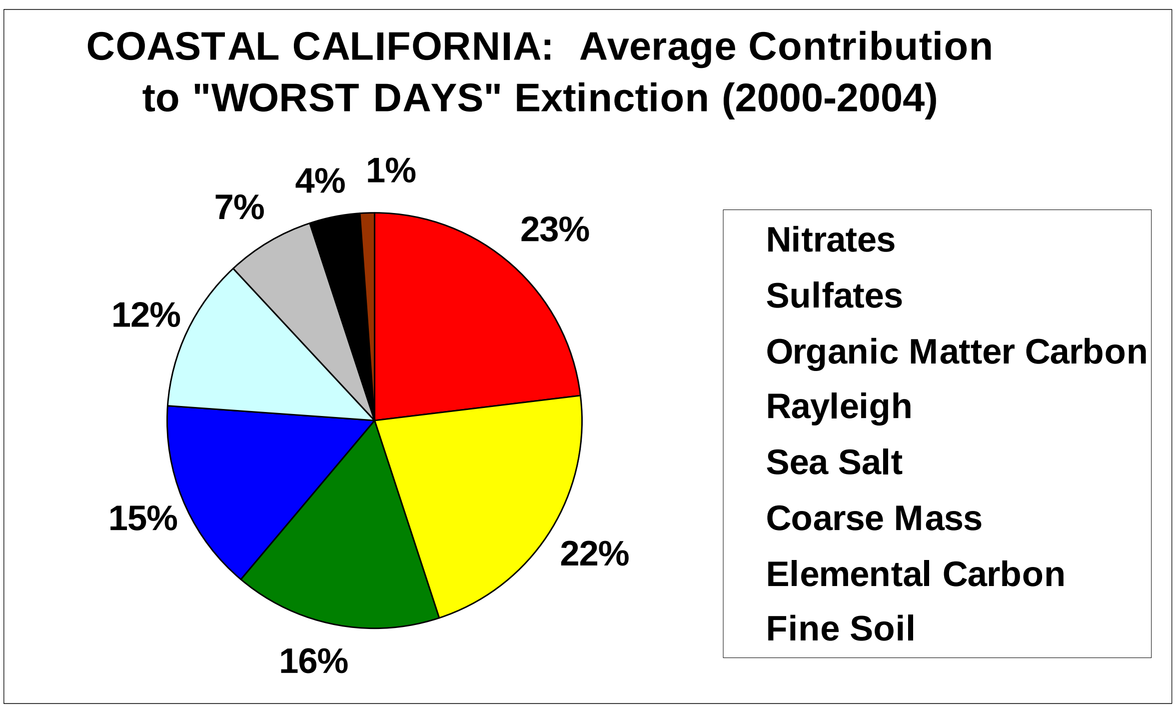
After sulfates, organic aerosols are the next highest driver of haze on worst days in Southern California, on average. In large part, these are due to sustained peaks of organic aerosol during large wildfires that ravaged forests weakened by drought and bark beetle infestations during the baseline years. The year-round growing season in Southern California also delivers plant-emitted carbon compounds that subsequently combine to form organic aerosols, especially in the forested Wilderness Areas. Neither wildfires nor biogenic emissions can be controlled. However, California's Smoke Management Program limits the impacts of anthropogenic fires, with controls and permits for prescribed burning by private and public land managers. Open burning for residential or commercial purposes is already banned in most of Southern California. Agricultural burning is diminishing, as farmlands and pasture are converted to non-agricultural uses.

Existing stringent State and air district controls of reactive organic gas emissions from consumer products and mobile, stationary, and area sources, to reduce ozone formation, have the benefit of also reducing organic aerosol formation. These controls are continuously updated, considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. As a result, anthropogenic emissions of organic aerosols will decrease at least 20 percent across the Southern sub-region by 2018. Despite the inability to control the predominately natural causes of organic aerosols, modeled projections indicate that organic aerosols from all sources will still decrease approximately 11 percent across the Southern sub-region by 2018.

4.7.4 Coastal California

There are five Class 1 Areas on or relatively close to the California coast of the Pacific Ocean: Redwoods National Park, Point Reyes National Park, Pinnacles National Monument, Ventana Wilderness, and the San Rafael Wilderness. These are grouped as the Coastal sub-region because prevailing winds from the ocean affect them directly. Four contiguous air basins comprise the sub-region: the North Coast, San Francisco Bay Area, North Central Coast, and South Central Coast Air Basins, encompassing the 900 kilometer distance from northernmost to southernmost Class 1 Areas. Three of the Class 1 Areas include Pacific shoreline as well as higher elevations in the mountain ranges along the California Coast Ranges. Pinnacles and San Rafael are farther inland along the crest line of the inner coastal mountain ranges, at 1,000 to 2,000 meters. These two Class 1 Areas are exposed more often to reverse flows of “inland” air masses that drain oceanward through passes and river valleys. Figure 4-17 shows the average contributions of haze species to worst day light extinction in the baseline years at the four IMPROVE monitors representing the Class 1 Areas of the Coastal sub-region.

Figure 4-17 Species Contributions to Worst Days (Southern Class 1 Areas)

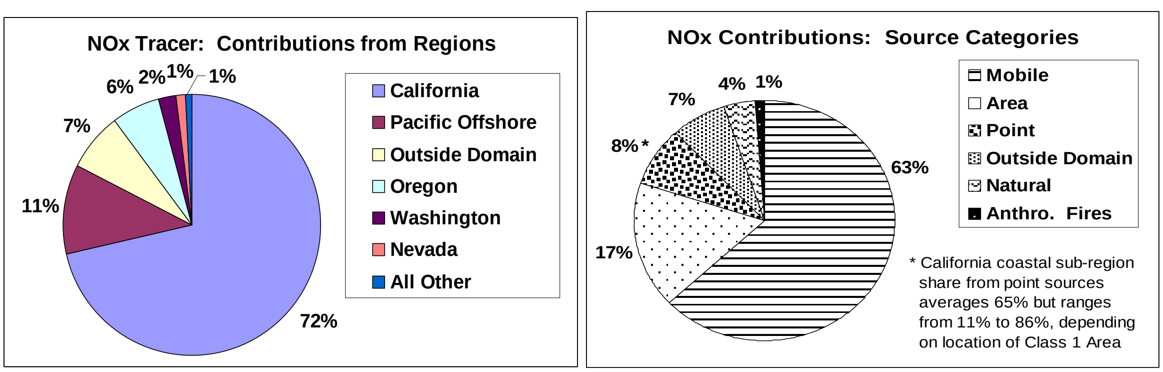


The causes of haze in each Class 1 Area of this sub-region do vary slightly from the averages depicted in Figure 4-17. The relative influence of nitrates, sulfates, organic matter, Rayleigh and sea salt vary in influence considerably more than coarse mass, elemental carbon, and fine soil due to factors such as latitude, elevation, relative humidity, distance from the shoreline and prevailing offshore winds, and exposure to air masses flowing from inland valleys with different land uses.

Natural contributions from Rayleigh and sea salt show dramatic differences, depending on the elevation of the Class 1 Area and its distance inland from the coast, but these “causes” of haze are not “controllable.” The contributions of fine soil, elemental carbon, and coarse mass to light extinction are at or below 15 percent at all of the Coastal Class 1 Areas. These pollutants are also largely the result of “uncontrollable” natural events, such as wildfires or local wind events in uninhabited forests and bare-soil areas. Therefore, the four-factor analysis again focuses on the anthropogenic source categories contributing nitrates, sulfates, and organic matter carbon. At each Class 1 Area, these three species are predominant haze drivers on worst days during the year.

The relative prevalence of on-shore and off-shore winds, and the variability of population density and land use near each Class 1 Area, affects the strength of each of the three major drivers of haze. Prevailing winds from off-shore bring in a mix of natural marine sulfates, anthropogenic marine commercial shipping emissions, out-of-State and international industrial pollutants, and transported wildfire smoke that can overwhelm emissions from “on-land” sources. California is addressing commercial marine shipping emissions, including in-port activities, through long-term programs. The results of these efforts will not be available until the mid-course review. Landside emissions have been addressed through existing programs to reduce ozone and particulate matter to attain State and federal health standards. The following analysis explains the significant existing controls of sources closest to the respective Class 1 Areas.

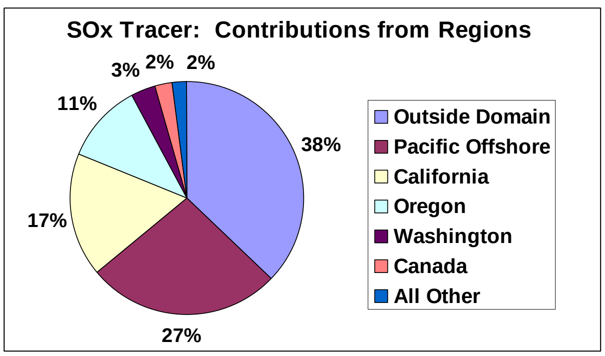
Figure 4-18 Worst Days NOx Source Attribution (Coastal Class 1 Areas)

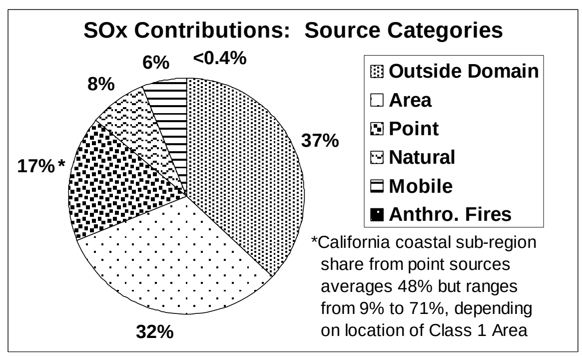


On average, nitrates causes the most light extinction on worst days in the Coastal sub-region, although sulfates exert more influence at Redwoods National Park and at the San Rafael Wilderness, as explained in the discussion of sulfates. Taken together, NOx emissions in California from all the source categories account for about 72 percent of the nitrates. This amounts to less than 20 percent of the total light extinction at every Coastal Class 1 Area. Mobile sources, including emissions from commercial marine shipping offshore in the Pacific Ocean, account for the bulk of NOx emissions. Reductions in on-land mobile source NOx should decrease about 60 percent from 2002 to 2018.

The air districts in the three contributing air basins (San Francisco Bay Area, North Central Coast, and South Central Coast) have all enacted source controls considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source beyond federal requirements because they are all nonattainment for stricter State health standards for ozone or particulate matter. They have also adopted all feasible measures to reduce NOx as required by State law to mitigate the impact of their emissions on the ozone attainment status of downwind air basins in the Central Valley. While there is a slight increase in stationary source NOx influence on the Coastal Class 1 Areas by 2018, it is more than offset by the overall mobile source reductions near every Coastal Class 1 Area. Overall, existing controls in the Coastal sub-region achieve a 40 to 55 percent reduction in nitrate extinction by 2018 at the Coastal Class 1 Area IMPROVE monitors. This will all occur while the population in the Coastal sub-region increases 16 percent (about 1.6 million more people) from 2002 to 2018.

Figure 4-19 Worst Days SOx Source Attribution (Coastal Class 1 Areas)





Overall, sulfates are the second highest cause of worst days haze in the California coastal sub-region. Sulfates in the Coastal sub-region originate largely from SOx emissions outside California. SOx contributions from the Pacific Offshore region alone exceed those from California. Marine commercial shipping emissions in shipping lanes along the entire coast account for a measurable share of the SOx inventory at Coastal Class 1 Areas because prevailing offshore winds blow these emissions inland. These sources, along with natural sources of sulfates are not fully “controllable”. As discussed below, landside SOx sources in California’s local air basins influence visibility largely when prevailing winds come from inland, or on stagnant days. The analysis below assesses the success of existing measures to reduce sulfate impacts from “controllable” sources.

In the North Coast Air Basin, the “controllable” (in-State, non-natural) sources have been held to 22 percent of the Basin’s total emissions inventory for SOx, using existing control measures to meet State health standards for ozone and particulate matter. Most of the anthropogenic sources are usually downwind of Redwoods. As a result, each of the local fire, mobile, area, and point sources categories contribute less than 10 percent of the sulfates contributed by all regions to Redwoods, according to the SOx tracer analysis. The sub-regional share of total extinction at Redwoods National Park is less than 0.5 percent from local SOx sources, considering the four factors, cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life.

The percentage of sulfates attributed to sources in the San Francisco Bay Area, North Central Coast, and South Central Coast Air Basins is higher than in the North Coast Air Basin because the population is much higher and the land uses more diverse. Area source contributions are higher, in part because the emissions inventory surrogates are linked to population and density. Nevertheless, combustion emissions of SOx from anthropogenic sources are already limited, since California already requires reduced sulfur in all commercially available fuels (coal, natural gas, gasoline and fuel oil.) Also, internal combustion engines used in portable construction equipment and stationary engines and pumps are already regulated, even in agricultural uses. By 2018, the SOx tracer tool shows that existing controls of Coastal sub-region area sources will reduce their contribution to the overall California share of sulfates by 14 percent. Likewise, existing mobile source controls can achieve an 11 percent reduction in that category's contribution to Coastal sub-region sulfates.

A review of the top 100 SOx-emitting stationary sources in the Coastal sub-region shows that 35 facilities emitted more than 100 tons per year of SOx in 2006. The facility with the highest SOx emissions Statewide, 6353 TPY of SOx in 2006, is a BART-eligible refinery in the San Francisco Bay Area Air Basin. The BART determination for this facility is discussed in Chapter 5; significant emissions reductions will be implemented by 2013. Only seven other facilities emit more than 1000 TPY of SOx in the counties whose emissions could affect the Coastal sub-region. Four are refineries in the San Francisco Bay Area Air Basin whose BART-eligible units went through subject-to-BART modeling and did not show an impact greater than 0.5 dv above the threshold. One facility in the South Central Coast Air Basin permanently shut down its high SOx-emitting kiln at the end of 2007 to reduce greenhouse gas emissions. One cement plant in the Mojave Desert Air Basin is usually downwind of the nearest Coastal Class 1 Area, 160 kilometers away, and went through New Source Review for a modern kiln design in 1982. Another refinery in the Los Angeles Air Basin is under the RECLAIM program for continuous reductions of emissions. No further changes were identified for these facilities, when considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source.

In summary, the point source category shows a slight increase in the contribution to sulfates in the Coastal sub-region, but that growth is limited to 5 percent due to existing controls of particulate matter necessary to maintain the current attainment status for Federal particulate matter standards. As mentioned previously, the Coastal Class 1 Areas are all in nonattainment areas for State health standards for particulate matter. The affected air districts have adopted all feasible stationary source measures on a path to reduce emissions, as required by State law. California expects that additional measures will also be adopted and implemented in the future, to keep the Coastal sub-region in attainment of new federal particulate matter standards. These will be discussed in the mid-course review. Despite the anticipated 16 percent increase in population in the Coastal sub-region by 2018 from 2002 levels, the sub-region's share of sulfate extinction will decrease 3 percent on average on worst days, with existing controls in effect.

Along with sulfates, nitrates, sea salt and Rayleigh gas scattering, organic aerosols are significant drivers of worst days haze in Coastal California. In large part, these days are associated with sustained peaks of organic aerosol during large wildfires. The smoke containing the organic mater aerosols can be local or transported with minimal dispersion over long distances by ocean air masses. Biogenic emissions also contribute organic aerosols during the growing season, in direct relation to the types of vegetative covering at the respective Class 1 Areas. Neither wildfires nor biogenic emissions can be controlled. However, California's Smoke Management Program is used to limit the impacts of anthropogenic fires. Despite population growth, anthropogenic emissions of organic aerosols are decreasing. They will be lower than current levels by 2018 due to existing stringent State and air district controls of reactive organic gas emissions from consumer products and other source categories, to reduce ozone formation. These controls are continuously updated, considering the four factors, cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. Future refinements will be reported in the mid-course review.

4.8 Consultation

California consulted with nearby states regarding the 2018 Progress Strategy by actively participating in the WRAP regional planning organization. Via many WRAP meetings, California conveyed to the WRAP states California's 2018 Progress Strategy and the benefits it provides in improving visibility at all Class 1 Areas impacted by California emissions. In addition, California contacted neighboring states directly. Through this consultation process, the WRAP states concurred that California's 2018 Progress Strategy was appropriate for setting reasonable progress goals for both within State and out-of-State Class 1 Areas within the context of a western regional planning perspective.

4.9 Conclusion

In general, California has reduced emissions at a faster pace than anywhere in the world over the last forty years by introducing cleaner technologies. We evaluated our 2018 Progress Strategy from a western regional perspective in light of the four factors and have determined that the 2018 Progress Strategy provides a cost-effective, far-reaching, and comprehensive basis for setting our reasonable progress goals for the purpose of Regional Haze planning. However, due to the severity of California's air quality problems and the need to meet State and federal air quality standards, ARB will continue to develop additional strategies for years to come. Notably, in 2007 the Air Resources Board adopted a comprehensive Statewide strategy to provide for attainment of the federal 8-hour ozone and PM2.5 standards that outlines a plan for the development of a combination of far-reaching measures. ARB controls and benefits from future strategies will continue to reduce emissions through the 2018 time and improve visibility at all Class 1 Areas impacted by California emissions. California will evaluate the benefits of the 2018 Progress Strategy as well as new measures adopted in upcoming years during the mid-course review.

5. REGIONAL HAZE BART REQUIREMENT

5.1 Overview of Federal BART Requirement

In addition to development of the broader 2018 Progress Strategy, the Best Available Retrofit Technology (BART) requirement of the Regional Haze Rule involves a specific review of existing, older stationary sources that pre-dated the 1977 Clean Air Act Amendments and therefore, were not subject to New Source Performance Standards (NSPS.) The purpose is to identify older emission sources that contribute to haze at Class 1 Areas and can be retrofit to reduce emissions.

The BART requirement applies to all emission units that fit all three of these criteria:

1. came into existence between August 7, 1962 and August 7, 1977, referred to as "BART-era" in this Plan;
2. are at facilities in the 26 NSPS categories listed below in Table 5-1; and
3. have a total potential to emit (PTE) of at least 250 tons per year (TPY) of NOx, SOx, PM10, VOC, or ammonia, from all BART-era emission units at the same facility.

Emission units which meet all three of these criteria are termed BART-eligible. If the emissions of all the BART-era units at a single facility exceed any one of the pollutant thresholds, then all the BART-era units are considered potentially "BART-eligible", no matter what their emissions level of the other pollutants. If an emission unit (source) has not been retrofit or sufficiently controlled, and has a visibility impact, then it becomes "subject-to-BART". A detailed analysis called the "BART determination" decides which retrofit or control option for the source is necessary to improve visibility.

Table 5-1 BART Categories (New Source Performance Standards categories)

1. Fossil-fuel fired steam electric plants with >250M BTU/hr heat input	14. Coke oven batteries
2. Coal cleaning plants (thermal dryers)	15. Sulfur recovery plants
3. Kraft pulp mills	16. Carbon black plants (furnace process)
4. Portland cement plants	17. Primary lead smelters
5. Primary zinc smelters	18. Fuel conversion plants
6. Iron and steel mill plants	19. Sintering plants
7. Primary aluminum ore reduction plants	20. Secondary metal production facilities
8. Primary copper smelters	21. Chemical process plants
9. Municipal incinerators capable of charging >250 tons of refuse daily	22. Fossil-fuel boilers with >250 MBTU per hour heat input
10. Hydrofluoric, sulfuric, and nitric acid plants	23. Petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels
11. Petroleum refineries	24. Taconite ore processing facilities
12. Lime plants	25. Glass fiber processing plants
13. Phosphate rock processing plants	26. Charcoal production facilities

Basically, the Regional Haze Rule requires the Plan to provide:

1. A list of all BART-eligible sources within the state; and
2. A determination of BART for each BART-eligible source in the state that emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area.

Summary lists of BART-eligible units and those needing BART determinations are included later in this chapter.

5.2 Stationary Source Control in California

California has a long history of controlling emissions from stationary sources. Thirty-five local air districts have regulatory authority over stationary sources in the State. California was able to simplify the BART process somewhat because it has had a Best Available Retrofit Control Technology (BARCT) requirement since 1988. BARCT is:

> "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."

The requirement to meet BARCT for existing sources applies to all air districts not attaining the California standards for ozone as well as to those upwind districts whose emissions contribute to air quality in a downwind non-attainment district.

Further, all air districts not attaining the State standards must consider all feasible measures to reduce air pollution and adopt and implement measures to attain the State standards as soon as possible. Except for one of the smaller rural air districts in the State, which has no BART-eligible sources, all the other air districts do not attain at least one State standard. The California Air Quality Standards are more stringent than the federal standards. Therefore, the air districts already have adopted and implemented BARCT rules or stringent control measures for sources. Every few years, the California Association of Air Pollution Control Officers Association, in conjunction with ARB, conducts a Statewide evaluation of source category controls used by the air districts to determine all feasible measures.

5.3 The BART Process in California

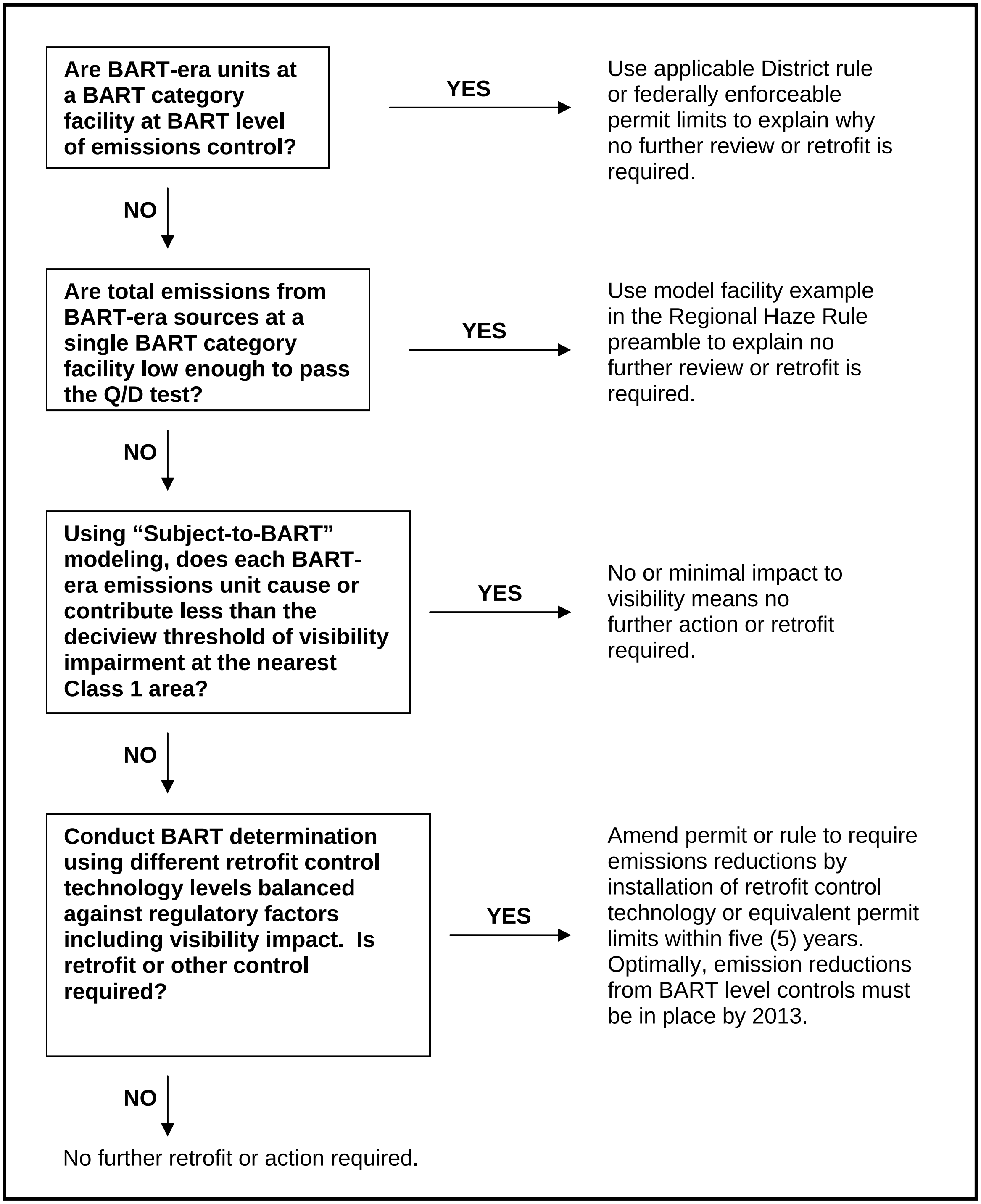
Many BART-eligible sources have already been retrofit or controlled, by air district permit or prohibitory rule, to a BART equivalent or better level. To list those sources and then to select the ones which could be retrofit, ARB began with facilities potentially having BART-eligible sources. The WRAP contractor Eastern Research Group, Incorporated (ERG) prepared a short list of all facilities in California permitted under Title V of the Clean Air Act that fall into the 26 BART categories. Title V requires permits for facilities that emit the targeted pollutants above a threshold ranging from 100 TPY to 250 TPY, depending on the attainment status in different parts of California.

While NOx, SOx, and PM emissions must be evaluated for BART-eligibility, the Regional Haze Rule gives states the discretion to excuse facilities solely exceeding the threshold for VOC or ammonia provided that those pollutants do not contribute to impaired visibility at Class 1 Areas. In California, ammonia emissions from area, mobile, and natural sources exceed those from stationary sources. Also, since secondary organic aerosols formed from anthropogenic VOC emissions are not significant contributors to haze on worst days in California, the State chose not to include sources that exceed the threshold for VOCs. When worst days in California are driven by organic aerosols, they appear to be the result of seasonally high biogenic emissions from plants or from wildfire events. Therefore, California's BART-eligible list includes only BART-era units with total emissions of NOx, SOx, or PM above the BART threshold at a single facility.

As stated in our July 2, 2004 letter to U.S. EPA commenting on the BART Regulation, California believes that air districts have generally already adopted and implemented rules requiring the best available retrofit control technology (BARCT) as part of the planning requirements to meet both federal and California air quality standards. (The letter is included in Appendix H.) These BARCT level rules meet the BART-level requirements of the Regional Haze Rule on a source category basis. Give the large number of BART-eligible sources in California, this rule-based approach provides a more efficient process, while still ensuring that the Regional Haze Rule BART control requirements are met. California believes this rule-based approach meets the intent of Regional Haze requirements and achieves the same results as a case-by-case BART determination.

ARB worked with the air districts' staffs to create the required summary lists for the Plan. Air district staff provided information regarding control level and age of units. Figure 5-1 illustrates the stepwise winnowing process for confirming which listed BART-eligible sources already meet BART levels and for finding the few remaining sources that might have been grandfathered from stringent controls and therefore, may need a BART determination.

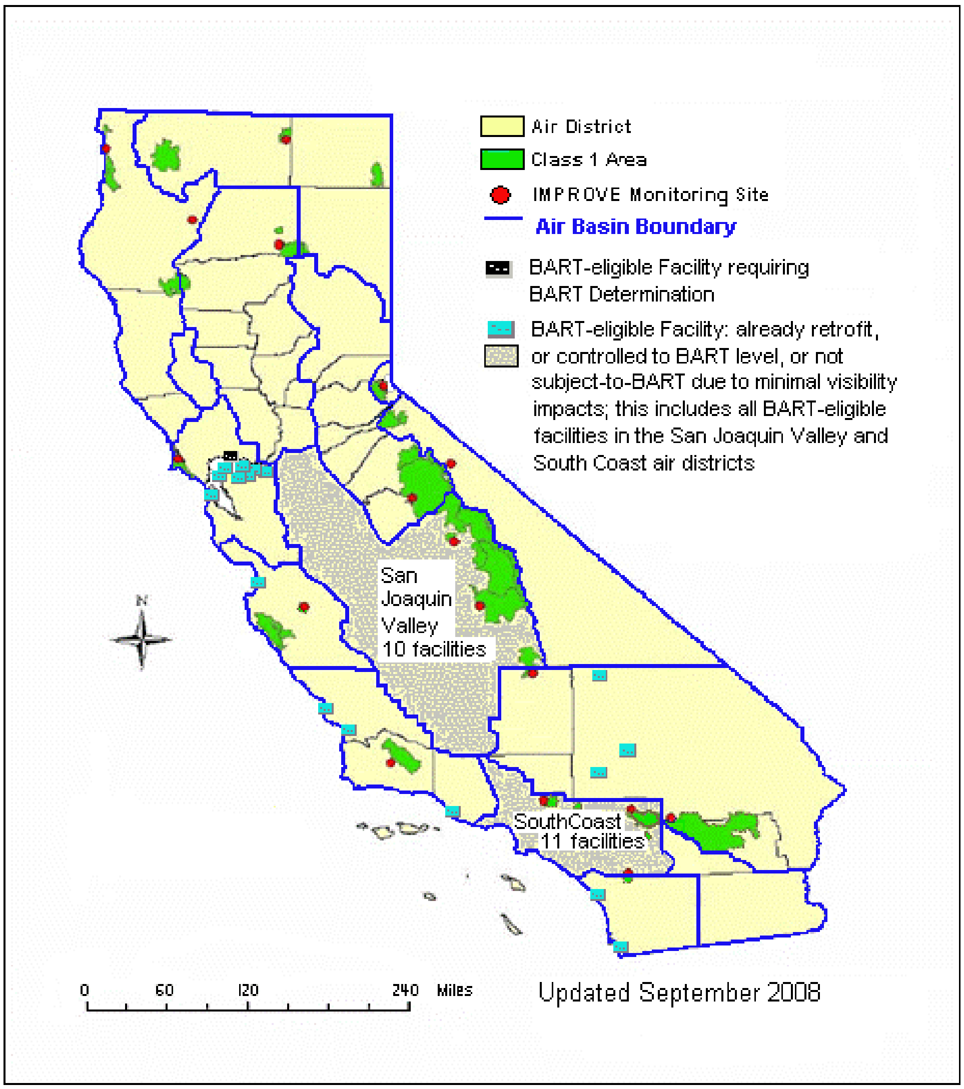
Figure 5-1 California's BART-eligible Source Review Process



5.4 Locating BART-eligible Source Facilities

The locations of facilities with BART-eligible sources are mapped in Figure 5-2, showing their proximity to Class 1 Areas. Most of the BART-eligible sources are found along the coast, in the San Joaquin Valley, in the South Coast Air Basin and in the Mojave Desert. In California, the types of sources are predominately power plants, refineries, industrial boilers, cement plants, and manufacturing plants. Although there are numerous BART-eligible sources, many are excused from a BART determination because they are already controlled to a BART equivalent level. Some BART-eligible sources active during the Plan baseline period (2000-2004) have been shut down permanently since then. Those sources already scheduled for replacement before 2013, were not put through a BART determination because the facility is required to go through New Source Review and replace the old units with Best Available Control Technology (BACT).

Figure 5-2 Location of Facilities with BART-eligible Sources



5.5 Listing BART-eligible Sources

The Regional Haze Rule requires listing of all BART-eligible sources at a facility. Table 5-2 is the list of BART-eligible sources in California. Air districts provided the information on which sources are compliant with the respective prohibitory rule establishing operational emission limits or the permit conditions that are equivalent to the most stringent technology feasible in their area for the source category. When an air district adopts a rule, California air quality and environmental laws require that the air district's staff report contains an analysis of cost-effectiveness, energy and environmental impact, best available technology including equipment lifetime, and local economic impact, among other things. The air districts' rulemaking process takes into consideration the factors also required for a BART determination. Therefore, California did not proceed to the subject-to-BART modeling or BART determination phase when the source was already equipped with the most stringent technology, or, is at the level of control deemed cost-effective by the air district for that source category.

5.6 Visibility Impact Analysis

The BART rule allows a "subject-to-BART" screening prior to a BART determination that excuses sources from further review if the impact does not cause or contribute to visibility impairment. A one deciview increment is the amount of change in clarity that a human eye can detect when viewing an object on the horizon. Therefore, in the BART rule, the U.S. EPA set the contribution increment of 0.5 deciviews above the baseline threshold as the indicator of *contributing* to visibility impact and allowed states the discretion to set a lower impact threshold. For subject-to-BART visibility impact screening, the baseline threshold in California was set at the Statewide average deciview level at Baseline Conditions.

The U.S. EPA also allows all the BART-eligible sources at a facility to be excused from further review if the ratio of their cumulative potential to emit (Q) in tons per year of NOx and SOx divided by the distance in kilometers (D) to the nearest Class 1 Area, is less than 10. This rule of thumb ($Q/D < 10$) applies only when no other facilities with BART-eligible sources are close to the surrounding Class 1 Areas, so as to avoid cumulative impacts. U.S. EPA used modeled scenarios to demonstrate that a maximum impact of 0.5 deciview impact above the threshold of the baseline best day average for the nearest Class 1 Area was not exceeded, when $Q/D < 10$. Several of California's facilities with BART-eligible sources are within 25 kilometers of a Class 1 Area and therefore their BART-eligible emission units could not be excused via a Q/D calculation.

It is possible that several BART-eligible emission units, cumulatively, might cause or contribute to impaired visibility because they are clustered very close to a Class 1 Area, even though they individually have less than the maximum

0.5 deciview impact above the allowed threshold. In California, if the modeled visibility impact of the sum of the pertinent facility emissions exceeded the threshold by 0.5 deciviews, then BART determinations were required for each individual BART-eligible emissions unit at the facility.

The CalPuff modeling protocol used to determine visibility impacts is described in Appendix C. California conducted this “subject-to-BART” visibility modeling only on sources not sufficiently controlled by the air district rules. The BART requirement also allows the exclusion of pollutants below a de minimus emissions level from subject-to-BART visibility modeling when evaluating an entire facility for visibility impact if:

1. a PTE <15 TPY for PM emissions, or
2. a PTE <40 TPY of SOx emissions, or
3. a PTE <40 TPY of NOx emissions.

Those emission units at a single facility that cumulatively emit only the pollutant(s) falling below these de minimus thresholds were listed but excused from further review.

5.7 BART Determination Overview

A BART determination evaluates retrofit options for an individual source, starting with the most stringent level, until the appropriate level is determined. Since local air districts permit stationary sources, the local air districts are responsible for the BART determination taking into account:

1. available retrofit control options;
2. any pollution control equipment in use at the source (which affects the availability of options and their impacts);
3. costs of compliance for control options;
4. remaining useful life of the facility;
5. energy and non-air quality environmental impacts of control options, and
6. visibility impacts analysis.

Where MACT or LAER standards exist for a source category, California views these as meeting or exceeding a BART level of control. The permitee may be able to show compliance with a lesser level of control when the six factors listed above are considered.

5.8 BART-eligible List and Results of Subject-to-BART Modeling

Table 5-2 lists the BART-eligible sources in California identified and evaluated by ARB and the air districts. The list also summarizes which BART-eligible units needed subject-to-BART visibility modeling and why the others did not. Only one modeled facility had a visibility impact greater than 0.5 deciviews over the threshold.

Table 5-2 List of BART-eligible Sources (Emission Units)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Bay Area Air Quality Management District	Chevron Refinery (Richmond) – #4 Rheniformers, F-3550 & F-3560 – #4 Rheniformers, F-3570 & F-3580 – #5 Rheniformers, F550 & F560 – #5 Rheniformers, F570 & F580 – #1 JHT Furnace #247 – #1 JHT Furnace #210A&B – Furnaces for #5 Naptha Hydrotreaters F410 & F447 – Furnace) VGO Desulfurizer F-1610 – #4 Crude Unit F 1100a – #4 Crude Unit F1100b – #4 Crude Unit F1160 – LSFO Cooling Tower – 3 CAT Cooling Tower E460 – F-100 Asphalt Solution Heater SDA Isomax – F-110 Asphalt Solution Heater SDA Isomax – F-120 Asphalt Solution Heater SDA Isomax – F-320 Naphtha Vaporizer, H2 Plant Isomax – F-330 Naphtha Vaporizer, H2 Plant – F-410 & F-420 TKC Feed Furnaces/TKC Isomax Umits – F-510 & F-520 & F-530 TKN Feed Furnace/Isomax – F-610 & F-620 &F-630 Isocracker Feed Furnace and Isomax W/Ultra Low NOx Burners – F-710 TKC Fractionator and Isomax – F-730 Isocracker Splitter Feed Furnace and Isomax W/Ultra Low NOx Burners – F-731 Isocracker Reboiler and Isomax W/Ultra Low NOx Burners	BAAQMD Regulation 9, Rule 1 BAAQMD Regulation 9, Rule 10, Section 303 40 CFR 60, Subpart J 40 CFR 63, Subpart UUU Consent Decree with U.S. EPA	NO Modeled visibility impact is 0.393 dv above the threshold

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
	Chevron Refinery (Richmond) (continued) – F305 H2 Reforming Furnace, H2 Plant – F355 Reforming Furnace, H2 Plant – Isomax Cooling Tower -E-261 – Alkane Cooling Water Tower – F-2170 Stack Gas Heater #1 SRU Cat. Crack. – F-2270 Tail Gas Heater #2 SRU – F-2370 Tail Gas Heater #3 SRU – *High Level Flare, LSFO (6010) – *V-282 South Isomax Flare (6012) – *North Isomax Flare V-281 (6013)		
Bay Area Air Quality Management District	Conoco-Phillips Refinery and Carbon Plant under single permit (Rodeo) – Kiln (stack 2) – U240_B-1 Boiler – U240_B-2 Boiler – U240_B-101 Heater – U240_B-202 Heater – U240_B-401 Heater – U244_Heaters: B-501 & B-502 & B-503 & B-504 & B-505 – U244_B-506 Heater – U244_B-507 Heater – U248_B-606 Heater – U236 Cooling Tower – U240 Cooling Tower – U200 Cooling Tower – *Dedust Oil Storage Tank (no emissions) – *Rotary Cooler #2 (no emissions) – *Sulfur Pit 236 (no emissions) – *Sulfur Pit 238 (no emissions)	– BAAQMD Regulation 9, Rule 1 – BAAQMD Regulation 9, Rule 10, Section 303 – 40 CFR 60, Subpart J – Consent decree with EPA	NO Modeled visibility impact is 0.366 dv above the threshold

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
	Conoco-Phillips Refinery and Carbon Plant under single permit (Rodeo) (continued) – *C-1 Flare – *U240_Uni-Cracking Unit 240 – *U244 Reforming Unit 244 – *U248 Unisar Unit 248 – *U40 Raw Materials Receiving		
Bay Area Air Quality Management District	Mirant Power Plants under single permit Antioch (A0018) – Boiler #10 (Low NOx Burners & SCR) Pittsburg (A0012) – Boiler No. 7 – Emergency Diesel Generator 36 – No. 7-1 Diesel Fire Pump – No. 7-2 Diesel Fire Pump Potrero (A0026) – Boiler No. 3-1	– BAAQMD Regulation 9, Rule 11, Section 308 for NOx (0.28 lb NOx/MMbtu) – Permit requires exclusive use of low sulfur natural gas to control PM10 and SO2 at the boilers at facilities A0012 and A0018	NO Already at BART level
Bay Area Air Quality Management District	Rhodia Sulfuric Acid Plant (Martinez) – Sulfuric acid plant – Cooling tower – *Natural Gas Preheater Furnace (start-up only, below 40 TPY) – *Sulfur Storage Tank T-2 – *Sulfur Storage Tank T-12	– Consent Decree limits SOx emissions to 2.2 lbs SO2 per Ton; current actual emissions range 0.6 to 0.8 lbs SO2 per Ton with baseline period maximum of 1.74 tons per day for sulfur plant – Storage tanks have no reported emissions	NO Modeled visibility impact is 0.092 dv above the threshold

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Bay Area Air Quality Management District	Shell Refinery (Martinez) – EMSR7 Cooling Tower # 32 (LOP) – Thermal Oxidizers S.P. # 1 (stack 3) – Thermal Oxidizers S.P. # 2 (stack 3) – EMSR1-CO Boiler # 2 (SCR & ESP) – *LMSR1 Utilities Lime Storage Bin 1 – *EMSR1 Utilities Lime Storage Bin 2 – *Misc. Sand Hopper (storage, not used routinely, no vents) – *LOG LPG Loading Flare (abatement device for LPG loading rack) – *LOP Auxiliary Flare (emergency use only) – *LUBS2 Cooling Tower # 35 (not operating since 2003)	– BAAQMD Regulation 9, Rule 10 covers NOx from CO Boiler which is abated with SCR and ESP – Many BART-era units are closed or controlled storage systems with no reported emissions – 40 CFR 60, Subpart J – Consent decree with EPA	NO Modeled visibility impact is 0.169 dv above the threshold
Bay Area Air Quality Management District	Tesoro Refinery (Martinez) – #51 Furnace-#2 Reformer Auxiliary Reheat – Alkylation Turbine – No. 3 Crude Unit Cooling Tower – Sulfur Recovery Unit – *Tank 691 Safety Flare	– BAAQMD Regulation 9, Rule 1 – BAAQMD Regulation 9, Rule 9 (55 ppmv NOx @15% 0_2 at alkylation turbine) – BAAQMD Regulation 9, Rule 10, Section 303 – 40 CFR 60, Subpart J – 40 CFR 63, Subpart UUU – Consent decree with EPA	NO Modeled visibility impact is 0.069 dv above the threshold

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Bay Area Air Quality Management District	Valero Refinery (Benicia) – Crude pre-Heat Process Furnace F-101 (Main Stack P-1) – Reduced Crude pre-Heat Process Furnace F-102 (Main Stack P-1) – FCCU Regenerator R-702 (Main Stack P-1) – Coker (Main Stack P-1) – Stacks P30 & P31: Reformer Furnaces S21/*S22 – Stacks P19 & P20: Turbine/Waste Heat Boiler SG-701 – Stack P47: Turbine/Waste Heat Boiler SG-702 – Stacks P17 & P18: Turbine/Waste Heat Boiler SG-401 – Stacks P24 & P25: Turbine/Waste Heat Boiler SG-1031 – Stack P50: Claus Units 1 & 2 – Cooling Tower – Sulfur Storage Tank (any emissions routed to stacks P24/25) – *Acid Gas Flare – *Butane Flare ST-1701 – *South Flare ST-2101 (Flare Gas Recovery System) – *North Flare ST-2103 (Flare Gas Recovery System) – *Sulfur Storage Pit at Sulfur Plant (any emissions routed to SRU) – *TK 2325: Brine Saturator (no emissions) – *Sulfur Plant 'A' Tail Gas Incinerator F-1302A (used only for SRU upset) – *Sulfur Plant 'B' Tail Gas Incinerator F-1302B (used only for SRU upset) – *Lime Silo 2303 controlled by baghouse; permit-limited throughput 292 TPY	– Claus Units are at MACT level; subject to NSPS and NESHAPS limits – BAAQMD Regulation 9, Rule 1 – BAAQMD Regulation 9, Rule 9 – BAAQMD Regulation 9, Rule 10, Section 303 – 40 CFR 60, Subpart J – 40 CFR 63, Subpart UUU – Flares subject to consent decree	YES Modeled visibility impact is 0.758 dv above the threshold BART Determination required.

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Mojave Desert Air Quality Management District	Coolwater Reliant (Daggett) (EGU, all units>250MMBTU/hr) – Boiler 2 (#1078) (paired w/ Boiler #1, which is not a "BART-era" boiler) – Turbine 31 (#1079) – Turbine 32 (#1080) – Turbine 41 (#1081) – Turbine 42 (#1082) (gaseous fuel, very limited use of liquid fuel as emergency back-up)	Boilers: FGR NOx: 70 ppm (0.09 lb/MMBtu) (gas) 115 ppm (0.15 lb/MMBtu) (liquid) per MDAQMD Rule 1158 (Boilers permit limited to 1319 TPY total combined emissions) Turbines: WI NOx: 42 ppm (gas), 65 ppm NOx (liquid) per MDAQMD Rule 1158	NO Modeled visibility impact is 0.489 dv above the threshold
Mojave Desert Air Quality Management District	Searles Industrial (Searles Lake) (boilers >250 MBTU/hr) – Argus Boiler 554 (#26) – Argus Boiler 555 (#25) – Backup Boiler #483 (#22) • < 40TPY each of NOx, SOx • <15 TPY PM (Coal fuel, tangentially fired design)	Boilers: Argus Boilers have FGR, LNB, OFA, voluntary urea injection, wet scrubber, ESP Boiler #22 has permit-limited hours of operation NOx: 221 lb/hr (0.22 lb/MMBtu) SOx: 44.7 lb/hr (0.04 lb/MMBtu) PM10: 45 lb/hr (0.04 lb/MMBtu) Turbine: SCR NOx: 42 ppm	NO Modeled visibility impact is 0.208 dv above the threshold
Mojave Desert Air Quality Management District	TXI Cement (Oro Grande) (Portland Cement plant) – 5 kilns (each 130MMBTU/hr) – 2 Kilns (each 120MMBTU/hr with waste boiler) – 1 pre-calciner kiln (727 MMBTU/hr)	Complete Replacement in 2007 with new kilns under New Source Review (old kilns and boilers went out of service early 2008)	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Monterey Bay Unified Air Pollution Control District	Dynergy Moss Landing, LLC (formerly Duke Energy, Moss Landing Power Plant) (EGU) – Boiler Unit 6 – Boiler Unit 7	– Both tangential-fired boilers retrofit post-1980 with SCR, regulatory limit of 10ppm NOx and 10ppm ammonia slip – Burns natural gas; fuel oil not allowed – CEM on this facility report annually to district – NOx: Rule 4-31 limit 0.30 lbs/million Btu – SOx: low sulfur fuel only – Cooling System best achievable non-air environmental impact per California Energy Commission's Order No. 00-1025-24	NO
San Diego County Air Pollution Control District	Cabrillo Encina Plant (Carlsbad) (EGU) – Units 1-5 have SCR – Unit 6 is peaking unit with water injection & permit limited to 877 hours of operation	SCR or permit-limited operation	NO
San Diego County Air Pollution Control District	Duke Energy (South Bay) (EGU) – Units 1-4 have SCR – Unit 5 is peaking unit with water injection & permit limited to 877 hours of operation	SCR or permit-limited operation	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
San Joaquin Valley Air Pollution Control District	J R Simplot Company (Nitrogenous Fertilizer and Sulfuric Acid Plant (Lathrop) – Sulfuric Acid Plant	– TOTAL PTE NOx + SOx + PM10 = 660 TPY – Distance to nearest Class 1 Area > 100 kilometers and facility is not clustered with other sources, Q/D < 10	NO
San Joaquin Valley Air Pollution Control District	Big West (formerly Equilon Bakersfield Refinery) (also former IVEC and Tosco refineries in Bakersfield) – Process Heaters/ Boilers/ Steam Generators/ Internal Combustion Engines (all less than 250MMBTU/hr.) – Flares – Cooling Towers – Tanks	– NOx controlled by BARCT Rules 4305, 4306, 4701, 4702 – Flares controlled by Rule 4311 – Tanks: Rule 4623 – During Baseline: NOx>250 TPY PTE, but phased reductions bring current operations to Total PTE NOx+SOx+PM10 ~ 313 TPY – Distance to nearest Class 1 Area = 80 kilometers and facility is not clustered with other sources, Q/D < 10	NO
San Joaquin Valley Air Pollution Control District	Aera Energy LLC (Coalinga oil fields – southwest of Fresno on west side of Valley) (Permit 1121) ~7,600 barrels of heavy crude per day	– Boilers: BARCT Rules 4305 & 4306 – Tanks: Rule 4623 – Low sulfur fuel used	NO
San Joaquin Valley Air Pollution Control District	Aera Energy LLC (Midway Sunset Complex NW of Bakersfield) (Combined Permit 1136/1548) – IC engines – light oil production field ~50,000 barrels per day	– IC engines: BARCT Rules 4701 & 4702 – Tanks: Rule 4623 – Low sulfur fuel used where system not electrified	NO
San Joaquin Valley Air Pollution Control District	Aera Energy LLC (Bellridge Complex oil fields near Fellows) (also former Shell California Production Western E & P) (Combined Permit 1135/1547) heavy oil production field >140,000 barrels per day all boiler steam generators <250 MMBTU/Hr heat input	– Boilers: BARCT Rules 4305 & 4306 – Tanks: Rule 4623 – Low sulfur fuel used – Shell Facility during baseline period now part of Aera Bellridge Complex	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
San Joaquin Valley Air Pollution Control District	Chevron (by 2008) formerly Nuevo Energy Co. aka Plains Exploration & Production Co. (Fresno County "Address": S. 7f T. 20s R. 16e (Permit 2885) – gas & light oil production *(Actual NOx/SOx/PM10 <250TPY during baseline years; PTE not available)*	– IC engines: BARCT Rules 4701 & 4702 – Tanks: Rule 4623 – Low sulfur fuel used – Converting to electrified engines	NO
San Joaquin Valley Air Pollution Control District	Nuevo Energy Company aka Plains Exploration & Production Company (Kern County) (Permit 1372) – heavy oil production – all boiler steam generators <250 MMBTU/Hr heat input *(Actual NOx/SOx/PM10 < 250TPY during baseline years; PTE not available)*	– Boilers: BARCT Rules 4305 & 4306 – Tanks: Rule 4623 – Low sulfur fuel used	NO
San Joaquin Valley Air Pollution Control District	Spreckels Sugar Company (Mendota) (Permit 1179) – 311 MBTU/hr Boiler	– Boiler: BARCT Rules 4305 & 4306 – Low sulfur fuel used	NO
San Joaquin Valley Air Pollution Control District	Occidental Of Elk Hills, Inc. (by 2008) aka Vintage Petroleum Inc (Kern County) (Permit 1738) – light oil production Occidental Of Elk Hills, Inc. (linked to Vintage) (Gas Plant) (Tupman, Kern County) (Permit 2234) – Crude Petroleum & Natural Gas production – 2000 horsepower IC engine	– IC engines: BARCT Rules 4701 & 4702 – Tanks: Rule 4623 – Low sulfur fuel used – Converting to electrified engines	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
San Joaquin Valley Air Pollution Control District	Chevron USA Inc. (Fresno) aka Chevron-Texaco (Permit 0311) – heavy oil production – Large boiler Chevron USA Inc (Kern) aka Chevron-Texaco (Kern County) (Permit 1127) – Heavy Oil Production Texaco Exploration aka Chevron-Texaco (Fresno) (Permit 1311) – Heavy Oil Production Santa Fe Energy Resources, Inc aka Chevron-Texaco (Permit 1311) (sold to Texaco and dismantled 1998) Chevron USA Inc aka Chevron-Texaco (Kern County) (Permit 1128) – Heavy Oil Production Chevron USA Inc aka Texaco Explor & Prod Inc aka Chevron-Texaco (Kern County)(Permit 1129) – Heavy Oil Production Texaco California Inc. (TCI) aka Chevron-Texaco (Kern County)(Permit 1141) – Heavy Oil Western	Boilers: BARCT Rules 4305 & 4306 Tanks: Rule 4623 Low-sulfur fuel used *(All these facilities may have been operating under separate permits during the baseline years but they are all under one permittee by 2008)* *(Permits 1127, 1128, 1129, 0311, 1131, 1141 are all connected)*	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
San Luis Obispo County Air Pollution Control District	Duke Energy (Morro Bay EGU) – Unit 3 retrofit 1994-5 (OFA, LNB, FGR) – Unit 4 retrofit 1994-5 (OFA, LNB, FGR) (application to replace entire facility pending approval by California Energy Commission)	NOX: entire facility permit limited to 2.5 TPD, bubbled with post 1977 units 6 and 7, (facility<1000TPY) SOX: natural gas fired – State low sulfur fuel limits	NO
San Luis Obispo County Air Pollution Control District	Conoco-Phillips (formerly TOSCO) (Santa Maria Refinery) – coke calciner	Conoco-Phillips surrendered permit for Santa Maria Calciner in November 2007 per agreement with CA Attorney General for GHG reductions	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
South Coast Air Quality Management District	Rhodia Sulfuric Acid Plant (Carson)	SOx & NOx: RECLAIM [2] PTE for PM10 is <15TPY	NO
South Coast Air Quality Management District	California Portland Cement (Colton)	SOx & NOx: RECLAIM [2] PM10: Rule 1156 and kilns vented to baghouse equipped with pulse jet electronic control	NO
South Coast Air Quality Management District	So Cal Gas (Natural Gas Transmission) (Northridge)	SOx & NOx: RECLAIM [2] PTE for PM10 is <15TPY	NO
South Coast Air Quality Management District	BP West Coast Products (refinery)(Carson) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	BP Wilmington Calciner (refinery)(Wilmington) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	Ultramar, Inc. (refinery) (Wilmington) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
South Coast Air Quality Management District	Chevron Products Company (refinery) (El Segundo) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	Exxon Mobil Oil Corporation (refinery) (Torrance) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	Conoco Phillips Company (refinery) (Carson) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	Conoco Phillips Company (refinery) (Wilmington) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO
South Coast Air Quality Management District	Tesoro Corporation (refinery) (Wilmington) – Coke handling Unit – FCCU – Cooling Towers	SOx & NOx: RECLAIM [2] PM: R1158 & R1105.1 as adopted in 1999 & 2003	NO

Table 5-2 List of BART-eligible Sources (Emission Units) (continued)

Air District	BART-Eligible Source [1]	BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm)	Further Action Needed
Ventura County Air Pollution Control District	Reliant EGU (Ormond Beach) – Unit 1 Steam Generator (SCR in 1990's, AI) – Unit 2 Steam Generator (SCR in 1990's, AI) (natural gas, lo-sulfur fuel) – two auxiliary steam generators (LNB, FGR in 1990's)	BARCT (California Best Available Retrofit Control Level for Ventura) Total facility emission levels given as illustrative example only: Permitted Emissions (TPY) 2004 Actual Emissions (TPY) 86.70 ROC 38.3 ROC 621.58 NOx 84.5 NOx 154.34 PM 28.9 PM 37.04 SOx 6.9 SOx 2778.20 CO 520.5 CO permit allows full time use of Unit Nos. 1 & 2	NO

[1] For the facilities requiring subject-to-BART modeling, listed units preceded with an asterisk were not modeled for one of the following reasons:
- the unit is utilized during start-up, shut-down, malfunction, and other unpredictable, non-routine upsets;
- the unit is used for emergency relief, when upstream control units cannot accommodate sudden, non-routine emissions;
- the unit has minimal emissions into a closed system where its emissions are captured and routed to another unit which was modeled; or
- the unit is permit-limited to an emission level that is below the de minimus levels for NOx, SOx, and PM10, and is effectively controlled to BART level such that there is no more stringent control option available for the unit.

The emissions from these units are very low, but they were "brought into" BART-eligible listing because emissions from other BART-eligible units at the facility exceeded the 250 TPY threshold.

[2] The RECLAIM Program in the South Coast Air Quality Management District is designed to generally substitute a cap-and-trade market mechanism for a command-and-control regulatory structure in the pursuit of NOx and SOx emissions reductions from major facilities within the District. The intent of the program is to reduce emissions of these pollutants at a faster rate than could be achieved by traditional methods and at lower overall cost.

The RECLAIM Program was originally adopted in 1993, and requires three stages of emission reduction by 2011. In the first stage, which extended to 2000, facilities were required to compute emissions using historical activity rates and emission factors representing best available retrofit technology (BARCT) in 1993. Facilities were further required to meet facility-wide emission targets based on these 1993 BARCT factors by 2000. In the second phase of emission reductions, affected facilities were required to reduce NOx and SOx emissions between 2000 and 2003 by a uniform percentage calculated by the District. RECLAIM rules require that this reduction be sufficient to bring the aggregate of affected facility emissions to attainment targets specified in the 1991 Air Quality Management Plan.

In 2005, the District conducted a study to determine whether reductions under these first two phases were equivalent or greater than those that would have been achieved by the application of BARCT rules to all affected facilities. This study concluded that BARCT limits were more restrictive in 2005 than in 1993, and recommended amendments to the RECLAIM program to achieve these new lower levels. The RECLAIM rules were amended in 2005 and regulated facilities now must further reduce emissions by 2011 to achieve facility-wide emission levels equivalent to those represented by 2005 BARCT limits.

As a result of the scope of the RECLAIM Program in covering all facilities emitting four or more tons per year of NOx or SOX, and the diligence with which SCAQMD staff have analyzed and compared the benefits of this program to the universal application of BARCT to all stationary sources, the RECLAIM Program can be deemed equivalent in terms of emission reduction to the application of a universal BARCT regulation or the equivalent BART limitation under U.S. EPA's visibility protection program.

Abbreviations Used in Table 5-2

AI – Ammonia Injection
BARCT – Best Available Retrofit Control Technology
dv – Deciview or deciviews
EGU – Electric Generating Unit
ESP – Electrostatic Precipitator
FCCU- Fluid Catalytic Cracking Unit
FGR – Flue Gas Recirculation
GHG – Greenhouse gas
IC – Internal Combustion (engines)
lbs – pounds
JHT – Jet Hydrotreater
LNB – Low NOx burner
MMBTU – One million British Thermal Units, (also a thousand thousand BTUs)
NOx – Oxides of Nitrogen
NSCR – Non-Selective Catalytic Reduction
OFA – Over Fire Air
PM – Particulate Matter (usually followed by 10 or 2.5 to denote the largest particle size in microns)
ppm – Parts per million
PTE – Potential to Emit
Q/D – Q is the total of PTE for NOx + SOx + PM10 divided by distance in kilometers to Class 1 Area
ROC – Reactive Organic Carbon
SCR – Selective Catalytic Reduction
SOx – Oxides of Sulfur
SRU – Sulfur Recovery Unit
TBD – To be determined
TPD – Tons per Day
TPY – Tons per Year
WI – Water Injection

5.9 BART Determination

Valero Refining Company (Valero) operates a refinery in Benicia, in Solano County, in the San Francisco Bay Area Air Quality Management District (BAAQMD). The refinery is about 50 kilometers east of Point Reyes National Seashore. It has 27 individual BART-eligible units. Eighteen of the units emit to 12 stacks. Four are flares subject to a consent decree. Five units have no emissions or very low, non-routine, upset emissions collected and routed to pollution control devices or newer process units after 1977. The 24-hour maximum emissions during 2000-2002 were modeled for the 12 stacks. The flares were not modeled due to the non-routine nature of their operations. The remaining units were not modeled for the same reason, and because their minimal emissions are collected by non-BART-eligible controls or processes. The baseline case reflects operations during the modeling period used to obtain subject-to-BART modeling results.

Since the modeled impact of the cumulative emissions from the BART-eligible units at the facility was more than 0.5 dv, but less than one deciview over the threshold, the impacts are considered to contribute to, but not cause, haze at the Point Reyes National Seashore on the coast north of San Francisco. Therefore, BAAQMD completed a BART determination for the BART-eligible sources at the facility (Appendix D).

The BAAQMD evaluated every source for the most stringent level of technical control first. If a technology was not feasible due to physical or operational constraints, energy or non-air quality related impacts, or compliance cost, it was ruled out. The existing level of control and the lifetime of the existing equipment were also considered in evaluating the options. The Claus Units and the Cooling Tower are already operating at BART level, considering the available technology, operational constraints, and the cost of replacement for minimal emission reductions. In other words, no retrofit controls are available for the Cooling Tower and the Claus Units better than what currently exists, short of a complete rebuild. Also, these two types of units exist in part to control emissions. The Cooling Tower has internal baffles to dampen the emissions of condensable aerosol particles and the Claus Units are part of a SOx capture and recovery system. Further, the sulfur storage tank is a “closed system” built before 1977, but connected since then to the Claus units as a means of eliminating any emissions.

Based on the BAAQMD analysis, ARB modeled visibility impact for two scenarios. Option 1 includes the most stringent controls feasible for five of the emission units, including potential replacement of one reformer furnace with a Best Available Control Technology (BACT) level unit under New Source Review. The existing reformer furnace currently operates at BART level, but Option 1 includes the furnace replacement to BACT standards to evaluate the visibility impact. Option 2 adds selective catalytic reduction for the four boiler-turbine sets to Option 1, to determine whether the incremental benefit to visibility is cost-effective. The summary of modeled options for the Valero Refinery in Benicia are in Table 5-3.

Table 5-3 Summary of BART Determination Modeling

VALERO REFINERY (Benicia)	BART Determination Modeling	NOx 24-hr. max. TPD	SOx 24-hr. max. TPD	PM10 24-hr. max. TPD	deciviews over threshold on 8th highest day
Baseline Scenario	Units listed from Table 5-2 summarized as: • Four Main Stack P-1 Units: -Coker -Process Furnace F101 -Process Furnace F102 -FCCU Regenerator R702 • Reformer Furnace S-21 • Four Boiler-Turbine Sets • Two Claus Units • One Cooling Tower	3.83	17.14	0.77	0.758 dv
Option 1	• Retrofit and replace units contributing to main stack • Potential replacement of reformer furnace to BACT level under NSR	3.22	1.25	0.72	0.291 dv
Option 2	• Retrofit and replace units contributing to main stack • Potential replacement of reformer furnace to BACT level under NSR • SCR for Boiler-Turbine Sets	2.01	1.25	0.72	0.200 dv

Due to a Consent Decree, the BAAQMD is legally required to implement the BART level controls described in Table 5-4 below. These controls will be implemented within 5 years after U.S. EPA approves the Plan. In 2005, Valero Refinery Company and the U.S. EPA entered into a Consent Decree that underlies the improvements listed for the BART-eligible units emitting to a new Main Stack that will replace Stack P-1. The Consent Decree requires the improvements to be implemented by June 30, 2012, at the latest. The emission limit will be enforceable and assured by permit conditions assigned by the BAAQMD to the permits to construct and permits to operate these specific units at the Valero Refinery.

As explained above, Valero is evaluating the possibility of constructing a new reformer furnace to replace an existing BART-eligible furnace (S-21 or S-22.)

The existing BART-eligible reformer furnaces operate at a BART level of 0.033 pounds of NOx per million BTU of heat input on a refinery-wide basis, based on an operating-day average. CalPuff modeling evaluated the visibility impact of a replacement furnace in lieu of an existing unit in both Options 1 and 2. The potential (BACT-level) replacement would reduce NOx and PM, but slightly increase SOx, for a total change in magnitude of about 80 tons per year of all pollutants combined. The additional visibility improvement at Point Reyes National Seashore due to replacing either existing furnace S-21 or S-22 is estimated to be about 0.02dv, a very marginal impact on visibility for the cost per ton of pollutant reduced. Nevertheless, this analysis does not preclude the refinery from proceeding with upgrades and new construction to reduce emissions in the future.

As explained in the BART Determination Report (Appendix D), adding Selective Catalytic Reduction to the Boiler-Turbine Sets was deemed not cost-effective for the minimal improvement in visibility, about 0.025 dv per linked boiler-turbine set. Lesser controls for these units were not evaluated for visibility impact. As with the potential reformer furnace replacement discussed above, the incremental improvement in visibility is approaching a level of uncertainty in modeling. Instead, the boiler turbine sets will continue to operate under the existing BAAQMD Prohibitory Regulation 9, Rule 9 requiring a NOx concentration of no more than 55 ppmv at 15% O2.

Although the four BART-eligible flares at the Valero Refinery were not modeled, a consent decree between the U.S. EPA and the Valero Refining Company requires a flare minimization protocol. It also requires a causal analysis for excursions above 500 lbs SO2/day. The flares already have upstream gas recovery systems, which are considered BACT for flares.

A summary of the BART emission limits and retrofit controls on BART-eligible units at the Valero Refinery is found in Table 5-4.

Table 5-4 BART Determination for Selected Units at Valero Refinery

UNIT	NOx Emission Limit Citation	SO_2 Emission Limit Citation	PM Emission Limit Citation	BART Implementation Date
"Main Stack:" -Valero Coker, -FCCU, -CO Boilers (Units S3, S4, S5, S6)	BAAQMD Permit Condition #11030, part 3	Consent Decree entered in *United States, et. al. v. Valero Refining Company, et. al., (W.D. Tex., Civil Action No. SA-05-CA-0569, entered November 23, 2005)*	SIP Regulation 6	Limits incorporated in Title V Permit by December 31, 2013

6. SOURCE APPORTIONMENT AND MODELING RESULTS

The Regional Haze Rule requires that the Plan contain information regarding the sources contributing to visibility impairment as well as visibility projections for the 2018 milestone year. To provide the necessary technical and policy tools needed by states and tribes to comply with these requirements, the WRAP has established a Regional Modeling Center (RMC) at the University of California, Riverside with assistance from ENVIRON Corporation and the University of North Carolina. The RMC provides assistance to state and tribal agencies in conducting regional haze analyses over the western United States. This analysis has been performed by operating regional scale, three-dimensional air quality models that simulate the emissions, chemical transformations, and transport of gaseous criteria pollutants and fine particulate matter (PM) and consequent effects on visibility in Class 1 Areas in the western United States. In the RMC analyses, states participated in various forums to help develop a coordinated emissions inventory as discussed in Chapter 3, to evaluate the modeling processes, and to analyze source impacts on regional haze. Detailed information on the WRAP RMC modeling can be found in Appendix E.

6.1 Description of Source Apportionment Methods

A variety of modeling and data analysis methods can be used to evaluate the role of different source types in contributing to visibility at a given receptor site. One method, the weighted emissions potential analysis, was developed as a screening tool to decide which source regions have the potential to contribute to haze formation at Class 1 Areas, based on annual emissions inventories, baseline period wind patterns, and source to Class 1 Area distances. Although the weighted emissions potential analyses used a slightly different inventory than the modeling used to estimate future concentrations, it is still a good indicator of the sources contributing to haze.

Another method of source apportionment is to implement a mass-tracking algorithm in an air quality model to explicitly track for a given emissions source, the chemical transformations, transport, and removal of the PM that was formed from that source. This algorithm, the PM Source Apportionment Technology (PSAT), was implemented in the Comprehensive Air Quality Model with extensions (CAMx) and used for the WRAP modeling analysis. PSAT performs source apportionment based on user-defined source groups. A source group is the combination of a geographic source region and an emissions source category. PSAT was performed for organic carbon, sulfate and nitrate. The different source categories evaluated include point sources, area sources, biogenics, off-shore emissions, natural and anthropogenic fires, on- and off-road mobile sources, road dust, fugitive dust, and wind blown dust.

6.2 Source Apportionment Results

Examples of the results of these source apportionment methods are provided in this section in order to highlight how these tools can be used to identify the key source contributions to haze at California's Class 1 Areas. Results are shown for organic carbon, nitrate, and sulfate, the three drivers of haze in California. These examples illustrate three key groupings of source contributions: 1) anthropogenic sources within the WRAP region, 2) natural sources, and 3) sources, both anthropogenic and natural, from outside the WRAP region. More detailed information on source attribution for each individual Class 1 Area can be found in Appendix B.

6.2.1 Organic Carbon Source Apportionment

As described in Chapter 2, organic carbon is a key driver of haze at many Class 1 Areas. Figure 6-1 shows source apportionment results for organic carbon at the Hoover Class 1 Area on the 20 percent worst days. The plot shows the amount of organic carbon that is derived from secondary organic aerosols from biogenic sources, secondary organic aerosols from anthropogenic emissions, and organic carbon that is directly emitted from both biogenic and anthropogenic sources. The secondary biogenic contributions to haze are the result of VOC emissions from plants, which react in the atmosphere to form organic aerosols. Biogenic contributions are significant throughout the year, but increase substantially during the summer months when plants are in their most active growth phase. The contribution from anthropogenic secondary organic aerosols (i.e. from anthropogenic VOC emissions) is very small. The remaining organic carbon comes from directly emitted sources, which also increase during the summer.

Figure 6-2 shows the results of the weighted emissions potential analysis for sources of directly emitted organic carbon at Hoover on the 20 percent worst days in 2002 as compared to 2018. The weighted emissions potential analysis shows that natural fire (wildfires) is the largest contributor, representing approximately 50 percent of the directly emitted organic carbon. This contribution is expected to remain constant in 2018. A large contribution from natural fire is seen at many Class 1 Areas in Northern California and the Sierras, with some areas such as Dome Lands indicating that almost 90 percent of the directly emitted organic carbon can be attributed to natural fire.

Figure 6-1 Organic Aerosol Source Attribution

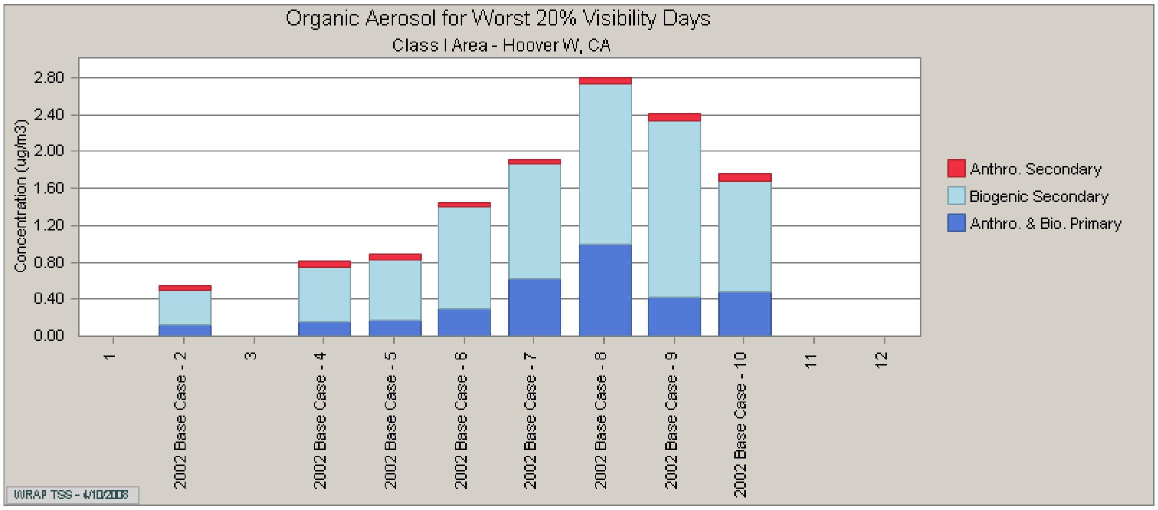
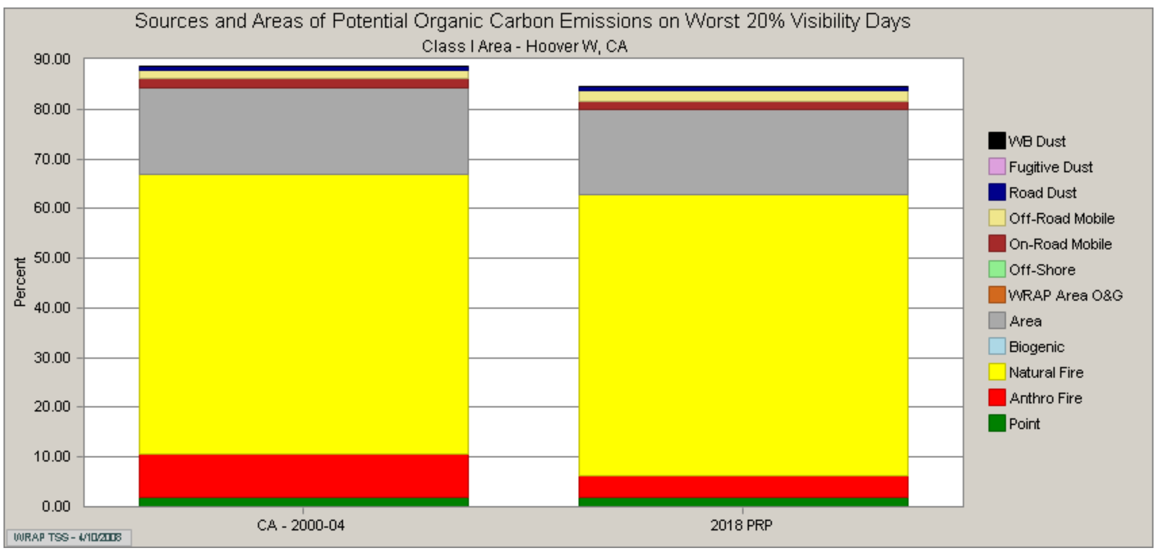


Figure 6-2 Sources of Organic Carbon on Worst 20 Percent Haze Days



6.2.2 Nitrate (NOx) Source Apportionment

Figures 6-3 and 6-4 illustrate the results of the nitrate PSAT analysis for the San Gabriel Wilderness Area on the 20 percent worst days. In contrast to the previous organic carbon example, the bulk of nitrate contributions at San Gabriel were found to come from anthropogenic sources, with roughly 75 percent of the nitrate from sources within the WRAP region. Of this, the largest contributions were from on- and off-road mobile source emissions in California. The figures also highlight the substantial future visibility improvement that will result from mobile source sector emission reductions. Similar findings regarding the predominance of California mobile sources were found for nitrate at the majority of other Class 1 Areas.

Figure 6-3 Sources of Nitrogen Oxides on Worst 20 Percent Haze Days

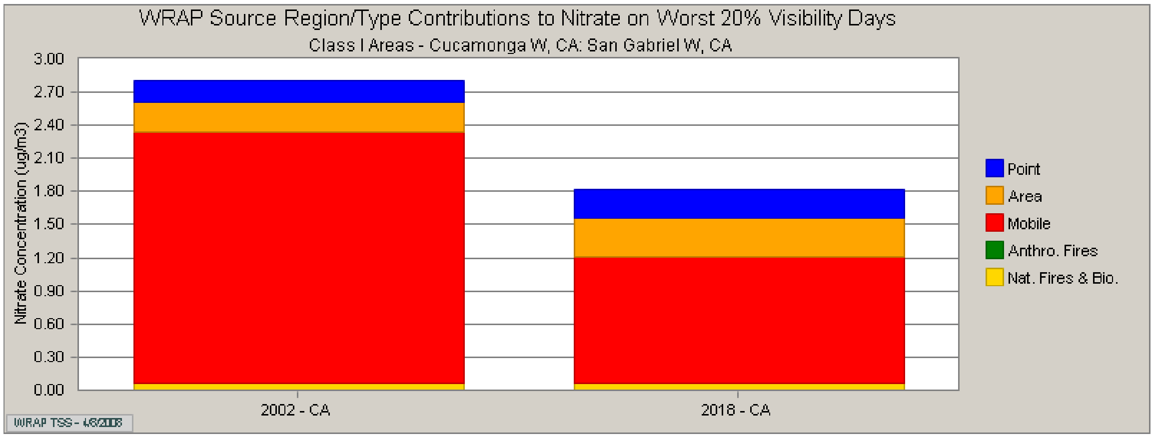
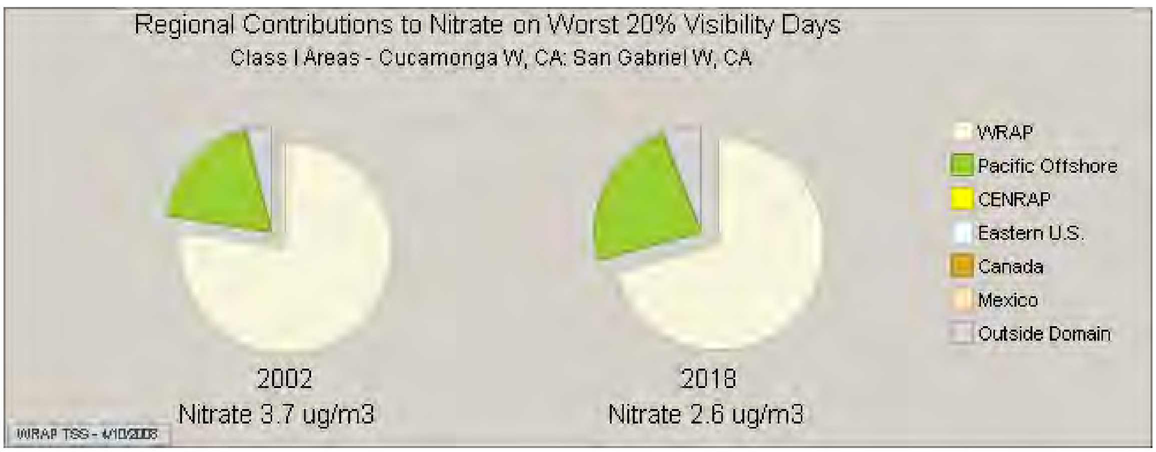


Figure 6-4 Source Region Origin of Nitrate on Worst 20 Percent Haze Days



6.2.3 Sulfate Source Apportionment

Figure 6-5 shows the results of sulfate PSAT analysis for Redwoods National Park on the 20 percent worst days. Point and area sources represent the largest category of California emissions for sulfate, however, California's aggregate contribution is less than 2 percent to the modeled sulfate contributions at Redwoods. On the coast, sulfur oxide sources include natural emissions from marine organisms, as well as large contributions from shipping in the Pacific Off-Shore region. Figure 6-6 provides an example of the impact of different source regions at the Redwoods Class 1 Area based on the PSAT analysis. This analysis illustrates that not only do the emissions that are quantified in the Pacific Offshore region contribute significantly, but that emissions outside the WRAP modeling domain contribute approximately half of the sulfate at this Class 1 Area.

Similar impacts from non-WRAP source regions were seen at California's other Coastal and Southern California sub-region sites.

Figure 6-5 Sources of Sulfur Oxides on Worst 20 Percent Haze Days

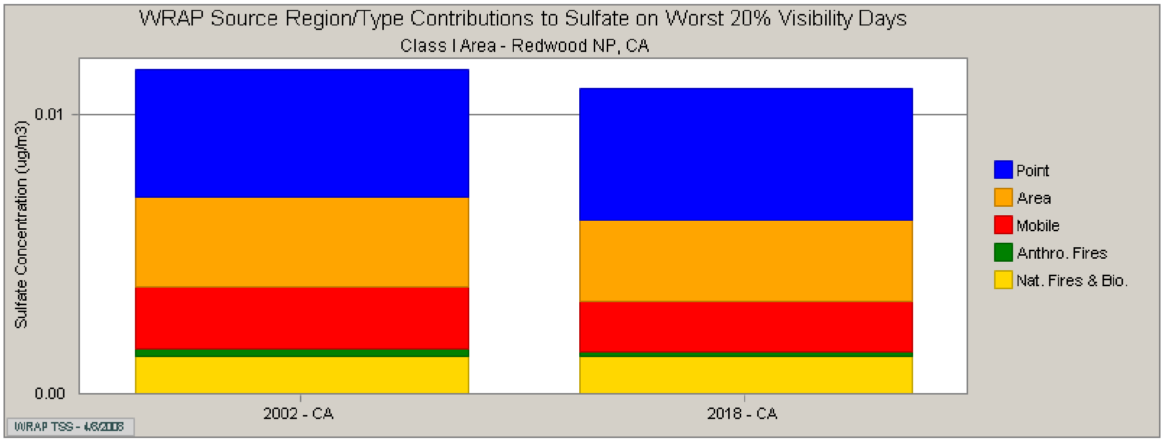
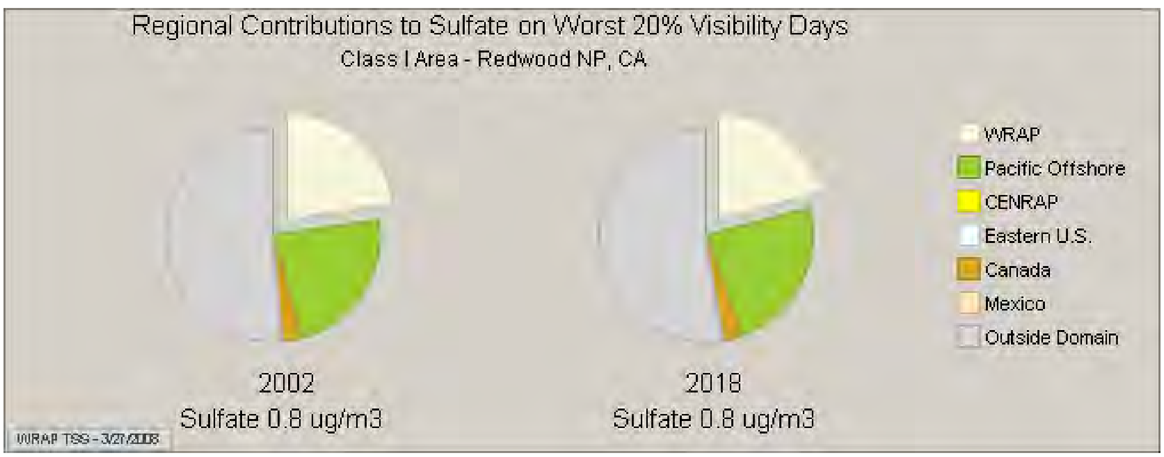


Figure 6-6 Source Region Origin of Sulfate on Worst 20 Percent Haze Days



6.2.4 Summary of California Source Apportionment

Using the weighted emissions potential analyses, estimates for the 20 percent worst haze days based on baseline conditions were made for each Class 1 Area of the contribution from directly emitted organic carbon emissions that are derived from California anthropogenic emission sources. California anthropogenic, directly emitted, organic carbon appears to contribute approximately half or less of the organic carbon in most areas except Point Reyes National Seashore (67 percent) and Pinnacles Wilderness Area (73 percent). Class 1 Areas in Southern California show less than 40 percent contributions from the anthropogenic, directly emitted, organic carbon sources. As explained in earlier sections, much of the directly emitted organic carbon in

California comes from wildfires. In addition, source apportionment modeling found that the majority of secondary organic carbon is derived from biogenic emission sources.

PSAT modeling was also conducted to provide estimates of the source region/categories contributing to nitrate and sulfate at each Class 1 Area. For nitrate, California anthropogenic NOx sources contribute 50 percent or more of the nitrate in all California Class 1 Areas with the exception of Redwoods National Park (7 percent). In contrast, the California anthropogenic sulfate contribution ranges from 1 to 35 percent. Class 1 Areas in California, especially the Coastal sub-region and in Southern California see larger impacts from off-shore shipping. Class 1 Areas in Southern California show slightly higher contributions from California anthropogenic sulfate (22 percent to 35 percent) than other Class 1 Areas, reflecting the proximity to point sources such as refineries as well as port-related activities. Using the information from the California anthropogenic emission sources in combination with the examples provided in Figures 6-1 through 6-6, the three primary drivers of haze in California will continue to come from natural sources for carbon, mobile sources for nitrate, and off-shore and non-WRAP region sources for sulfate. As stated in Chapter 4, California's 2018 Progress Strategy focuses on achieving significant reductions from sources within our jurisdiction, particularly mobile sources.

6.3 Transported Sources that Impact Baseline Visibility

As illustrated in the previous section, while sources within California have an influence on visibility at California Class 1 Areas, sources outside of California also cause an impact. The varied and complex terrain of California, coupled with complex meteorology allow for the transport of emission sources to Class 1 Areas from areas as close as neighboring states, Mexico, and the Pacific Ocean, to as far away as Asia. The following sections provide brief descriptions of the source regions outside of California that also cause visibility impacts in California's Class 1 Areas.

6.3.1 Mexico

Mexican emissions, particularly SOx, can be significant contributors to decreased visibility. The Class 1 Areas in the Salton Sea and the San Diego Air Basins are particularly influenced by transport from Mexico. California is strongly involved in collaborative efforts to complete emissions inventories and conduct pollutant monitoring to better characterize these impacts.

6.3.2 Asian dust

Asian dust has been seen in North America for a few very large events, most notably in April 1998 and again in April 2001. Some of this dust is natural but it is often accompanied by biomass smoke, agricultural dust, motor vehicle and industrial emissions. Asian aerosols can be a major component of PM in otherwise "clean" rural sites, but control of this source is difficult. Figure 6-7 shows the 2001 Asian dust storm and its affects on California monitors. Figure 6-8 shows a satellite photo of an Asian dust cloud.

Figure 6-7 Asian Dust Storm affect on CA monitors

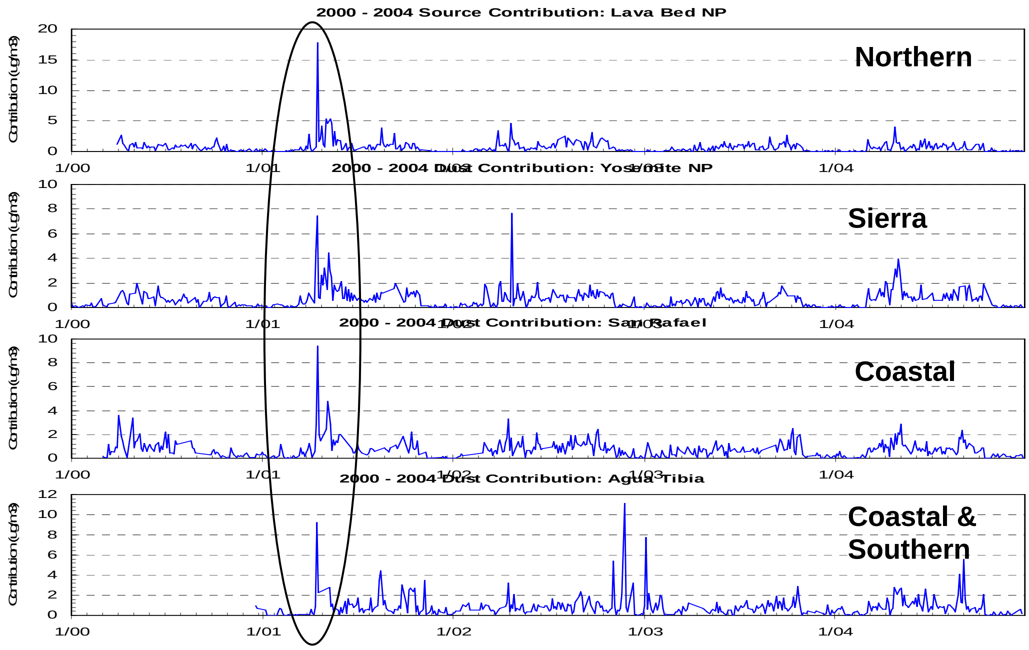
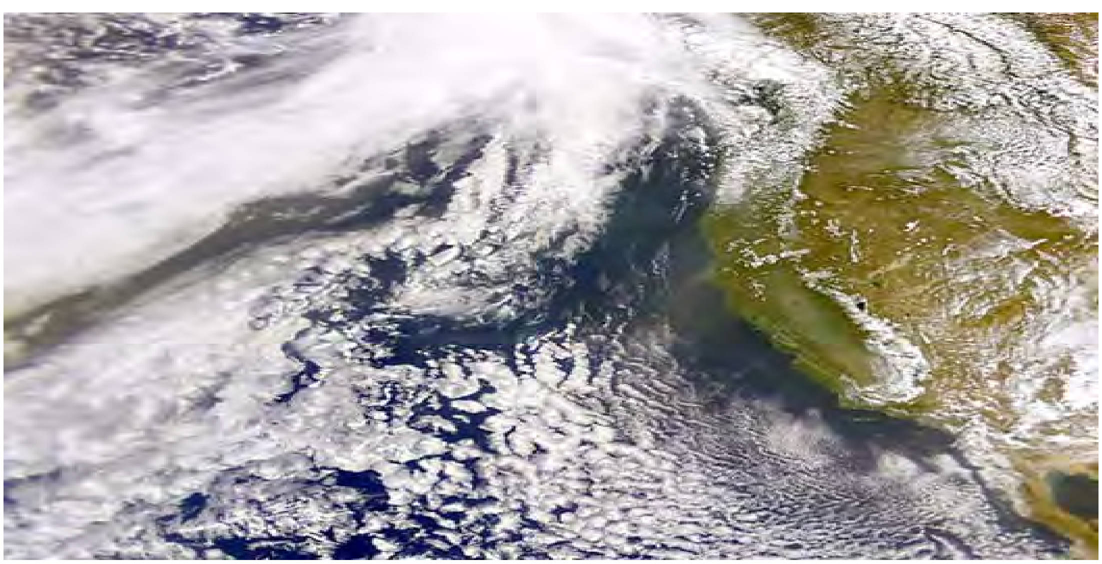


Figure 6-8 Asian Dust Storm traveling over to North America



6.3.3 Pacific Ocean, shipping emissions

Emissions from ocean-going vessels are a substantial contributor to sulfate visibility impairment at many of California's Class 1 Areas near the coast. Significant growth in shipping activity is expected in the near future. Ships have little or no emissions controls and tend to run on high emitting bunker fuel. The WRAP Pacific Offshore category looks at the combined offshore emissions from California, Washington, and Oregon. California control efforts for the near-shore portion of these emissions within our jurisdiction are described in Chapter 4, however, additional national and international efforts are needed to reduce the emissions from ships in transit further offshore.

6.3.4 Neighboring States

With mountains in the east and north, the ocean to the west, and prevailing weather patterns that move from west to east, emissions from neighboring states are not expected to significantly impact California, except for smoke from large wildfires. The western states are working in partnership through the WRAP to provide for coordinated haze planning in the West.

6.4 CMAQ Modeling Results for 2018

The previous sections provided an assessment of the sources contributing to haze. The Regional Haze Rule also requires an estimate of the effectiveness of California's 2018 Progress Strategy in improving visibility to be used in setting reasonable progress goals. In order to understand how emission source projections impact visibility in the future, the RMC used the Community Multi-scale Air Quality (CMAQ) model to simulate expected visibility levels in 2018 for the WRAP region. The CMAQ model has been designed to approach air quality as a whole by including state-of-the-science capabilities for modeling multiple air quality issues, including visibility degradation, fine particles, ozone, toxics, and acid deposition. In this way, CMAQ combines the capabilities to enable a community modeling practice. CMAQ is also designed to have multi-scale capabilities so that it can be used for urban and regional scale model simulations. The number and size of grid cells and the number and thicknesses of layers are defined by the user, based in part on the size of the modeling domain to be used for each modeling project. CMAQ offers a variety of choices in the numerical algorithms for treating many of these processes, and it is designed so that new algorithms can be included in the model.

CMAQ was used to project visibility levels from the mandated five-year (2000-2004) baseline period to 2018, the end of the first progress period, for both the 20 percent worst and 20 percent best days. This reflects the WRAP Plan02c and 2018b emissions scenarios. The visibility levels are estimated using baseline meteorological conditions and baseline and future emission inventories. Since it is difficult to replicate actual values, the model is used in a relative sense to evaluate the impact of emission changes. This relative change is called the Relative Response Factor (RRF), which is defined as the ratio of the future-year modeling results to the current-year modeling results. The calculated RRFs are then applied to the baseline observed visibility conditions to project 2018 observed visibility.

Table 6-1 shows the 2018 modeling results for the 20 percent worst and 20 percent best days. It is based on the monthly weighted RRFs comparing the 2000-04 baseline emissions to 2018 emissions. California selected the monthly weighted RRFs since they more accurately reflected the seasonality of the visibility problem. As shown in Table 6-1, the 2018 modeled projections for the 20 percent worst visibility days in all Class 1 Areas in California make progress towards natural conditions despite only having control of up to 50 percent of the problem. The 2018 modeled projections for the 20 percent best visibility days in all Class 1 Areas in California also show improving visibility.

The degree of improvement is dependent upon the contributions in each area from anthropogenic versus natural emission sources, as well as from sources outside of California. For example, in San Gorgonio, a wilderness area that is just downwind of the South Coast Air Basin, the improvement in visibility is nearly eight times larger than that achieved at Desolation, a wilderness area near Lake Tahoe. Because visibility is largely due to anthropogenic emissions in the upwind urban areas of the South Coast, the comprehensive control programs of ARB and the South Coast Air Quality Management District to attain the federal ozone and particulate matter standards will result in significant improvements in visibility at San Gorgonio. In contrast, analysis of the nature of the visibility problem at Desolation has found that wildfires as well as natural emissions from plants are a large portion of visibility impairment in the area. Therefore controls on anthropogenic emissions have a much more limited impact.

Table 6-1 Visibility Progress Summary (deciviews, Haze Algorithm II)

Lava Beds NP South Warner WA	15.1	14.4	7.9	3.2	3.0
Lassen Volcanic NP Caribou WA Thousand Lakes WA	14.2	13.3	7.3	2.7	2.5
Marble Mountain WA Yolla Bolly-Middle Eel WA	17.4	16.4	7.9	3.4	3.2
Desolation WA Mokelumne WA	12.6	12.3	6.1	2.5	2.5
Hoover WA	12.9	12.5	7.7	1.4	1.3
Yosemite NP Emigrant WA	17.6	16.7	7.6	3.4	3.2
Ansel Adams WA Kaiser WA John Muir WA	15.5	14.9	7.1	2.3	2.1
Sequoia NP Kings Canyon NP	25.4	22.7	7.7	8.8	8.1
Dome Lands WA	19.4	18.1	7.5	5.1	4.7
SOUTHERN CALIFORNIA					
San Gabriel WA Cucamonga WA	19.9	17.4	7.0	4.8	4.1
San Gorgonio WA San Jacinto WA	22.2	19.9	7.3	5.4	5.0
Joshua Tree WA	19.6	17.9	7.2	6.1	5.7
Agua Tibia WA	23.5	21.6	7.6	9.6	8.9
COASTAL CALIFORNIA					
Redwood NP	18.5	17.8	13.9	6.1	5.8
Point Reyes NS	22.8	21.3	15.8	10.5	10.1
Pinnacles WA Ventana WA	18.5	16.7	8.0	8.9	8.1
San Rafael WA	18.8	17.3	7.6	6.4	5.8

TSS Date: 11/12/2008

To provide insight into the visibility improvement that will result from NOx (primarily mobile source sector) emission reductions, Table 6-2 shows 2018 modeled visibility progress from nitrate reductions. The 2018 nitrate modeled projections for the 20 percent worst visibility days in all Class 1 Areas in California make tremendous progress. Between the baseline period and 2018, modeled nitrate is reduced from 21 percent to 56 percent at Class 1 Areas in California. Tables 6-3 and 6-4 show 2018 modeled visibility progress from sulfate and organic carbon (OC) reductions, respectively. Even though the sulfate and OC reductions do not make as much progress as nitrate, the 2018 modeled projections for 20 percent worst visibility days in all Class 1 Areas in California are reduced up to 5 percent for sulfate and from 4 to 22 percent for OC. Sulfate and OC show less progress due to the impacts of uncontrollable sources such as shipping/offshore and biogenic/wildfire emissions.

Table 6-2 Modeled visibility progress from nitrate reduction with California's 2018 Progress Strategy

Lava Beds NP South Warner WA	3.5	2.4	31
Lassen Volcanic NP Caribou WA Thousand Lakes WA	3.7	2.1	43
Marble Mountain WA Yolla Bolly-Middle Eel WA	6.1	3.6	41
Desolation WA Mokelumne WA	2.4	1.7	29
Hoover WA	1.6	1.2	25
Yosemite NP Emigrant WA	8.1	5.3	35
Ansel Adams WA Kaiser WA John Muir WA	7.0	5.5	21
Sequoia NP Kings Canyon NP	60.7	30.4	50
Dome Lands WA	16.0	8.5	47
San Gabriel WA Cucamonga WA	27.7	16.1	42
San Gorgonio WA San Jacinto WA	44.9	28.8	36
Joshua Tree WA	27.3	17.8	35
Agua Tibia WA	29.9	16.3	45
Redwood NP	6.0	4.2	30
Point Reyes NS	38.4	21.2	45
Pinnacles WA Ventana WA	17.1	9.1	47
San Rafael WA	12.6	5.6	56

TSS Date: 11/12/2008

Table 6-3 Modeled visibility progress from sulfate reduction with California's 2018 Progress Strategy

Lava Beds NP South Warner WA	6.8	6.6	3
Lassen Volcanic NP Caribou WA Thousand Lakes WA	6.8	6.6	3
Marble Mountain WA Yolla Bolly-Middle Eel WA	8.4	8.1	4
Desolation WA Mokelumne WA	5.1	5.1	0
Hoover WA	5.0	4.9	2
Yosemite NP Emigrant WA	7.9	7.7	3
Ansel Adams WA Kaiser WA John Muir WA	7.6	7.5	1
Sequoia NP Kings Canyon NP	16.5	16.2	2
Dome Lands WA	12.0	11.8	2
San Gabriel WA Cucamonga WA	12.3	11.7	5
San Gorgonio WA San Jacinto WA	13.2	12.8	3
Joshua Tree WA	12.3	11.8	4
Agua Tibia WA	31.8	30.2	5
Redwood NP	14.9	14.2	5
Point Reyes NS	14.1	13.8	2
Pinnacles WA Ventana WA	13.9	13.6	2
San Rafael WA	20.4	19.9	2

TSS Date: 11/12/2008

Table 6-4 Modeled visibility progress from organic carbon reduction with California's 2018 Progress Strategy

Lava Beds NP South Warner WA	22.0	20.9	5
Lassen Volcanic NP Caribou WA Thousand Lakes WA	17.2	15.6	9
Marble Mountain WA Yolla Bolly-Middle Eel WA	35.3	32.5	8
Desolation WA Mokelumne WA	14.1	13.3	6
Hoover WA	15.4	14.5	6
Yosemite NP Emigrant WA	29.0	26.4	9
Ansel Adams WA Kaiser WA John Muir WA	16.8	15.7	7
Sequoia NP Kings Canyon NP	32.4	30.2	7
Dome Lands WA	17.1	16.2	5
San Gabriel WA Cucamonga WA	15.3	11.9	22
San Gorgonio WA San Jacinto WA	14.0	12.6	10
Joshua Tree WA	10.3	9.5	8
Agua Tibia WA	17.6	16.5	6
Redwood NP	8.0	7.7	4
Point Reyes NS	12.1	11.5	5
Pinnacles WA Ventana WA	13.2	12.1	8
San Rafael WA	12.4	11.2	10

TSS Date: 11/12/2008

In summary, modeling and source apportionment results show that all 29 California Class 1 Areas make progress towards improving visibility in 2018 and that California's 2018 Progress Strategy is effective at reducing emission sources under State control.

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7. Demonstration of Reasonable Progress Goals

7.1 Reasonable Progress Requirements

The Regional Haze Rule requires California to establish goals for the year 2018 that provide for reasonable progress towards achieving natural visibility conditions in 2064 at each of its Class 1 Areas. The Reasonable Progress Goals (RPGs) must be expressed in deciviews and indicate the planned improvement in visibility for the 20 percent most-impaired days (worst days) of the baseline years by 2018. The Plan must also ensure no degradation in visibility for the 20 percent least-impaired days (best days) of the baseline years.

In establishing the RPGs, a state must consider four factors:

1. costs of compliance;
2. time necessary for compliance;
3. energy and non-air quality environmental impacts of compliance; and
4. remaining useful life of any potentially affected sources.

California included a demonstration showing how these factors were taken into consideration in the previous discussion of the 2018 Progress Strategy. The rulemaking process for both ARB and the local air districts in California have embodied consideration of the four factors for decades. Continuous efforts to attain and maintain the federal and State health-based air quality standards are the reason that California feels confident that every reasonable measure is included in the State's 2018 Progress Strategy backing the RPGs.

It is also important to note that the Regional Haze Rule states that the RPGs established by a state are not directly enforceable, but rather will be considered by U.S. EPA in evaluating the adequacy of the measures in the Plan to achieve the progress goal adopted by a state. Specifically, U.S. EPA noted in the Regional Haze Rule that:

> "There are no presumptive targets that states are required to meet to achieve reasonable progress. States have flexibility in determining their reasonable progress goals based on consideration of the statutory factors. However, the final rule requires states to conduct certain analyses to ensure that they consider the possibility of setting an ambitious reasonable progress goal, one that is aimed at reaching natural conditions in 2064."

7.2 Reasonable Progress Goals in California

California has set RPGs for each California Class 1 Areas as shown in Table 7-2. These RPGs are based upon the results of the WRAP modeling scenario described in Chapter 6. While the 2018 scenario that was modeled includes the benefits of control measures adopted by ARB and local air districts, it does not include possible BART reductions because they were not available at the time of WRAP modeling. However, reductions due to BART expected in California and from upwind states will have minimal effect on haze at the California IMPROVE monitors. These reductions will be included in future regional modeling and progress re-evaluated at the mid-course review.

The projected deciview levels are the modeled results of the phased implementation of California's 2018 Progress Strategy. This strategy represents an ambitious and far-reaching level of control for achieving reductions in the anthropogenic contributions to visibility impairment in California. California's 2018 Progress Strategy for reducing haze has focused on identifying the major drivers of haze on worst days, and determining the primary sources of those species and their precursors. In particular, significant reductions in the nitrate component of haze are predicted due to the extensive NOx emission reductions from California's mobile source control programs. However, evidence from source apportionment analysis showed that not all of the emissions contributing to haze come from anthropogenic sources within California's control. Emissions from natural sources such as wildfires and biogenics, whether from in-State or out-of-State, can contribute significantly to impaired visibility at all Class 1 Areas in California. In addition, visibility impacts are also seen from international sources outside the WRAP states.

Hence, for this first planning period, our focus is on demonstrating the improvements in visibility that will result from California's broad spectrum of control efforts. We believe the RPGs are reasonable for the first planning period considering: (a) California is controlling in-State anthropogenic sources at levels well beyond those achieved through national programs; (b) the 2018 Progress Strategy has embodied the four-factor analysis requirement for decades and is, therefore, reasonable from a western regional perspective; (c) there are significant contributions from sources not included in the WRAP region, and (d) there is uncertainty in the values being reflected in the current natural conditions due to wildfires and biogenics which may underestimate the true natural conditions for the West.

The RPGs displayed in Table 7-2 show that visibility will improve on the worst days and will not deteriorate on the best days by 2018. While visibility is expected to improve in 2018 throughout the West, the greatest gains will be seen in California. Coastal and Southern California Class 1 Areas make the greatest progress. Sites in these regions have large contributions from nitrate and therefore California's mobile source NOx control program provides significant reductions in the nitrate component by 2018. Lesser progress is seen in Northern California and Sierra Nevada Class 1 Areas. While significant reductions in nitrate are also seen at these sites, the continuing impacts of natural fire, biogenics, offshore shipping and other emissions not included in the WRAP region limit the amount of overall progress that can be achieved.

In the following sections we have summarized the role of controllable versus uncontrollable emissions and the benefits of California's control programs for each haze component.

- **Organic carbon** is the primary or secondary driver of worst day haze, in all of the State but Southern California. The WRAP source apportionment analysis suggests that wildfires, biogenics (natural plant, animal, and soil organism emissions), and area sources are the primary contributors to organic carbon constituting from 25 percent to 90 percent on worst days. Biogenic emissions peak during the dry wildfire season, and contribute the most natural organic carbon annually. ARB's emissions inventory indicates the largest category of area source emissions of organic carbon may be winter-time residential wood combustion. Many air districts in California are developing programs to minimize the emissions from this source by requiring use of U.S. EPA certified woodstoves, and instituting voluntary or mandatory no-burn day programs. Stringent ARB controls for mobile sources are also helping to curb both directly emitted PM and volatile organic carbon emissions that contribute to the organic carbon component of visibility impairment.

- **Nitrates** are a key driver of haze at many sites, especially in Southern California and other sites located near major urban areas and transportation corridors. In-State anthropogenic NOx emissions are estimated to account for 7 percent to 86 percent of nitrate contributions to haze at California Class 1 Areas. Reducing this precursor to nitrate formation is a major first step in reducing regional haze. The gradient of least to most influence corresponds directly to the amount of mobile source NOx emissions nearby. Back-trajectory analyses and future conditions modeling indicate that substantial reductions in nitrate, roughly 50 percent at every State Class 1 Area are achievable due to planned mobile source NOx emission reductions.

- **Sulfates** also drive haze at all IMPROVE monitors on some worst days, but the influence is most perceptible along the coast. Offshore and non-WRAP region sources are the largest contributors, accounting for approximately 50 to 75 percent of the measured sulfate levels. In-State anthropogenic emissions are estimated to account for 1 percent to 35 percent. There are very few large SOx sources in California and low sulfur fuel is already required for both mobile and stationary sources. Offshore emissions appear to contribute both natural marine sulfates and SOx from marine commercial shipping activities. California's Goods Movement Program is designed to address many port-related SOx emissions. The feasibility of further SOx reduction measures will be evaluated during the mid-course review.

- **Coarse Mass** does not drive haze on worst days in California, although occasionally it may contribute to a single worst day at some of the drier Class 1 Areas in the Mojave Desert and on the lee side of the Sierra Nevada.

The days with slightly elevated coarse mass are almost always associated with windblown dust events, including transport from Asian dust storms. These wind-driven events also cause very slight elevations in fine soil (PM2.5 fraction of dust), but this species never drives worst days. The 2018 Progress Strategy includes localized dust controls that keep these species at very low concentrations throughout the year.

- **Elemental Carbon** is not a driver of haze on worst days in California. Despite its strong capability to extinguish light, emissions are very low and are not expected to increase. In 2000, California initiated a Diesel Risk Reduction Program that focuses on reducing toxic air contaminants in diesel exhaust, specifically carcinogenic hydrocarbons and soot particles. California has realized benefits from this program as elemental carbon trends at IMPROVE monitors have already shown progress. Future benefits are expected as rules adopted during the baseline period continue their phased implementation. The WRAP modeling has demonstrated significant reductions in the contributions from elemental carbon in 2018 due to California's programs to address on- and off-road mobile sources.

- **Fine soil** is not a driver of haze on worst days. In fact, it contributes the least to haze Statewide. It is less than 1 percent of the annual contribution to light extinction at many IMPROVE monitors on best and worst days, with the highest annual average worst day contribution being just over 5 percent at one isolated IMPROVE monitor (HOOV) in the rain shadow (dryer, lee side) of the Sierra Nevada. On a day-to-day basis, fluctuations in concentration at the IMPROVE monitors are associated with high wind events, including receiving fallout from intercontinental transport after Asian dust storms. Dust control programs to reduce coarse mass also affect fine soil.

7.3 Uniform Rate of Progress

As part of the goal setting process, the Regional Haze Rule requires states to assess a linear path towards natural conditions for each Class 1 Area. This linear path is termed the Uniform Rate of Progress (URP). It represents a uniform rate of deciview reduction if haze levels on the worst days decreased the same number of deciviews per year over 60 years beginning in 2004 and ending at natural conditions in 2064. This can also be expressed as the glide path or slope of the line between 2004 and 2064. Figure 7-1 illustrates these concepts. States must compare their RPGs to the level that would be achieved in 2018 if progress were to follow this linear glide path. The URP is not a regulatory goal or standard but merely a benchmark, against which progress towards natural conditions can be evaluated.

If a state establishes RPGs for 2018 that result in a slower rate of visibility improvement than the glide path, a state must demonstrate how the selected RPG and the consequent rate of progress are reasonable. A state must also provide an assessment of the number of years it would take to achieve Natural Conditions if improvement continues at the rate different from the uniform rate of progress. Using Sequoia National Park as an example, Figure 7-2 shows a possible alternative path to Natural Conditions if the slope to reach the selected 2018 RPG (22.7 deciviews) at SEQU is maintained beyond 2018. Figure 7-2 shows that the Natural Conditions worst days (7.7 deciviews) would be reached by 2096, if the rate of progress in future planning periods is the same as in this first planning period.

Figure 7-1 Uniform Rate of Progress Illustration

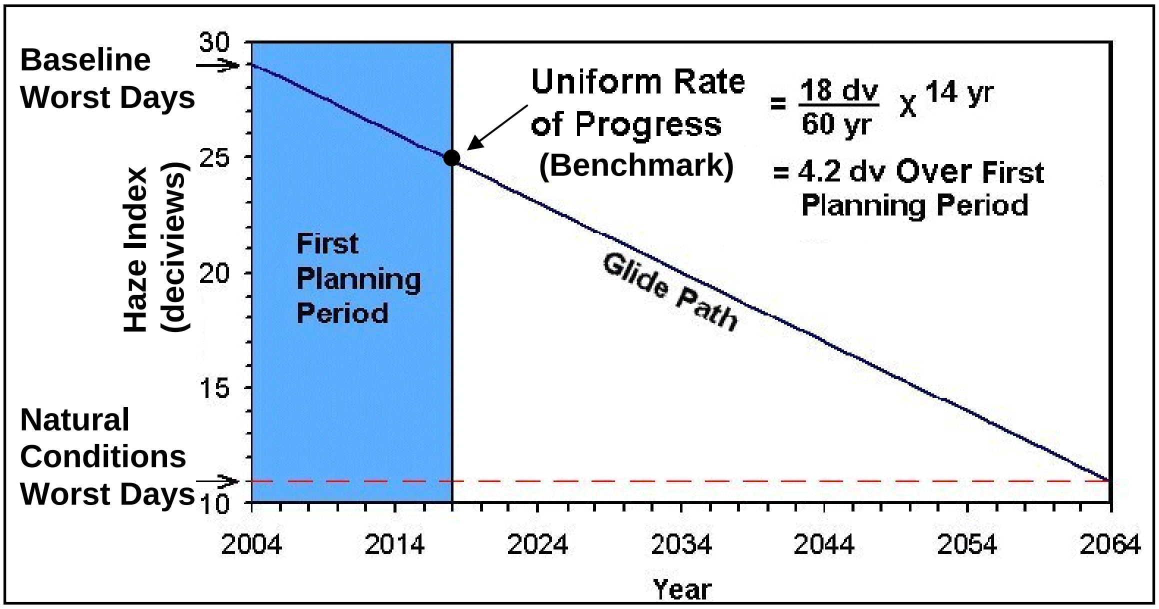
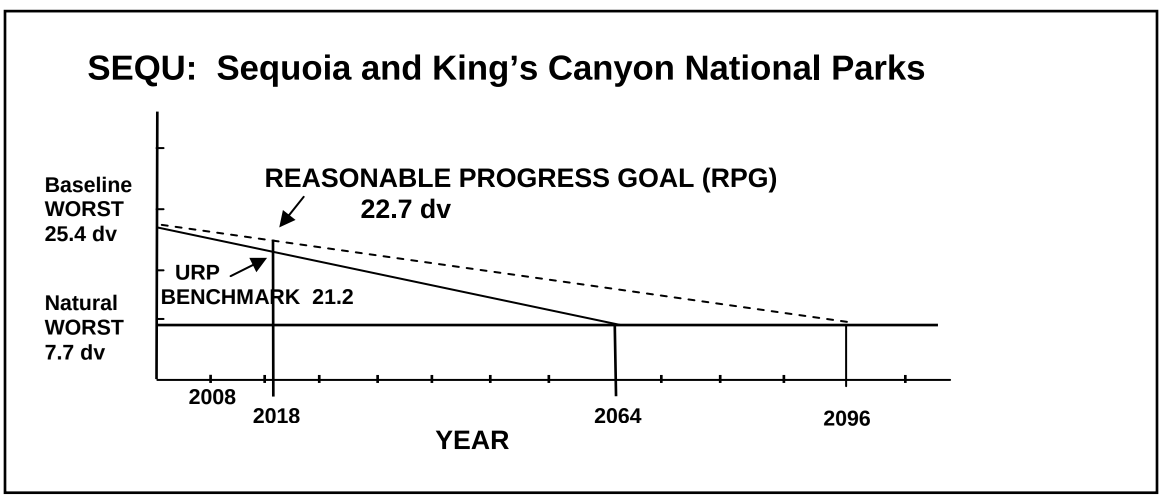


Figure 7.2 Example of Alternate Glide Path to Natural Conditions



The URP goals for each of the 17 IMPROVE monitors and their respective Class 1 Areas are included at the end of this Chapter in Table 7-2. Table 7-2 also provides an estimate of the number of years to achieve natural conditions if the current rate of progress were to continue. California makes progress towards the URP goals at all Class 1 Areas. Class 1 Areas in the Coastal and Southern California sub-regions make 51 percent to 94 percent progress towards the 2018 benchmark on the glide path, while Class 1 Areas in Northern California and the Sierra Nevada make 20 percent to 64 percent progress.

Past experience has shown that the path to cleaner air quality does not move in a straight line, although steady incremental improvements have been made in the past fifty years. Technological breakthroughs, changing land use patterns, the global economy, and climate change will affect the slope of the glide path in future planning periods beyond 2018. While no area meets the 2018 benchmark due to the influence of natural emissions from wildfires and biogenics, as well contributions from sources outside the WRAP region, each area makes significant progress and the rationale for the appropriateness of California's reasonable progress goals was provided earlier in this chapter.

To highlight the visibility improvement that will result from mobile source sector emission reductions, Table 7-1 shows 2018 modeled visibility progress from nitrate reductions. The 2018 nitrate modeled projections for 20 percent worst visibility days in most Class 1 Areas in California meet the 2018 URP benchmarks for nitrate except at San Gorgonio and Kaiser Wilderness Areas. In most Class 1 Areas, the 2018 nitrate modeled projection is even lower than the 2018 URP benchmark by up to 38 percent. At the San Gorgonio and Kaiser Wilderness Areas, the 2018 nitrate modeled projections fall short only 3 percent and 4 percent, respectively, of meeting the 2018 worst days URP benchmark. Nitrate is the haze component which comes primarily from NOx emissions within California. This analysis demonstrates that California's control program goes well beyond what is required.

As noted above, the WRAP analysis has indicated that sources not included in the WRAP region, such as from international shipping and emissions from Mexico and Asia, can provide substantial contributions to visibility impairment. Class 1 Areas nearest the Pacific Ocean are particularly impacted from offshore shipping emissions. California's Goods Movement Program targets reducing port and offshore emissions from sources that are under the Air Resources Board's regulatory control. However, given the expected growth in shipping activity, California is working with the federal government and international organizations to reduce the contributions to visibility impairment from these sources under federal and international control.

It also should be recognized that the URP for each Class 1 Area is based on the U.S. EPA calculated default natural visibility conditions. As stated previously, California, along with the western region, is researching what the definition of natural conditions should be in order to better reflect the impact of biogenic emissions, wildfires, and global dust transport. An increase in 2064 natural condition levels would decrease the slope of the URP and therefore better align the progress that can be achieved from sources under the control of the western states with the glide path. At each mid-course review and with every 10-year Plan revision, the slope beyond 2018 will be re-evaluated based upon the monitoring data, new controls, and a better understanding of natural conditions.

Table 7-1 Modeled visibility progress from nitrate reduction with California's 2018 Progress Strategy

Lava Beds NP South Warner WA	3.5	3.1	2.4	23
Lassen Volcanic NP Caribou WA Thousand Lakes WA	3.7	3.2	2.1	33
Marble Mountain WA Yolla Bolly-Middle Eel WA	6.1	5.1	3.6	29
Desolation WA Mokelumne WA	2.4	2.0	1.7	16
Hoover WA	1.6	1.4	1.2	19
Yosemite NP Emigrant WA	8.1	6.2	5.3	15
Ansel Adams WA Kaiser WA John Muir WA	7.0	5.3	5.5	-3
Sequoia NP Kings Canyon NP	60.7	36.0	30.4	16
Dome Lands WA	16.0	11.2	8.5	24
San Gabriel WA Cucamonga WA	27.7	18.4	16.1	12
San Gorgonio WA San Jacinto WA	44.9	27.7	28.8	-4
Joshua Tree WA	27.3	18.1	17.8	1
Agua Tibia WA	29.9	19.5	16.3	17
Redwood NP	6.0	5.6	4.2	26
Point Reyes NS	38.4	24.2	21.2	12
Pinnacles WA Ventana WA	17.1	12.1	9.1	25
San Rafael WA	12.6	9.1	5.6	38

TSS Date: 4/2/2008

7.4 Conclusion

From a national perspective, California has gone well beyond national control levels in terms of reducing emissions. This enhanced level of control, along with the fact that natural and non-WRAP sources limit California's ability to meet the uniform glide path benchmark, support the selection of California's 2018 Progress Strategy as reasonable for setting RPGs for the Class 1 Areas within the State.

However, visibility protection must be viewed from the broader standpoint of all of the environmental protection efforts in California as we continue to reduce emissions and drive new technology development in the future. In 2007, due to the need to attain federal air quality standards for 8-hour ozone and PM2.5, ARB developed a comprehensive strategy of measures that target NOx, SOx, and diesel PM emissions. This strategy sets the framework for attaining the standards and provides for emission reductions through the 2023 timeframe.

In general, California has already tackled the easy to find emission reductions. The emission reductions in the 2007 Statewide Strategy target clean-up of in-use heavy duty trucks, off-road sources, and goods movement sources. ARB is proposing a comprehensive fleet modernization program that would be equivalent to the entire 2014 truck fleet meeting 2007 truck standards. ARB is requiring on-road mobile source technology be used on off-road sources. Meeting the federal standards in the South Coast and the San Joaquin Valley, the two regions with the most severe air quality problems, will require an 88 and 75 percent reduction in NOx emissions from 2006 levels, respectively. In addition, California is targeting the health impacts near our busy goods movement sectors. In 2006, ARB approved a *2006 Emission Reduction Plan for Ports and Goods Movement*. That Plan maps the strategies to reduce emissions near ports, railways, and transportation corridors and is an essential component of California's effort to reduce community exposure to air pollution.

In addition, in 2006, California passed legislation (AB 32) that established the first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions of greenhouse gases. AB 32 requires the State to reduce greenhouse gas emissions to 1990 levels by 2020. California is required to have a plan for reaching this target by January 1, 2009. California will be evaluating many sectors including electricity, land use, oil and gas, transportation, cement facilities, agriculture, and waste management as to their impact on greenhouse gas emissions. Strategies to reduce greenhouse gas emission from these sectors will also provide reductions in other pollutants.

These future programs will provide further benefits in improving visibility throughout California. California will continue to revaluate progress and goals in the mid-course review time frame and in future planning periods. Since this is the first planning period, California anticipates more information regarding regional haze will be updated for each planning period including a better understanding of natural conditions, the impact of sources and controls, and new technology. California will examine these factors during the mid-course review and during development of future Plan revisions.

Table 7-2 Summary of Reasonable Progress Goal and Uniform Rate of Progress to Future Natural Conditions

California Class 1 Areas (Visibility Calculated in Deciviews)		2018 Worst Days RPG	2018 Worst Days URP	2064 Natural Conditions Worst Day	Percent Progress by 2018 towards Natural Conditions	Future Date for Reaching Natural Conditions at Current Rate	Current Best Day Conditions	2018 Best Day Projection
IMPROVE Monitor	Class 1 Area(s)							
TRIN *(1014 m.)*	Marble Mountain Wilderness Yolla Bolly-Middle Eel Wilderness	16.4	15.2	7.9	11%	2137	3.4	3.2
LABE *(1460 m.)*	Lava Beds National Monument South Warner Wilderness	14.4	13.4	7.9	10%	2148	3.2	3.0
LAVO *(1733 m.)*	Lassen Volcanic National Park Caribou Wilderness Thousand Lakes Wilderness	13.3	12.6	7.3	12%	2123	2.7	2.5
SIERRA CALIFORNIA								
BLIS *(2131 m.)*	Desolation Wilderness Mokelumne Wilderness	12.3	11.1	6.1	5%	2307	2.5	2.5
HOOV *(2561 m.)*	Hoover Wilderness	12.5	11.7	7.7	8%	2186	1.4	1.3
YOSE *(1603 m.)*	Yosemite National Park Emigrant Wilderness	16.7	15.3	7.6	9%	2160	3.4	3.2
KAIS *(2598 m.)*	Ansel Adams Wilderness Kaiser Wilderness John Muir Wilderness	14.9	13.6	7.1	7%	2200	2.3	2.1
SEQU *(519 m.)*	Sequoia National Park Kings Canyon National Park	22.7	21.2	7.7	15%	2096	8.8	8.1
DOME *(927 m.)*	Dome Lands Wilderness	18.1	16.6	7.5	11%	2132	5.1	4.7
COASTAL CALIFORNIA								
REDW *(244 m.)*	Redwood National Park	17.8	17.4	13.9	15%	2096	6.1	5.8
PORE *(97 m.)*	Point Reyes National Seashore	21.3	21.2	15.8	21%	2069	10.5	10.1
PINN *(302 m.)*	Pinnacles Wilderness Ventana Wilderness	16.7	16.0	8.0	17%	2086	8.9	8.1
RAFA *(957 m.)*	San Rafael Wilderness	17.3	16.2	7.6	13%	2109	6.4	5.8
SOUTHERN CALIFORNIA								
SAGA *(1791 m.)*	San Gabriel Wilderness Cucamonga Wilderness	17.4	16.9	7.0	19%	2076	4.8	4.1
SAGO *(1726 m.)*	San Gorgonio Wilderness San Jacinto Wilderness	19.9	18.7	7.3	15%	2095	5.4	5.0
AGTI *(508 m.)*	Agua Tibia Wilderness	21.6	19.8	7.6	12%	2121	9.6	8.9
JOSH *(1235 m.)*	Joshua Tree National Park	17.9	16.7	7.2	14%	2106	6.1	5.7

8. Consultation

The Regional Haze Rule requires consultation between states and Federal Land Managers during preparation of the Plan. Consultation with upwind and downwind states is important for mutual agreement on actions to support the respective Reasonable Progress Goals (RPGs) in each state. The Federal Land Managers, as caretakers of the Class 1 Areas, have a key role in preparation and implementation of the Plan. Consultation with Tribes is necessary when activities within state or Tribal lands cause or contribute to visibility impairment in respective Class 1 Areas.

8.1 Tribal Consultation

No Tribes requested input from California in development of their Tribal Implementation Plans. There are no tribal lands with Class 1 Area status in California. As a courtesy, California provided the WRAP coordinator for Tribes a written request to distribute an announcement of the release of the draft Plan for review.

8.2 Interstate Consultation

California has worked cooperatively since 1991 with other western states to address regional haze, first through the Grand Canyon Visibility Transport Commission (GCVTC) and then through the WRAP. Preparation of this initial Plan is the result of continuous consultation with fourteen other western states through regular meetings of the WRAP Working Groups and Forums, via conference calls, face-to-face meetings, and workshops. This coordination resulted in resolution of all technical tasks and policy decisions related to monitoring, emissions, fire tracking, BART, source attribution, modeling, and control measure issues as each Regional Haze Rule task was addressed. As a result of this extensive coordination, this Plan reflects California's element of a regionally consistent approach to addressing visibility impairment in the West.

Extensive documentation of all WRAP meetings and work products are provided on the WRAP website at http://wrapair.org. For specific details about meetings and topics of discussion, the various Forums and Work Groups web pages are found at http://wrapair.org/commforum.html.

In developing the RPGs for each Class 1 Area, each state must consult with those states which may reasonably be anticipated to cause or contribute to visibility impairment in a mandatory Class 1 Area. California used baseline period visibility data from the IMPROVE monitors along with the WRAP baseline modeling results to estimate California's emissions impact on neighboring states' Class 1 Areas (see Figure 8.1).

Figure 8.1 California, Oregon, Nevada, and Arizona Class 1 Areas

In the charts below, the first column shows the contribution of nitrates and sulfates to light extinction at these Class 1 Areas calculated from the IMPROVE monitoring data *measured* during the baseline period to provide perspective on the role of nitrates and sulfates to overall extinction. The second column shows California's contribution to particle mass calculated from the *modeled* concentrations of nitrate and sulfate for the baseline years. Particle light extinction calculated from actual monitoring data is somewhat different than relative species contributions derived from modeling due the model's ability to recreate each day. However, independently, they do show two things: (1) the role of nitrates and sulfates in driving light extinction at the Class 1 Area, and (2) the probable share of California emissions contributing to the pollutant species.

Table 8.1 Nitrate Contribution to Haze in Baseline Years

State and Class 1 Area	2000-2004 Average Annual Nitrate Share of Particle Light Extinction (measured values)		2000-2004 California's Average Annual Share of Nitrate Concentration (based on modeling)	
	Worst Days	Best Days	Worst Days	Best Days
Nevada				
Jarbidge Wilderness	4%	4%	8%	17%
Oregon				
Kalmiopsis Wilderness Area	9%	2%	13%	37%
Crater Lake National Park	7%	3%	20%	53%
Arizona				
Sycamore Canyon Wilderness Area	5%	4%	6%	23%
Grand Canyon National Park	9%	5%	34%	10%

When modeled, California NOx emissions contribute up to 34 percent of the nitrate concentrations at some neighboring states on worst days. As shown in Table 8.1, however, nitrate contributes less than 10 percent of the light extinction at the nearest Class 1 Areas in neighboring states. Hence, only a small portion of out-of-State visibility degradation is due to nitrate formed from California emissions. By 2018, NOx emissions from California are expected to decrease by more than 40 percent due to emission reductions from mobile sources in California. This will significantly reduce California's impact to the out-of-State Class 1 Areas.

Table 8.2 Sulfate Contribution to Haze in Baseline Years

State and Class 1 Area	2000-2004 Average Annual Share of Particle Light Extinction (based on measurements)		2000-2004 California's Average Annual Share of Sulfate Concentration (based on modeling)	
	Worst Days	Best Days	Worst Days	Best Days
Nevada				
Jarbidge Wilderness	16%	18%	5%	3%
Oregon				
Kalmiopsis Wilderness	29%	7%	1%	7%
Crater Lake National Park	19%	11%	5%	19%
Arizona				
Sycamore Canyon Wilderness	13%	10%	8%	3%
Grand Canyon National Park	21%	18%	8%	1%

As shown in Table 8.2, sulfate contributes less than 30 percent of the light extinction at the nearest Class 1 Areas in neighboring states. In the baseline years, modeling shows that California SOx emissions contribute less than 10 percent of the total concentration of sulfates at the nearest out-of-State Class 1 Areas on worst days. Thus, similar to nitrate, only a small portion of visibility degradation from sulfates are attributed to California emissions.
By 2018, total SOx emissions from California are not expected to change, despite current forecasts of a 30 percent population increase in California. Considerable reductions in mobile source emissions and early reductions in the SOx content of fuels statewide will offset a small amount of possible growth in other sectors. In the mid-course review, California plans to evaluate changes in the SOx emissions inventory and the subsequent impact on sulfates measured at the monitors.

Due to the topography and prevailing weather patterns, neighboring states do not significantly impact California very frequently. However, when they do, regional modeling of current controls shows that reductions to be implemented by 2018 in other states do help improve visibility at some California Class 1 Areas. California has determined that these controls are adequate for making reasonable progress in improving visibility in California. Preliminary visibility impact modeling for BART-eligible sources indicate that certain stationary sources in Arizona, Nevada, Oregon, and Washington may cause or contribute to visibility impairment in some California Class 1 Areas, on some days. The modeling reflects worst case emissions under all meteorological patterns. Whether any further reductions of emissions from these sources will show a beneficial impact on the worst days deciview level at any California Class 1 Area will not be known until final regional modeling is performed after this Plan submission. Therefore, any adjustments to California's RPGs to reflect benefits from BART will be made during the mid-course review.

In addition to ongoing interactions through the WRAP, California also consulted via telephone with our neighboring states, Oregon, Arizona, and Nevada, as well as Colorado, to discuss the impact of California emissions. In addition, California sent a written announcement to the WRAP primary contact in each of the WRAP states advising them of the availability of the draft Plan for comment, in advance of the public ARB hearing. Continuous consultation with all of the other fourteen western states of the WRAP in setting RPGs did not result in any concerns that have not been resolved.

8.3 Federal Consultation

Early in the Plan development process, California provided contacts at the ARB to the Federal Land Managers as required. Consultation with the Federal Land Managers on Plan development began in November 2006, with an in-person Regional Haze Teach-In at ARB headquarters that included State and regional representatives of the U.S. Forest Service (USFS), the National Park Service (NPS), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (FWS), the U.S. EPA and interested air districts. At the meeting, California's proposed 2018 Progress Strategy and RPGs were discussed.

After the November 2006 face-to-face meeting, an ad hoc ARB/Federal Land Managers Regional Haze Steering Committee (Steering Committee), which also included U.S. EPA Region 9 representatives, was formed and conducted monthly conference calls. Regional representatives of federal land management agencies were invited to participate to voice out-of-State issues. During these calls, ARB reviewed progress on the Plan tasks and requirements, and solicited input from the Federal Land Managers on updating information about Class 1 Areas and other concerns relating to visibility and the causes of regional haze. All proposed RPGs were discussed during these calls.

Some of the concerns raised by the Federal Land Mangers during the Steering Committee calls were incorporated in the technical tasks associated with Plan preparation and others addressed long-term actions. The input contributed to the descriptions of "controllable" and "uncontrollable" anthropogenic and natural sources. Federal Land Managers' knowledge of local sources did not indicate any existing stationary sources with specific reasonably attributable visibility impacts (RAVI), but did help identify pending growth in both stationary and area sources. These included specific stationary source locales with pending land use or energy siting applications and regional growth trends.

All of these growth nodes will occur in areas which are currently nonattainment for national and State air quality standards. The air districts are already charged with continuous improvement of their stationary and area source rules to achieve reductions to offset growth. Changing emissions will be updated in the regional haze inventory when they occur and will be included in the mid-course review assessments. Also, the USFS expressed their longstanding concern about ozone damage to forest health, and agreed that continued reductions in ozone precursors throughout the State would also be beneficial in reducing haze species formation.

As a result of input from the Federal Land Managers, two items will be continued in detail during the mid-course review because further research is required.

- The State is concerned that the U.S. EPA default for Natural Conditions in California may not adequately incorporate the impacts of wildfire smoke as well as biogenic emissions, thereby underestimating the deciview value of Natural Conditions. The Federal Land Managers are assisting in tracking the temporal and regional impacts of wildfire smoke which is necessary for development of an equitable attribution of this natural, uncontrollable source. If there is consensus, after collecting more data in the future, the "Natural Conditions" values at some Class 1 Areas in California may be adjusted upwards.

- The Federal Land Managers also requested that the Plan point to the possibility of coordinated administration of the Prevention of Significant Deterioration Program (PSD) with the Regional Haze Program. The U.S. EPA representatives participating in the discussion agreed that improvements for tracking impact increments have been a national concern. In California, local air districts and U.S. EPA Region 9 are currently responsible for PSD reviews of new sources. The ARB recommends that this item be addressed regularly through existing committees and reported on in the mid-course review.

The draft Plan was released for review by the Federal Land Managers, at least 60 days before the Board Hearing, with a written request for comments to the reviewers specified by the three Federal Land Management agencies which manage the Class 1 Areas in California: the U.S. Forest Service, the National Park Service, and the Bureau of Land Management. The Steering Committee also supported the plans for a public webcast workshop in Sacramento on the draft Plan on December 15, 2008, over one month prior to the public hearing. A webcast workshop facilitates broad participation by Federal Land Manager field office staff in remote locations via internet. Webcast workshops also enable "live" question and answer format for all participating in person and via the web. Both ARB staff who prepared the Plan, as well as the Federal Land Manager representatives and the public attending the workshop/webcast, were able to comment and respond in a non-hearing setting. The official written comments of the Federal Land Managers, as a result of the 60-day advance review, have been placed in Appendix F along with responses prepared by ARB staff.

8.4 Required Continued Consultation with Federal Land Managers

California will continue to coordinate and consult with the Federal Land Managers during the development of future progress reports and Plan revisions, as well as during the implementation of programs having the potential to contribute to visibility impairment in the mandatory Class 1 Areas via three existing venues: the Interagency Air and Smoke Council, the Air and Land Managers Group, and the WRAP.

Prior to Plan development, the Federal Land Management agencies in California, California Department of Forestry and Fire Protection (CDF), ARB, and local air districts met routinely in technical and policy forums. Since the 1990's, technical staff has met quarterly as the chartered Interagency Air and Smoke Council (IASC) to discuss measurement, monitoring, regulatory, planning, and outreach issues, among other things related to smoke management.

Beginning in 2002, upper management representatives from the same agencies began meeting on a regular basis as the Air and Land Managers Group (ALM) to resolve policy issues relating to smoke management. The Steering Committee formed as an ad hoc subset of the ALM specifically to address the Plan development. After Plan submittal, the ALM will continue to keep regional haze as a regular update item on their meeting agendas. In addition, the ARB will continue to foster coordination and communication with neighboring states to discuss issues related to inter-state smoke impacts.

The WRAP has agreed to host an annual convocation on regional haze, as a Board meeting or as a separate workshop, to discuss regional haze issues and foster continued communication between the states, Tribes, and the Federal Land Managers.

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9. FUTURE REGIONAL HAZE REQUIREMENTS

9.1 Introduction

This section addresses other future requirements specified in the Regional Haze Rule. In the future, the Regional Haze Rule requires states to:

- Include a monitoring strategy;
- Submit periodic reports evaluating progress towards the Reasonable Progress Goals (RPG), an assessment of significant changes in anthropogenic emissions, and adequacy of the Plan every five years; and
- Revise the Plan in 2018 and every ten years thereafter.

9.2 IMPROVE Monitoring Strategy

California will depend on the IMPROVE monitoring program to collect and report data for reasonable progress tracking as specified in the Regional Haze Rule for all Class 1 Areas in the State. The current IMPROVE monitoring network listed in Table 2-1 is adequate for analyzing California Class 1 Areas. Because Regional Haze is a long-term tracking program with a 60-year implementation period, California expects the configuration of the monitors, sampling site locations, laboratory analysis methods and data quality assurance, and network operation protocols will not change, or if changed, will remain directly comparable to those operated by the IMPROVE program during the 2000-2004 Regional Haze baseline period. Technical analyses and reasonable progress goals in this plan are based on data from these sites. California must be notified and agree to any changes in the IMPROVE program affecting the Regional Haze tracking sites, before changes are made.

California plans to use data reported by the IMPROVE program as part of the regional technical support analysis tools found at the Visibility Information Exchange Web System (VIEWS), as well as other analysis tools and efforts sponsored by the WRAP. California will participate in the regional analysis activities of the WRAP collectively to assess and verify progress toward RPGs, and support interstate consultation as the Regional Haze Rule is implemented.

California will depend on the routine, timely reporting of monitoring data by the IMPROVE program to VIEWS for the reasonable progress tracking sites. Further, California will continue to rely on U.S. EPA to operate the IMPROVE monitoring network.

9.3 Periodic Progress Reports

In 2013, California will initiate a mid-course review of progress in reaching the RPGs. During the mid-course review, California will:

- Report on additional emission reductions from post-2004 control measures not reflected in the 2018 Progress Strategy;
- Update natural conditions to reflect new information if available;
- Update the RPGs with latest WRAP modeling if appropriate;
- Re-evaluate the RPGs to determine if they should be adjusted to better reflect achievable improvements in visibility, as future control measures are adopted and implemented;
- Compare the actual deciview calculations against progress towards reaching the RPGs and the uniform rate of progress;
- Assess the impact at the monitors from BART-specific and post-2004 adopted and implemented measures; and
- Evaluate the adequacy of the existing Plan elements.

While California's 2018 Progress Strategy provides a comprehensive and aggressive basis for setting the RPGs in this Plan, attainment of new federal standards for ozone and particulate matter will require adoption of even more stringent measures as reflected in California's State Strategy adopted in 2007. These future measures go beyond the basic requirements for the regional haze program. However, the additional benefits realized from future control strategies implemented by 2012 will be evaluated in the context of the 2013 mid-course review.

9.4 Plan Revisions

As with the current Plan, California believes the elements needed for a Plan revision should be done on a regional basis. The regional process has been very effective in identifying issues that concern all of the western states and facilitating consultation. Two issues that should continue to be evaluated from a western regional perspective are natural conditions and visibility calculations. Natural wildfires tend to drive poor visibility in the West. However, currently, they are not excluded nor is their magnitude appropriately considered as part of natural conditions. The impact of wildfires needs to be accounted for so they are appropriately considered in achieving natural visibility. California plans to work with the WRAP and the Federal Land Managers in tracking wildfires to achieve a better understanding of the wildfire cycle near Class 1 Areas. Long term wildfire tracking will provide a solid foundation for incorporating wildfires into the natural conditions estimate. Also, as more information becomes available regarding how pollutants impact visibility, the western region should work together to update visibility calculations. This process has worked well in developing the Regional Haze II algorithm.

Finally, as part of the western region, California will revise the Plan in 2018 and every ten years there after. The Plan revision will include:

- Current calculation methodologies for visibility;
- Evaluation of the appropriateness of natural condition levels and updates if appropriate;
- Current visibility conditions for most impaired and least impaired days;
- Progress towards natural conditions;
- Effectiveness of California’s 2018 Progress Strategy;
- Affirmation or revision of reasonable progress goals;
- Updated emission inventories; and
- Re-evaluation of the monitoring strategy.

The Plan revision will also follow the appropriate inter-state and Federal Land Manager procedure consultations established in this Plan.

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10. California Environmental Quality Act

10.1 Introduction

The California Environmental Quality Act (CEQA) requires that State and local agency projects be assessed for potential significant environmental impacts. A project includes an activity undertaken by a public agency which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. Every project which requires a discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. The action of ARB to approve or disapprove this Regional Haze Plan (Plan) project is discretionary. As a certified State regulatory program, ARB is required to include in the CEQA environmental impact assessment the project description, analysis of alternatives, and an environmental analysis.

10.2 Description of the Proposed Project

The federal Clean Air Act requires states to prepare a plan demonstrating progress to achieve natural visibility conditions at federal Class 1 Areas by 2064. The 1999 Regional Haze Rule, promulgated by the United States Environmental Protection Agency (U.S. EPA), lays out specific requirements that each state must include in their plan to address the federal Clean Air Act visibility requirements. The Regional Haze Plan sets forth California's goals for improving visibility by 2018 at 29 Class 1 Areas in California to meet these requirements. These goals are based on already adopted control measures that insure visibility improvement at all of California's Class 1 Areas by 2018.

The Regional Haze Rule requires the Plan to contain the following key elements:

- Baseline and natural visibility conditions;
- Base and future year emission inventories;
- Long-term control strategy based on already adopted measures;
- Reasonable progress goals for 2018;
- Best available retrofit technology analysis;
- Consultation with states, tribes, and federal land managers; and
- Monitoring strategy.

One of the key elements in the Plan is the best available retrofit technology (BART) requirement. The BART requirement directs the State to evaluate large older sources from 26 categories to determine whether emission controls could be installed that would improve visibility at Class 1 Areas. This analysis was based on emissions from these sources during the baseline period (2000 through 2004) and identified sources emitting over 250 tons per year. ARB evaluated these larger sources to determine if existing controls were already at a BART-level control. Sources not controlled at a BART-level were then analyzed to determine whether they caused or contributed to visibility impairment at any

Class 1 Area. Through this extensive analysis, one source, Valero Refining Company, was identified as contributing to visibility impairment and needing to install BART-level controls on certain units at the facility pursuant to this requirement. Due to a 2005 consent decree between U.S. EPA and Valero Refining Company, Valero Refining Company is already required to install the BART-level controls. Therefore, the BART-level controls are pre-existing and not a result of the requirements in this Plan.

10.2 Alternatives to the Proposed Project

Because the Plan is required by federal law and because the Plan relies entirely on previously adopted measures, the environmental review of each measure was performed at the time each measure was adopted. No new measures are being proposed as part of the Plan.

The only alternative to the Plan would be the “No Project” alternative. With this alternative, ARB would not submit a plan to U.S. EPA for the protection of visibility in California’s Class 1 Areas. The “No Project” alternative would mean that California would not meet federal Clean Air Act requirements and U.S. EPA would be required to put in place a Federal Implementation Plan to address these requirements. Therefore, staff determined that the “No Project” alternative is not appropriate and the alternative was rejected.

10.3 Evaluation of Potential Effects on the Environment

This Plan is based on already adopted emission control measures and existing actions. The emission control measures have already been analyzed for environmental impacts as part of the rulemaking adoption process by ARB and the local districts. Therefore, the adopted and already implemented measures, along with the requirements of the consent decree are considered as part of the existing setting, and their impact will not be further analyzed.

APPENDIX A

Deciview Calculation Methodology

The California Regional Haze Plan uses the Haze Algorithm II for estimating the deciview values used in this plan. Haze pollutants are particles that have the ability to absorb and reflect light radiation; both actions extinguish light and decrease visibility. Particle mass, humidity, and temperature influence the amount of light extinction caused by haze species. Rayleigh scattering is affected by elevation and temperature. The following explains the process for estimating the deciview values.

1. The "HAZE ALGORITHM" uses Species Mass → to determine Light Extinction → which is converted to a Deciview Value.

2. Every third day, 24-hour mass measurements are made of all the haze species collected at each IMPROVE monitor and the Haze Algorithm is used to deliver individual species and total species Light Extinction in inverse megameters (Mm-1).

3. The Haze Algorithm for calculating Light Extinction (*b*ext) weights the Species Mass (*u*g/m3) measured at the IMPROVE monitors using particle size, humidity, and elevation as follows:

   *b*Sulfate = 2.2 x f*S*(RH) x [small SO4] + 4.8 x f*L*(RH) x [large SO4]
   *b*Nitrate = 2.4 x f*S*(RH) x [small NO3] + 5.1 x f*L*(RH) x [large NO3]
   *b*Organic Material Carbon = 2.8 x [Small OM] + 6.1 x [Large OM]
   *b*Elemental Carbon = 10 x [EC]
   *b*Fine Soil = 1 x [Fine Soil]
   *b*Sea Salt = 1.7 x f*SS*(RH) [Sea salt]
   *b*Coarse Mass = 0.6 x [CM]
   *b*Rayleigh = (Site Specific factor, related to elevation, ranging from 7+ to 11+ in California)
   *b*Nitric Oxide gas= 0.33 x [NO2 (ppb)] (not measured at most IMPROVE monitors).

4. The sum of the weighted extinction values gives the total daily extinction (Total *b*ext) for each day of measurement:

   Total *b*ext = *b*Sulfate + *b*Nitrate + *b*EC +*b*OMC + *b*Soil + *b*CM + *b*SS + *b*Rayleigh + *b*NO2

5. The deciview scale was created to describe the total light extinction capability of all haze species in the ambient air at a given time at a given location. The Deciview Value (dv) is the natural logarithm of the total calculated light extinction on each day of measurement. Mass measurements for all species must be available to calculate the dv for a given day.

   Deciview Value (dv) = 10 ln (Total bext / 10)

APPENDIX B

California Class 1 Area Visibility Descriptions

TRIN1 Monitor

The TRIN1 monitor location represents two wilderness areas located in the Marble and Klamath Mountains in Northern California. The wilderness areas associated with the TRIN1 monitor are Marble Mountain and Yolla-Bolly Middle Eel Wilderness Areas. The TRIN1 site has been operating since July 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

Section I. TRIN1 Wilderness Area Descriptions

I.a. Marble Mountain Wilderness Area

The Marble Mountain Wilderness Area (Marble Mountain) consists of about 200,000 acres of the Marble Mountains of northern California. Its northern boundary is about 25 miles south of the Oregon/California border. Its principal drainage is Wooley Creek that flows westward into the Salmon River drainage and Pacific Ocean via the Klamath River. Terrain is forested mountains, with highest elevations 2,103 meters to 2,195 meters. The lowest elevation is about 198 meters on the western boundary where Wooley Creek exits the Wilderness.

Figure 1. Marble Mountain Wilderness area

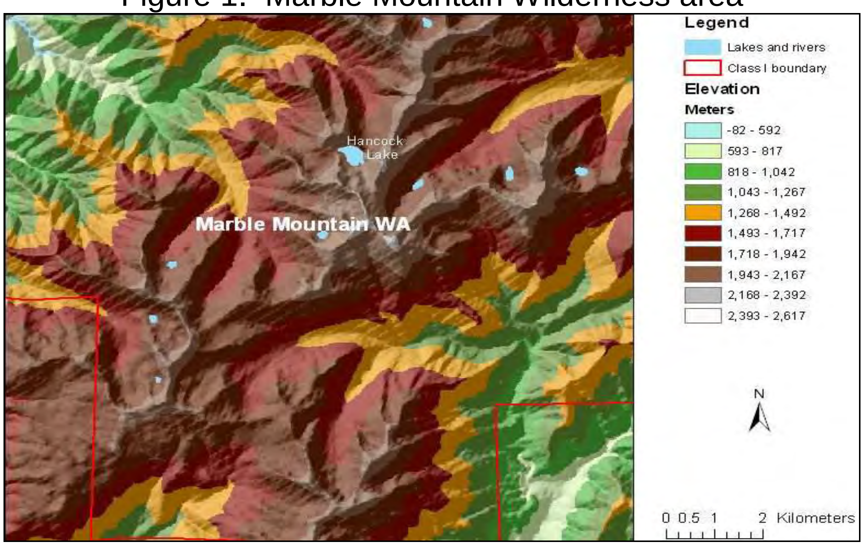
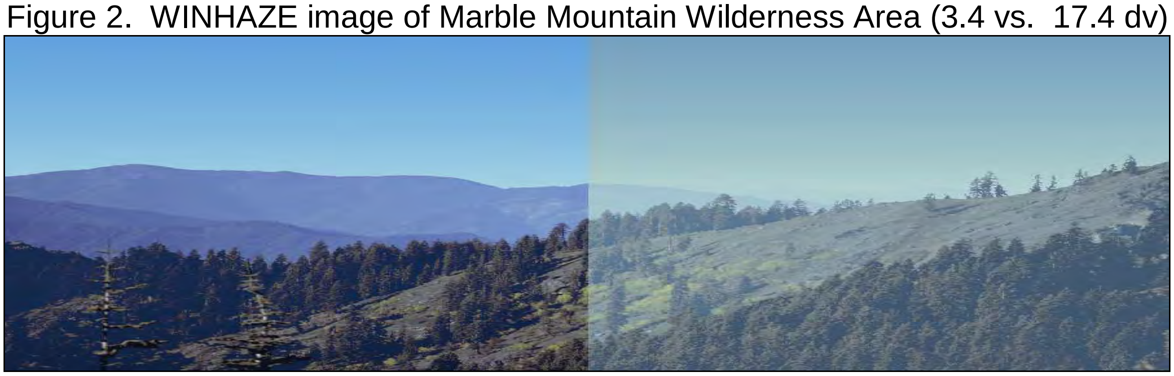


Figure 2. WINHAZE image of Marble Mountain Wilderness Area (3.4 vs. 17.4 dv)



I.b. Yolla-Bolly Middle Eel Wilderness Area

The Yolla Bolly – Middle Eel Wilderness Area (Yolla Bolly) lies on about 150,000 acres in the Klamath Mountains region near the southern extent of the Cascade Range in northern California. The wilderness is just west of the north end of the Sacramento Valley near Redding. On the west side the Wilderness the North and Middle Forks of the Eel River flow west into the Pacific Ocean near Redwood National Park. On the east side the South Fork of Cottonwood Creek flows to the northern Sacramento Valley between Redding and Red Bluff. The lowest elevation, about 792 meters, is on the eastern boundary where Cottonwood Creek exits the Wilderness, about 610 meters above the northern Sacramento Valley floor at Redding. The highest elevation is 2,467 meters at the peak of Mt Linn.

Figure 3. Yolla Bolly – Middle Eel Wilderness area

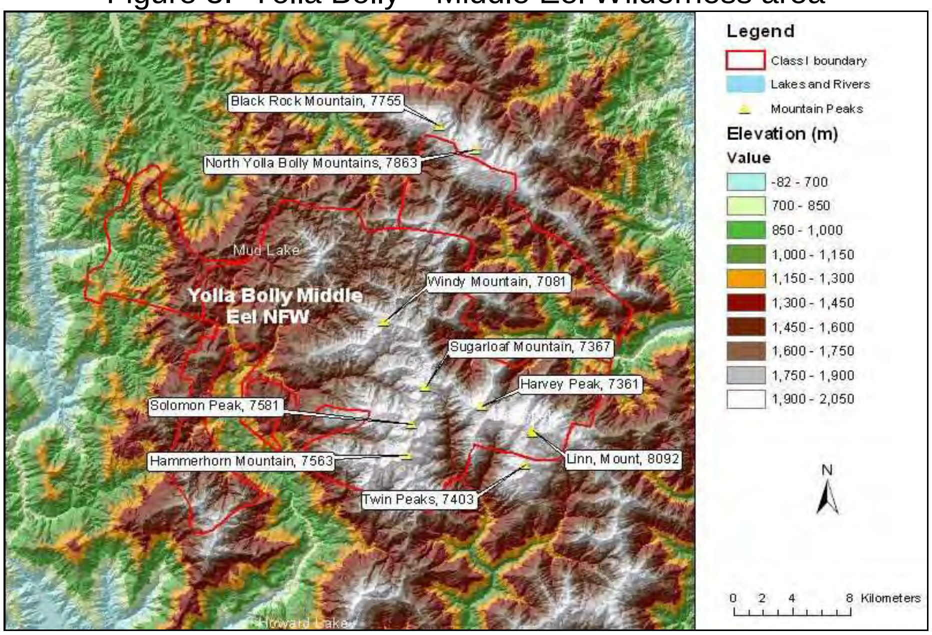


Figure 4. WINHAZE image of Yolla Bolly Wilderness Area (3.4 vs. 17.4 dv)

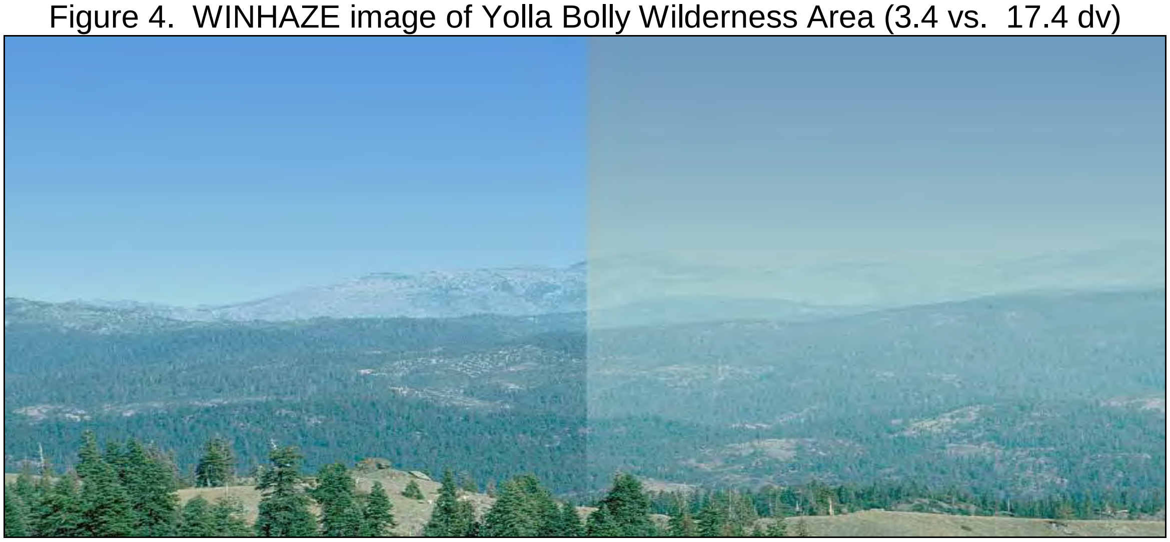


Figure 5. TRIN1 Monitor location in California

Section II. Visibility Conditions:

II.a. Marble Mountain Wilderness Area

Visibility conditions for Marble Mountain are currently monitored by the TRIN1 IMPROVE monitor in the Trinity Alps. The monitor is located at 40.7864 north latitude and 122.8046 west longitude, located midway between the Marble Mountain Wilderness Area and the Yolla Bolly – Middle Eel Wilderness Area in the Trinity Alps. TRIN1 is situated on a ridge crest of Pettijohn Mountain at an elevation of 1,014 meters. It is about 40 miles southeast of the Marble Mountain Wilderness, in the Trinity River drainage, with an intervening 1,798 to 1,981 meter crest line.

The monitoring location, TRIN1, may not be influenced by the same local sources that impact the Marble Mountain Wilderness because of the distance and intervening terrain. In particular, it may be more subject to Sacramento Valley emissions than the Marble Mountain Wilderness. It should be representative of aerosol characteristics in the Marble Mountain during periods of more uniform regional haze resulting from regional forest fire events or transport from more distant source regions on a global scale. The closest source region with anthropogenic emissions that may contribute to aerosol and haze at the TRIN1 site is the Sacramento Valley. The communities of Redding and Red Bluff are about 25 miles southeast of the site. The Sacramento Valley may provide a link between TRIN1 aerosol measurements and emissions from the larger Sacramento and San Francisco Bay areas during low level southerly flow. Marble Mountain is more distant, about 40 miles northwest of TRIN1 and 50 to 60 miles from the northern Sacramento Valley.

The TRINI location is adequate for assessing the 2018 reasonable progress goals for the Marble Mountain Wilderness Class 1 area.

II.b. Yolla-Bolly Middle Eel Wilderness Area

Visibility conditions for the Yolla Bolly – Middle Eel Wilderness are currently monitored by the TRIN1 IMPROVE monitor in the upper Trinity River valley. The monitor is located at 40.7864 north latitude and 122.8046 west longitude midway between the Marble Mountain Wilderness Area and the Yolla Bolly – Middle Eel Wilderness Area in the upper Trinity River valley. TRIN1 is situated on a ridgecrest of Pettijohn Mountain at an elevation of 1,014 meters. It is 40 to 50 miles north of Yolla Bolly – Middle Eel Wilderness. Also, it is within the Trinity River valley and separated from the northern Sacramento Valley by the intervening Trinity Mountains crestline with elevations of 2,820 meters and higher.

TRIN1 is probably not influenced by local transport from the Sacramento Valley to the same extent as Yolla Bolly when Valley emissions are transported across the Trinity Range during southerly flow conditions. It should be representative of aerosol characteristics at Yolla Bolly during periods of more uniform regional haze, resulting from regional forest fire events or transport from more distant source regions on a global scale. The Sacramento Valley is the closest source region with emissions that may contribute to haze in the Yolla Bolly. Sacramento Valley may provide a link to emissions from the larger Sacramento and San Francisco Bay areas during low level southerly flow.

The TRIN1 location is adequate for assessing the 2018 reasonable progress goals for the Yolla Bolly – Middle Eel Wilderness Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from TRIN1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the TRIN1 monitor is calculated at 3.4 deciviews for the 20% best days and 17.4 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

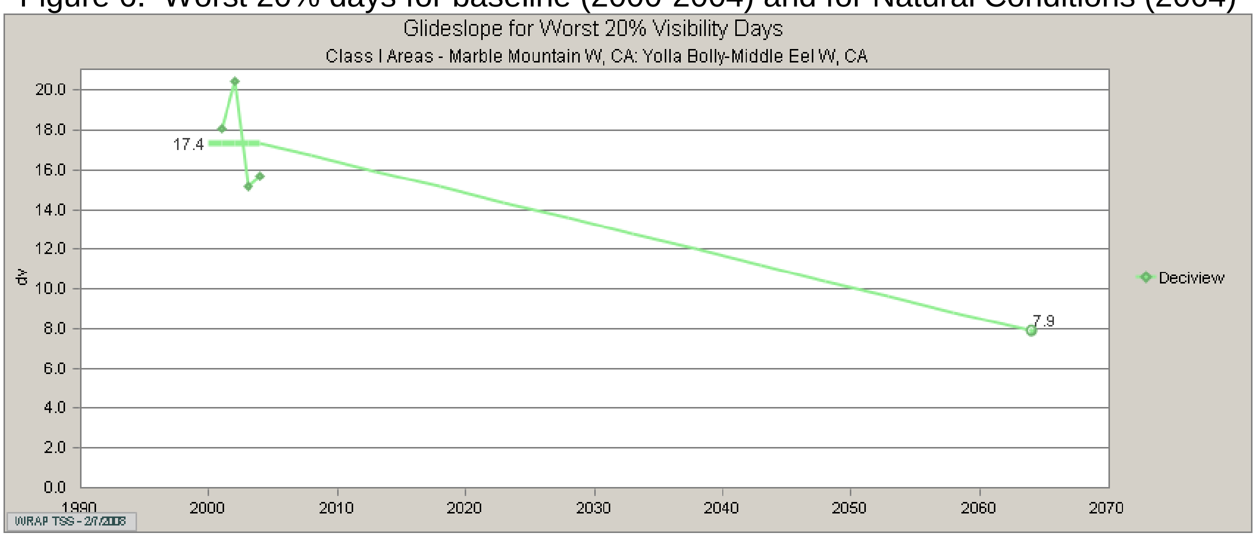
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the TRIN1 monitor is 1.2 deciviews for the 20% best days and 7.9 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 15.15 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 3.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at TRIN1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

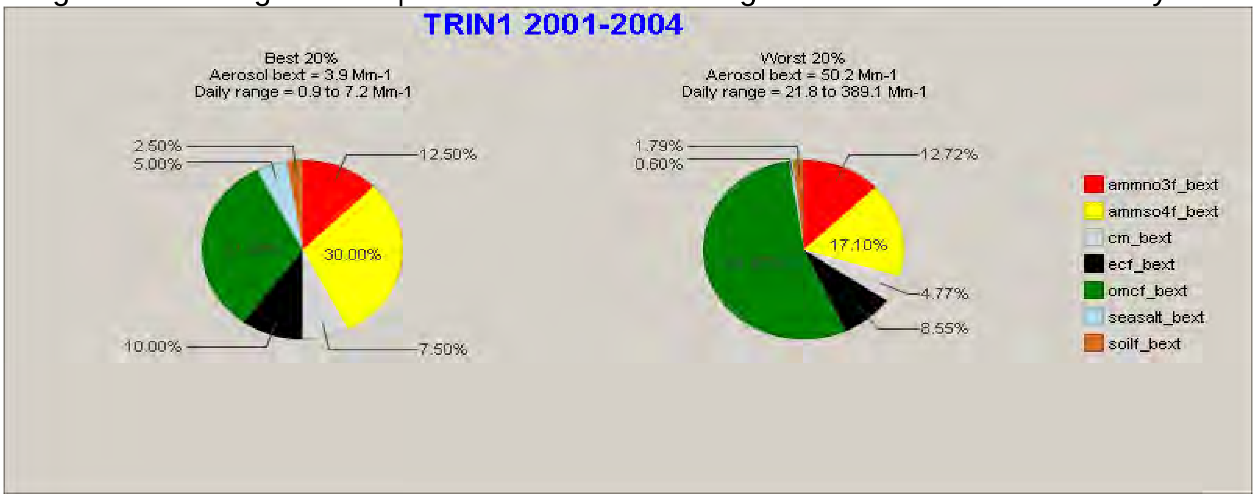
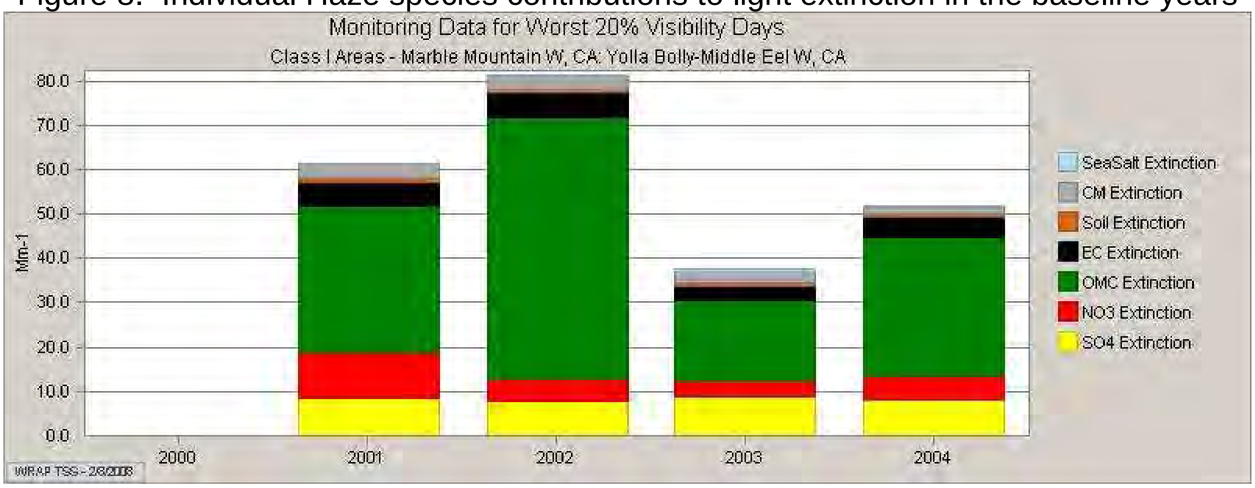


Figure 8. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 7 and 8, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on worst days at the TRIN1 monitor. Organic matter dominates both the best and worst days at the TRIN1 monitor.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and early spring while sulfates increase slightly in the summer months. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea salt and soil present throughout the years.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparative to Figure 9 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

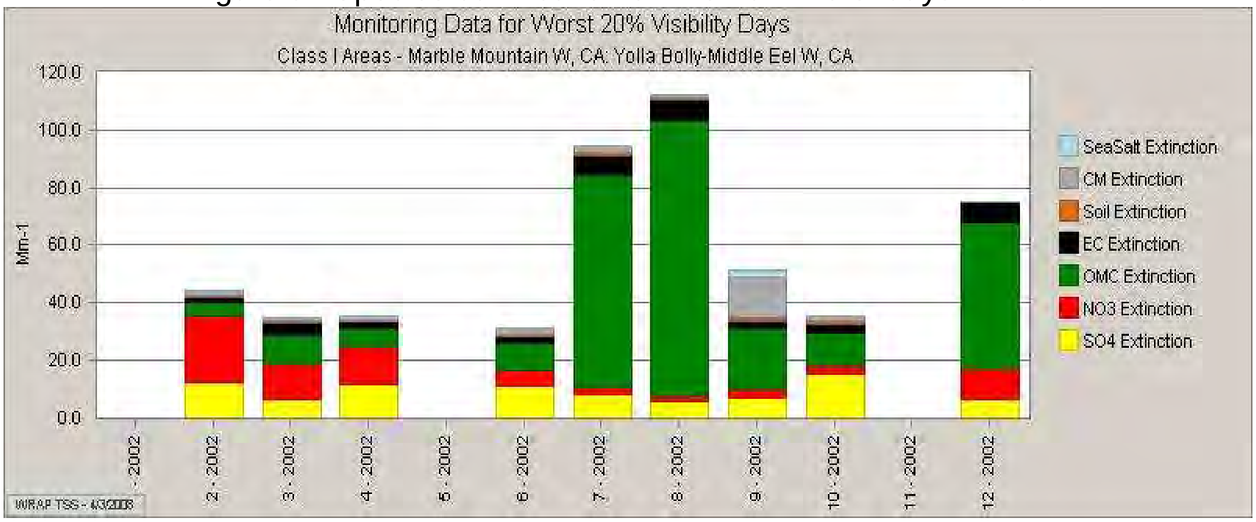
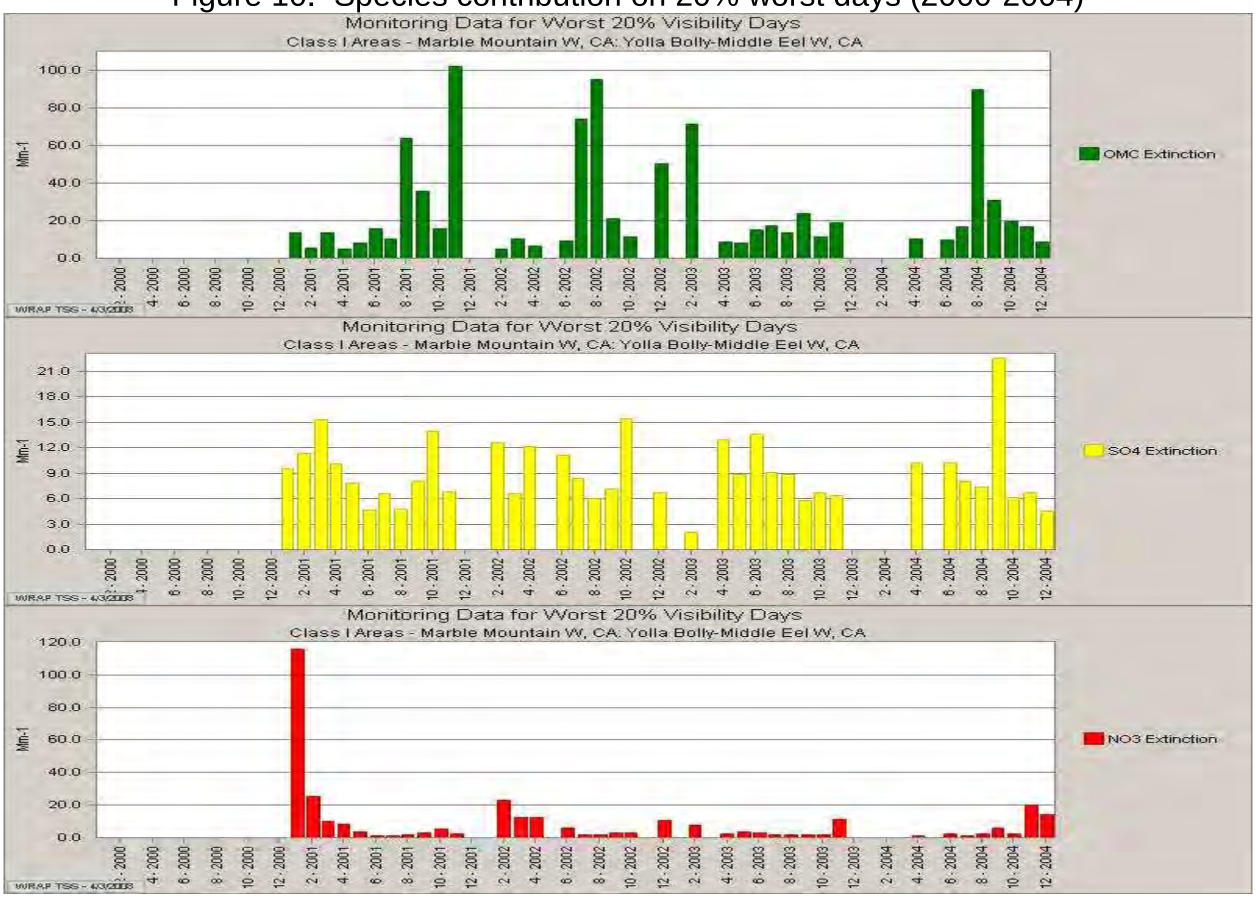


Figure 10. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at TRIN1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the TRIN1 monitor is from natural fire sources within Oregon. Oregon represents 67% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 62% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 36% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at TRIN1. The WRAP region represents 41% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Outside Domain Region (38%) and the Pacific Offshore Region (17%). California contributes 15% of the total sulfate emissions seen at the TRIN1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the TRIN1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figures 15 and 16 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (80%), followed by the Outside Domain Region (13%) and emissions from Pacific Offshore (5%). Mobile sources within California contribute the most nitrate at the TRIN1 monitor. In 2002, California accounted for 81% of all mobile sources. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11. Organic carbon source contribution from CA and outside regions

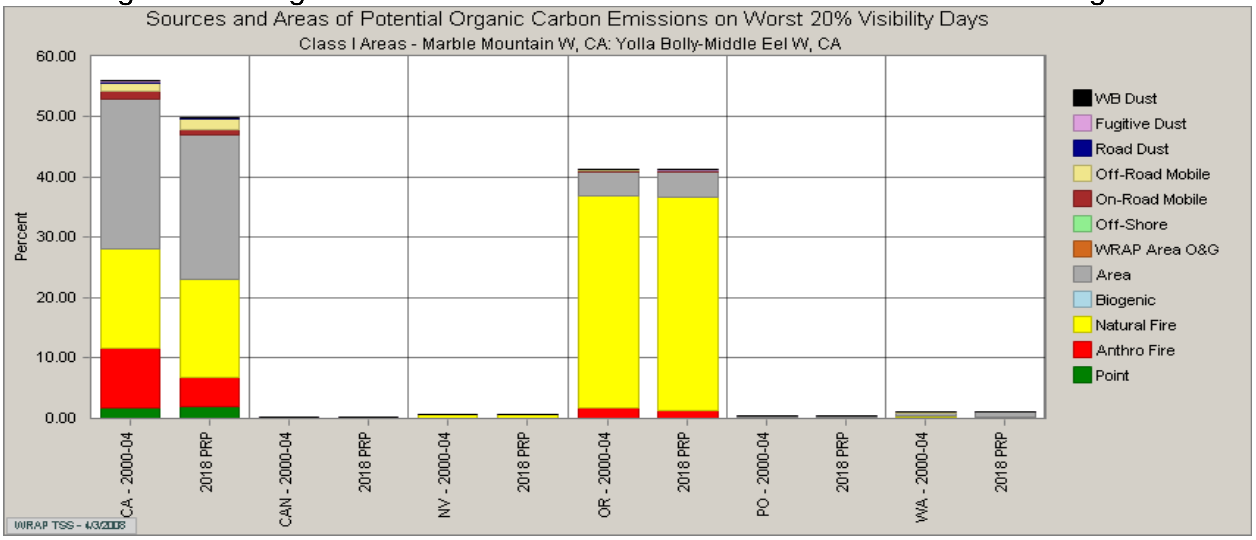


Figure 12. Organic carbon Anthropogenic and Biogenic Source Apportionment

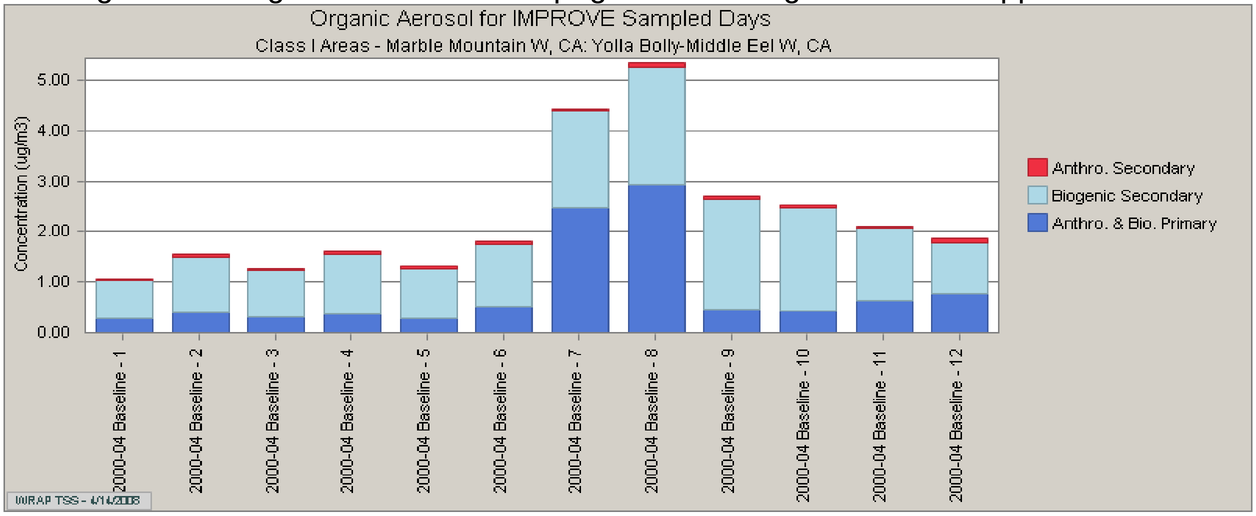


Figure 13. Regional Sulfate Contribution to Haze in 2002 and 2018

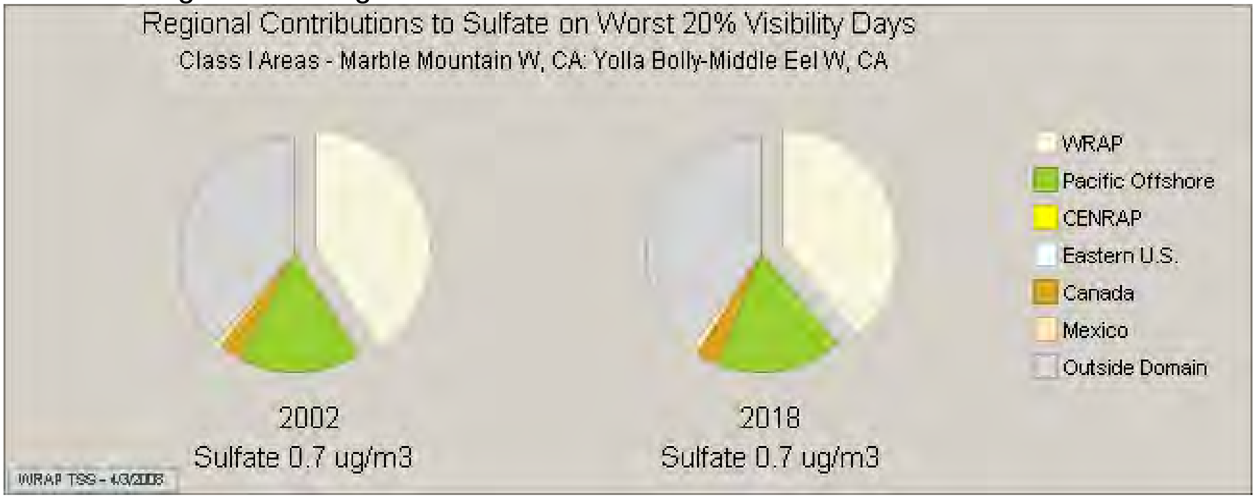


Figure 14. Sulfate source contribution from CA and outside regions

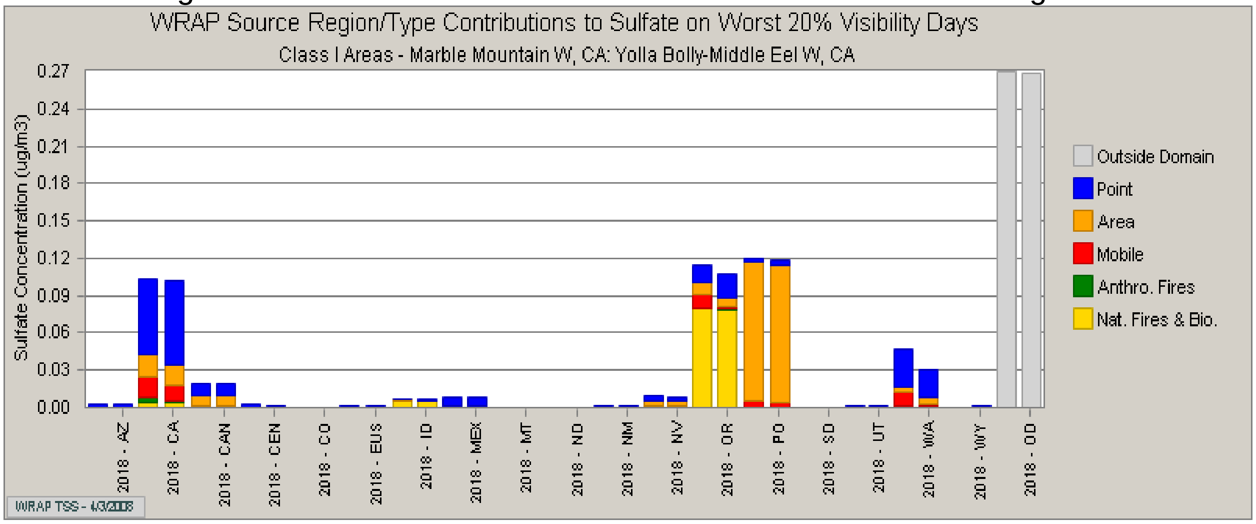


Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018

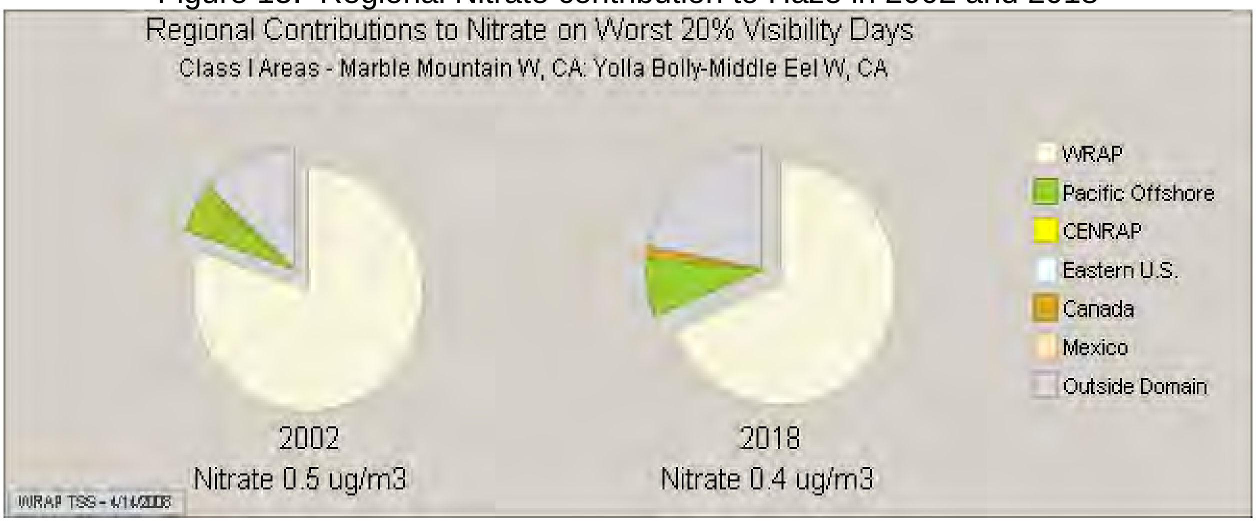
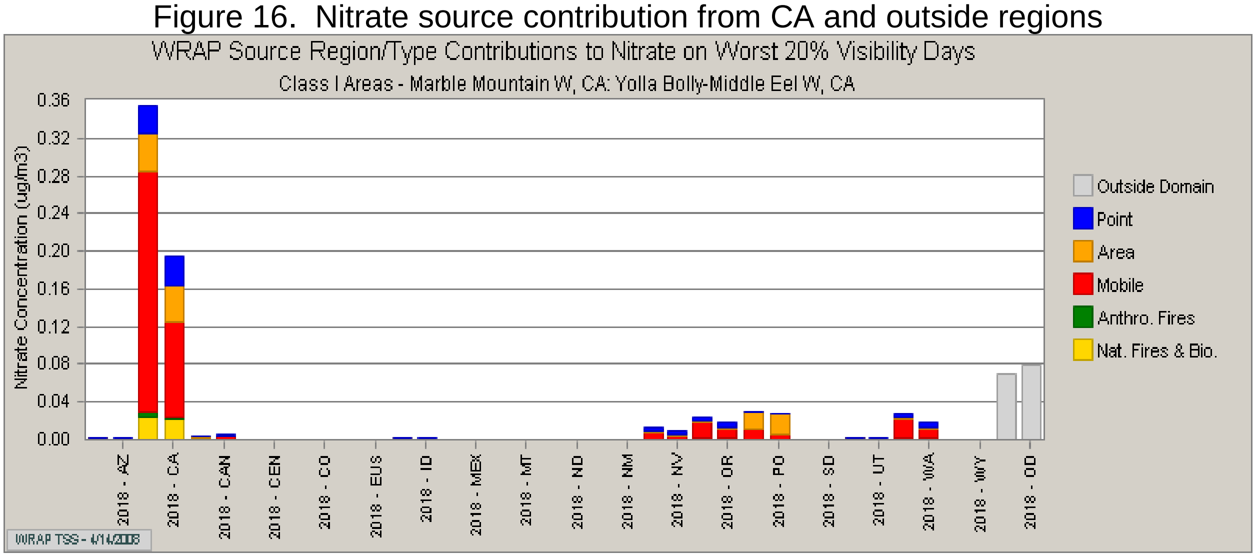


Figure 16. Nitrate source contribution from CA and outside regions



LABE1 Monitor

The LABE1 monitor location represents two wilderness areas located within Siskiyou and Modoc Counties. The wilderness areas associated with the LABE1 monitor are Lava Beds Wilderness area and South Warner Wilderness area. The LABE1 site has been operating since March 2000. This site does not have sufficient data for the entire baseline period. Data was not available for year 2000.

Section I. LABE1 Wilderness Area Descriptions

I.a. Lava Beds Wilderness Area

The Lava Beds Wilderness Area (Lava Beds) consists of 28,460 acres in the Lava Beds National Monument in northeastern California, bordering the eastern slopes of the Sierra Nevada range, 43 miles northeast of Mt. Shasta. Lava Beds terrain is flat, gently sloping upwards towards the southwest. Elevations range from about 1,219 meters to 1,737 meters.

Figure 1. LABE1 Monitor location

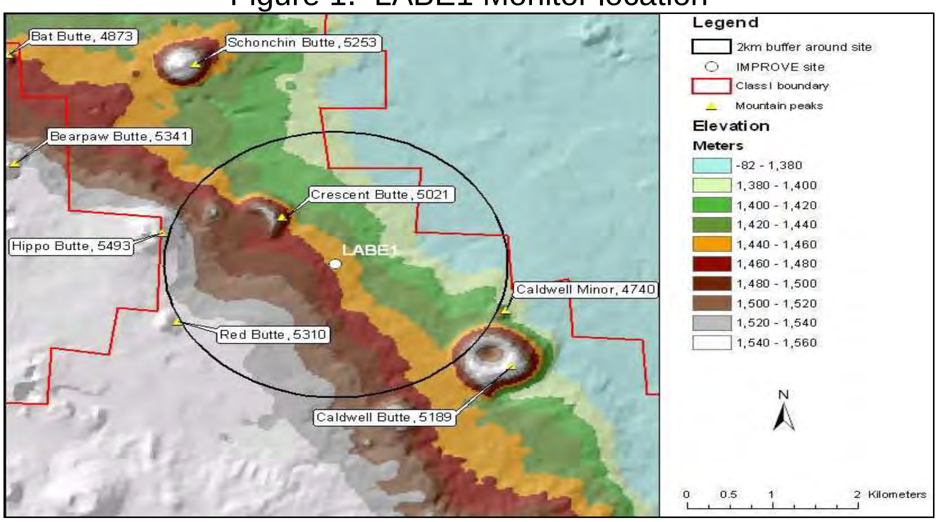
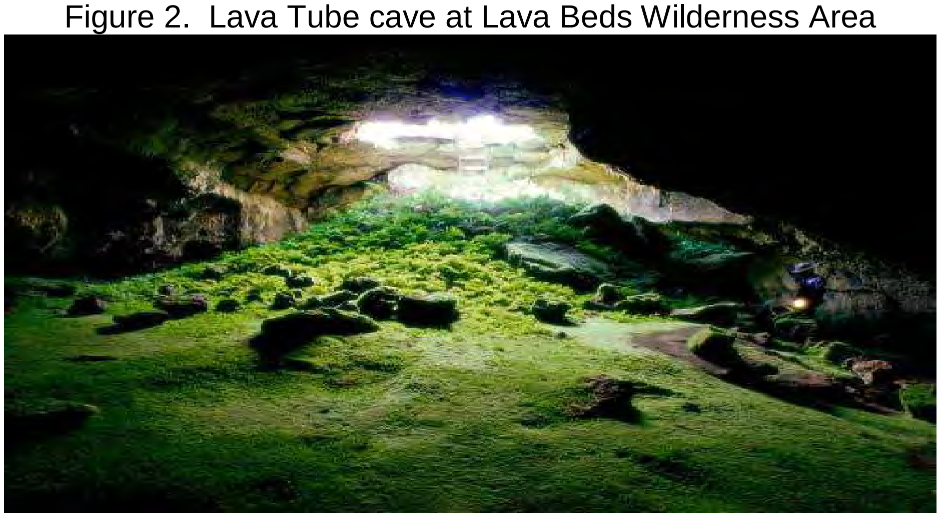


Figure 2. Lava Tube cave at Lava Beds Wilderness Area



I.b. South Warner Wilderness Area

The South Warner Wilderness consists of 70,385 acres on the Warner Mountain Range, an isolated spur of the Cascade Range in extreme northeastern California. Elevations range from about 1,600 meters along the eastern Wilderness Boundary to 3,015 meters at the crest of Eagle Peak. The terrain is gently rolling on the western slopes, with steeper eastern slopes.

Figure 3. South Warner Wilderness Area

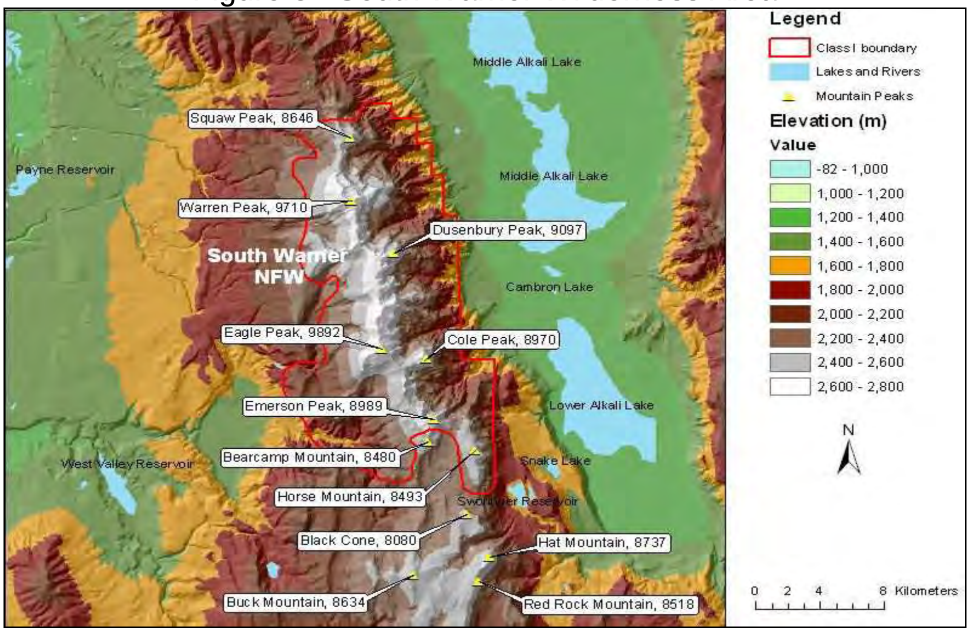


Figure 4. South Warner Wilderness Area

Figure 5. LABE1 Monitor location in California

Section II. Visibility Conditions:

II.a. Lava Beds Wilderness Area

Visibility conditions for Lava Beds are currently monitored by the LABE1 IMPROVE monitor. The monitor is located at 41.7117 north latitude and 121.5068 west longitude, located near the southern end of Lava Beds Wilderness at an elevation of 1,460 meters.

Lava Beds is located at the northwestern fringe of the Great Basin physiographic region. The nearest population area and potential source region is the northern Sacramento Valley to the southwest, separated from the Lava Beds and South Warner Wilderness areas by the northern Sierra Nevada and southern Cascade Ranges. High aerosol concentrations at LABE1 may result from regional forest fires. Entrained crustal material from exposed desert surfaces may be a source of particulate matter during strong wind episodes. At times during the extended summer a significant southerly component of flow from the Sacramento Valley could bring lofted emissions to the area over relatively low lying terrain between the southern Cascade Range and northern Sierra Nevada Range. Worst haze conditions at LABE1 may result from regional forest fires during regional stagnation episodes.

The LABEI location is adequate for assessing the 2018 reasonable progress goals for the Lava Beds Wilderness Class 1 area.

II.b. South Warner Wilderness Area

Visibility conditions for the South Warner Wilderness are currently monitored by the LABE1 IMPROVE monitor located near the southern end of Lava Beds Wilderness. The monitor is located at 41.7117 north latitude, 121.5068 west longitude, at an elevation of 1,460 meters, 70 miles northwest of the South Warner Wilderness Area.

The LABE1 IMPROVE site should be representative of the South Warner Wilderness Area during regionally homogeneous atmospheric conditions that prevail during worst haze conditions in this isolated area of northeastern California. The nearest population area and potential source region, with respect to the LABE1 IMPROVE site, is the northern Sacramento Valley to the southwest, separated from the South Warner Wilderness by the northern Sierra Nevada and southern Cascade Ranges. High aerosol concentrations at LABE1 may result from regional forest fires. Entrained crustal material from exposed desert surfaces may be a source of particulate matter during strong wind episodes.

The LABE1 location is adequate for assessing the 2018 reasonable progress goals for the South Warner Wilderness Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from LABE1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the LABE1 monitor is calculated at 3.2 deciviews for the 20% best days and 15.1 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

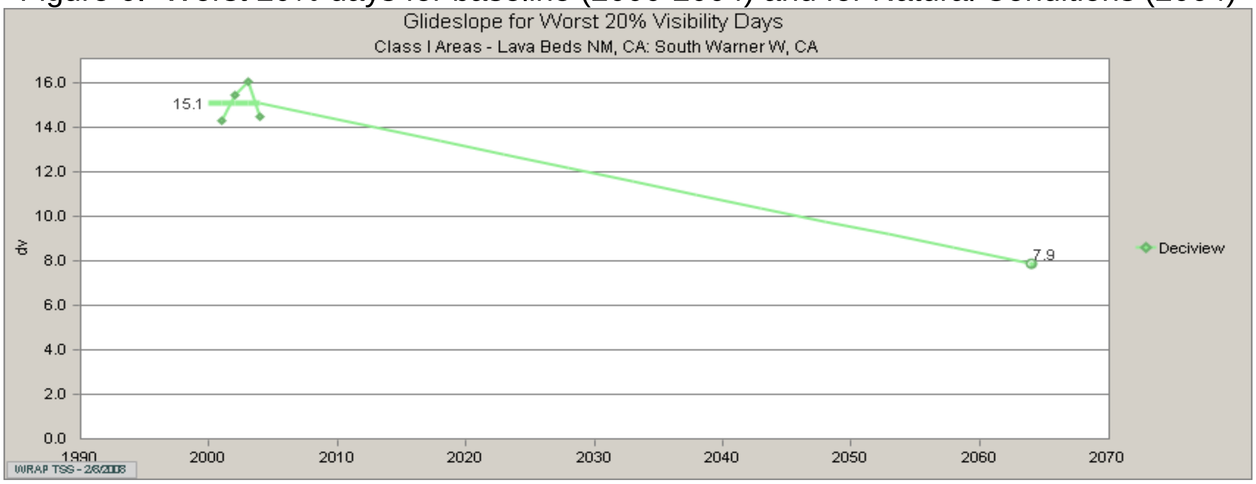
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the LABE1 monitor is 1.3 deciviews for the 20% best days and 7.9 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 13.37 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 3.2 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at LABE1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

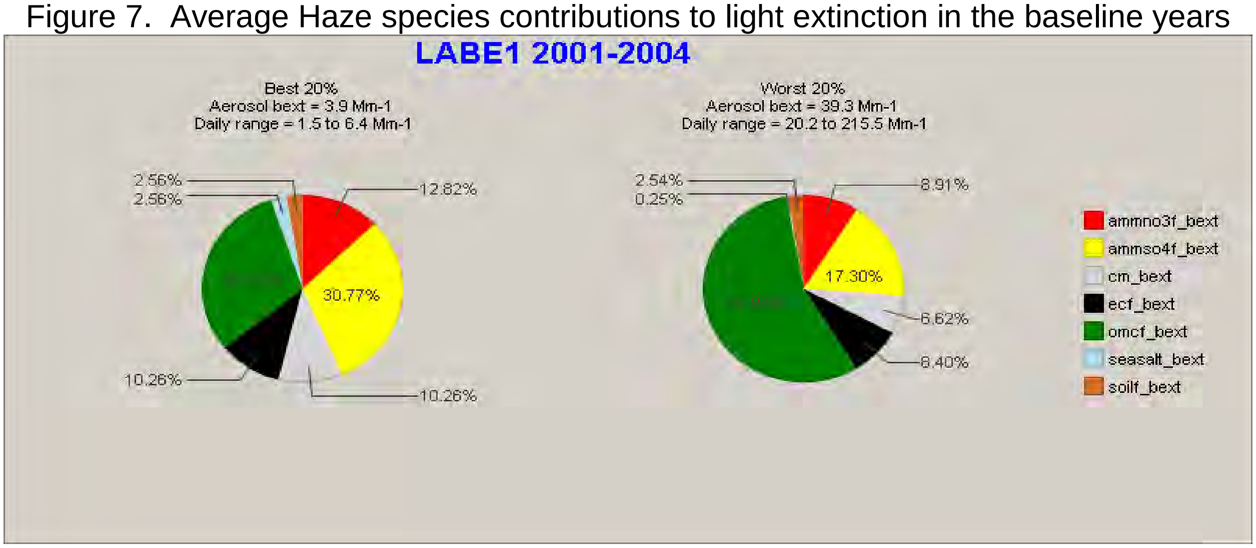
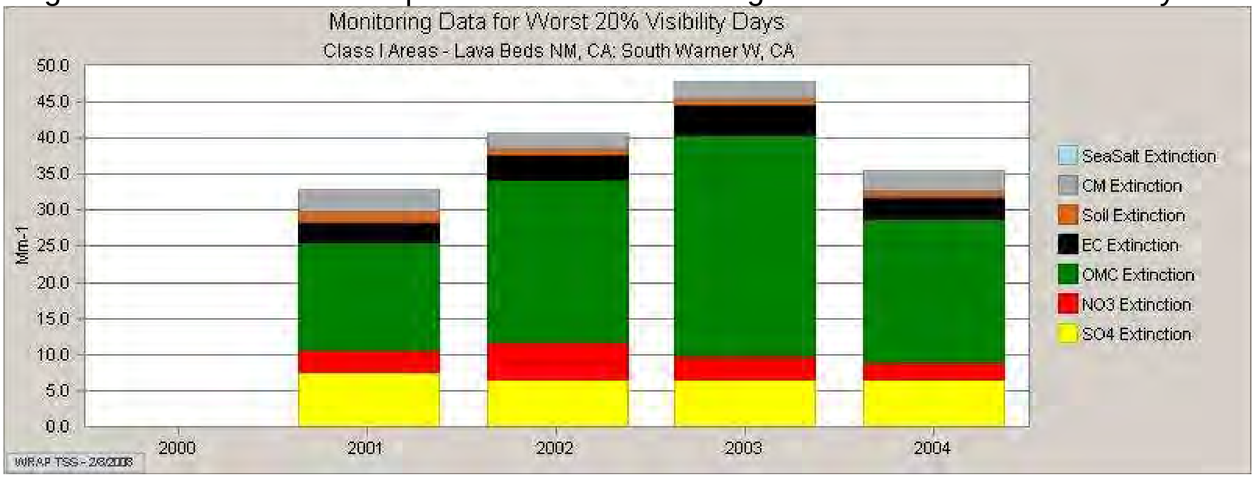


Figure 8. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 7 and 8, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on worst days at the LABE1 monitor. The worst days are dominated by organic matter while the best days are dominated equally by sulfates and organic matter. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter while sulfates increase slightly in the spring. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. Sea salt and soil are present at the LABE1 monitor but in very small amounts.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

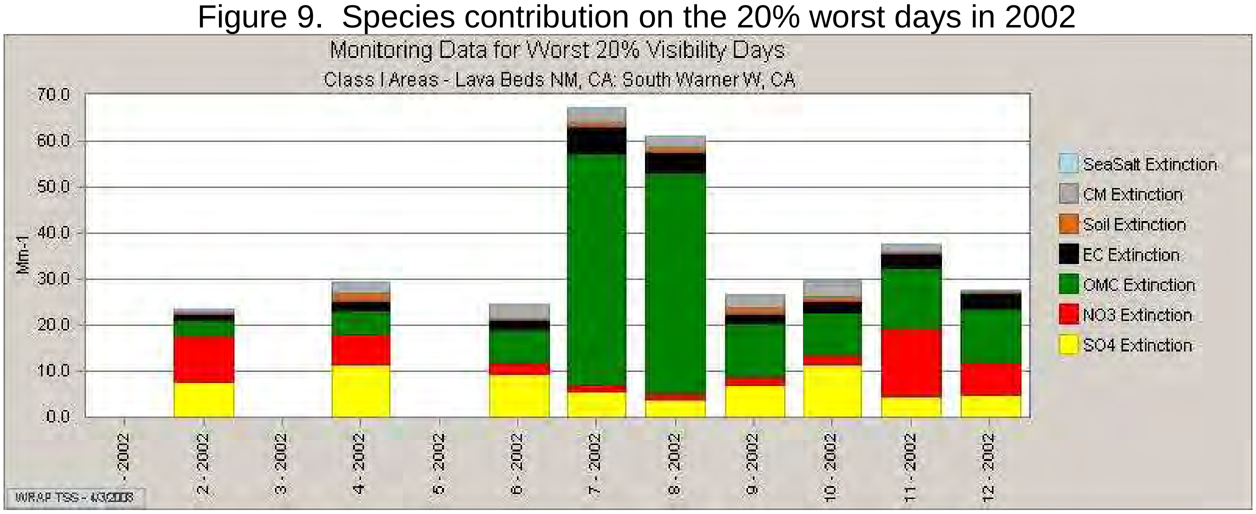
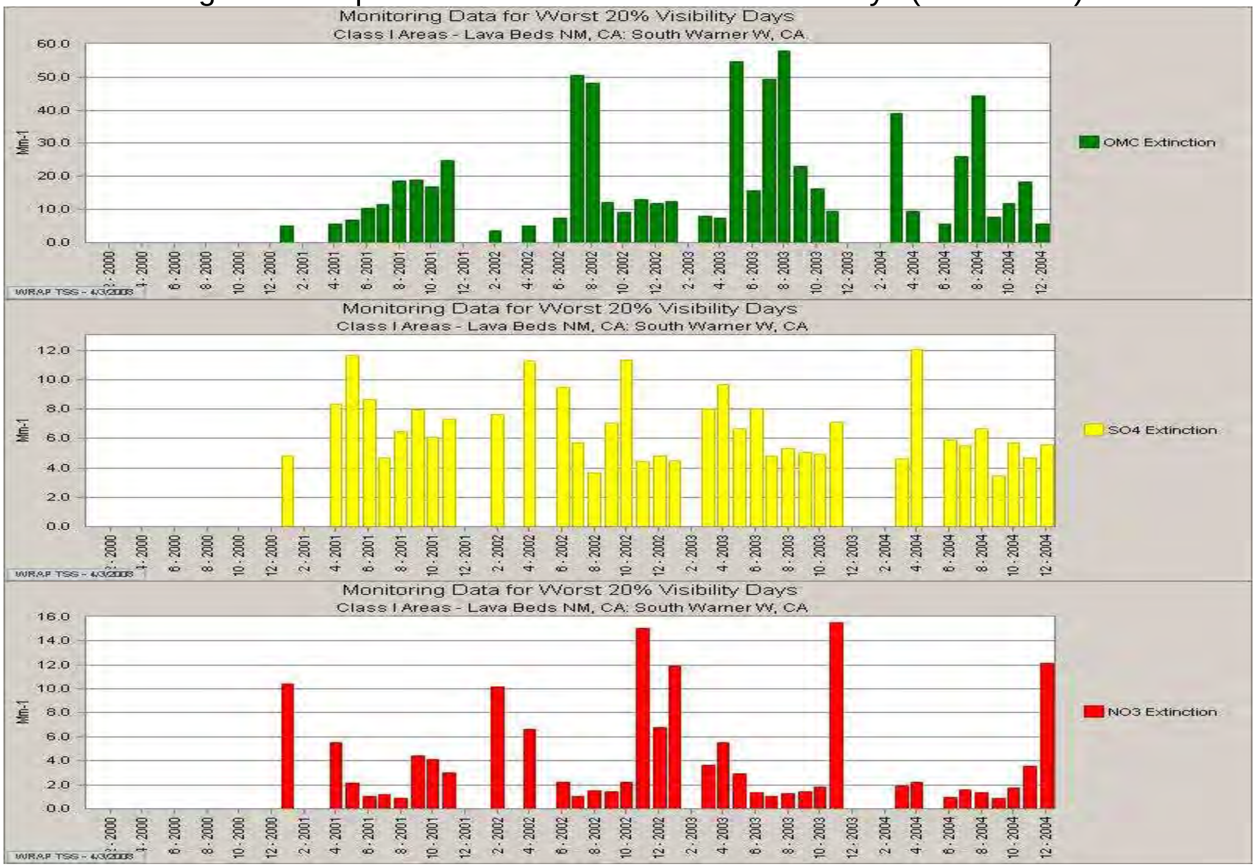


Figure 10. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at LABE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the LABE1 monitor is from natural fire sources within Oregon. Oregon represents 67% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 76% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 22% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at LABE1. The Outside Domain region represents 53% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (31%) and the Pacific Offshore Region (11%). California contributes 13% of the total sulfate emissions seen at the LABE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the LABE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figures 15 and 16 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (74%), followed by the Outside Domain Region (21%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrate at the LABE1 monitor. In 2002, 51% of the nitrate at the LABE1 monitor can be attributed to California. California accounts for 69% of all mobile source nitrate emissions. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11. Organic carbon source contribution from CA and outside regions

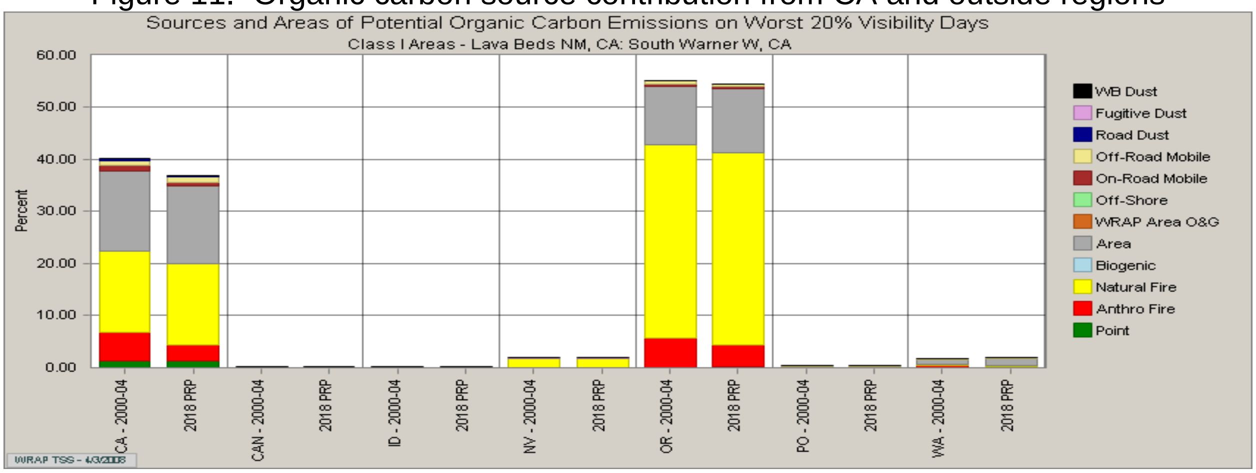


Figure 12. Organic carbon Anthropogenic and Biogenic Source Apportionment

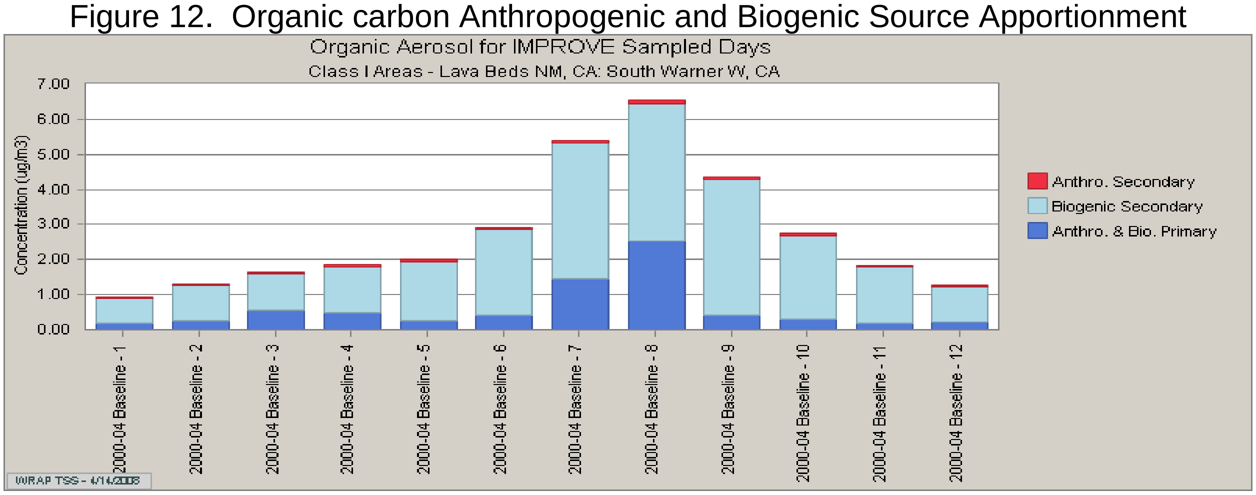


Figure 13. Regional Sulfate contribution to Haze in 2002 and 2018

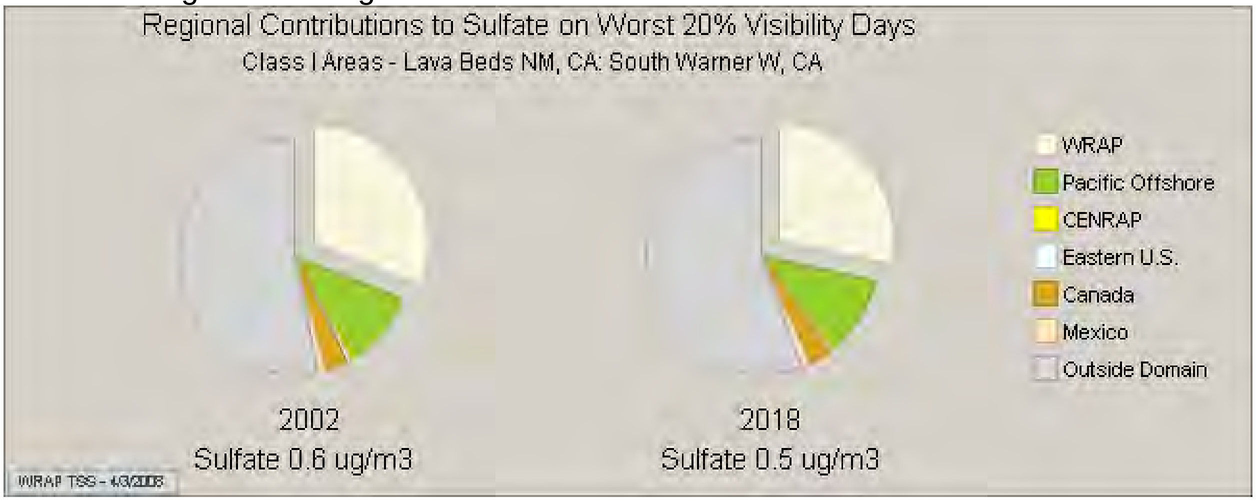


Figure 14. Sulfate source contribution from CA and outside regions

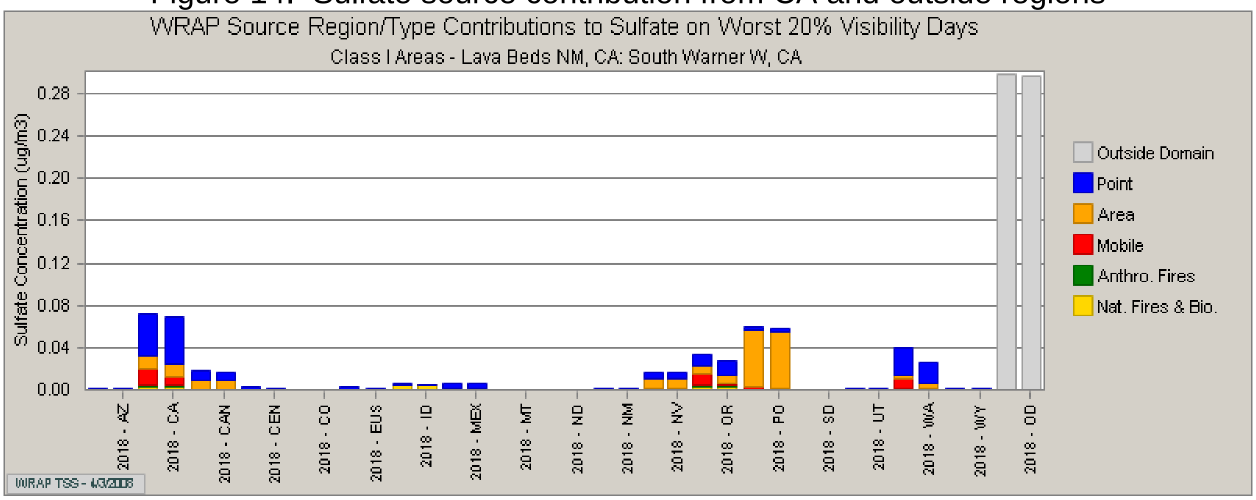


Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018

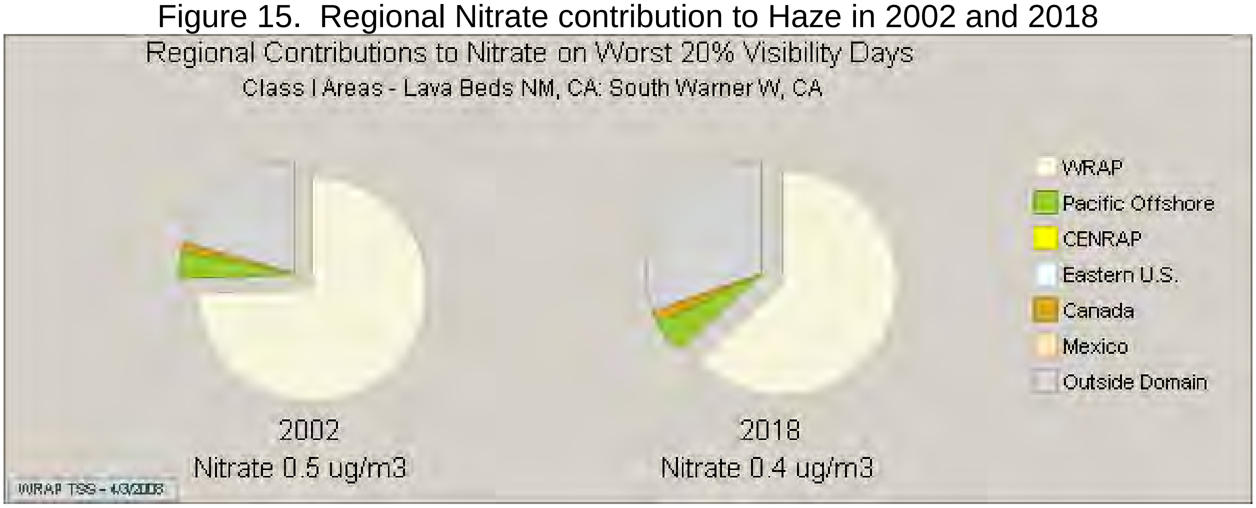
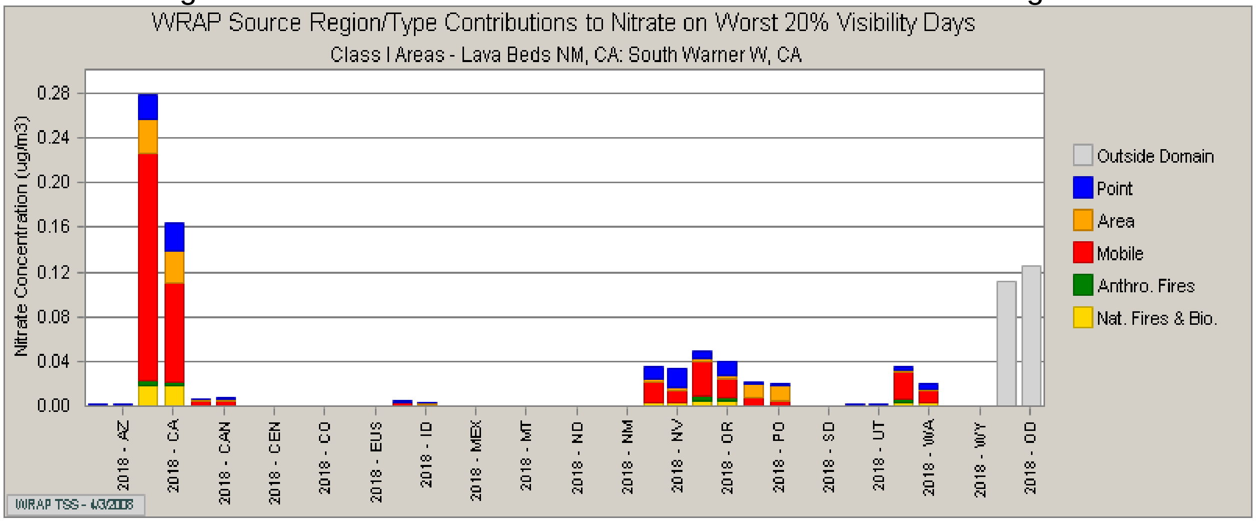


Figure 16. Nitrate source contribution from CA and outside regions



LAVO1 Monitor

The LAVO1 monitor location represents three wilderness areas located in Northern California near the Southern extreme of the Cascade Range. The wilderness areas associated with the LAVO1 monitor are Caribou Wilderness Area, Lava Beds Wilderness area and South Warner Wilderness area. The LAVO1 site has been operating since March 1988. This site has sufficient data for the entire baseline period.

<u>Section I. LABE1 Wilderness Area Descriptions</u>

I.a. Caribou Wilderness Area

The Caribou Wilderness Area (Caribou) consists of 20,500 acres in Northern California at the southern extreme of the Cascade Range and immediately adjacent to Lassen Volcanic National Park on its west side. Elevations range from nearly 1829 meters to the highest point, Red Cinder, at 2551 meters. The headwaters of the Susan River, which flows eastward towards Susanville and Honey Lake on the east slope of the Cascade Range, originate in Caribou Wilderness.

Figure 1. Caribou Wilderness Area

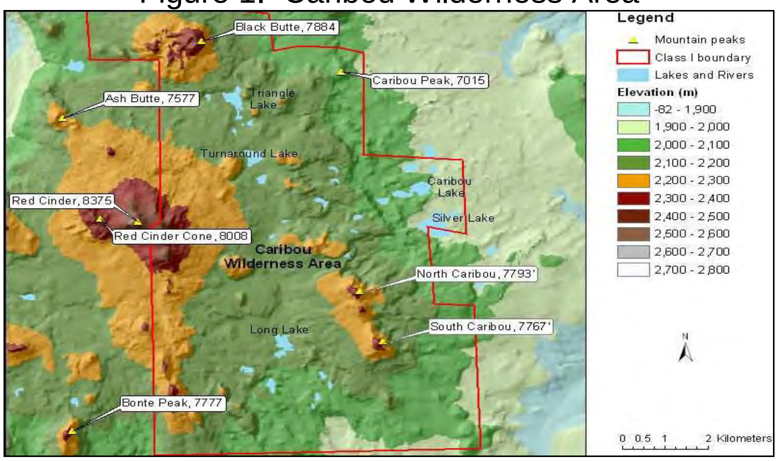


Figure 2. Image of Caribou Wilderness Area

I.b. Lassen Volcanic National Park

Lassen Volcanic National Park (Lassen) consists of 105,800 acres in northern California, at the southern extreme of the Cascade Range. Lassen consists of slopes and area surrounding Lassen Peak, elevation 3,187 meters. Lassen terrain consists of several volcanic cones in addition to Lassen Peak, and surrounding and intervening terrain. Lowest elevations are near 1,707 meters at points where streams exit the park. The entire Lassen park area is generally in terrain to the east of the north end of the Sacramento Valley, and is thus subject to upwind flow from the south and west, the directions to northern Sacramento Valley communities of Redding, Red Bluff, and Chico roughly 50 miles to the west, west-southwest, and south-southwest respectively. Typical northern Sacramento Valley elevations are 152 to 183 meters, or about 1,524 meters lower than the lowest Lassen elevations.

Figure 3. LAVO1 Monitor location

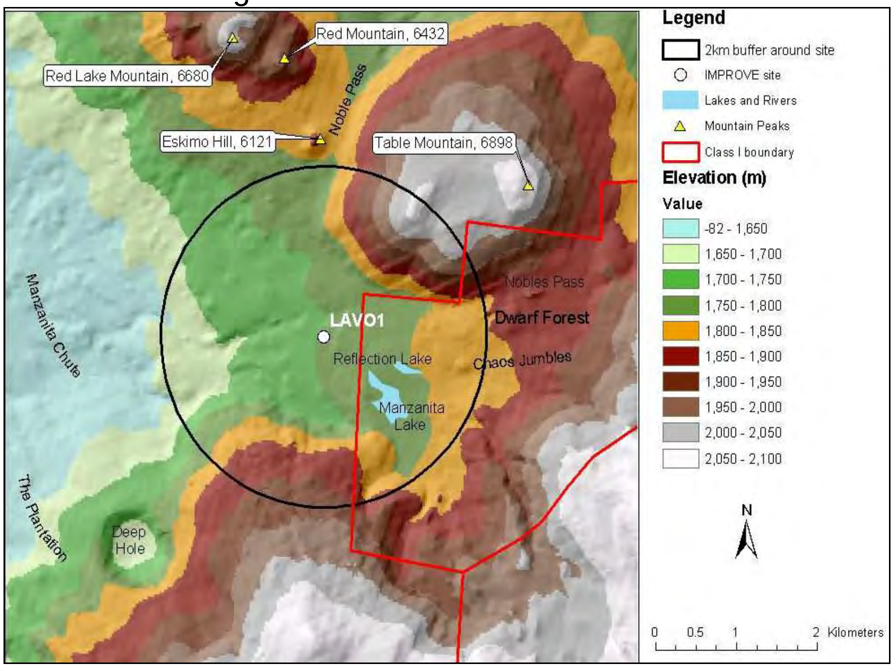


Figure 4. Image of Lassen Volcanic National Park

I.c. Thousand Lakes Wilderness Area

The Thousand Lakes Wilderness Area (Thousand Lakes) consists of 16,335 acres, 10 miles northwest of Thousand Lakes Wilderness Area near the southern extreme of the Cascade Range. It consists mainly of slopes extending downward from Crater Peak, elevation 2,645 meters. The lowest Wilderness elevation is 1,690 meters at the base of Crater Peak. The Thousand Lakes Wilderness Area, Thousand Lakes Wilderness Area and the Caribou Wilderness are in the same general area and all share the same general topographic features.

Figure 5. WINHAZE image of Thousand Lakes Wilderness Area (2.7 vs. 14.1 dv)

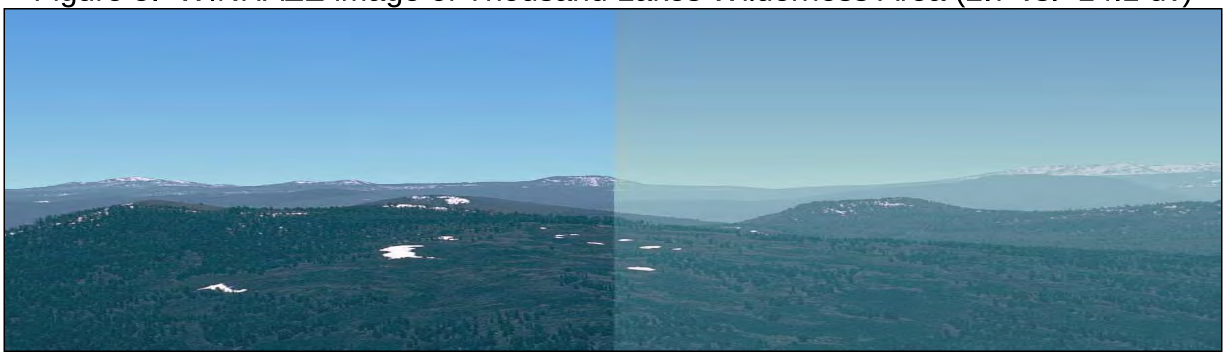


Figure 6. LAVO1 Monitor location in California

Section II. Visibility Conditions:

II.a. Caribou Wilderness Area

Visibility conditions for Caribou are currently monitored by the LAVO1 IMPROVE monitor located in Lassen Volcanic National Park, near the northwest entrance Ranger station. The monitor is located at 40.54 north latitude, 121.57 west longitude, 25 yards southeast of the Fire Station, at an elevation of 1733 meters. The site may be influenced by channeled flow in the Manzanita Creek drainage which flows west from the National Park and ultimately to the northern Sacramento Valley.

The Caribou Wilderness Area, Lassen Volcanic National Park, and Thousand Lakes Wilderness Area are in the same general area and share the same general topographic features. The Caribou Wilderness has a somewhat more direct link to the eastern slopes of the Cascades via the Susan River that flows into Honey Lake in northeastern California, approximately 50 miles east of the Wilderness. Caribou Wilderness may see somewhat more influence by sources on the western slope of the Cascade Range during infrequent east-west transport conditions that may not be represented by data from LAVO1. Potential haze sources on the eastern slopes of the Cascade Range include dry and intermittent lakes, sources of alkali dust, and windblown desert dust that could impact the Wilderness during extreme dust storms with an easterly direction component.

The LAVOI location is adequate for assessing the 2018 reasonable progress goals for the Caribou Wilderness Class 1 area.

II.b. Lassen Volcanic National Park

Visibility conditions for Lassen are currently monitored by the LAVO1 IMPROVE monitor. The monitor is located at 40.5398 north latitude and 121.5768 west longitude, near the northwest park entrance Ranger station, 25 yards southeast of the Fire Station, at an elevation of 1,733 meters. The site may be influenced be channeled flow in the Manzanita Creek drainage that flows west from the Park and ultimately to the northern Sacramento Valley.

The monitoring location is near the low end of the range of Lassen elevations. It should be representative of park locations in general. During surface inversion conditions, it should still be representative of lower elevations, and hence of worst (highest aerosol concentrations) conditions. It is located within or near the Manzanita Creek drainage that is a channel for nighttime drainage flow. The closest source region with emissions that may contribute to aerosol and haze in Lassen is the northern Sacramento Valley. Lassen may also be linked to emissions form the Sacramento area 120 to 150 miles south and from the San Francisco Bay area, during low level southerly flow through the central valleys.

The LAVOI location is adequate for assessing the 2018 reasonable progress goals for the Lassen Volcanic National Park Class 1 area.

II.c. Thousand Lakes Wilderness Area

Visibility conditions for Thousand Lakes are currently monitored by the LAVO1 IMPROVE monitor located near the entrance to Thousand Lakes Wilderness Area. The monitor is located at 40.5398 north latitude and 121.5768 west longitude, near the northwest park entrance Ranger station, 25 yards southeast of the Fire Station, at an elevation of 1,733 meters. The site may be influenced be channeled flow in the Manzanita Creek drainage that flows west from the Park and ultimately to the northern Sacramento Valley.

The monitoring location should be representative of park locations in general. During surface inversion conditions, it should still be representative of lower elevations, and hence of worst (highest aerosol concentrations) conditions. It is located within or near the Manzanita Creek drainage which is a channel for nighttime drainage flow. The closest source region with emissions that may contribute to aerosol and haze in Thousand Lakes Wilderness is the northern Sacramento Valley. Thousand Lakes may also be linked to emissions form the Sacramento area 120 to 150 miles south and from the San Francisco Bay area, during low level southerly flow through the central valleys.

The LAVO1 location is adequate for assessing the 2018 reasonable progress goals for the Thousand Lakes Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from LAVO1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the LAVO1 monitor is calculated at 2.7 deciviews for the 20% best days and 14.1 deciviews for the 20% worst days. Figure 7 represents the worst baseline visibility conditions.

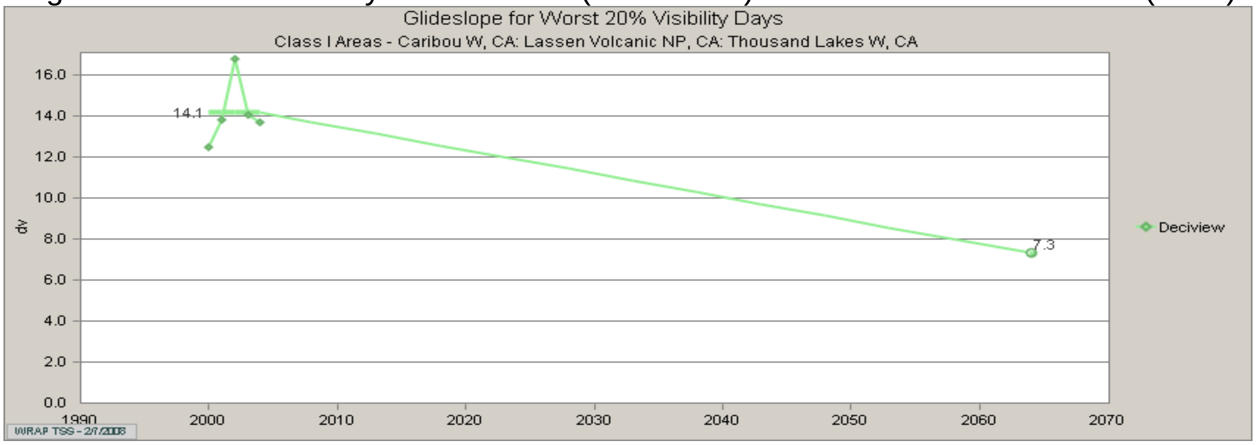
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the LAVO1 monitor is 1.0 deciviews for the 20% best days and 7.3 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 7 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 12.55 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.7 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 7. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 8 shows the contribution of each species to the 20% best and worst days in the baseline years at LAVO1.

Figure 8. Average Haze species contributions to light extinction in the baseline years

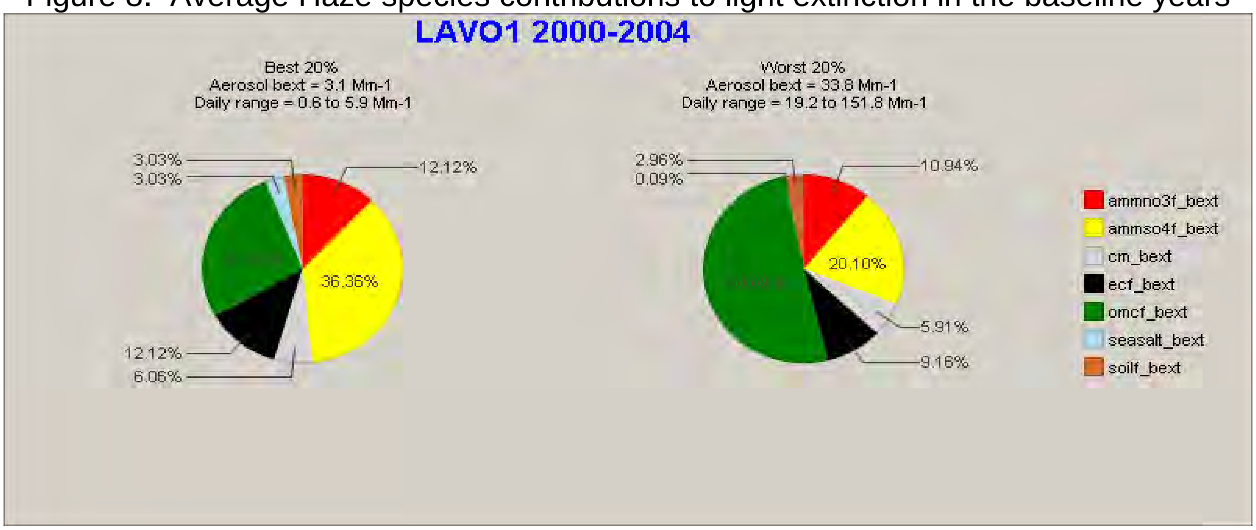
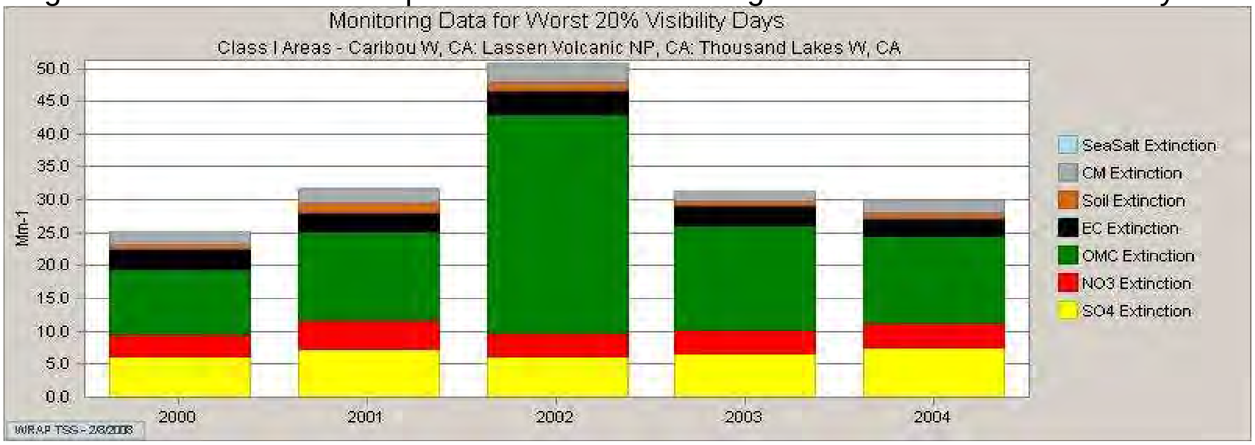


Figure 9. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 8 and 9, organic matter, sulfates, and nitrates have the strongest contributions to light extinction which degrades visibility on worst days at the LAVO1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate.

Figure 10 depicts the individual species contribution to worst days in 2003. Nitrates increase in the winter while sulfates increase slightly in the spring. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. Sea salt is not present at the LAVO1 monitor.

Figure 11 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 10 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 10. Species contribution on the 20% worst days in 2003

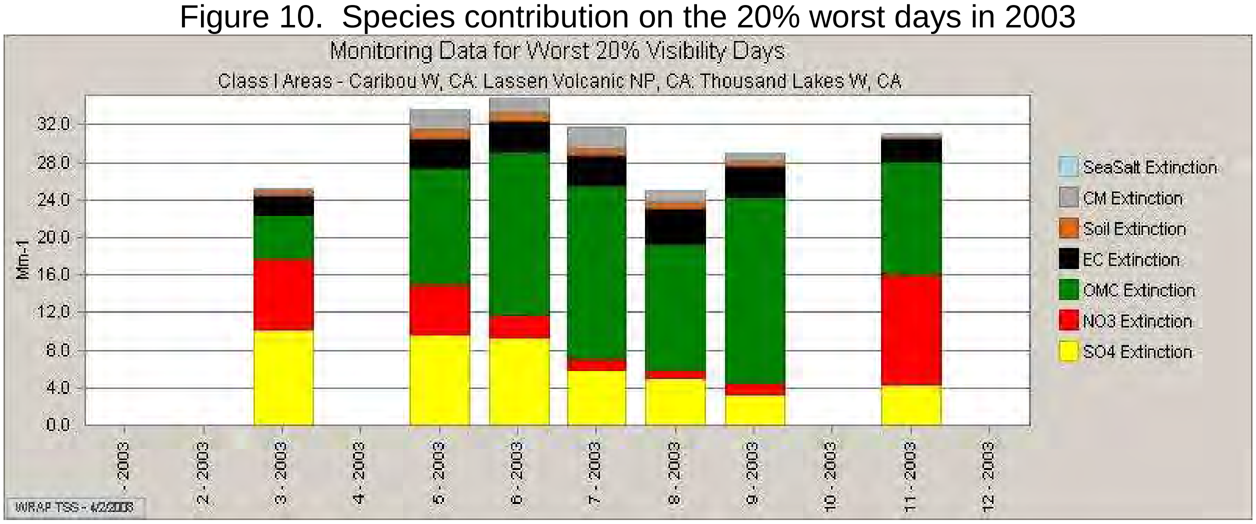
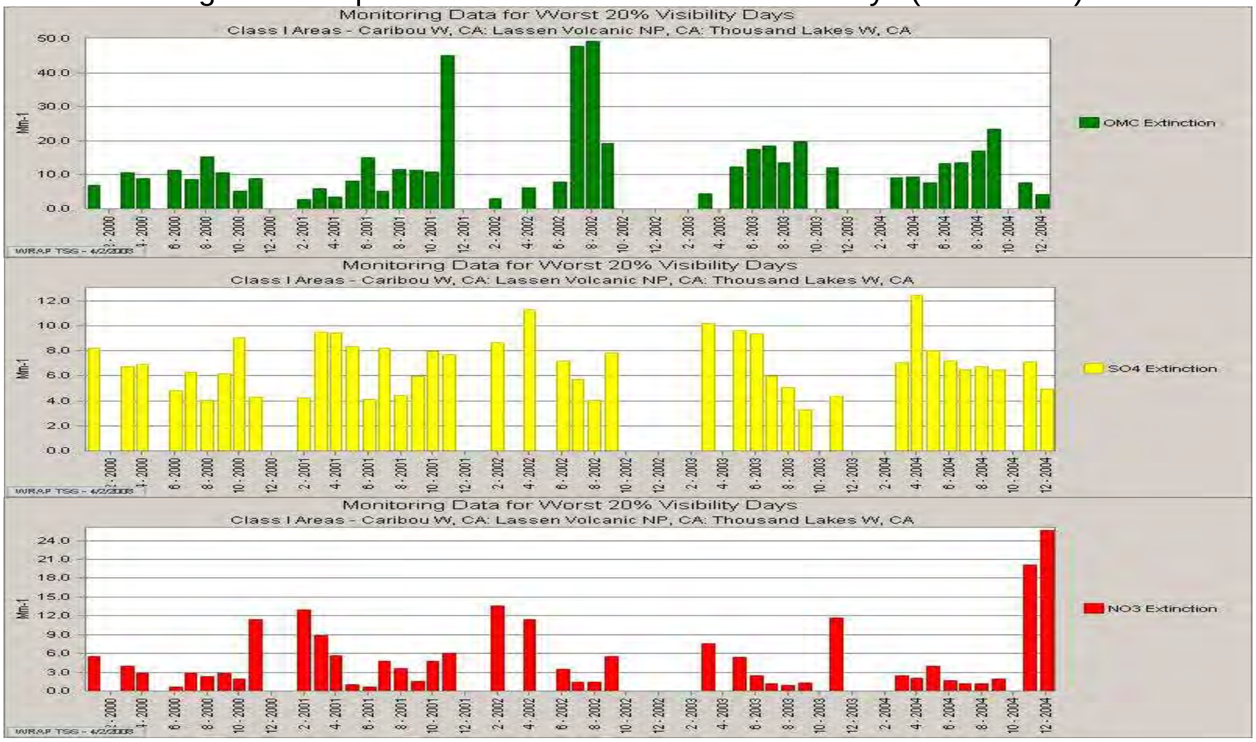


Figure 11. Species contribution on 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at LAVO1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the LAVO1 monitor is from area sources within California. California represents 90% of all area source contributions.

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 70% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 27% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at LAVO1. The WRAP region represents 41% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Outside Domain

Region (37%) and the Pacific Offshore Region (17%). California contributes 20% of the total sulfate emissions seen at the LAVO1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the LAVO1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore.

Figures 16 and 17 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (82%), followed by the Outside Domain Region (12%) and emissions from Pacific Offshore (6%). Mobile sources within California contribute the most nitrates at the LAVO1 monitor. In 2002, 72% of the nitrate at the LAVO1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the LAVO1 monitor in 2002 and 2018. Currently, California mobile sources are 74% of California contributions to nitrate at the LAVO1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 12. Organic carbon source contribution from CA and outside regions

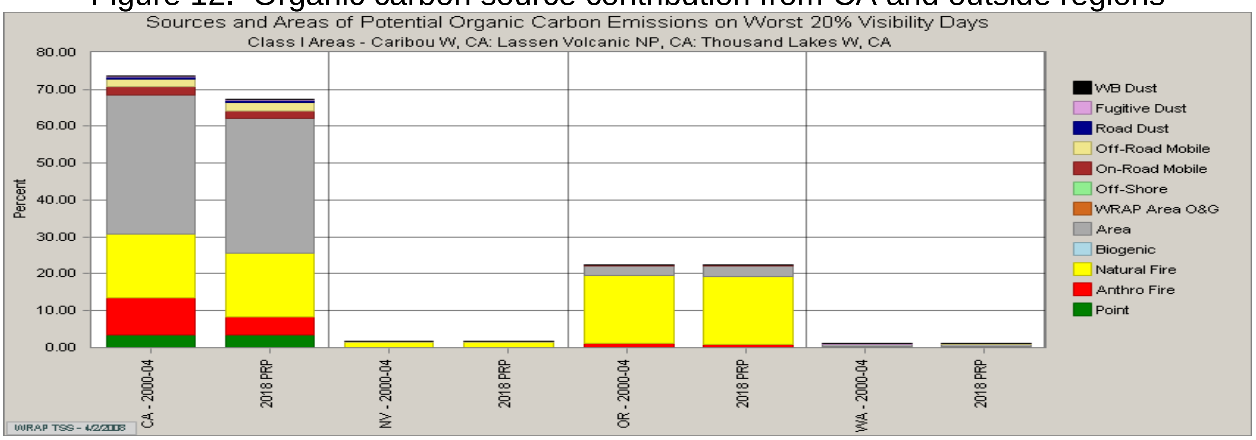


Figure 13. Organic carbon Anthropogenic and Biogenic Source Apportionment

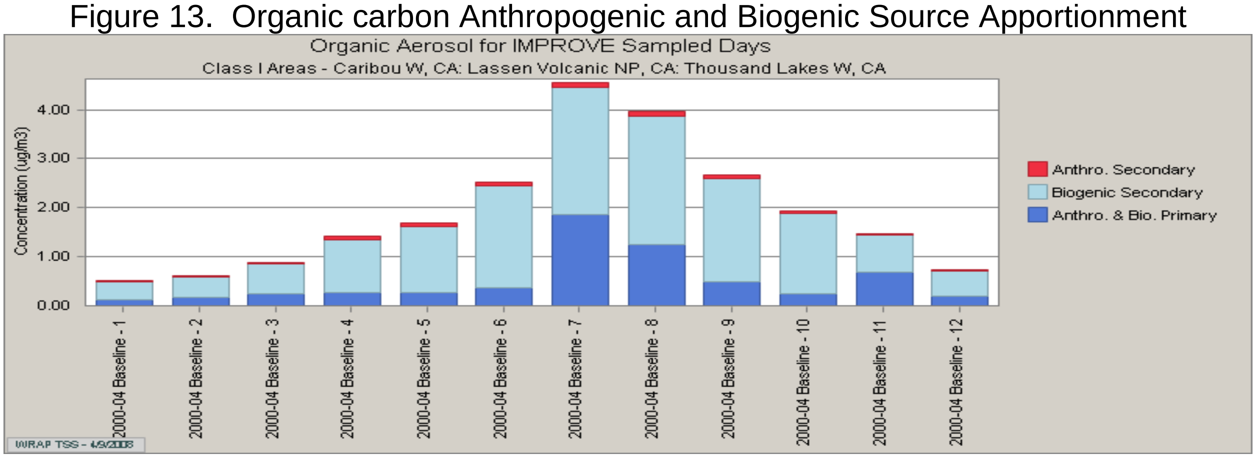


Figure 14. Regional Sulfate Contribution to Haze in 2002 and 2018

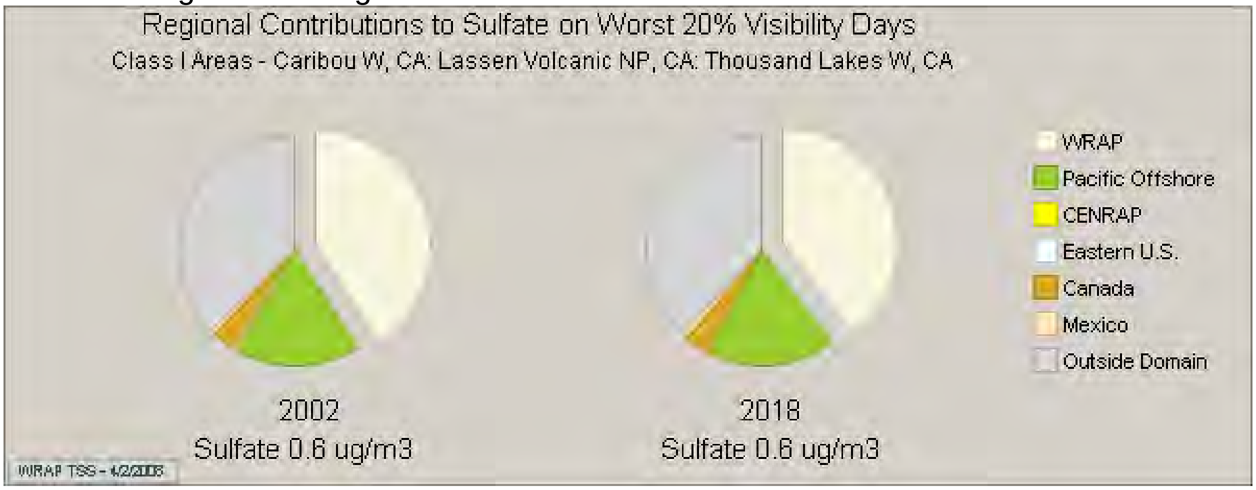


Figure 15. Sulfate source contribution from CA and outside regions

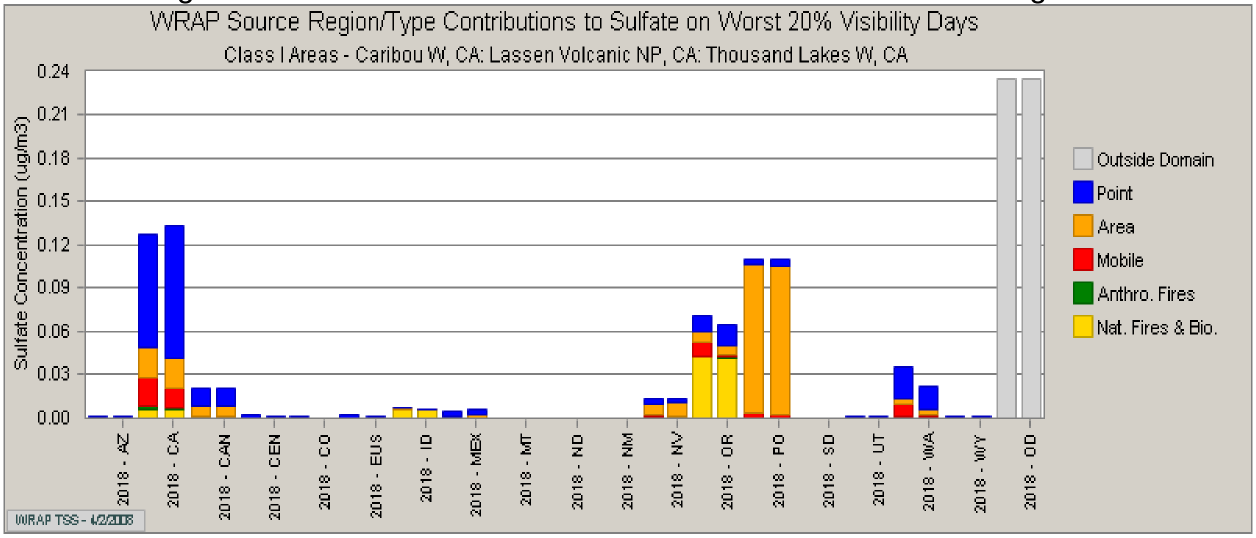


Figure 16. Regional Nitrate Contribution to Haze in 2002 and 2018

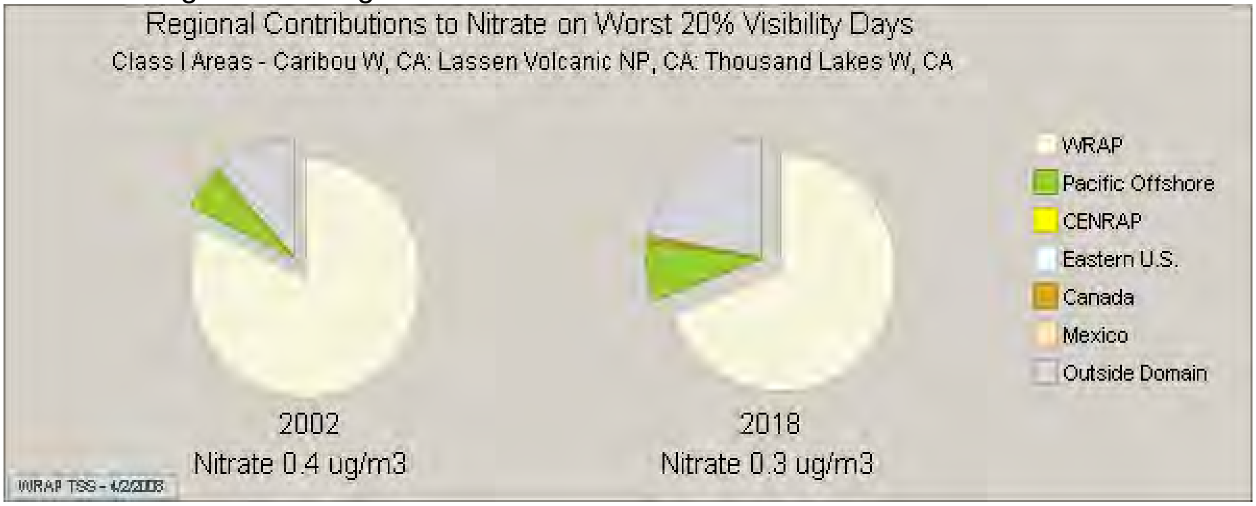
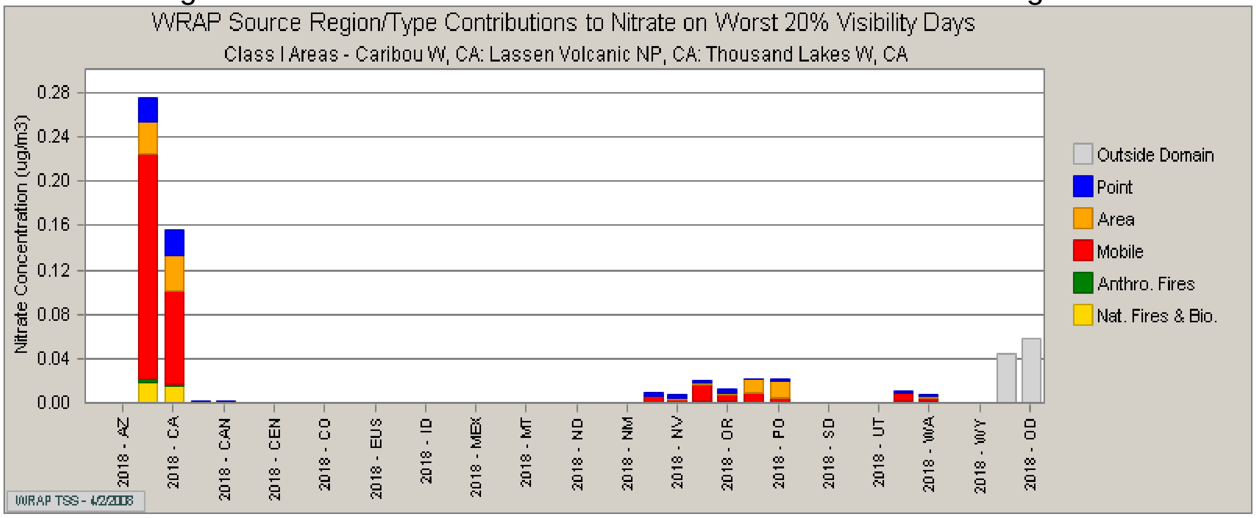


Figure 17. Nitrate source contribution from CA and outside regions



BLIS1 Monitor

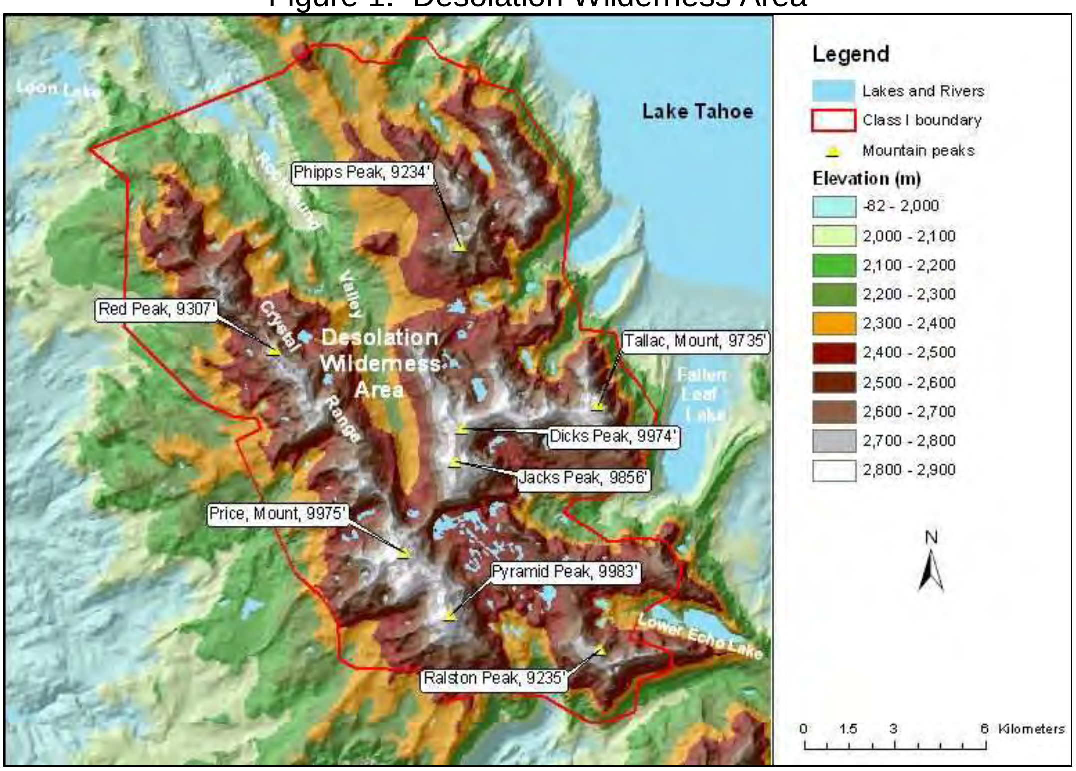
The BLIS1 monitor location represents two wilderness areas located along the crest of the Sierra Nevada mountain range, just west of Lake Tahoe. The wilderness areas associated with the BLIS1 monitor are Desolation Wilderness area and Mokelumne Wilderness area. The BLIS1 site has been operating since November 1990. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2004.

Section I. BLIS1 Wilderness Area Descriptions

I.a. Desolation Wilderness Area

The Desolation Wilderness Area (Desolation Wilderness) consists of 63,500 acres directly to the west of Lake Tahoe. It is bisected by the Rubicon River that flows northward from its source in the southern Wilderness to eventually flow into the headwaters of the American River and towards the San Joaquin Valley of central California. Wilderness elevations range from around 1,981 meters to 3,048 meters at the highest peaks. Lowest elevations are thus near Lake Tahoe's elevation of 1,897 meters. The nearest source of local emissions is probably the Lake Tahoe basin, immediately east of the Desolation Wilderness. However, most of the Wilderness is not part of the nearby Lake Tahoe air shed, although easternmost east facing slopes are.

Figure 1. Desolation Wilderness Area



I.b. Mokelumne Wilderness Area

The Mokelumne Wilderness Area (Mokelumne) consists of 105,165 acres and straddles the crest of the central Sierra Nevada range 15 to 20 miles south of Lake Tahoe. Watersheds drain to the Mokelumne River on the west slope and the Carson River on the east slope. The Mokelumne River opens up into the central San Joaquin Valley about 50 miles to the west. The prominent Wilderness topographic feature is the Mokelumne River Canyon. Elevations range from about 1,189 meters near Salt Springs Reservoir where the Mokelumne River exits the Wilderness on the south side to 3,164 meters at Round Top on the north side. Precipitation averages 50 inches annually on the west slope and as little as 15 inches on the east slope, 80 percent of it in the form of snow.

Figure 2. Mokelumne Wilderness Area

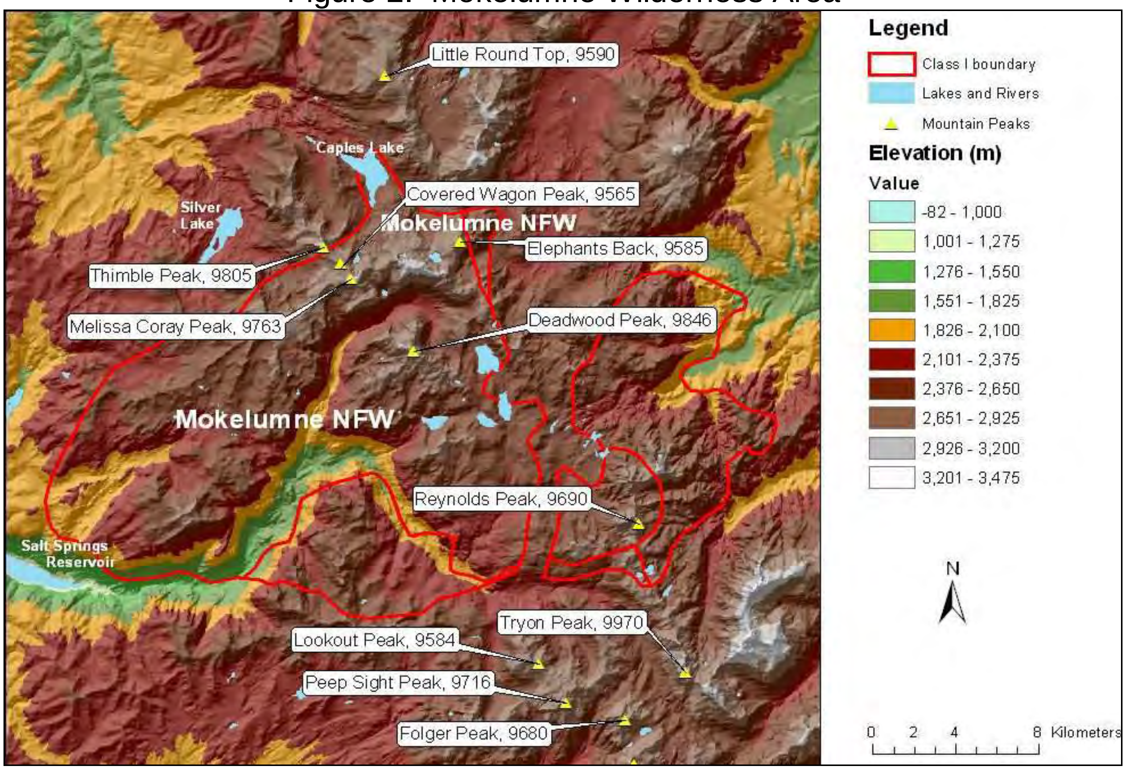


Figure 3. BLIS1 Monitor location in California

Section II. Visibility Conditions:

II.a. Desolation Wilderness Area

Visibility conditions for Desolation Wilderness are currently monitored by the BLIS1 IMPROVE monitor located at Bliss State Park. The monitor is located at 38.9761 north latitude, 120.1035 west longitude, near the western shore of Lake Tahoe at an elevation of 2,131 meters, about 219 meters above the shore of Lake Tahoe and near lowest elevations on the eastern slopes of Desolation Wilderness.

The BLIS1 monitoring site is about 219 meters above the shore of Lake Tahoe, and near the lowest Wilderness locations on slopes facing Tahoe Basin. It is likely more susceptible to local and trapped emissions in the Tahoe Basin that do not extend to higher Desolation Wilderness elevations. It is probably representative of Desolation

Wilderness locations on lower eastern slopes facing Lake Tahoe that may be worst case conditions overall, and during conditions of uniform regional haze. The closest source region with emissions that could contribute to haze in the Desolation Wilderness is the Lake Tahoe Basin. The more distant central Valley of California near Sacramento, from which emissions could be transported to Desolation Wilderness, is about 50 miles southwest, linked to Desolation Wilderness by the American River and Rubicon River. The Reno, Nevada area is about the same distance to the northeast but is generally downwind for prevailing wild directions and in a distant air shed.

Potential emission transport from source regions to the west in the California Central Valley occurs mainly in the summer. Locally, eastern Wilderness locations may be predominantly influenced by emissions within the Tahoe Basin. Highest summertime measured concentrations at BLIS1 are associated with regional forest fire events. In the absence of such regional events there is likely to be a significant contribution from vehicle traffic in the Tahoe Basin to aerosol measures at BLIS1. In the fall and winter there may be wood smoke impacts associated with prescribed burns and residential burning in the Tahoe Basin.

The BLISI location is adequate for assessing the 2018 reasonable progress goals for the Desolation Wilderness Class 1 area.

II.b. Mokelumne Wilderness Area

Visibility conditions for Mokelumne are currently monitored by the BLIS1 IMPROVE monitor located at Bliss State Park. The monitor is located at 38.9761 north latitude and 120.1035 west longitude near the western shore of Lake Tahoe at an elevation of 2,131 meters, about 219 meters above the shore of Lake Tahoe.

The BLIS1 IMPROVE site is close to and about 219 meters above the shore of Lake Tahoe, within the Tahoe Basin. There is no direct link to Mokelumne Wilderness, which is generally outside of the Tahoe Basin, except via the headwaters of the Upper Truckee River, separated from the Wilderness by higher terrain. BLIS1 is likely more susceptible to local and trapped emissions in the Tahoe basin that do not extend to Mokelumne Wilderness locations. It may be more representative of Mokelumne Wilderness locations during conditions of uniform regional haze. Emissions from Sacramento and Stockton, about 50 miles southwest, could be transported to the Mokelumne Wilderness, via the Mokelumne River. The Reno Nevada area is about the same distance to the northeast but is generally downwind for prevailing wind directions and in a distant air shed.

The BLIS1 location is adequate for assessing the 2018 reasonable progress goals for the Mokelumne Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from BLIS1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the BLIS1 monitor is calculated at 2.5 deciviews for the 20% best days and 12.6 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the BLIS1 monitor is 0.4 deciviews for the 20% best days and 6.1 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 4 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 11.10 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.5 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

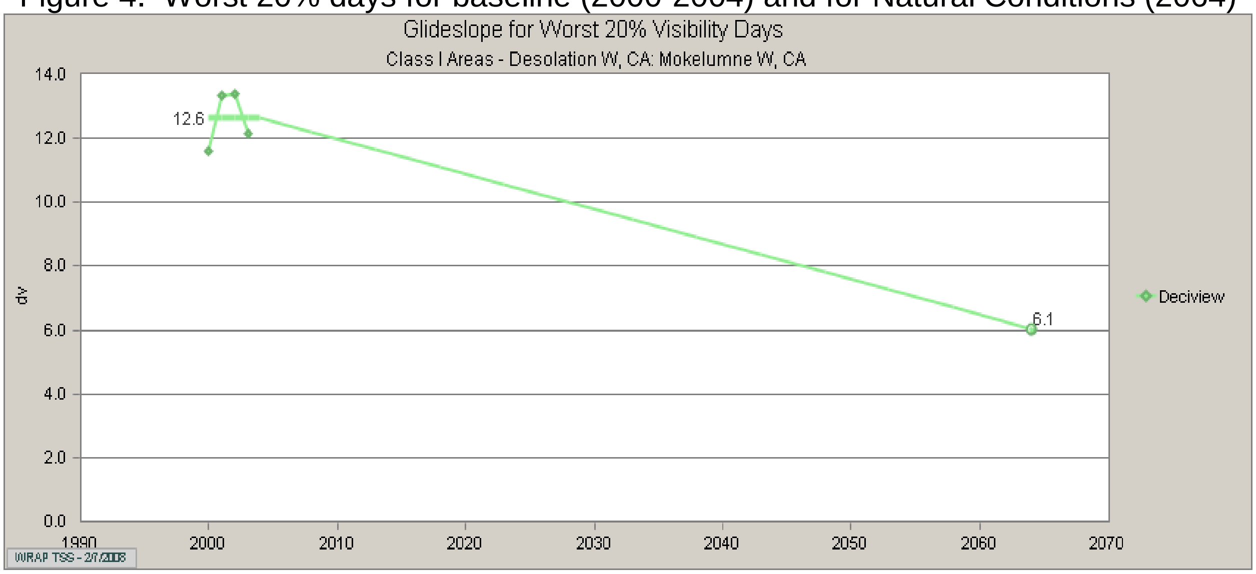
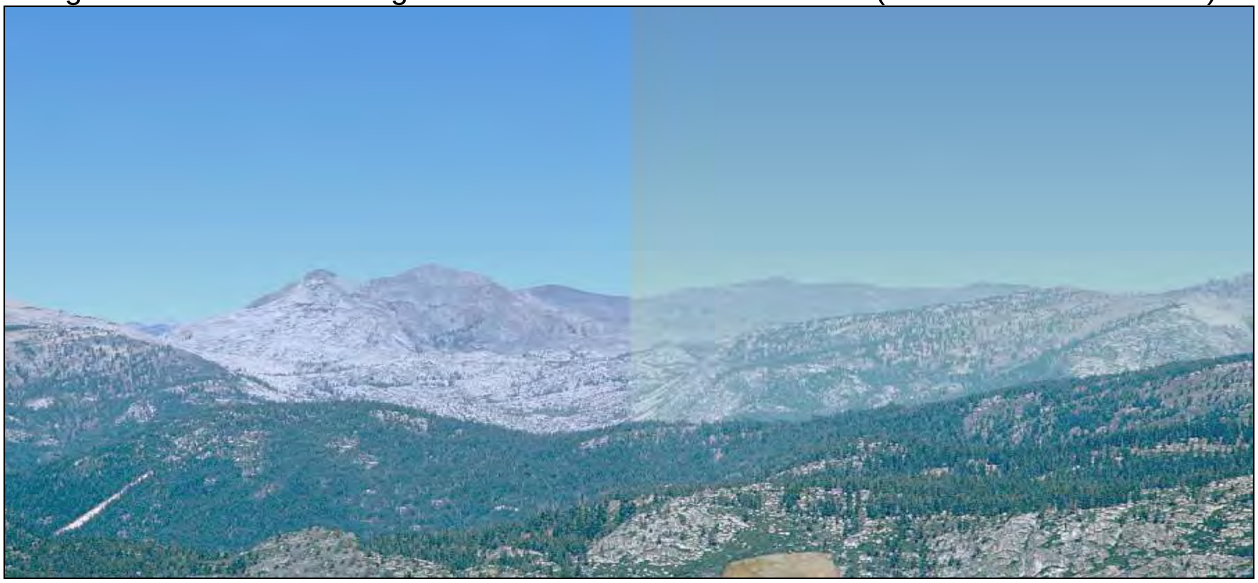


Figure 5. WINHAZE image of Desolation Wilderness Area (2.5 vs. 12.6 deciviews)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 6 shows the contribution of each species to the 20% best and worst days in the baseline years at BLIS1.

Figure 6. Average Haze species contributions to light extinction in the baseline years

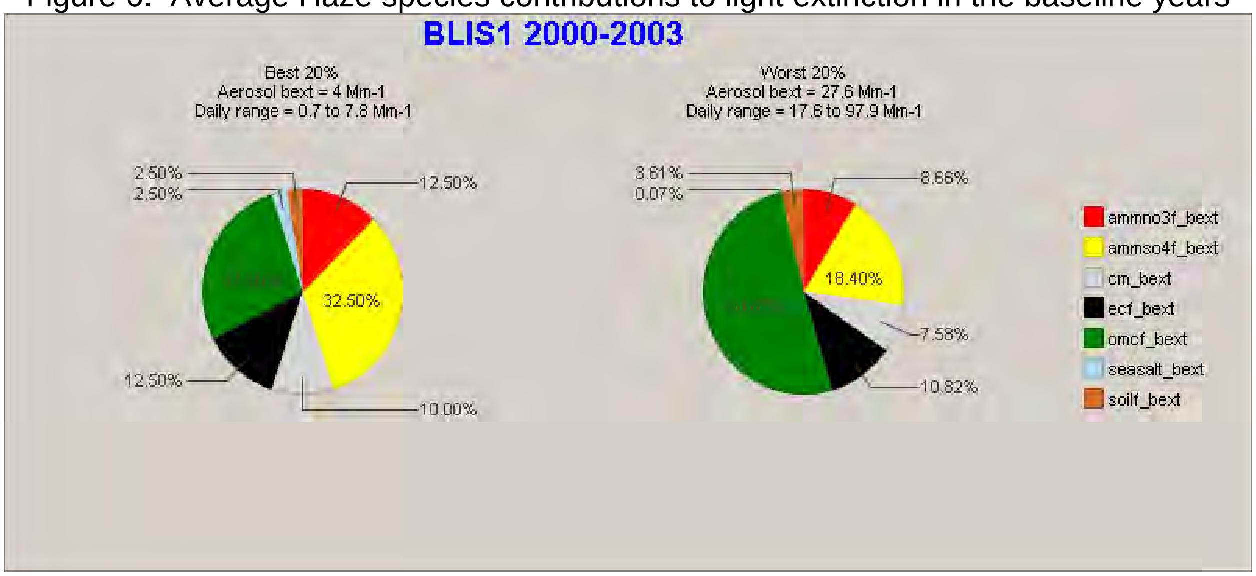
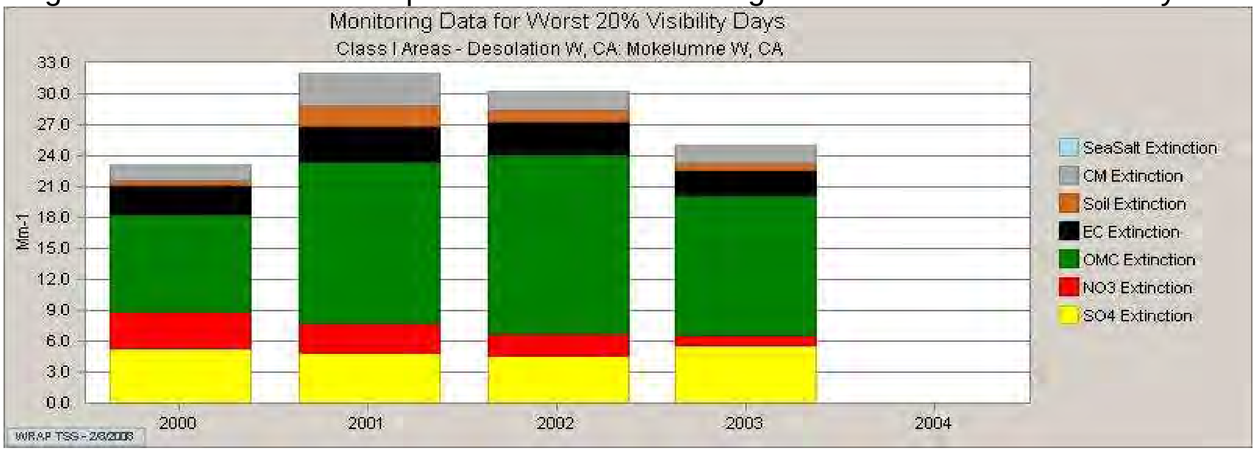


Figure 7. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 6 and 7, organic matter, sulfates, and elemental carbon have the strongest contributions to degrading visibility on worst days at the BLIS1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate. Data points for 2004 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 8 depicts the individual species contribution to worst days in 2002. Organic matter increases in the summer while sulfates increase slightly in the spring. The occurrence of elevated elemental carbon concentrations is sporadic throughout the year. Organic matter clearly dominates the other haze species on worst days, but sulfates, nitrates, elemental carbon, and coarse mass also contribute to the worst days. Sea salt has a very small contribution to haze at the BLIS1 monitor.

Figure 9 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 8 for organic matter, sulfates, elemental carbon, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 8. Species contribution on the 20% worst days in 2002

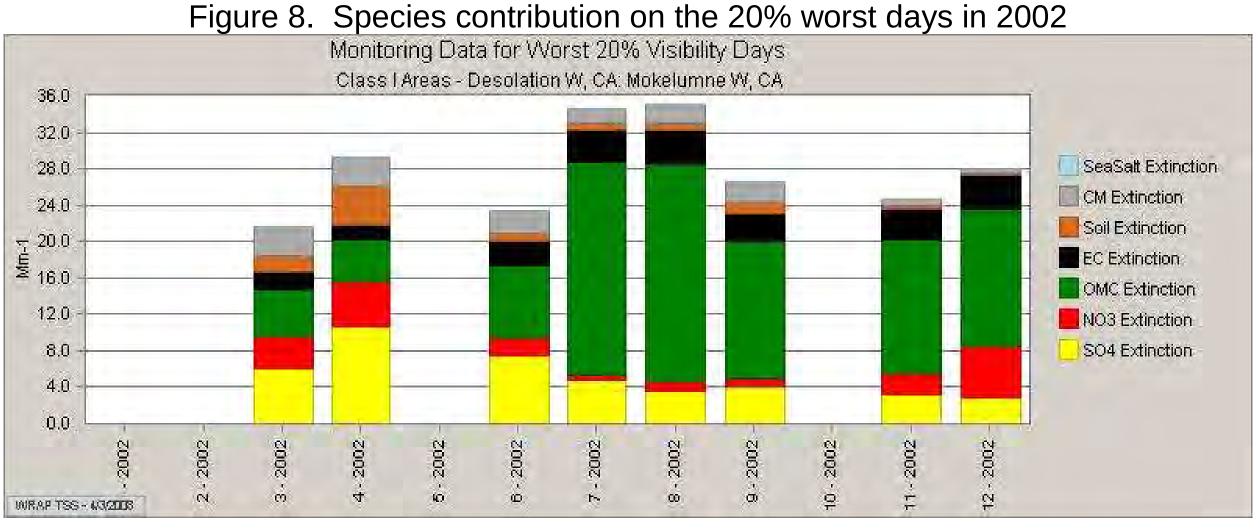
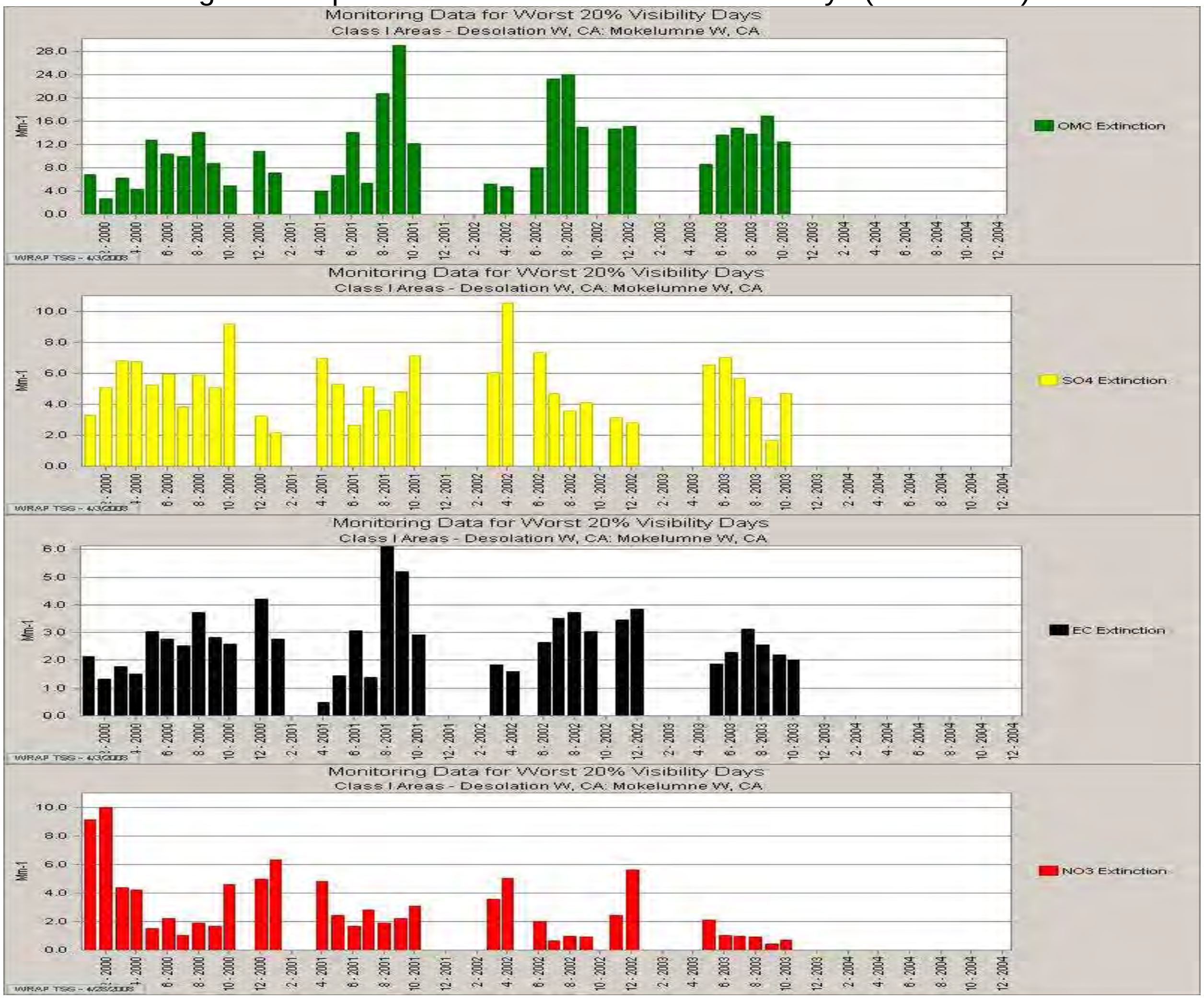


Figure 9. Species contribution on 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at BLIS1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 10 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the BLIS1 monitor is from natural fire sources within California. California represents 70% of all natural fire source contributions.

Figure 11 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 63% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 33% of the total organic carbon emissions and anthropogenic secondary emissions are responsible for the remaining emissions.

Figures 12 and 13 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at BLIS1. The Outside Domain region represents 41% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (39%) and the Pacific Offshore Region (13%). California contributes 20% of the total sulfate emissions seen at the BLIS1 monitor.

Individually, emissions from outside the modeling domain contribute the most sulfate concentrations at the BLIS1 monitor. The next largest contributor to sulfate concentration is area sources in the Pacific Offshore Region.

Figure 14 represents the elemental carbon source contribution from CA and outside regions. Natural fire occurrences within California contribute the highest concentration of elemental carbon at the BLIS1 monitor. California is responsible for 70% of the elemental carbon emissions from wild fires, followed by Nevada wild fire emissions (25%).

Figures 15 and 16 represent the regional contributions to nitrate on the 20% worst days in 2002 and 2018 at the BLIS1 monitor. The WRAP Region represents the largest contribution to nitrate in 2002 and 2018 (76%) followed by the Outside Domain Region (19%) and emissions from the Pacific Offshore (3%). In 2002, 57% of nitrate at the BLIS1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most nitrate concentrations at the AGT1 monitor in 2002 and 2018. Currently, California mobile sources are 72% of all California contributions at the AGT1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 10. Organic carbon source contribution from CA and outside regions

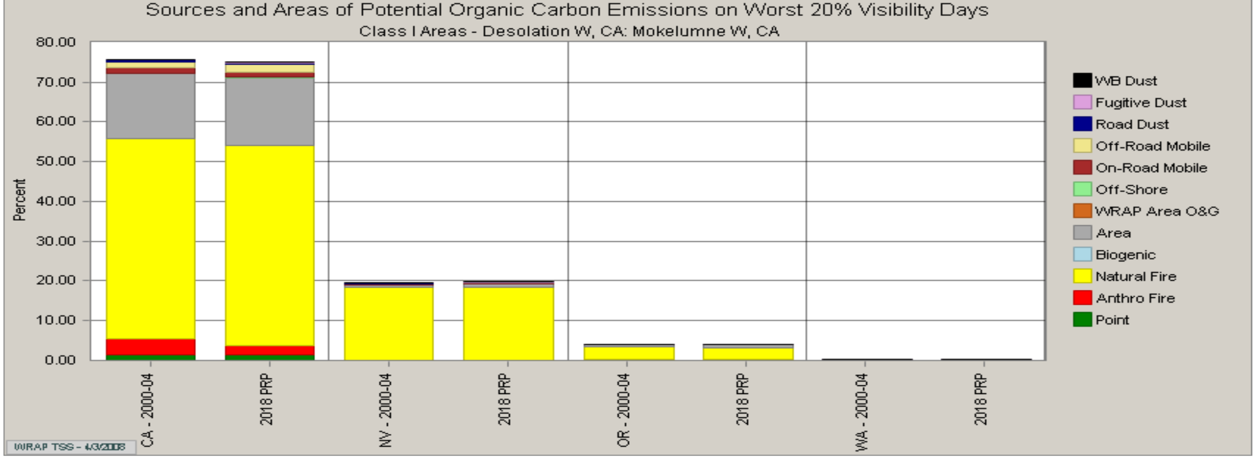


Figure 11. Organic carbon Anthropogenic and Biogenic Source Apportionment

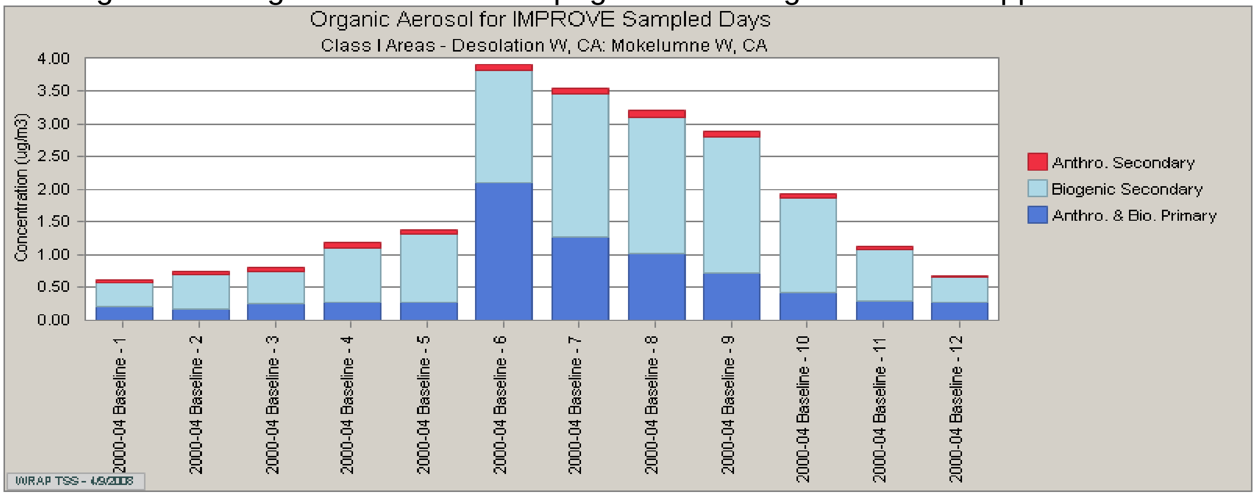


Figure 12. Regional Sulfate contribution to Haze in 2002 and 2018

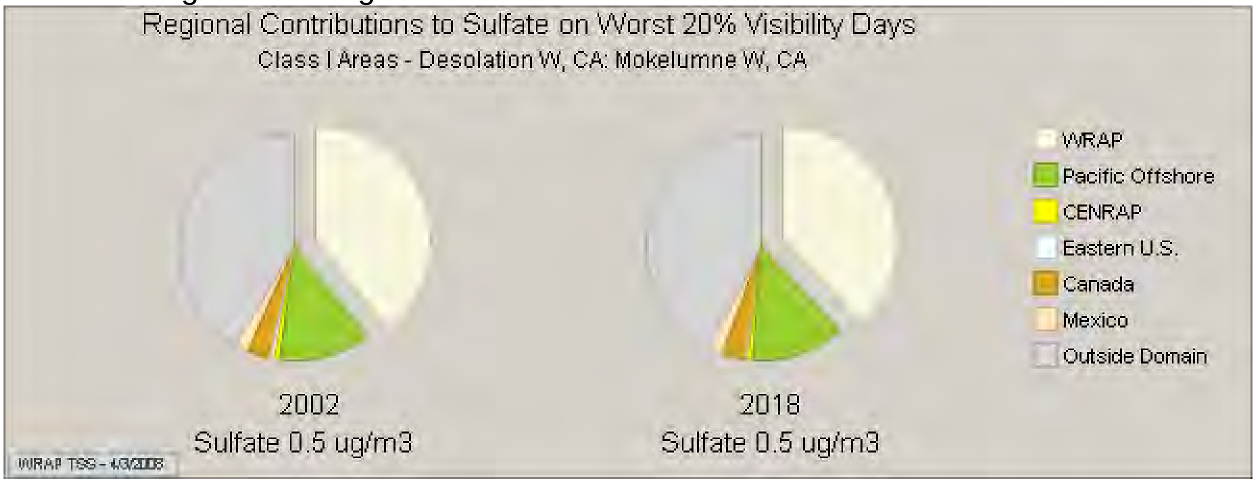


Figure 13. Sulfate source contribution from CA and outside regions

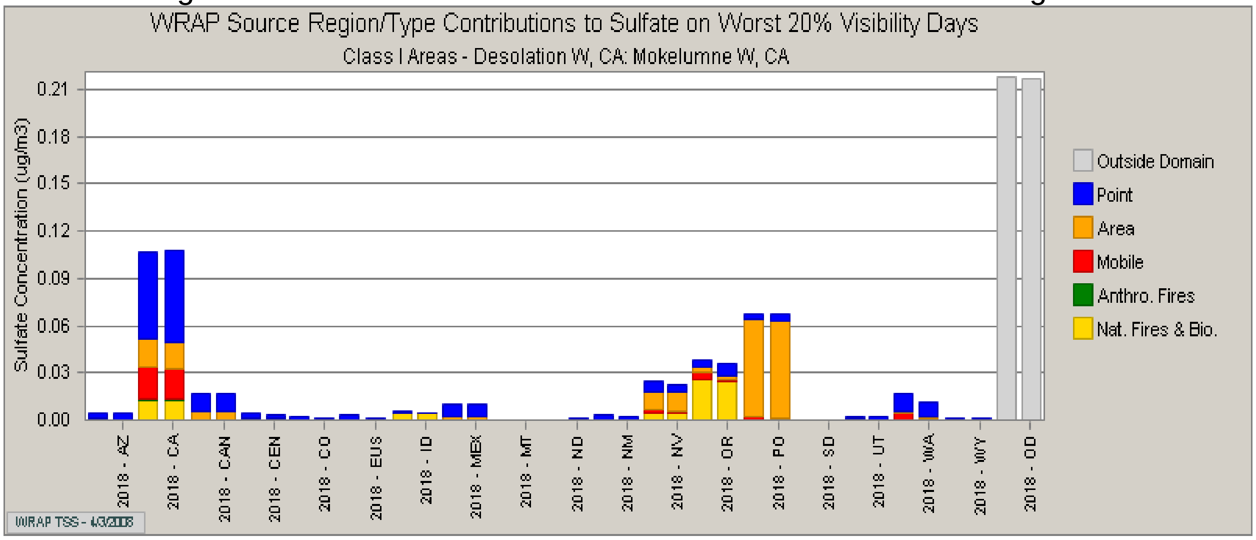


Figure 14. Elemental Carbon source contribution from CA and outside regions

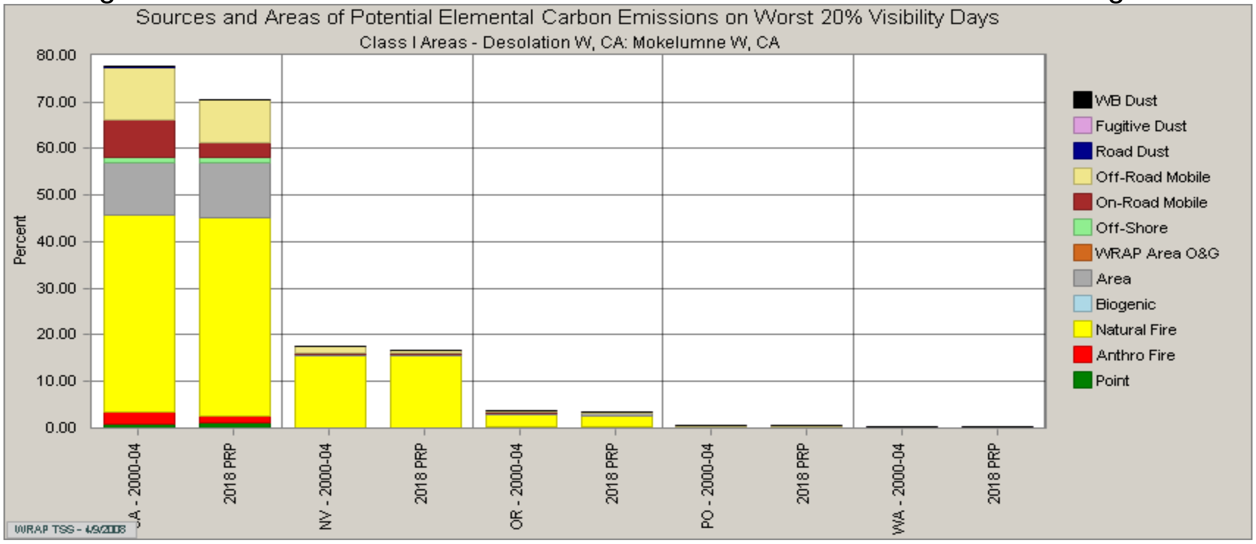


Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018

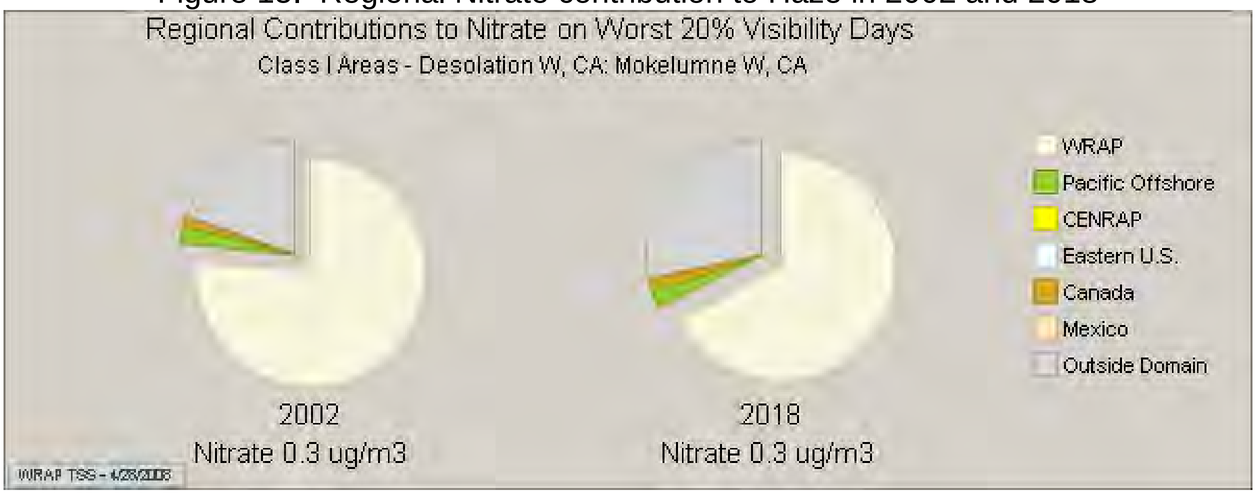
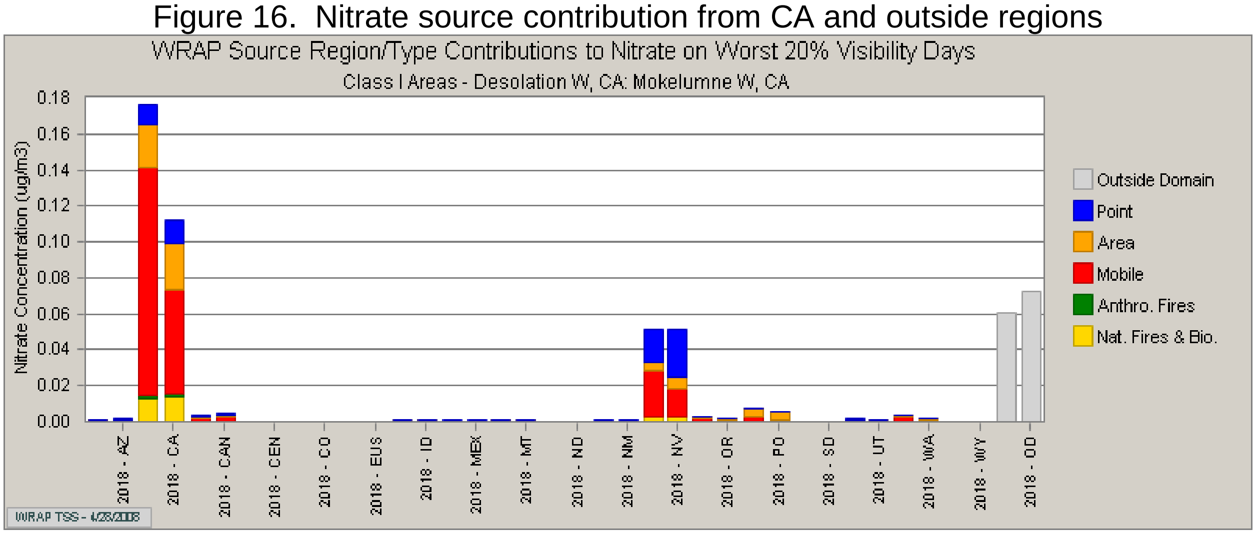


Figure 16. Nitrate source contribution from CA and outside regions



HOOV1 Monitor

Section I. Description

The Hoover Wilderness is an area of approximately 48,000 acres in the Sierra Nevada range, east of the crest and primarily in the rain shadow of the Sierra Nevada. It is located between Mono Lake and the eastern portion of Yosemite National Park. Elevations within the wilderness range from about 2,561 meters on lower slopes to over 3,658 meters on the crest. Streams flow eastward into Bridgeport Valley and Mono Valley from the northern Wilderness and into Mono Valley from the southern Wilderness. Mono Lake is a terminal lake with no outlet. Mono Lake and Owens Lake 93 miles to the south are major sources of windblown alkali dust that may impact visibility in the Wilderness.

Figure 1. HOOV1 Monitor location

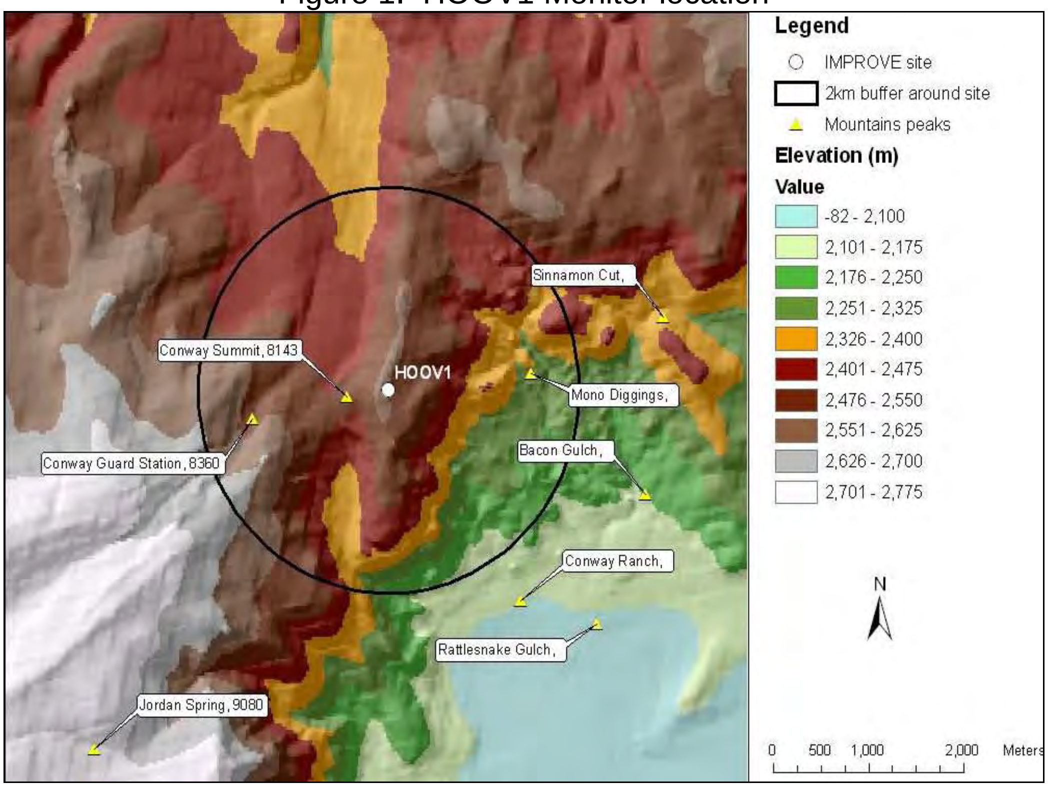


Figure 2. HOOV1 monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for Hoover Wilderness are currently monitored by the HOOV1 IMPROVE monitor. The monitor is located at 38.0881 north latitude and 119.1771 west longitude in a well-exposed location with an unobstructed vista into the Hoover Wilderness to the west. The monitor elevation is near the lower end of the range of Wilderness elevation and is about 488 to 610 meters above the Bridgeport and Mono Valley floors. HOOV1 data should be generally representative of aerosol characteristics in the Hoover Wilderness. During episodes of windblown dust from the valley floors it should represent worst visibility conditions at the most impacted lower Wilderness elevations. The site has been operating since July 2001. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

The Hoover Wilderness Area is on the east slopes of the Sierra Nevada, adjacent to Mono and Bridgeport Valleys. Mono Lake and Owens Lake 93 miles to the south are potential sources of alkali dust from these desiccated lake beds. Dust from these sources can be transported larger distances because it is unusually fine-grained compared to dust from other natural sources. The largest anthropogenic source region is the Central Valley, which could be a source of aerosols mixed upwards and transported across the Sierra Nevada crest by prevailing westerly winds.

The HOOVI location is adequate for assessing the 2018 reasonable progress goals for the Hoover Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from HOOV1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Hoover Wilderness Area is calculated at 1.4 deciviews for the 20% best days and 12.9 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Hoover Wilderness Area is 0.1 deciviews for the 20% best days and 7.7 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 11.66 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 1.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 3. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

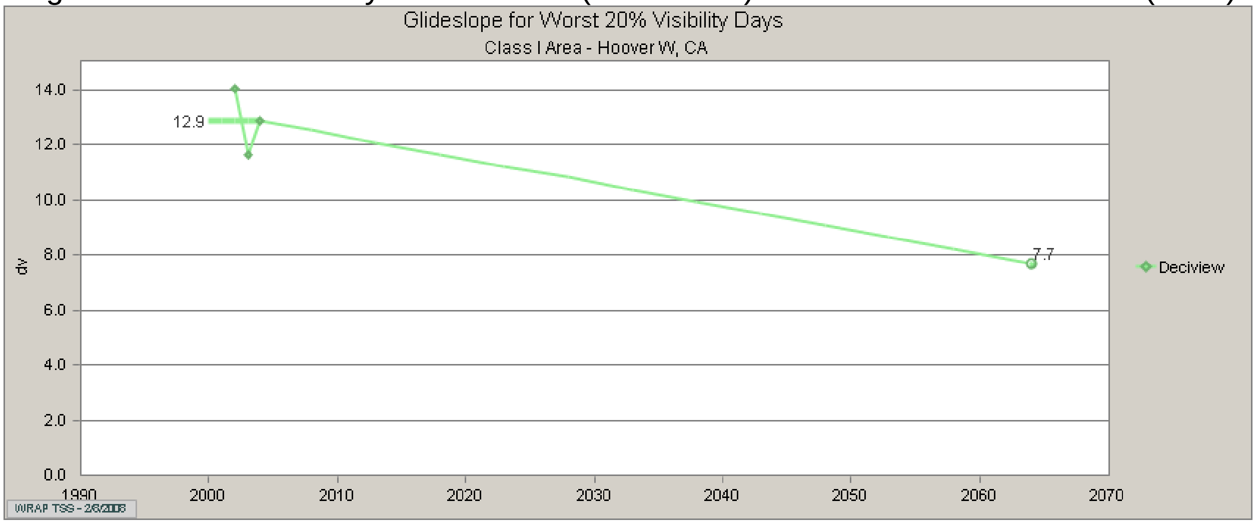


Figure 4. WINHAZE image of Hoover Wilderness Area (1.4 vs. 12.9 deciviews)

II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at HOOV1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

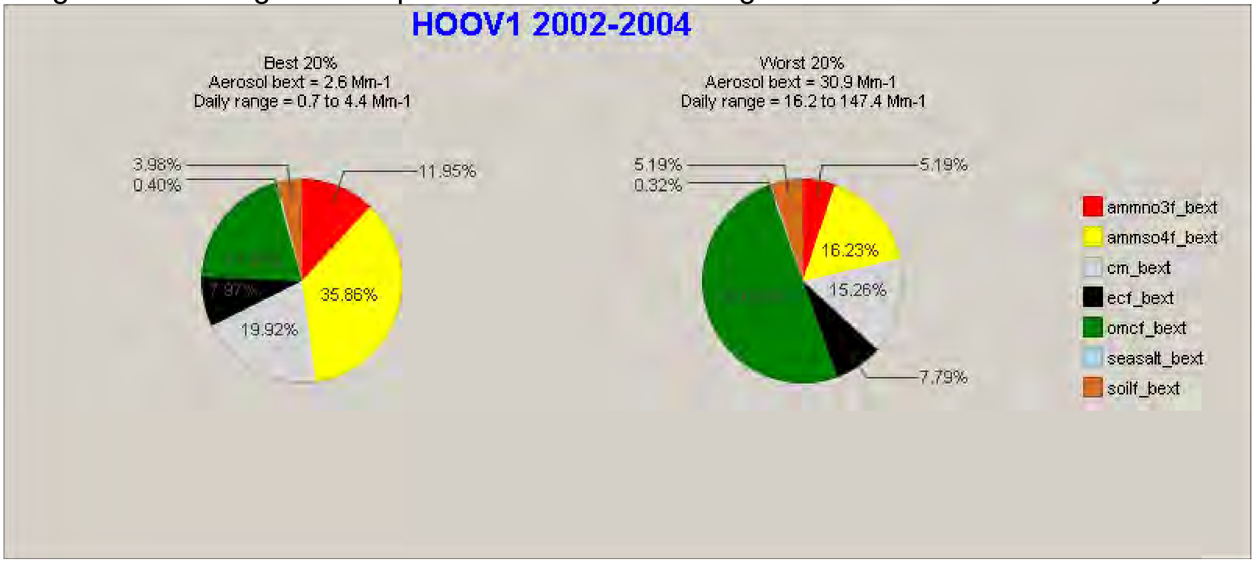
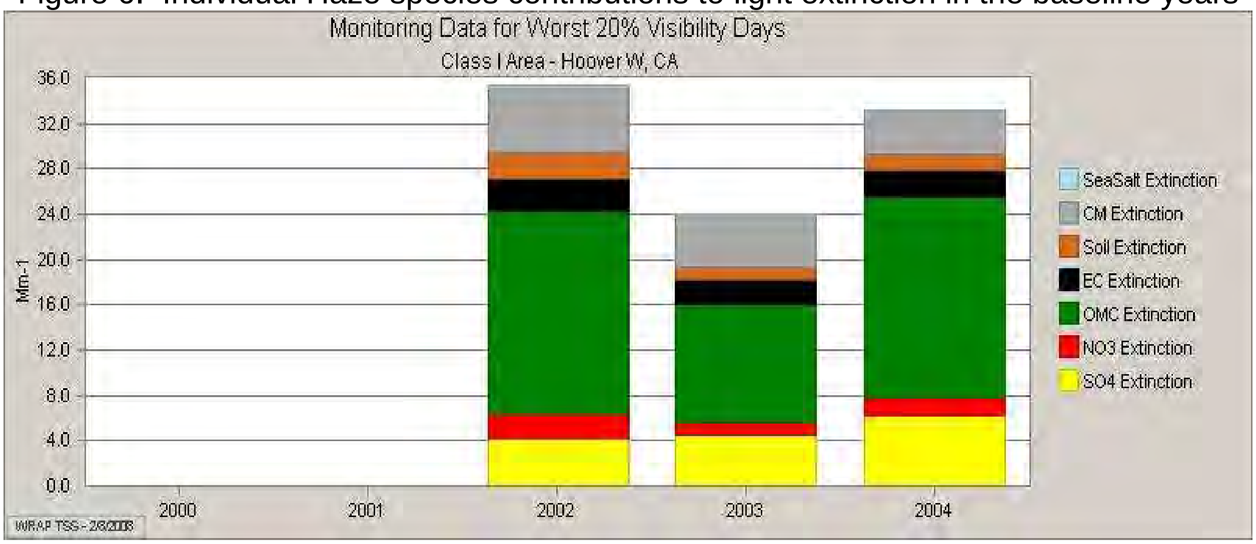


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, organic matter, sulfates, and coarse mass have the strongest contributions to degrading visibility on worst days at Hoover Wilderness Area. The worst days are dominated by organic matter, while the best days are dominated by sulfates. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Organic matter is seen to increase in the summer and winter. Sulfates increase in the late winter and early spring months. Coarse mass is not very predictable but does increase in the month of February. Organic matter clearly dominates the other haze species on worst days, but sulfate, nitrate, elemental carbon, coarse mass, and soil also contribute to worst days throughout the years. There are only trace amounts of sea salt present at this monitor.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, sulfates, coarse mass, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

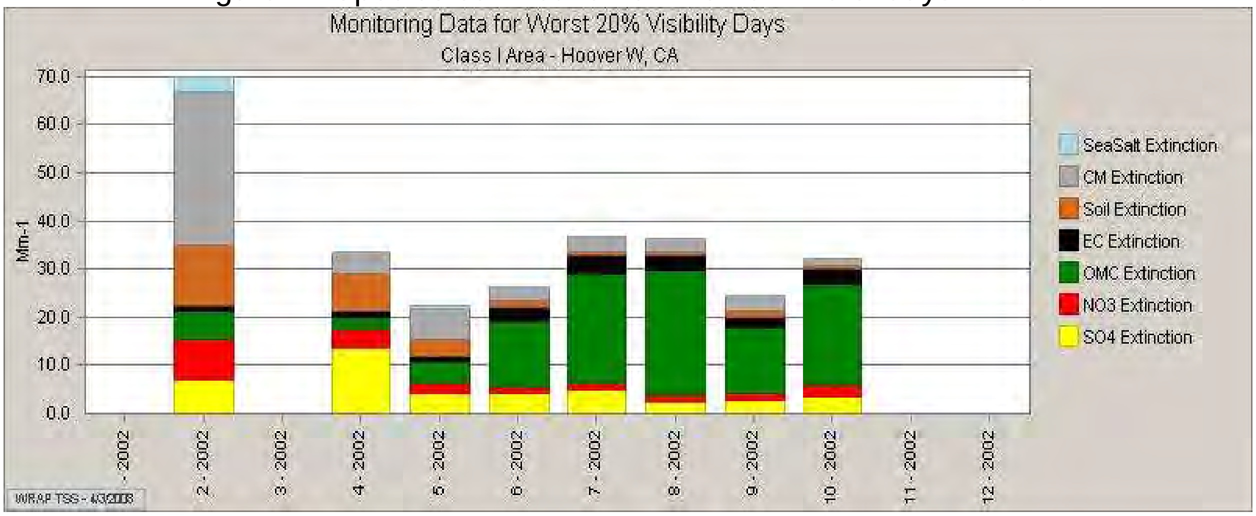
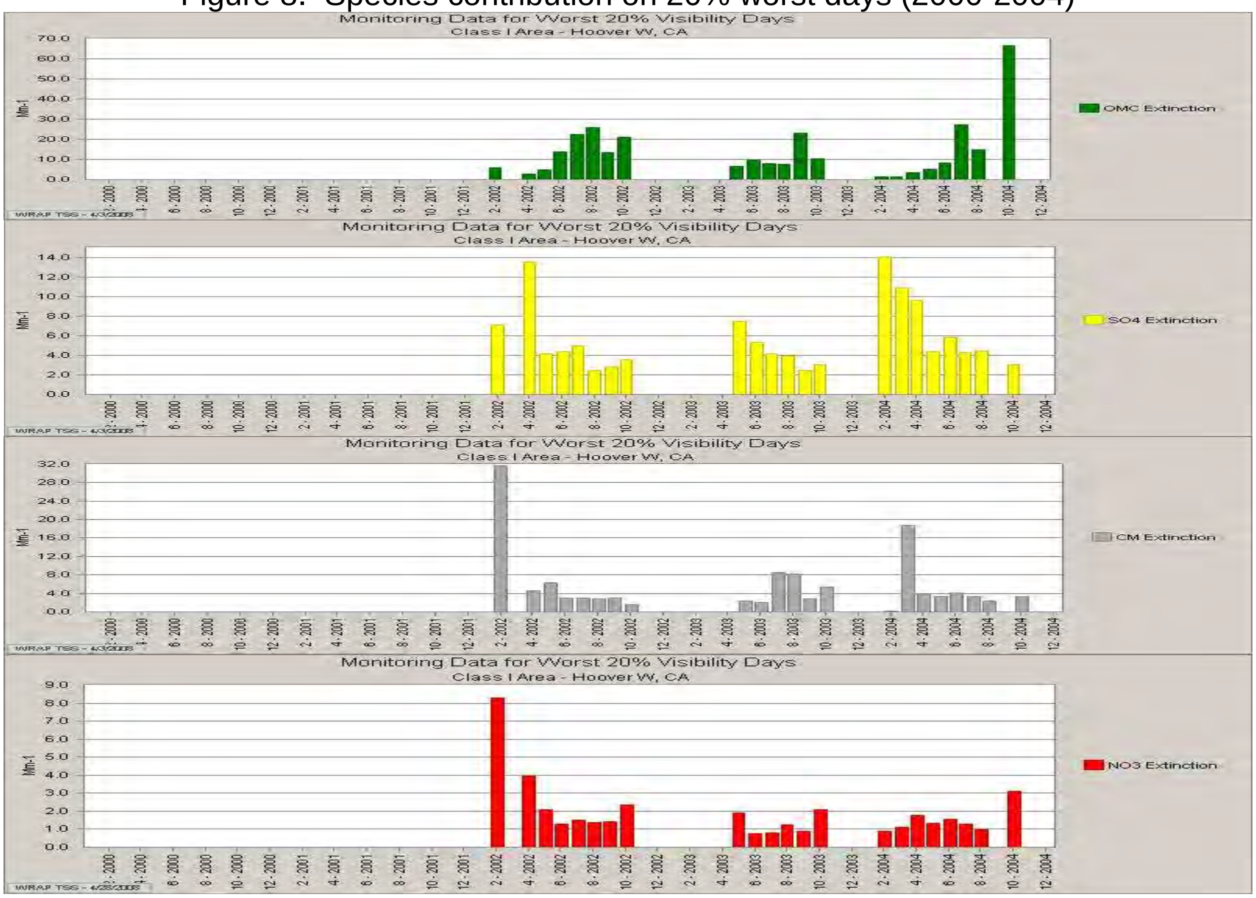


Figure 8. Species contribution on 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at HOOV1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 9 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the HOOV1 monitor is from natural fire sources within California. California represents 86% of all natural fire source contributions.

Figure 10 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 63% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 33% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 11 and 12 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at HOOV1. The Outside Domain region represents 45% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (12%). California contributes 19% of the total sulfate emissions seen at the HOOV1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the HOOV1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figure 13 shows the coarse mass source contribution from California and the outside regions. The largest contributor to coarse mass at the HOOV1 monitor is from road dust within California. California represents 95% of all road dust source contributions.

Figures 14 and 15 represent the regional contributions to nitrates on the 20% worst days at the HOOV1 monitor. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (68%), followed by the Outside Domain Region (27%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrates at the DOME1 monitor. In 2002, 52% of the nitrate at the HOOV1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the HOOV1 monitor in 2002 and 2018. Currently, California mobile sources are 73% of California contributions to nitrate at the DOME1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 9. Organic carbon source contribution from CA and outside regions

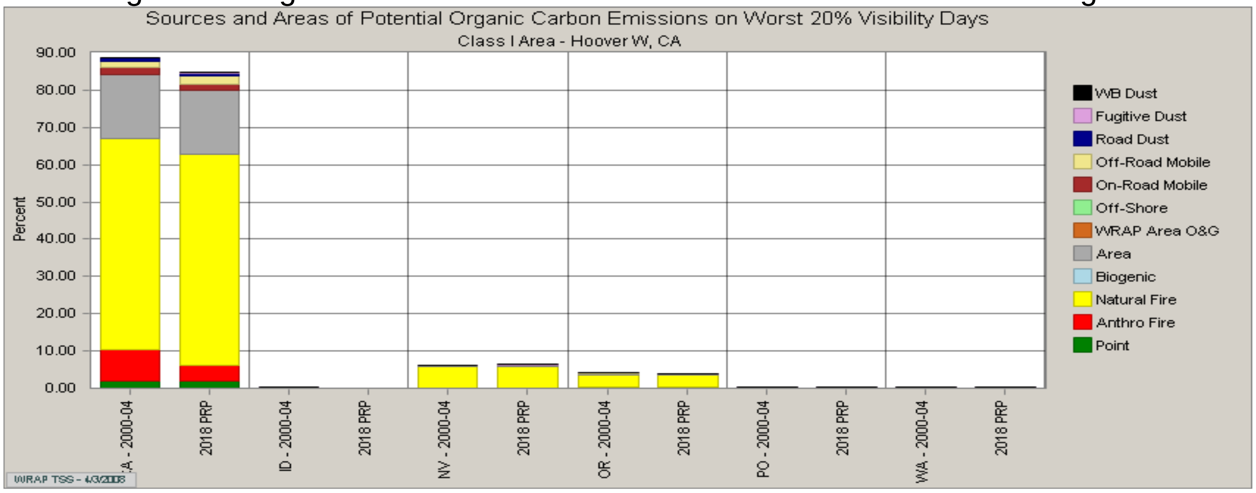


Figure 10. Organic carbon Anthropogenic and Biogenic Source Apportionment

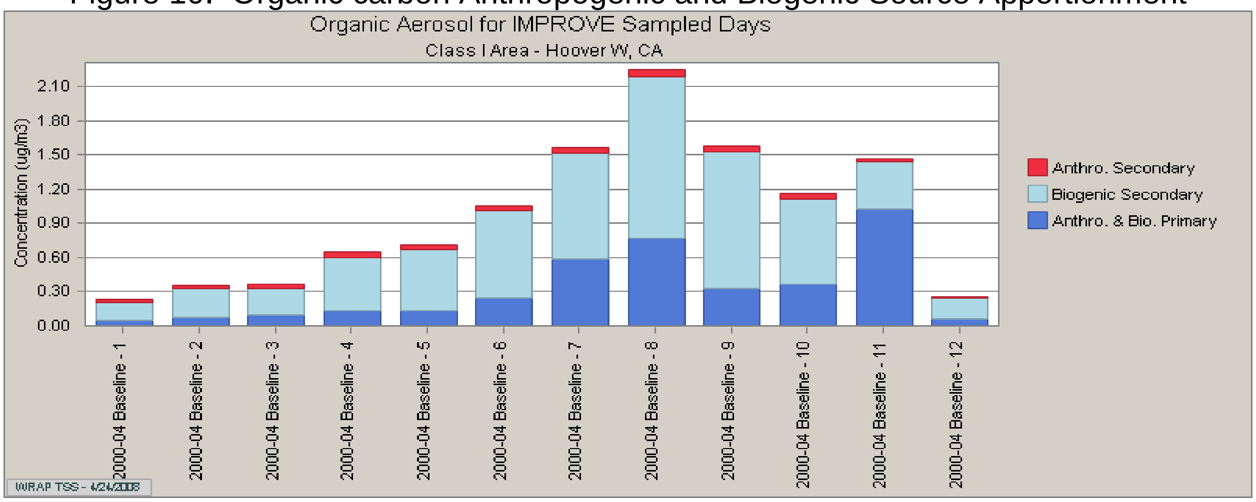


Figure 11. Regional Sulfate contribution to Haze in 2002 and 2018

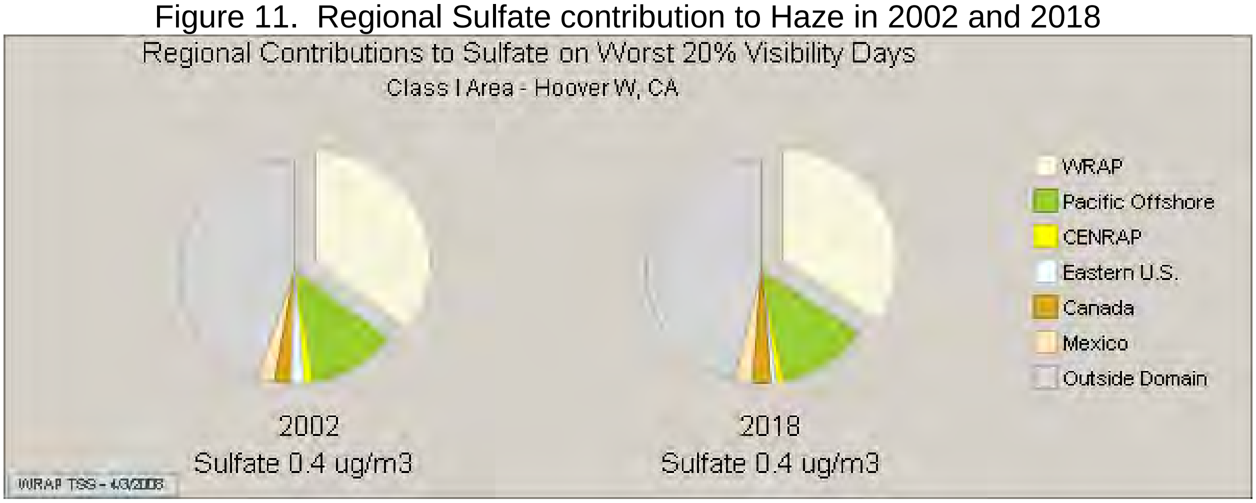


Figure 12. Sulfate source contribution from CA and outside regions

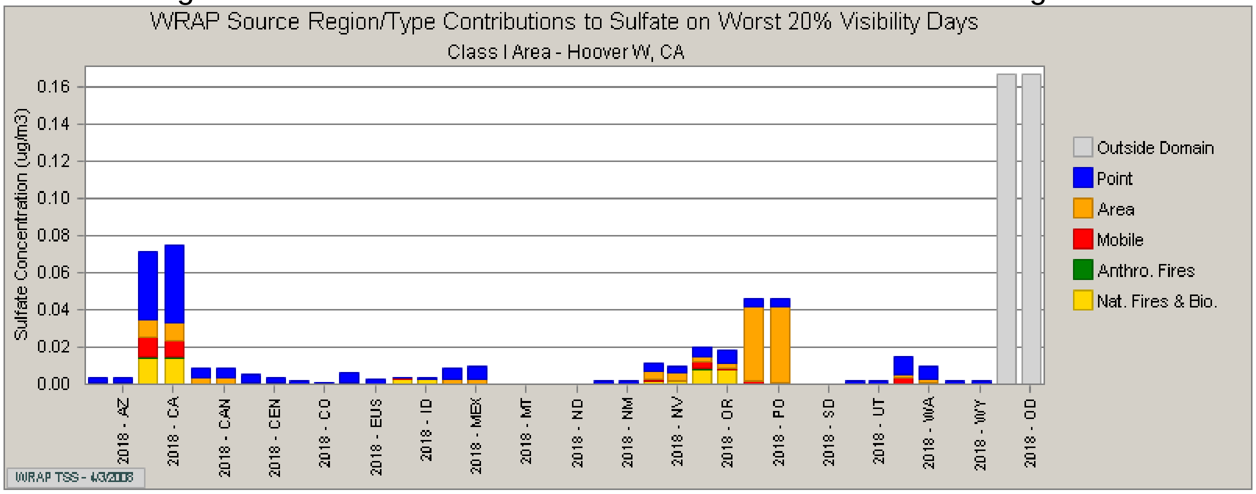


Figure 13. Coarse mass source contribution from CA and outside regions

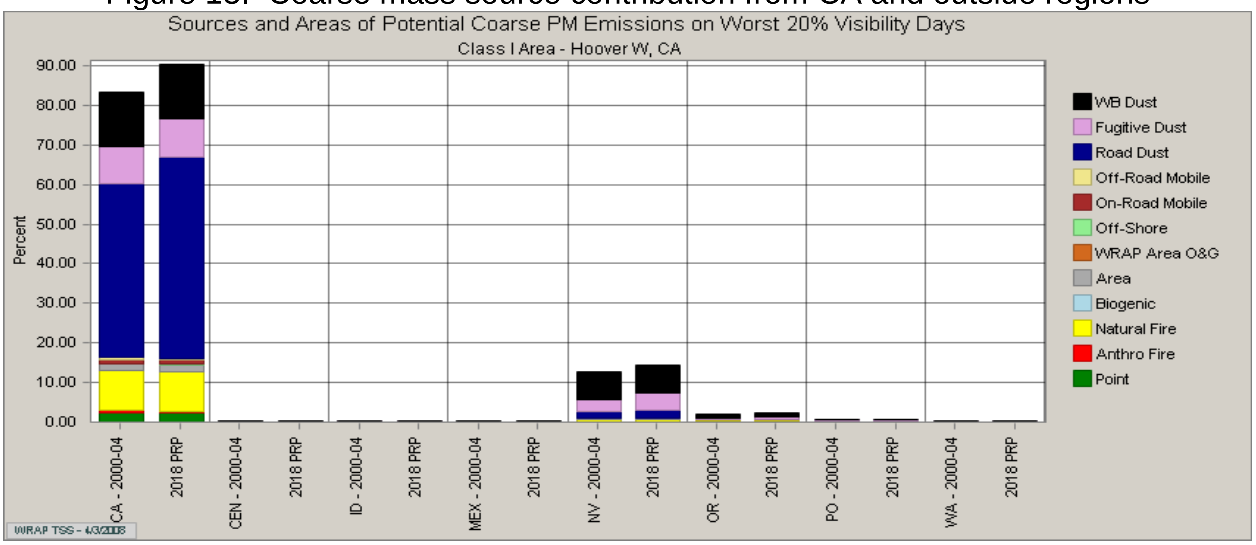


Figure 14. Regional Nitrate contribution to Haze in 2002 and 2018

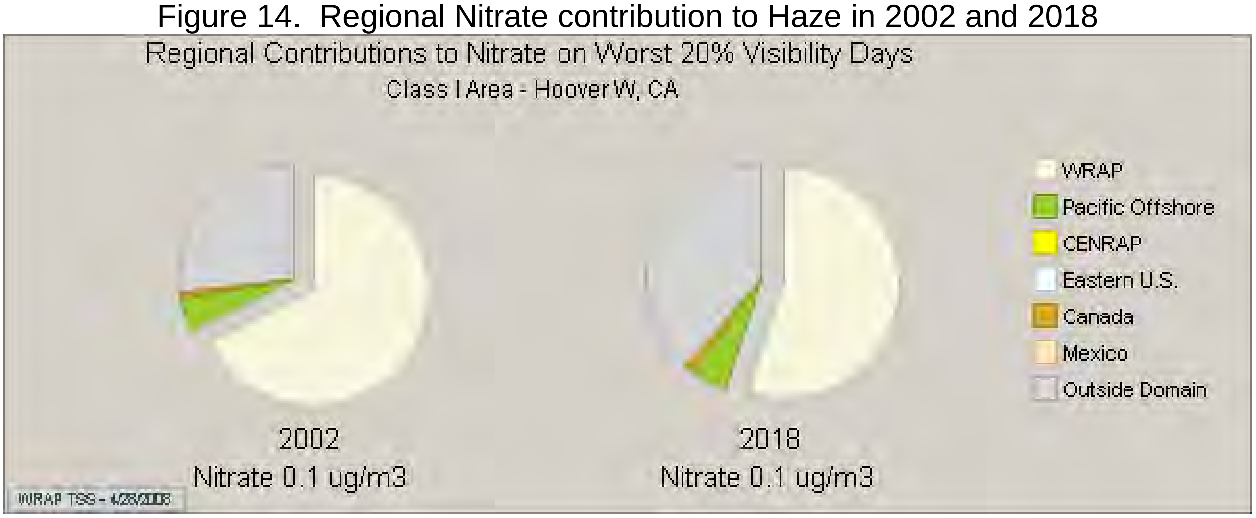
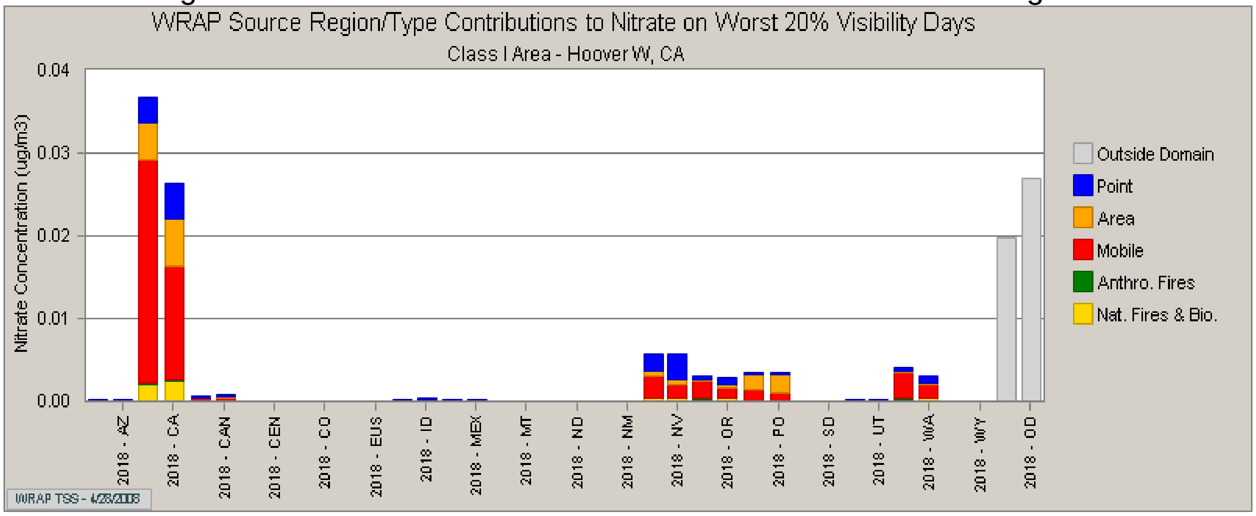


Figure 15. Nitrate source contribution from CA and outside regions



YOSE1 Monitor

The YOSE1 monitor location represents two wilderness areas located in the central Sierra Nevada Range. The wilderness areas associated with the YOSE1 monitor are Emigrant Wilderness Area and Yosemite National Park. The site has been operating since March 1988. The monitor has sufficient data for the five baseline years of 2000 – 2004.

Section I. YOSE1 Wilderness Area Descriptions

I.a. Emigrant Wilderness Area

The Emigrant Wilderness Area consists of 113,000 acres on the upper western slope of the central Sierra Nevada Range. It is bordered by Yosemite National Park on the south. Watersheds drain to the Stanislaus via the south Fork of the Stanislaus in the northern Wilderness, and the Tuolumne River via Cherry Creek in the southern Wilderness. The Stanislaus and Tuolumne Rivers flow southwest and open up into the San Joaquin Valley about 30 miles southwest of the Wilderness boundary. The central San Joaquin Valley area is the nearest major source region for anthropogenic emissions that could affect visibility in the Wilderness. Wilderness elevations range from about 1,524 meters at Cherry Reservoir to 3,527 meters at Leavitt Peak on the Sierra Nevada crest.

Figure 1. Emigrant Wilderness Area

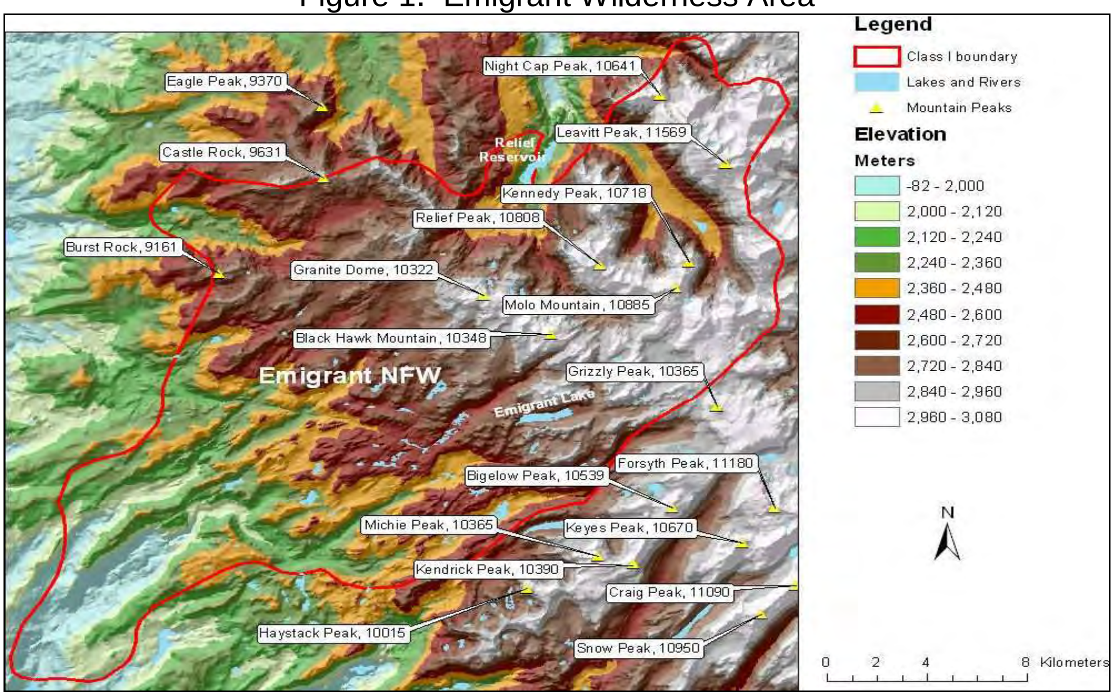
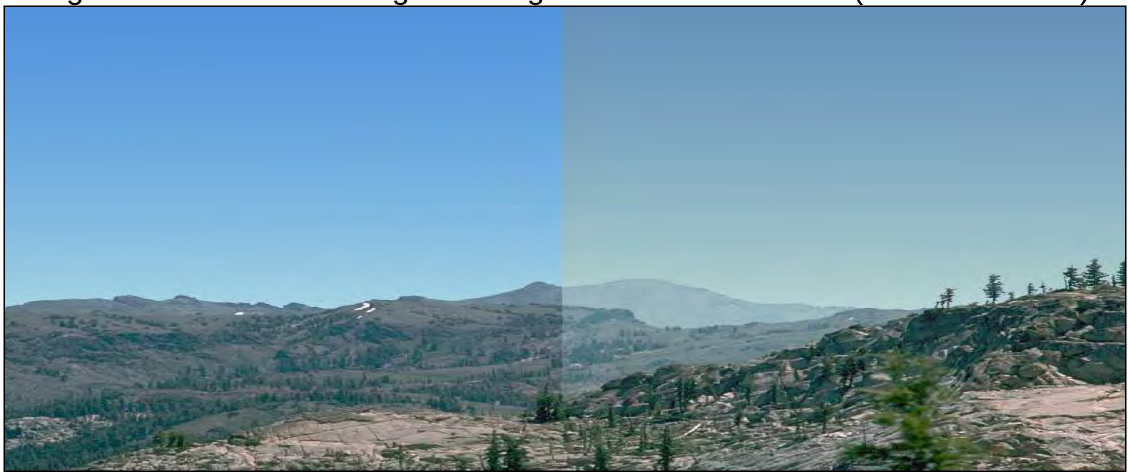


Figure 2. WINHAZE image of Emigrant Wilderness Area (3.4 vs. 17.6 dv)



I.b. Yosemite National Park

Yosemite National Park (Yosemite) consists of approximately 750,000 acres in the central Sierra Nevada range, west of the crest. It includes headwaters of the Tuolumne River in the north, and the Merced River to the south. The Tuolumne and Merced Rivers flow west and open up into the San Joaquin Valley about 20 miles west of the Yosemite boundary. The central San Joaquin Valley is the nearest major source region for anthropogenic emissions that could affect visibility in Yosemite. Park elevations range from about 600 meters where the Tuolumne River exits the Park and 1,000 meters where the Merced River exits the Park, to up to 4,000 meters at the Sierra Nevada crest which forms the Park's eastern boundary. Lowest elevations are 457 meters or more above the San Joaquin Valley floor. The Tuolumne and Merced Rivers form steep canyons, the Grand Canyon of the Tuolumne River and Yosemite Valley, respectively, and are oriented east to west in the heart of Yosemite.

Figure 3. YOSE1 Monitor location

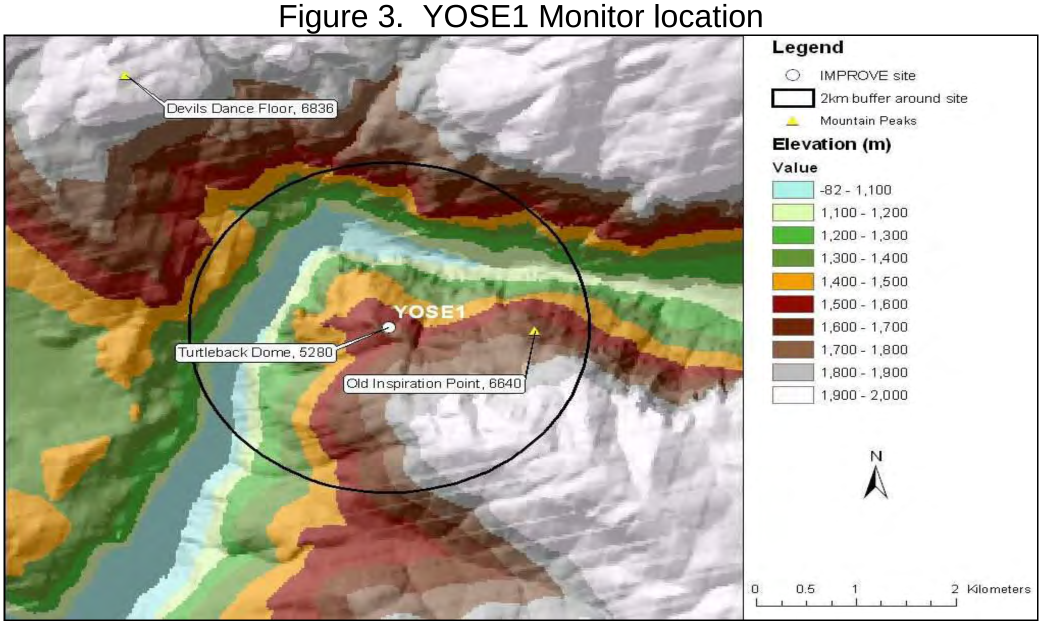


Figure 4. WINHAZE image of Yosemite National Park (3.4 vs. 17.6 deciviews)

Figure 5. YOSE1 Monitor location in California

Section II. Visibility Conditions:

II.a. Emigrant Wilderness Area

Visibility conditions for the Emigrant Wilderness are currently monitored by the YOSE1 IMPROVE monitor in Yosemite National Park. The monitor is located at 37.7133 north latitude and 119.7061 west longitude near the west end of Yosemite Valley at an elevation of 1,603 meters.

The lowest elevations in Emigrant Wilderness are higher than the lowest Yosemite Park elevations, but are still near the YOSE1 elevation. Data from YOSE1 should be representative of aerosol concentrations and composition in the Merced and Tuolumne River areas of central Yosemite National Park and in the upper Stanislaus River area of the Emigrant Wilderness Area, except when the areas are influenced by different local sources such as wild land fires. The nearest major population center and source region for emissions that could contribute to haze in the Emigrant Wilderness and measured at YOSE1 is the San Joaquin Valley, 30 miles west of the western park boundary.

The YOSE1 location is adequate for assessing the 2018 reasonable progress goals for the Emigrant Wilderness Class 1 area.

II.b. Yosemite National Park

Visibility conditions for Yosemite are currently monitored by the YOSE1 IMPROVE monitor. The monitor is located at 37.7133 north latitude and 119.7061 west longitude near the west end of Yosemite Valley at an elevation of 1,603 meters.

Data from YOSE1 should be representative of aerosol concentration and composition in the Yosemite Valley and Merced River areas of central Yosemite National Park. It should also be representative of the Tuolumne River area except when the two areas are influenced by different local sources such as wildland fires. YOSE1 is at an elevation of 1,603 meters, 300 to 400 meters above the canyon floor, so there could be times when canyon bottom locations are within a surface inversion that does not extend upward to the monitoring site elevation. The nearest major population center and source region for emissions that could contribute to haze measured at YOSE1 is the San Joaquin Valley, 20 miles west of the western Park boundary to which it is linked by the Tuolumne and Merced River valleys.

The YOSE1 location is adequate for assessing the 2018 reasonable progress goals for the Yosemite National Park Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from YOSE1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the YOSE1 monitor is calculated at 3.4 deciviews for the 20% best days and 17.6

deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

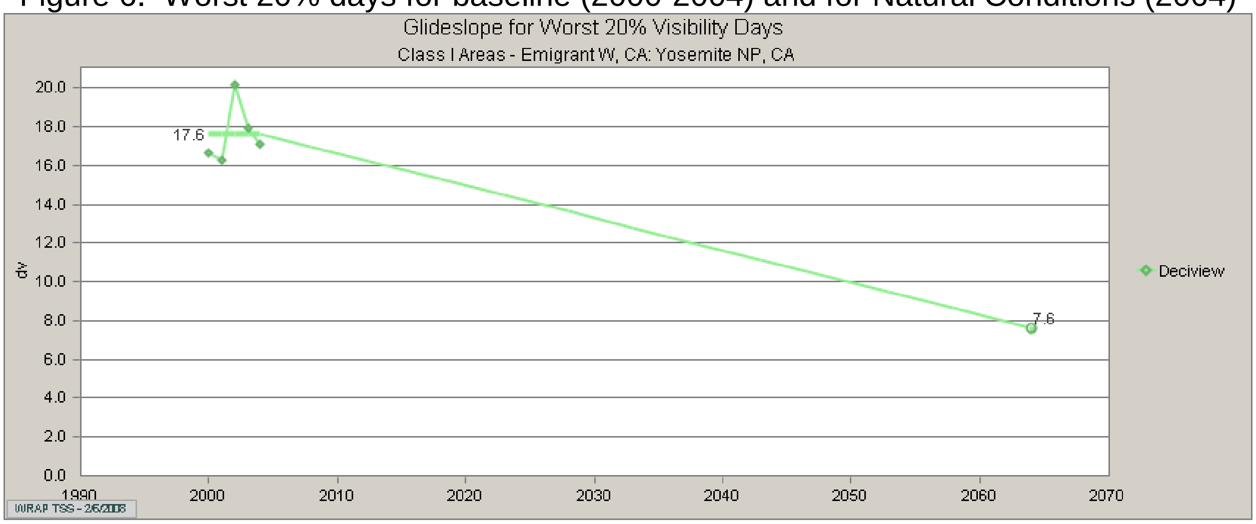
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the YOSE1 monitor is 1.0 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 15.30 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 3.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at YOSE1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

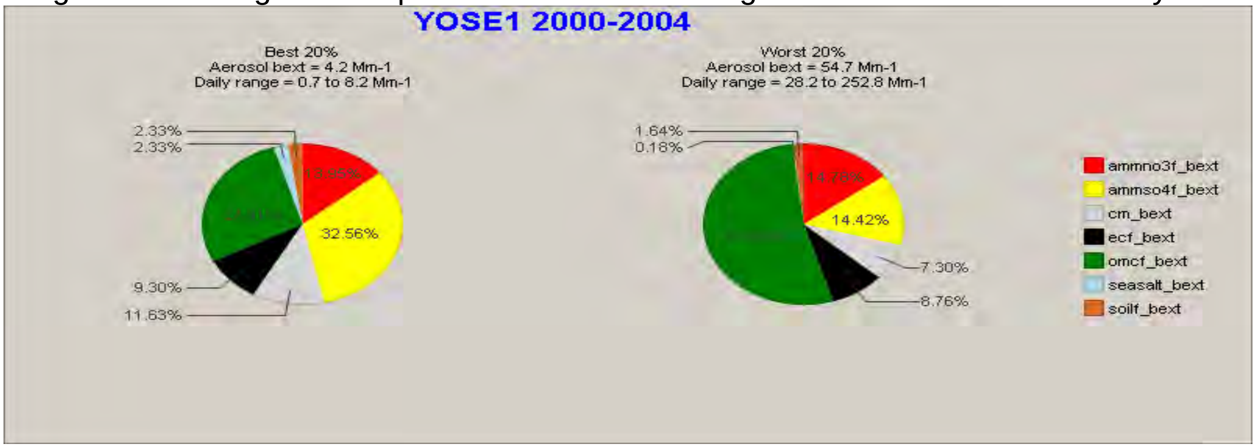
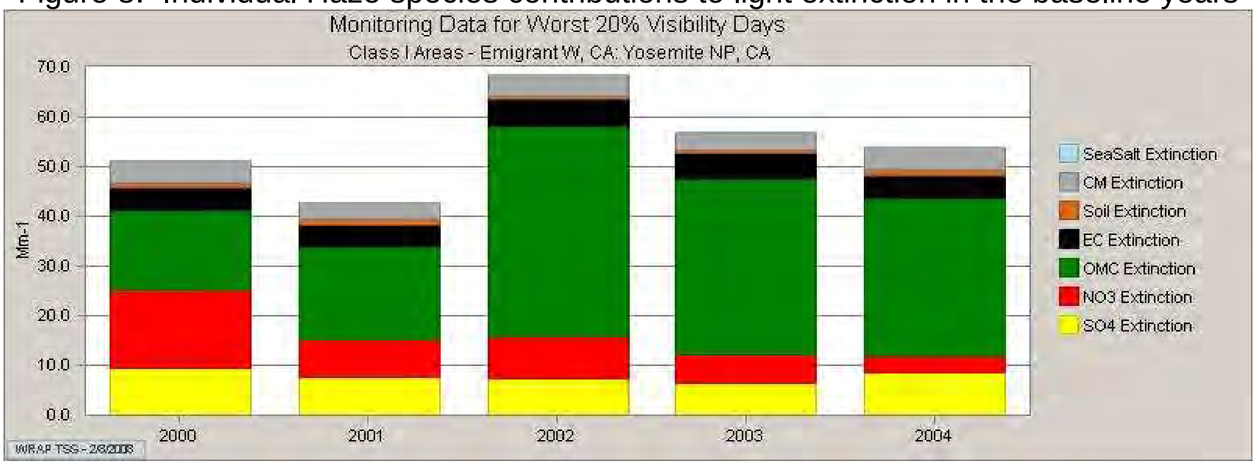


Figure 8. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 7 and 8, organic matter, nitrates, and sulfates have the strongest contributions to degrading visibility on worst days at the YOSE1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate. The monitor has sufficient data for the five baseline years of 2000 – 2004.

Figure 9 depicts the individual species contribution to worst days in 2002. Organic matter increases in the fall and winter and nitrates increase in the winter months. Sulfates remain relatively stable throughout the year but do see a slight increase in the summer. Organic matter clearly dominates the other haze species on worst days but nitrates, sulfates, elemental carbon, and coarse mass also contribute to the worst days throughout the year. There are only trace amounts of soil and sea salt present at this monitor.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

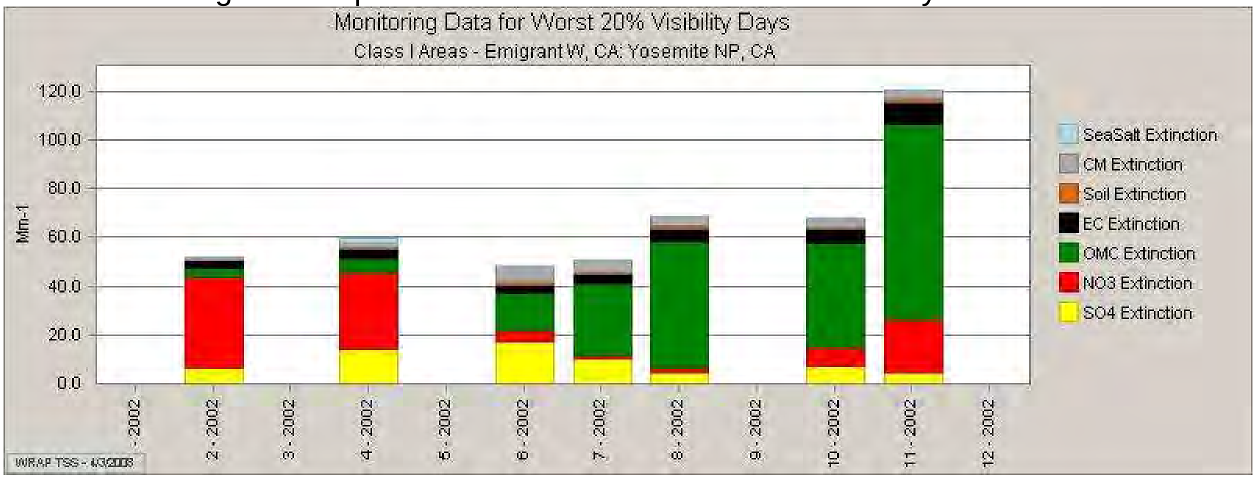
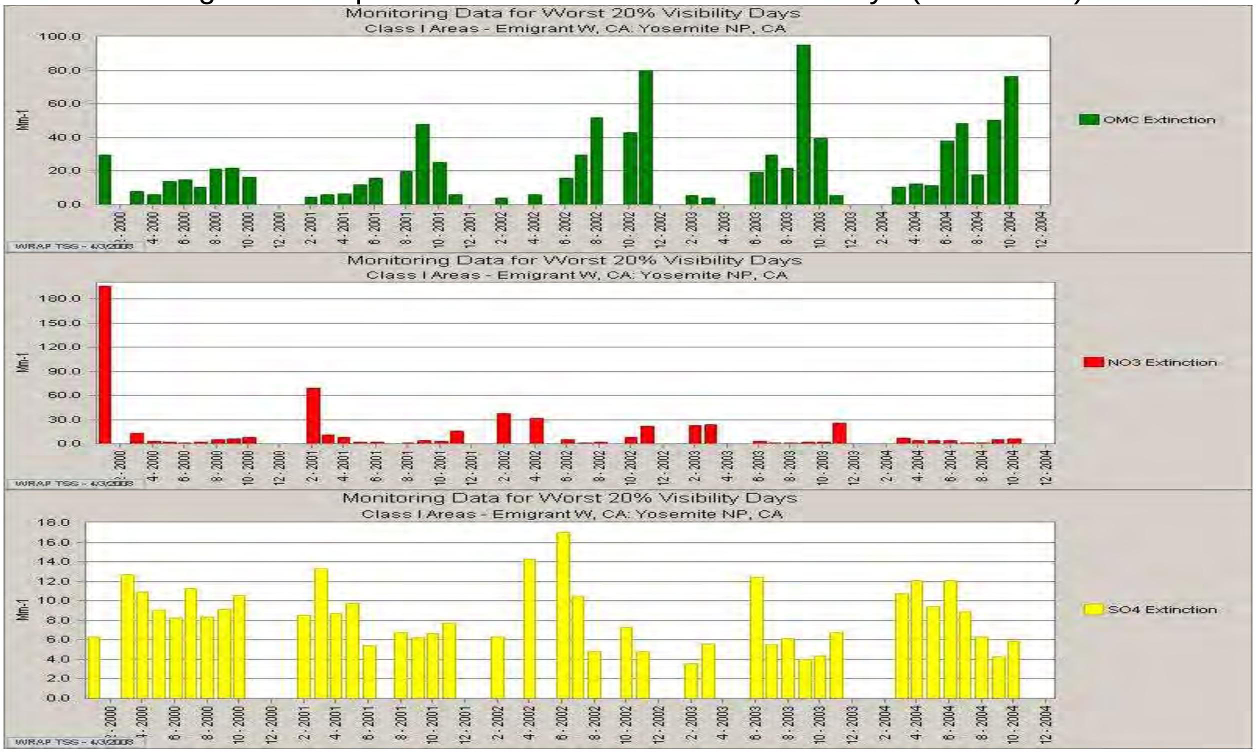


Figure 10. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at YOSE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the YOSE1 monitor is from natural fire sources within California. California represents 88% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 60% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 36% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (78%), followed by the Outside Domain Region (17%) and emissions from Pacific Offshore (5%). Mobile sources within California contribute the most nitrates at the YOSE1 monitor. In 2002, 87% of the nitrate from mobile sources at the YOSE1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 15 and 16 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at the YOSE1 monitor. The Outside Domain region represents 43% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (36%) and the Pacific Offshore Region (15%). California contributes 22% of the total sulfate emissions seen at the YOSE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the YOSE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore.

Figure 11. Organic carbon source contribution from CA and outside regions

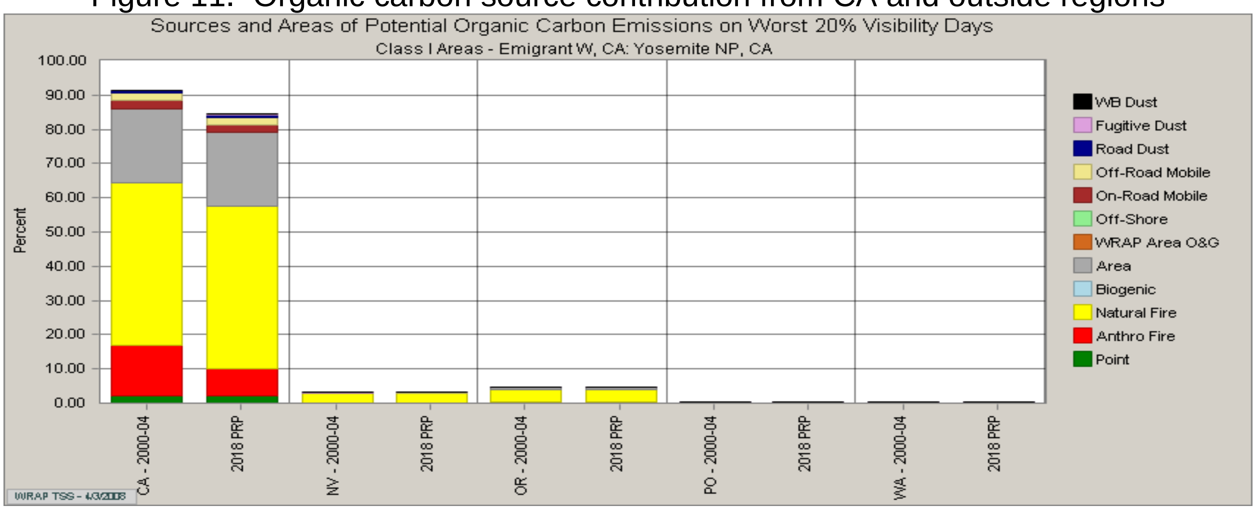


Figure 12. Organic Carbon Anthropogenic and Biogenic Source Apportionment

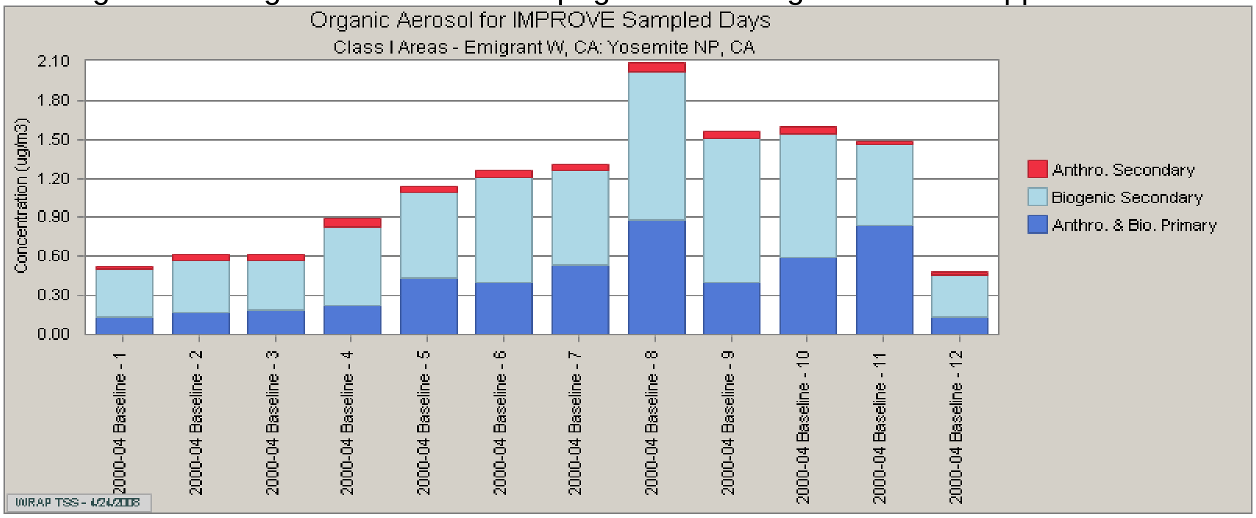


Figure 13. Regional Nitrate contribution to Haze in 2002 and 2018

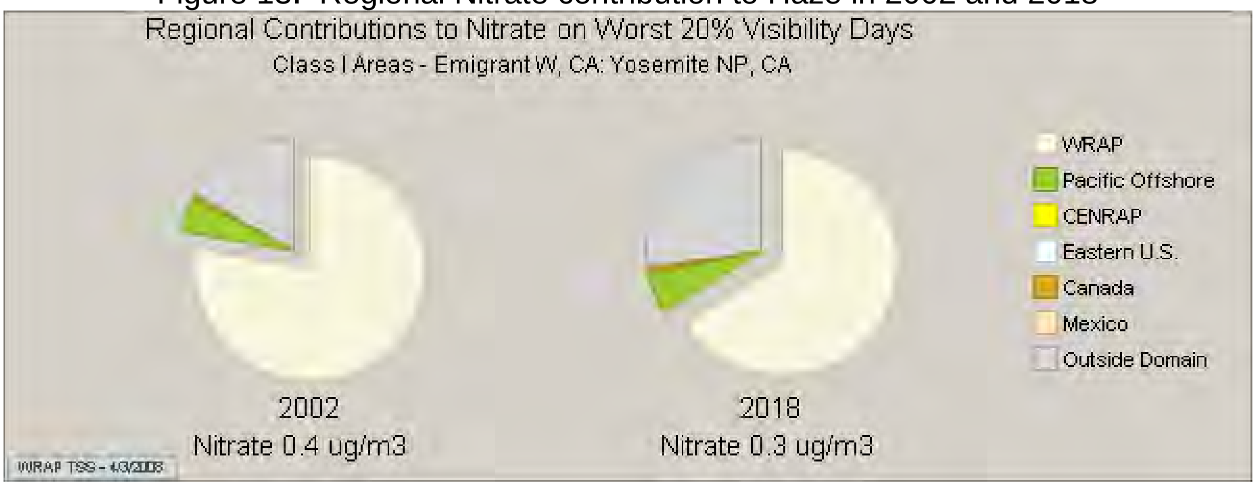


Figure 14. Nitrate source contribution from CA and outside regions

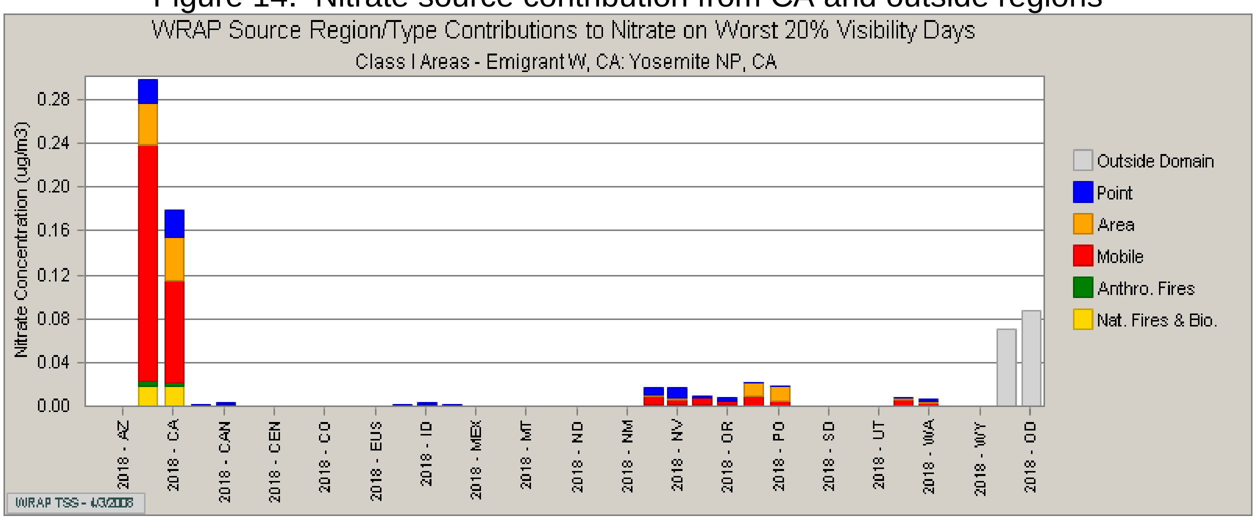


Figure 15. Regional Sulfate contribution to Haze in 2002 and 2018

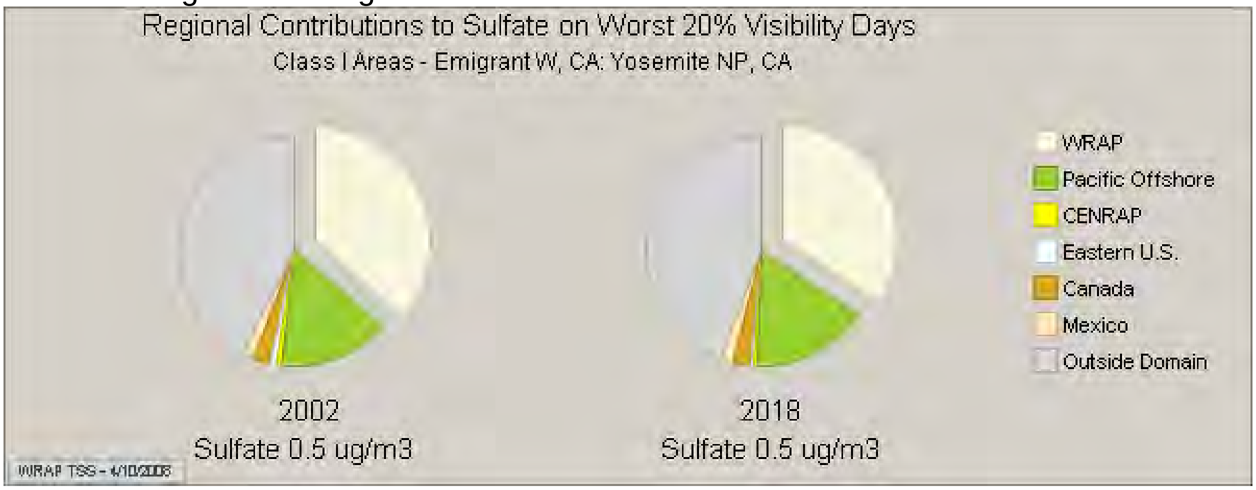
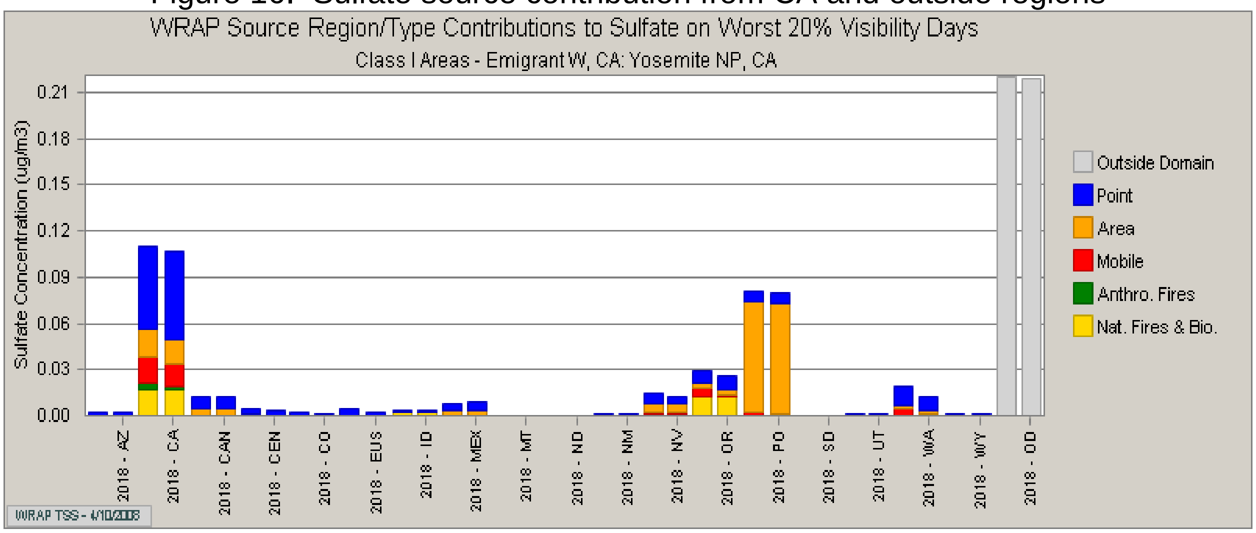


Figure 16. Sulfate source contribution from CA and outside regions



KAIS1 Monitor

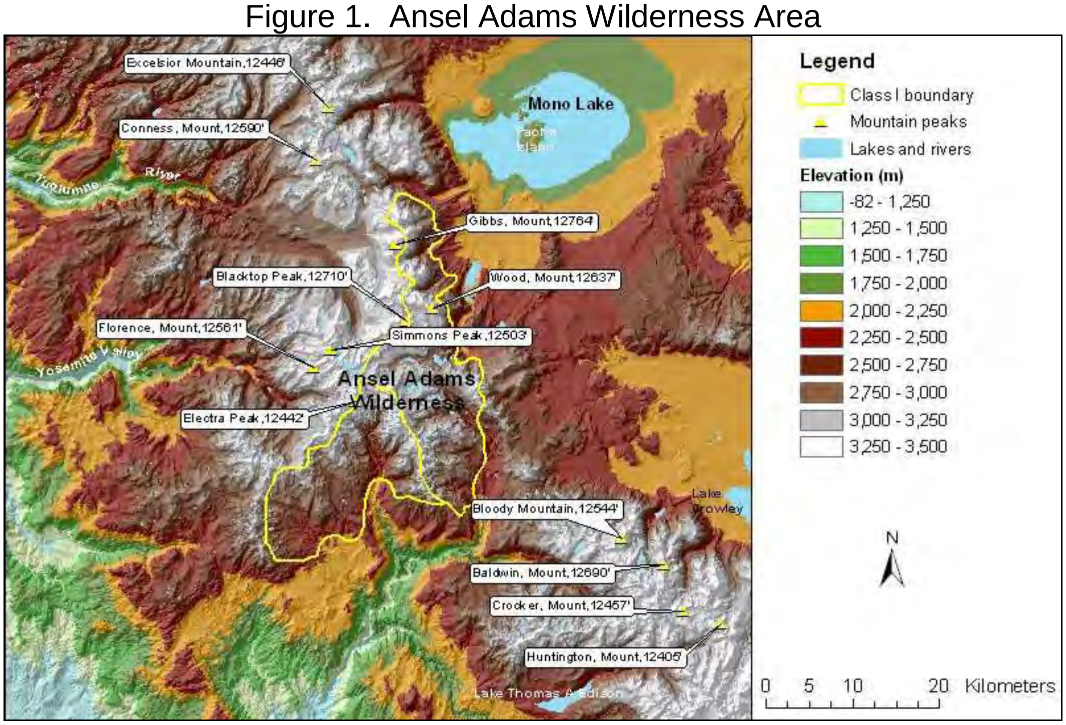
The KAIS1 monitor location represents three wilderness areas within the Sierra Nevada mountain range. The wilderness areas associated with the KAIS1 monitor are Ansel Adams Wilderness area, John Muir Wilderness area, and Kaiser Wilderness area. The KAIS1 site has been in operation since January of 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

<u>Section I. KAIS1 Wilderness Area Descriptions</u>

I.a. Ansel Adams Wilderness Area

The Ansel Adams Wilderness Area formerly known as the Minarets Wilderness, is located in both the Sierra and Inyo National Forests and covers approximately 228,500 acres (138,660 acres are in Sierra National Forest). Ansel Adams is characterized by spectacular alpine scenery with barren granite peaks, steep-walled gorges and rock outcroppings. Elevations range from 1,067 meters to 4,010 meters and there are several small glaciers on the north and northeast facing slopes of the highest peaks. There are also a number of fairly large lakes on the eastern slope of the precipitous Ritter Range. The Ansel Adams Wilderness contains the headwaters of the North and Middle Forks of the San Joaquin River. The San Joaquin River flows south and west from the Wilderness and eventually opens up into the San Joaquin Valley 20 to 25 miles west of the Wilderness and just north of Fresno. This central San Joaquin Valley area is the nearest major source region for anthropogenic emissions that could affect visibility in the Wilderness.

Figure 1. Ansel Adams Wilderness Area

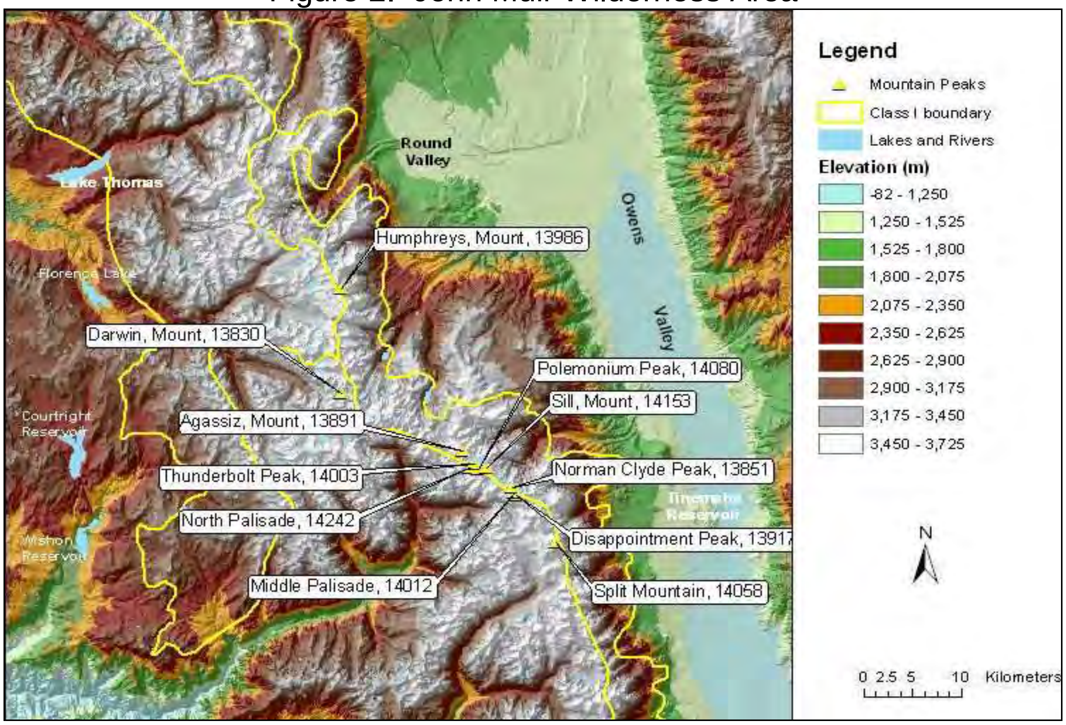


I.b. John Muir Wilderness Area

The John Muir Wilderness Area consists of 581,000 acres, and extends for 100 miles along the crest and on both sides of the Sierra Nevada in the Inyo and Sierra National Forests. The wilderness extends from Reds Meadow (near Mammoth Mountain) in the north, to south of Mount Whitney. The wilderness area also spans the Sierra north of Kings Canyon National Park, and extends in the west side of the park down to the Monarch Wilderness. West of the crest, it includes the headwaters of the South and Middle Forks of the San Joaquin River and the North Fork of the Kings River. The San Joaquin and Kings rivers flow westward into the San Joaquin Valley, about 30 miles west of the western wilderness boundary. The wilderness contains the most spectacular and highest peaks of the Sierra Nevada. The peaks are typically made of granite from the Sierra Nevada batholiths and are dramatically shaped by glacial action. The southernmost glacier in the United States (the Palisades Glacier) is contained with the wilderness area.

Western elevations extend from the Sierra Nevada crest down to 1,219 meters where the South Fork of the San Joaquin River exits the Wilderness. East of the crest, the Wilderness includes eastern slopes of the Sierra Nevada roughly between Mammoth Lakes in the north and Owens Lake in the south, a distance of nearly 100 miles, and elevations between the highest elevation at Mt. Whitney (4,418 meters) and lowest elevations near 1,524 meters on the west side of the Owen Valley. Eastern portions are generally in the rain shadow of the Sierra Nevada. The San Joaquin Valley is the nearest major source region for emissions that could affect visibility in Wilderness areas west of the Sierra Nevada crest.

Figure 2. John Muir Wilderness Area



I.c. Kaiser Wilderness Area

The Kaiser Wilderness Area consists of 22,700 acres within the western slopes of the Sierra Nevada's Pacific Crest. It includes Kaiser Ridge, with elevations ranging from about 2,195 meters to 3,146 meters on Kaiser Peak in the center of the Wilderness. On the north side streams flow north into the San Joaquin River, and on the south side into Big Creek which merges with the San Joaquin River west of the Wilderness. The San Joaquin River flows westward and eventually opens up into the San Joaquin Valley 20 miles west of the Wilderness and just north of Fresno. The central San Joaquin Valley is the nearest major source region for emissions that could affect visibility within the Wilderness.

Figure 3. KAIS1 Monitor location

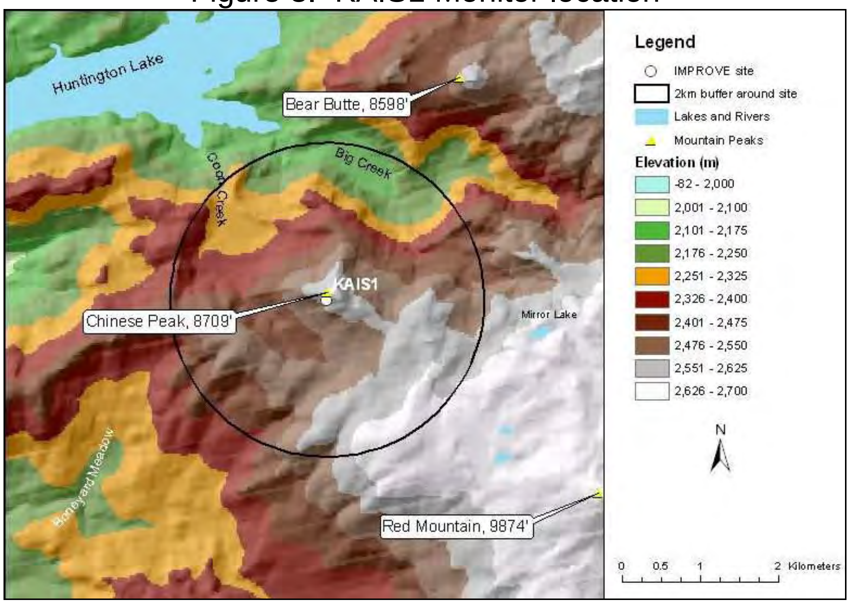


Figure 4. Looking west from the Kaiser monitoring site

Figure 5. KAIS1 Monitor location in California

Section II. Visibility Conditions:

II.a. Ansel Adams Wilderness Area

Visibility conditions for Ansel Adams Wilderness area are currently monitored by the KAIS1 IMPROVE monitor located in the Kaiser Wilderness Area. The monitor is located at 37.22 north latitude and 119.1546 west longitude, 79 meters below the crest of Chinese Peak across Huntington Lake and the Big Creek drainage to the south. The KAIS1 monitor is at an elevation of 2,598 meters, about 10 miles south of the southernmost boundary of Ansel Adams Wilderness Area. Data from KAIS1 should be representative of aerosol concentration and composition in Ansel Adams Wilderness Area.

The Ansel Adams Wilderness Area and vicinity are drained by the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San Joaquin River channel opens up into the San Joaquin Valley 20 to 25 miles to the southwest, where the primary population center is Fresno.

The KAIS1 location is adequate for assessing the 2018 reasonable progress goals for the Ansel Adams, John Muir, and Kaiser Wilderness Class I areas.

II.b. John Muir Wilderness Area

Visibility conditions for the John Muir Wilderness Area are currently monitored by the KAIS1 IMPROVE monitor in the Kaiser Wilderness Area. The monitor is located at 37.2207 north latitude and 119.1546 west longitude, 79 meters below the crest of Chinese Peak at an elevation of 2,598 meters, about 3 miles west of the western boundary of the John Muir Wilderness Area. The KAIS1 site is in a well exposed location with an unobstructed vista into the South Fork of the San Joaquin River headwaters. Data from KAIS1 should thus be representative of aerosol concentrations and composition in western portions of the John Muir Wilderness except at valley and canyon bottom locations during valley inversion conditions. KAIS1 is much less representative of John Muir Wilderness locations east of the Sierra Nevada crest, which are probably more susceptible to local emissions in the Owen Valley area, notably from Owens Dry Lake near the southern Wilderness boundary and a major source of windblown alkali dust.

The western John Muir Wilderness Area and vicinity are drained by the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San Joaquin River channel opens up into the San Joaquin Valley 20 to 25 miles to the southwest, where the primary population center is Fresno. The eastern John Muir Wilderness, on the eastern slopes of the Sierra Nevada, comprised much of the west side of the Owens Valley, the nearest local source region for emissions that could affect visibility west of the Sierra Nevada crest. Owens Valley includes Owens Lake, a major source of windblown dust.

The KAIS1 location is adequate for assessing the 2018 reasonable progress goals for the John Muir Wilderness Class 1 area.

II.c. Kaiser Wilderness Area

Visibility conditions for Kaiser are currently monitored by the KAIS1 IMPROVE monitor. The monitor is located at 37.2207 north latitude and 119.1546 west longitude, 79 meters below the crest of Chinese Peak across Huntington Lake and the Big Creek drainage to the south. KAIS1 is well exposed, with an unobstructed vista into Kaiser Wilderness from a distance of 3 to 6 miles. The elevation at KAIS1 is 2598 meters.

Data from KAIS1 should be very representative of aerosol concentrations and composition in the Kaiser Wilderness Area. The Kaiser Wilderness Area and vicinity are drained by the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San Joaquin River channel opens up into the San Joaquin Valley 15 to 20 miles to the Southwest, where the primary population center is Fresno. Potential local transport routes into the Kaiser Wilderness area include San Joaquin Valley emissions transported directly via diurnal upslope/down slope flow, or trapped under a persistent inversion. The most likely season for transport of San Joaquin emissions into the Kaiser Wilderness is summer. Springtime transport may be associated with agricultural and forest prescribed burning in San Joaquin Valley and National Forest lands. Autumn transport is less frequent because of a persistent San Joaquin Valley inversion that confines emissions to lower elevations.

The KAIS1 location is adequate for assessing the 2018 reasonable progress goals for the Kaiser Wilderness Class 1 area.

II.d. Baseline Visibility

Baseline visibility is determined from KAIS1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the KAIS1 wilderness areas is calculated at 2.3 deciviews for the 20% best days and 15.5 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

II.e. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the KAIS1 wilderness areas is 0.04 deciviews for the 20% best days and 7.1 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.f. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 13.57 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.3 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

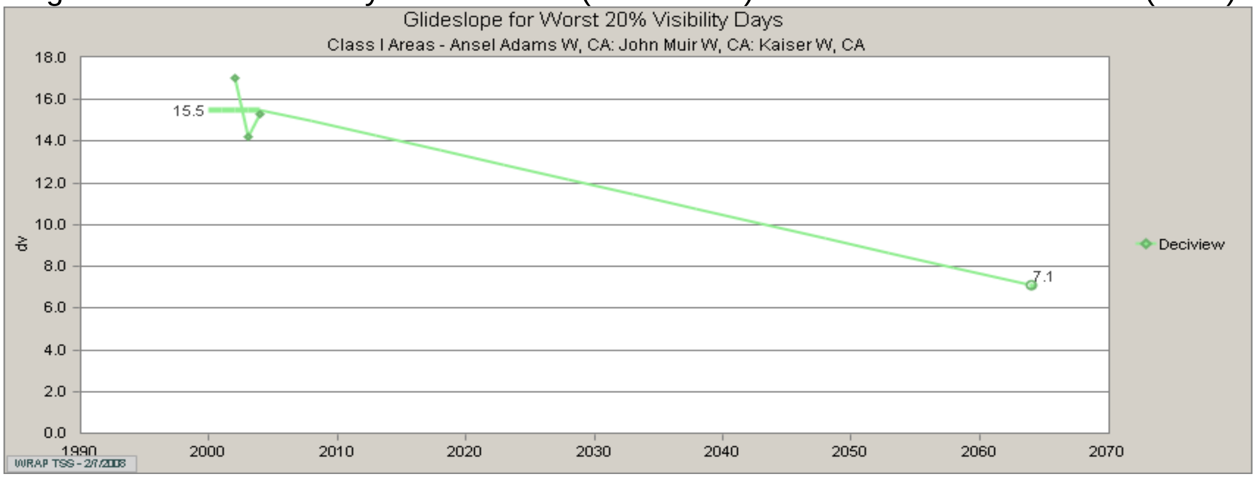
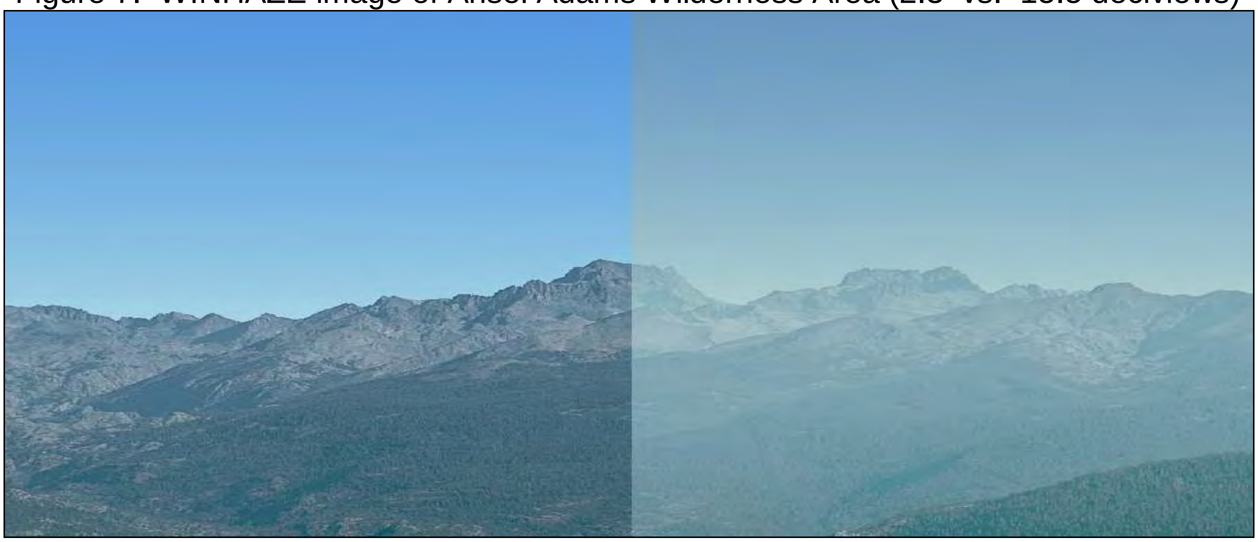


Figure 7. WINHAZE image of Ansel Adams Wilderness Area (2.3 vs. 15.5 deciviews)



II.g. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 8 shows the contribution of each species to the 20% best and worst days in the baseline years at KAIS1.

Figure 8. Average haze species contributions to light extinction in the baseline years

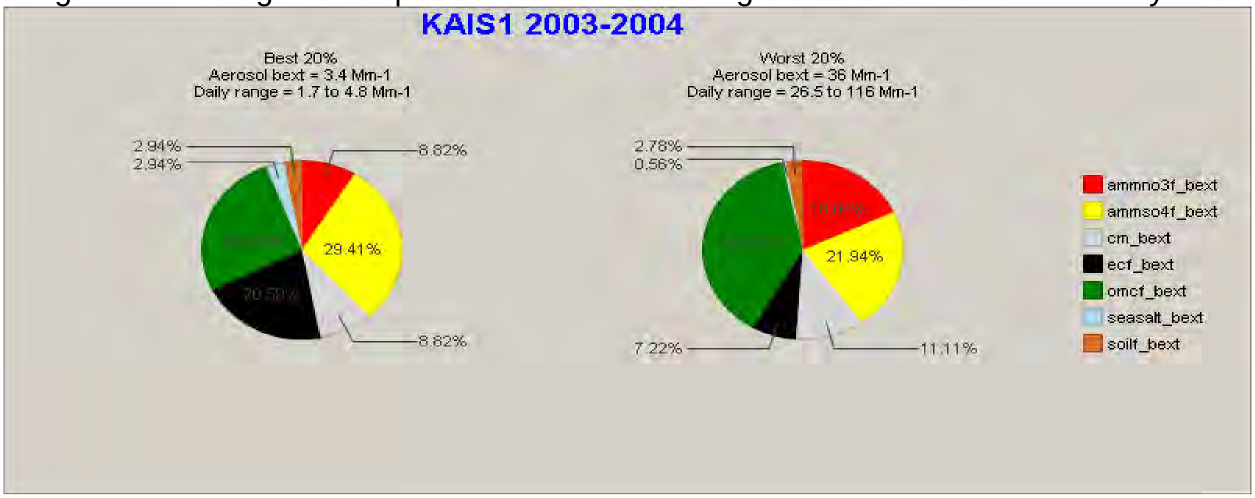
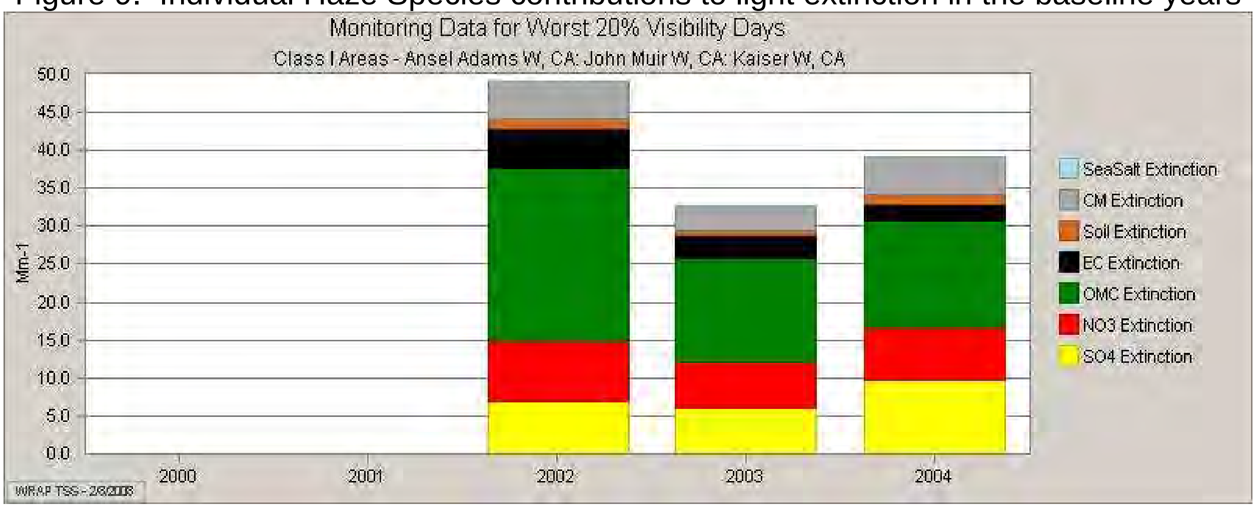


Figure 9. Individual Haze Species contributions to light extinction in the baseline years



As shown in Figures 8 and 9, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on the worst days at the KAIS1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 10 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and early spring while sulfates increase slightly in the summer months. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea salt seen throughout the year.

Figure 11 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 10 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires. The spike in late July of 2002 can be attributed to smoke transported into the Central Valley of California from the Biscuit Fire which burned almost 500,000 acres in the Siskiyou National Forest in southwestern Oregon and the Six Rivers National Forest in northwestern California. The spike in organic carbon for the months of August and September of 2002 can be attributed to the McNally fire which burned 150,670 acres in the Sequoia National Forest.

Figure 10. Species contribution on the 20% worst days in 2002

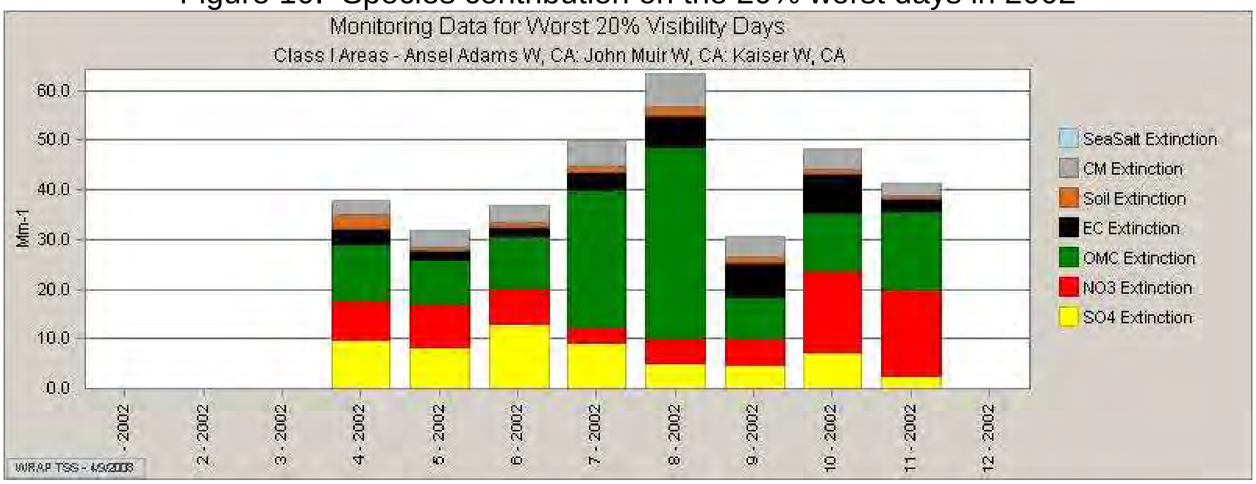
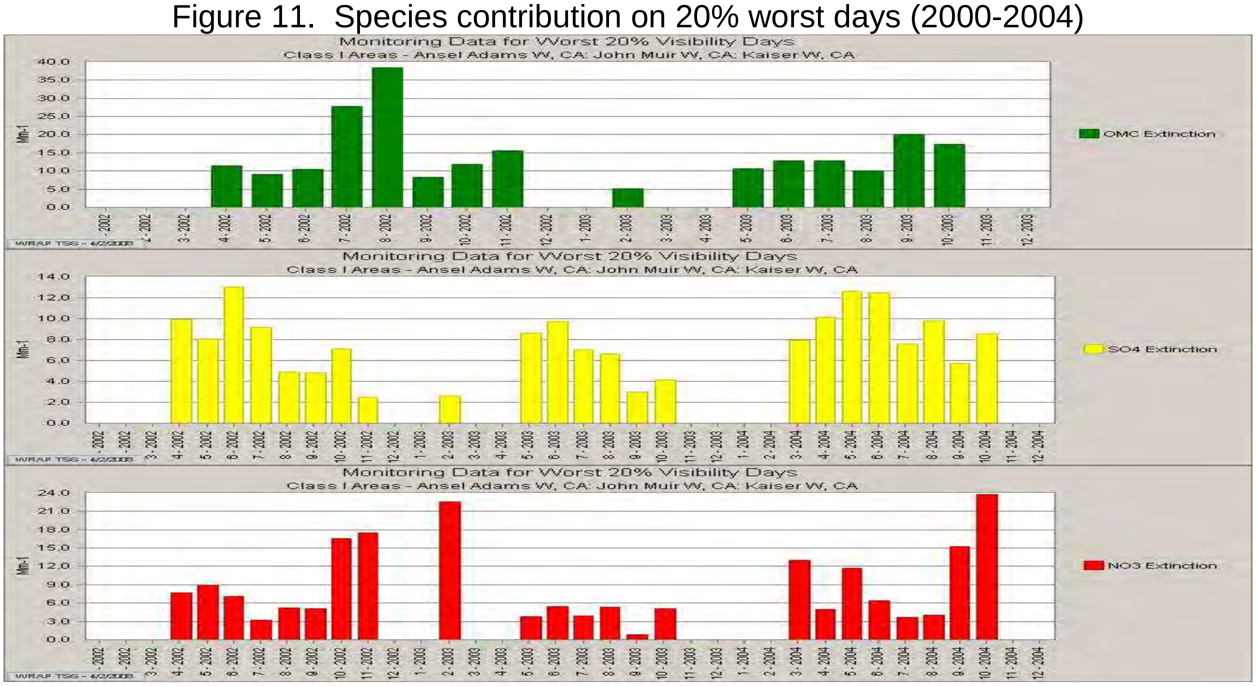


Figure 11. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at KAIS1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the KAIS1 monitor is from natural fire sources within California. California represents 86% of all natural fire source contributions.

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 73% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 24% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at KAIS1. The Outside Domain region represents 45% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (15%). California contributes 19% of the total sulfate emissions seen at the KAIS1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the KAIS1 monitor. The next largest contributor to sulfate concentrations is from area sources in the Pacific Offshore Region.

Figures 16 and 17 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (74%), followed by the Outside Domain Region (20%) and emissions from Pacific Offshore (6%). Mobile sources within California contribute the most nitrate at the KAIS1 monitor. In 2002, 63% of the nitrate at the KAIS1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the KAIS1 monitor in 2002 and 2018. Currently, California mobile sources are 73% of California contributions to nitrate at the KAIS1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 12. Organic carbon source contribution from CA and outside regions

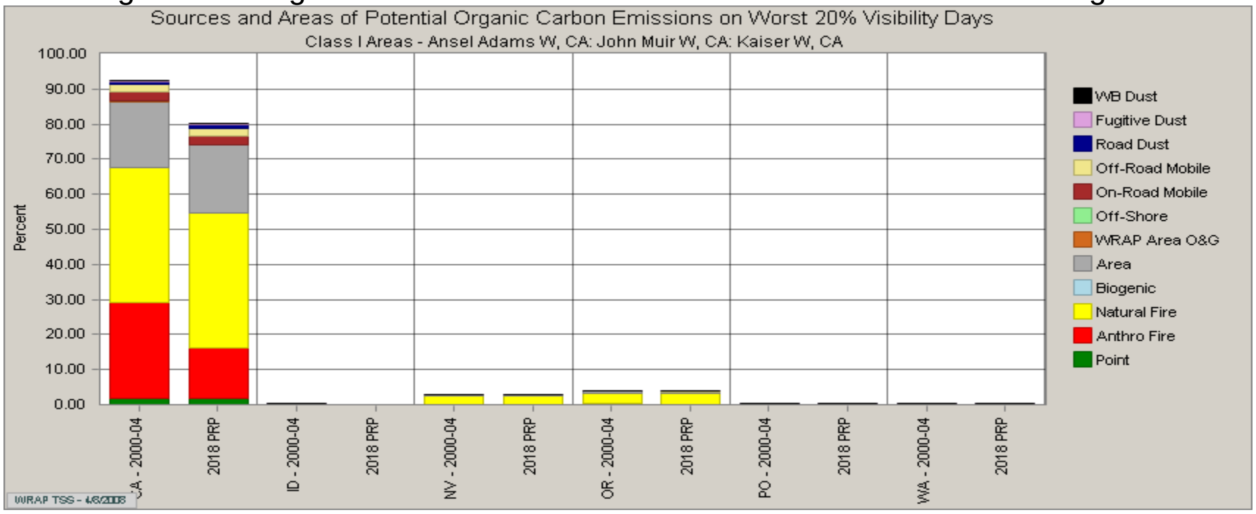


Figure 13. Organic carbon Anthropogenic and Biogenic Source Apportionment

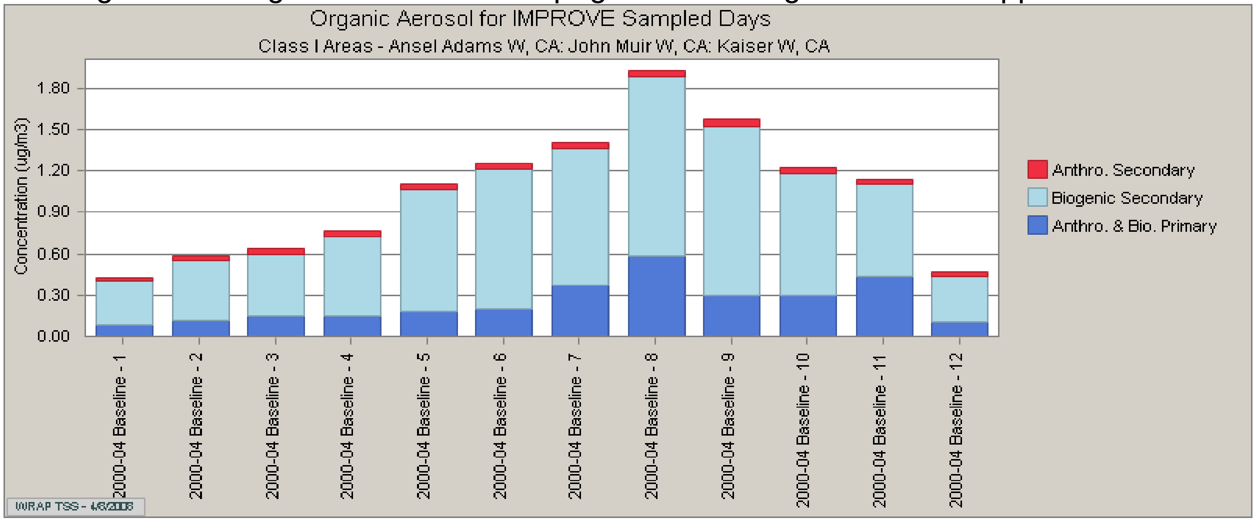


Figure 14. Regional Sulfate Contribution to Haze in 2002 and 2018

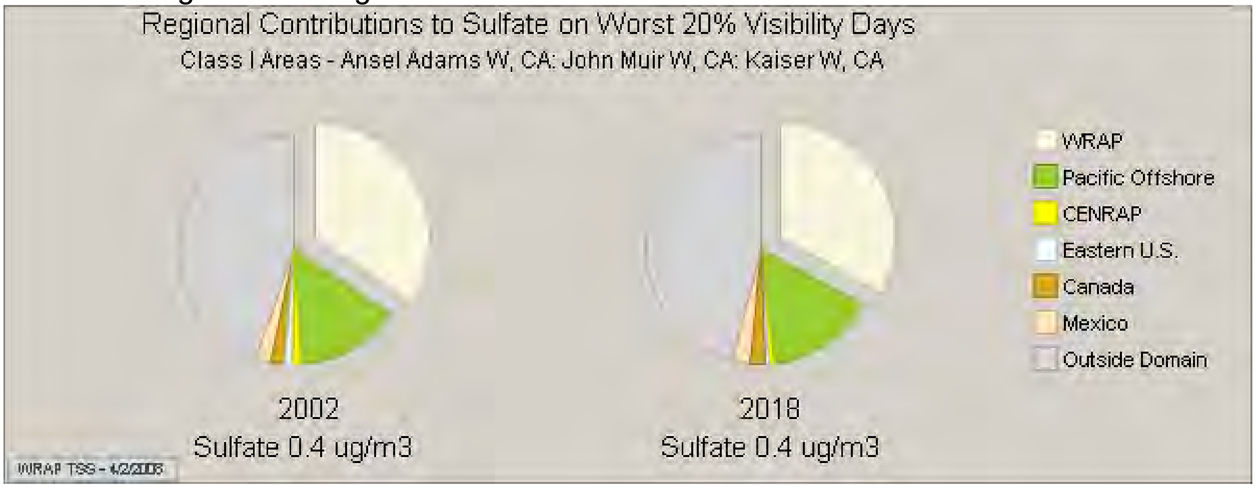


Figure 15. Sulfate source contribution from CA and outside regions

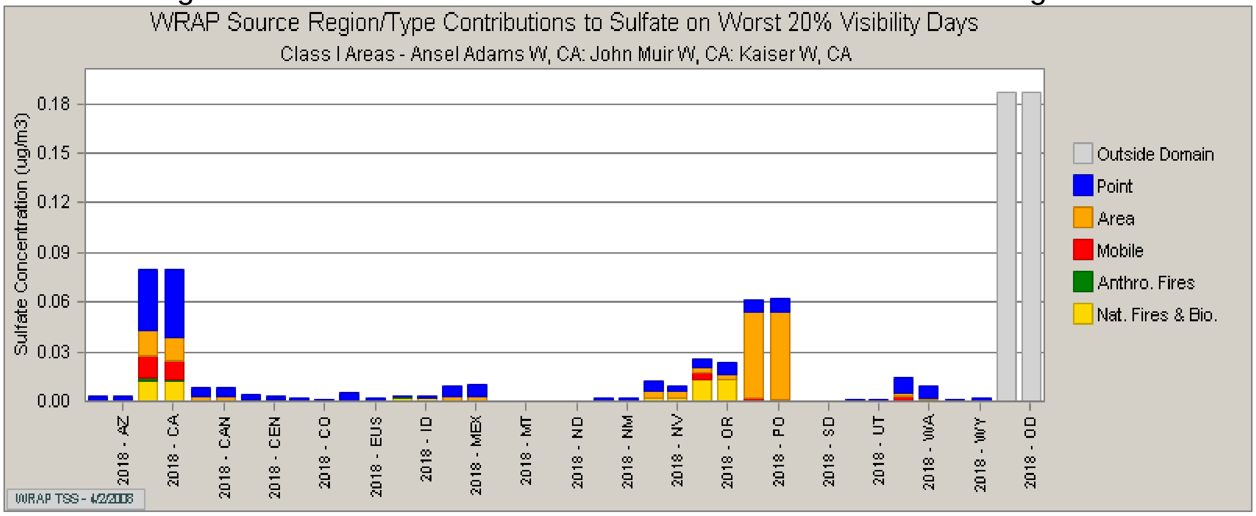


Figure 16. Regional Nitrate Contribution to Haze in 2002 and 2018

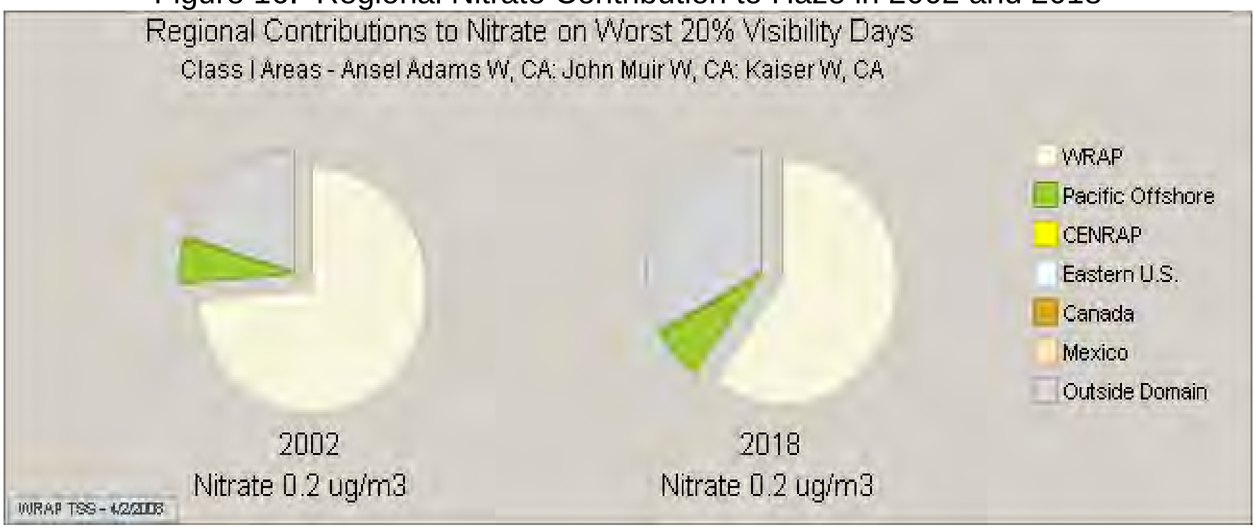
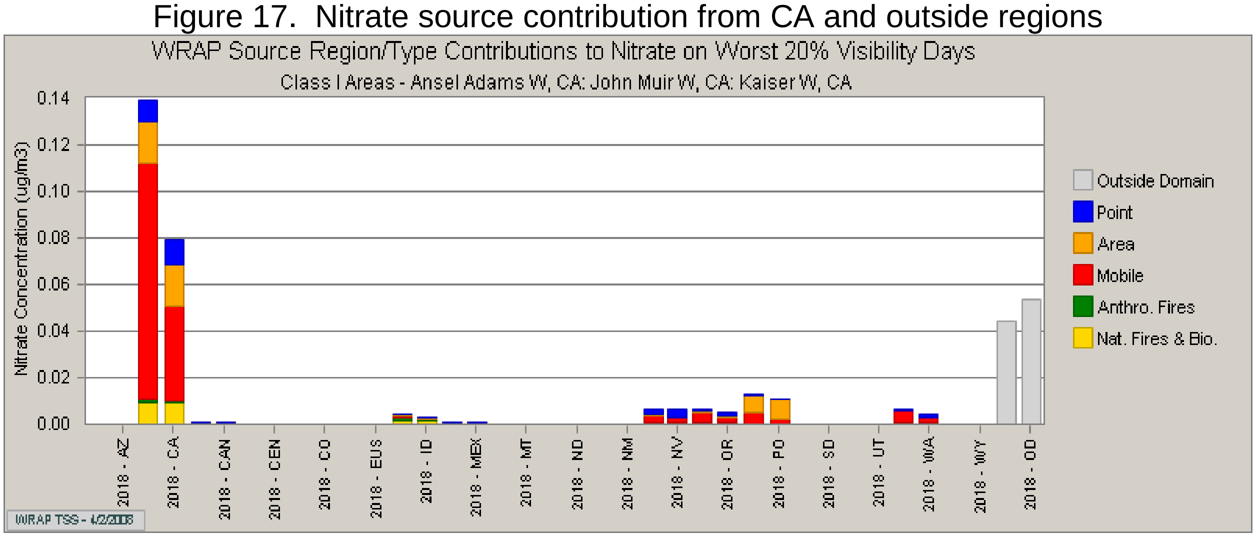


Figure 17. Nitrate source contribution from CA and outside regions



SEQU1 Monitor

The SEQU1 monitor location represents two wilderness areas located in the Southern Sierra Nevada Mountain Range. The wilderness areas associated with the SEQU1 monitor are Kings Canyon and Sequoia National Parks. Although data on haze pollutants has only been collected since 1997, the site has been operating since March 1992. This site has sufficient data for the five baseline years of 2000 – 2004.

<u>Section I. SEQU1 National Park Descriptions</u>

I.a. Kings Canyon National Park

Kings Canyon National Park consists of 459,994 acres of the western slopes of the southern Sierra Nevada range. Sequoia and Kings Canyon National Parks share a long boundary and are managed as one park, with Kings Canyon NP to the north of Sequoia NP. Kings Canyon National Park elevations range from around 1,219 meters where westward flowing streams exit the Park on the west side, to over 3,962 meters along the Sierra Nevada crest that forms the eastern boundary and culminates at the peak of Mt. Whitney at the Sequoia NP boundary. Essential topographic features of Kings Canyon include the Middle and South Forks of the Kings River that flow from the Sierra Nevada crest and merge 6 miles west of the National Park boundary, ultimately flowing into Pine Flat Reservoir and opening up into the San Joaquin Valley 25 miles east of Fresno. The Middle Fork of Kings River flows through the steep and narrow Kings Canyon, near 762 meters deep and 1 to 2 miles wide at the rim. Lowest elevations at the western boundary where the tow Forks of the Kings River exit the National Park are near 1,219 meters. San Joaquin Valley is the source of most local emissions that affect visibility within the Park.

Figure 1. Kings Canyon National Park

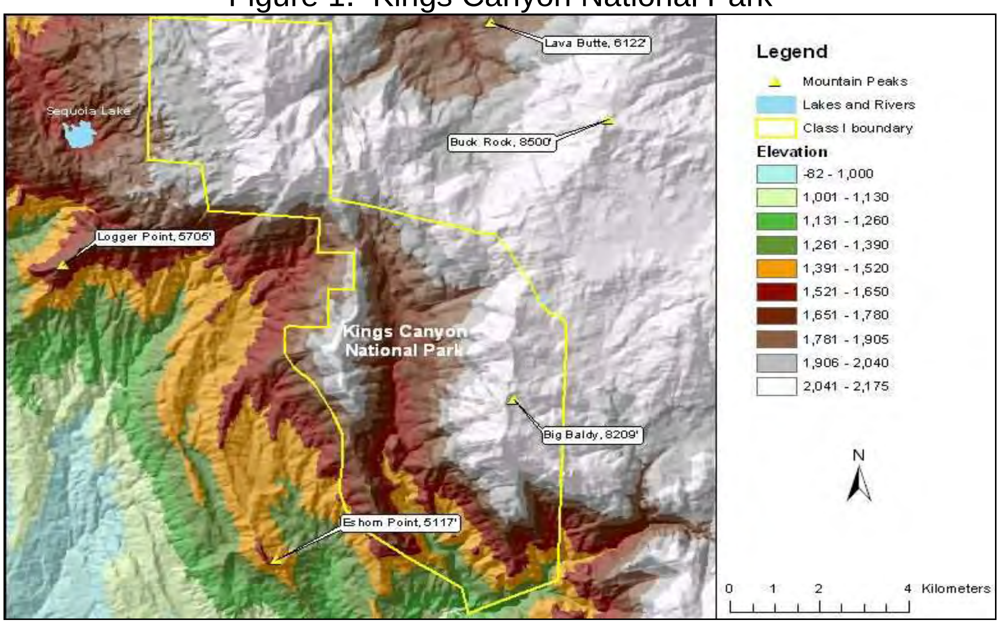
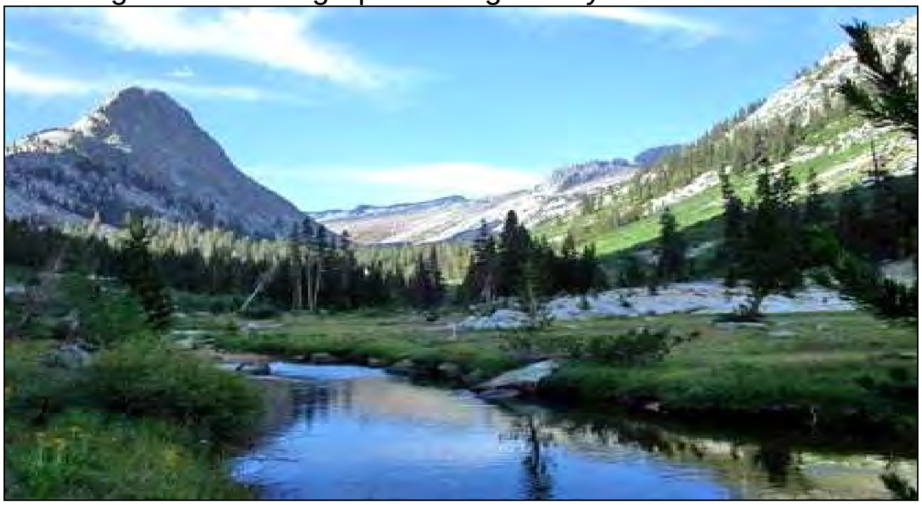


Figure 2. Photograph of Kings Canyon National Park



I.b. Sequoia National Park

Sequoia National Park (Sequoia) consists of 386,642 acres of the western slopes of the southern Sierra Nevada range. Sequoia and Kings Canyon National Parks share a long boundary and are managed as one park, with Kings Canyon National Park (Kings Canyon) to the north of Sequoia. Elevations range from around 457 meters where westward flowing streams exit the Park on the west side, to over 3,962 meters along the Sierra Nevada crest that forms the eastern boundary and culminates at the peak of Mt. Whitney, at an elevation of 4,417 meters. Essential topographic features include the North, Middle and East Forks of the Kaweah River that flow out of the Park on the west side and the Kern River that flows southward out of the eastern Park area. These drainages connect the Park with central and southern portions of the San Joaquin Valley, the source for most local emissions that affect visibility within the Park.

Figure 3. SEQU1 Monitor location

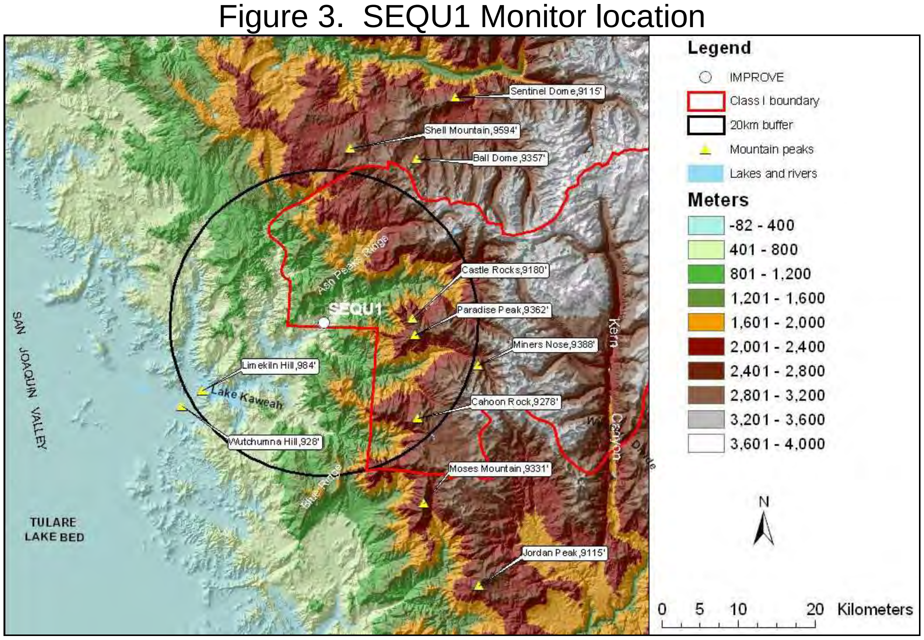


Figure 4. Photograph of Sequoia National Park

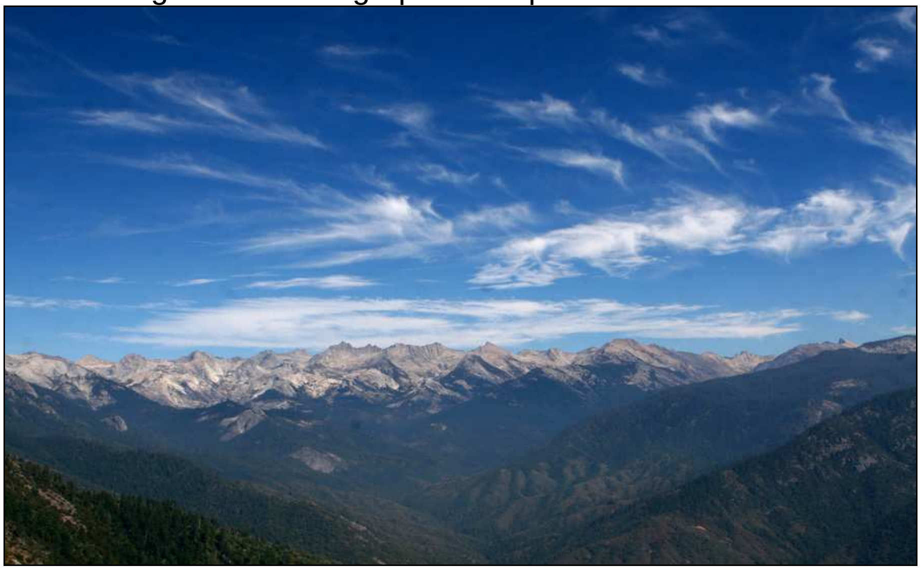


Figure 5. SEQU1 Monitor location in California

Section II. Visibility Conditions:

II.a. Kings Canyon National Park

Visibility conditions for Kings Canyon are currently monitored by the SEQU1 IMPROVE monitor. The monitor is located at 36.49 north latitude and 118.83 west longitude in the Middle Fork of the Kaweah River drainage near its exit from the Sequoia National Park south of Kings Canyon. At an elevation of 519 meters, the site is about 64 meters above the river.

SEQU1 is situated near the bottom of one of the valleys that drain Sequoia National Park on its west side, at the very lowest end of elevation ranges within Sequoia NP and well below the lowest Kings Canyon elevations. It is well located for observing San Joaquin Valley emissions at western park boundaries, and emissions from more local sources, and may represent highest aerosol concentrations and most severe visibility impacts within Park boundaries. During inversion conditions it may not be as representative of aerosol concentrations and composition at highest Sequoia and Kings Canyon elevations that could be impacted by emission from more distant source regions on a synoptic to global scale. It may be less representative of aerosol characteristics in the more distant Kings Canyon National Park than in Sequoia National Park. Kings River Middle and South Forks exit Kings Canyon about 25 miles east of central San Joaquin Valley and 50 miles east of Fresno. Lowest elevations of Kings Canyon are around 701 meters higher than lowest elevations of Sequoia and the SEQU1 monitoring site, and are near the upper end of the typical summertime San Joaquin Valley mixing heights. SEQU1 aerosol data should still represent maximum impact within the two Parks due to San Joaquin Valley emissions.

The SEQU I location is adequate for assessing the 2018 reasonable progress goals for the Kings Canyon National Park Class 1 area.

II.b. Sequoia National Park

Visibility conditions for Sequoia are currently monitored by the SEQU1 IMPROVE monitor operated by the National Park Service. The monitor is located at 36.49 north latitude and 118.83 west longitude in the Middle Fork of the Kaweah River drainage near its exit from the Park. At an elevation of 519 meters, the site is about 64 meters above the river.

The monitoring location is at the western boundary of the Sequoia National Forest, in the foothills of the Sierra Nevada, and in the lowest elevation range of the Forest. It is well-located for observing localized air flows along the Kaweah River drainage and from the adjacent San Joaquin Valley. The elevation of the SEQU1 IMPROVE monitoring station is within both the summer and winter inversion layers of the San Joaquin Valley. Since it receives transported emissions from the San Joaquin Valley, the monitor may register the highest aerosol concentrations and most severe visibility impacts within the Forest boundaries. During inversion conditions, the measurements may not be as representative of aerosol concentration and composition at higher Park elevations that could be impacted by emissions from more distant source regions on a synoptic to global scale.

The SEQU I location is adequate for assessing the 2018 reasonable progress goals for the Sequoia National Park Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from SEQU1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SEQU1 monitor is calculated at 8.8 deciviews for the 20% best days and 25.4 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

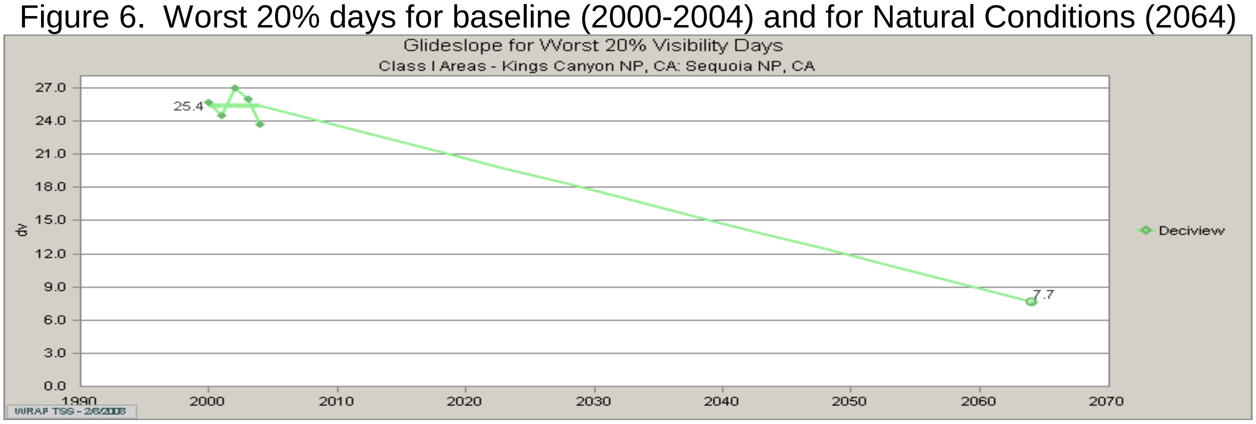
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the SEQU1 monitor is 2.3 deciviews for the 20% best days and 7.7 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 21.24 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 8.8 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at SEQU1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

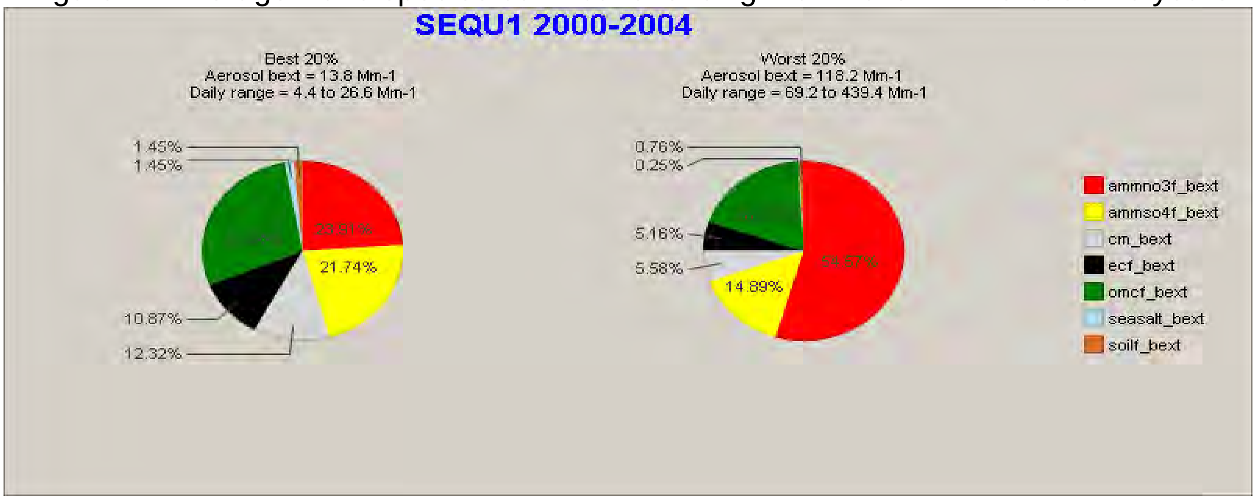
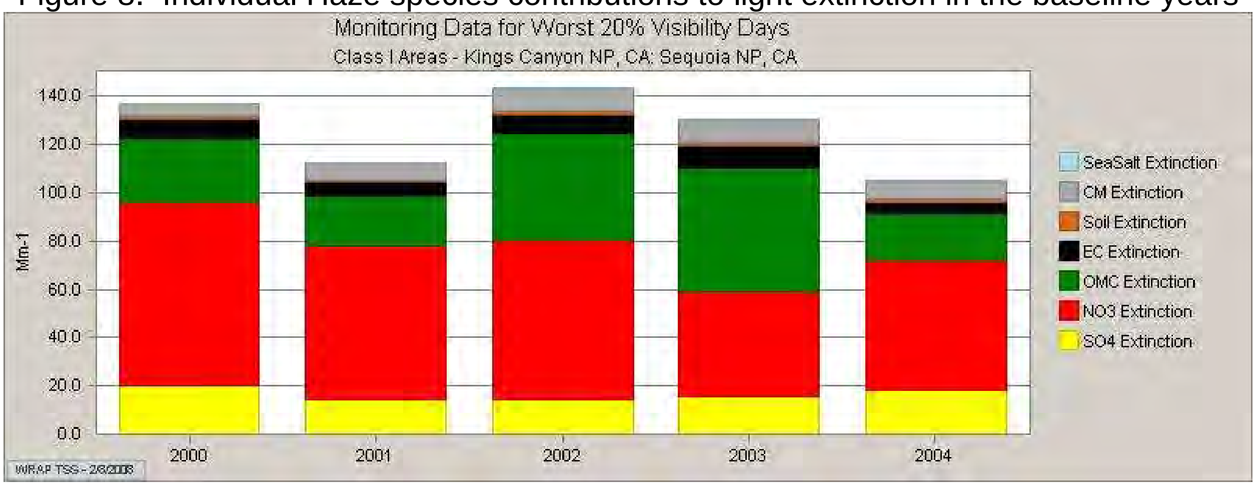


Figure 8. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 7 and 8, nitrates, organic matter, and sulfates have the strongest contributions to light extinction which degrade visibility on worst days at the SEQU1 monitor. The worst days are dominated by nitrates, while the best days are dominated by organic matter.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring while sulfates increase slightly in the spring and summer months. Organic matter remains high throughout the summer. Nitrates clearly dominate the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea salt and soil present throughout the year.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for nitrates, organic matter, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

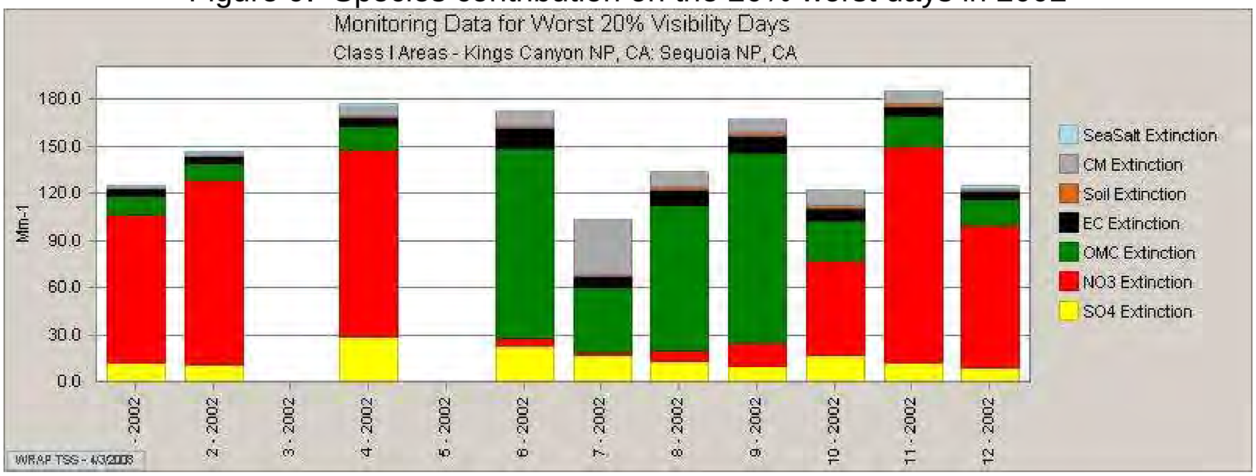
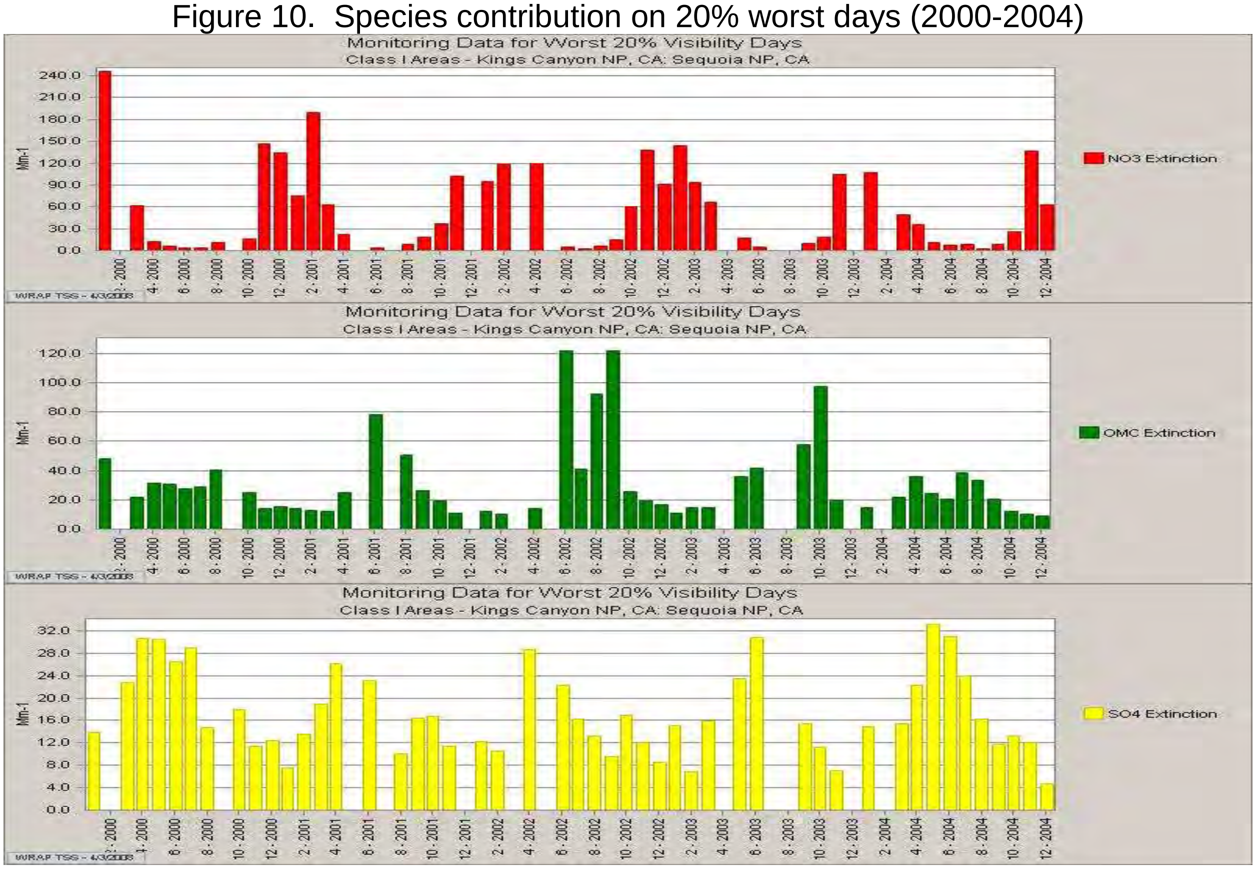


Figure 10. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at SEQU1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (86%), followed by the Outside Domain Region (9%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrates at the SEQU1 monitor. In 2002, 94% of the nitrate from mobile sources at the SEQU1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SEQU1 monitor is from natural fire sources within California. California represents 97% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 60% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 35% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 15 and 16 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SEQU1. The Outside Domain region represents 48% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (13%). California contributes 25% of the total sulfate emissions seen at the SEQU1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the SEQU1 monitor. Pacific Offshore area sources and California point sources contribute an equal amount to the sulfate concentrations at the SEQU1 monitor following outside the modeling domain.

Figure 11. Regional Nitrate Contribution to Haze in 2002 and 2018

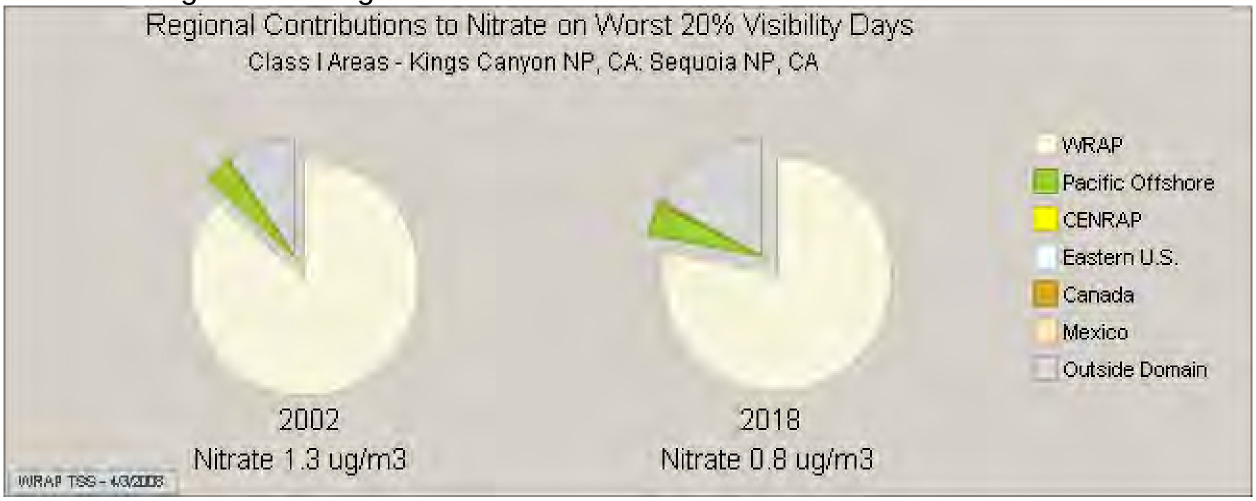


Figure 12. Nitrate source contribution from CA and outside regions

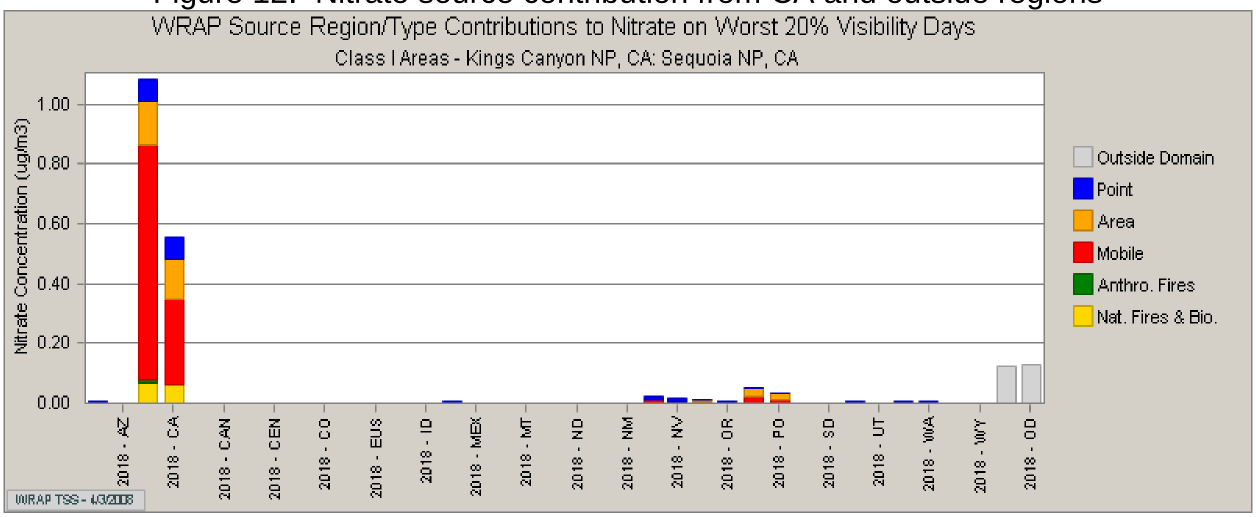


Figure 13. Organic carbon source contribution from CA and outside regions

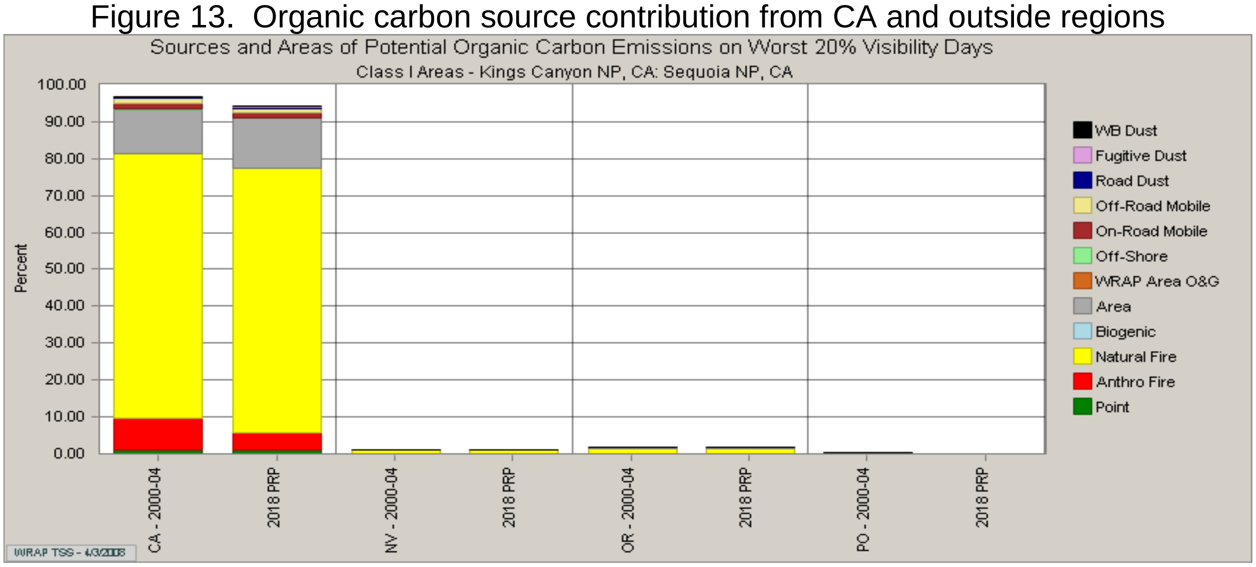


Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment

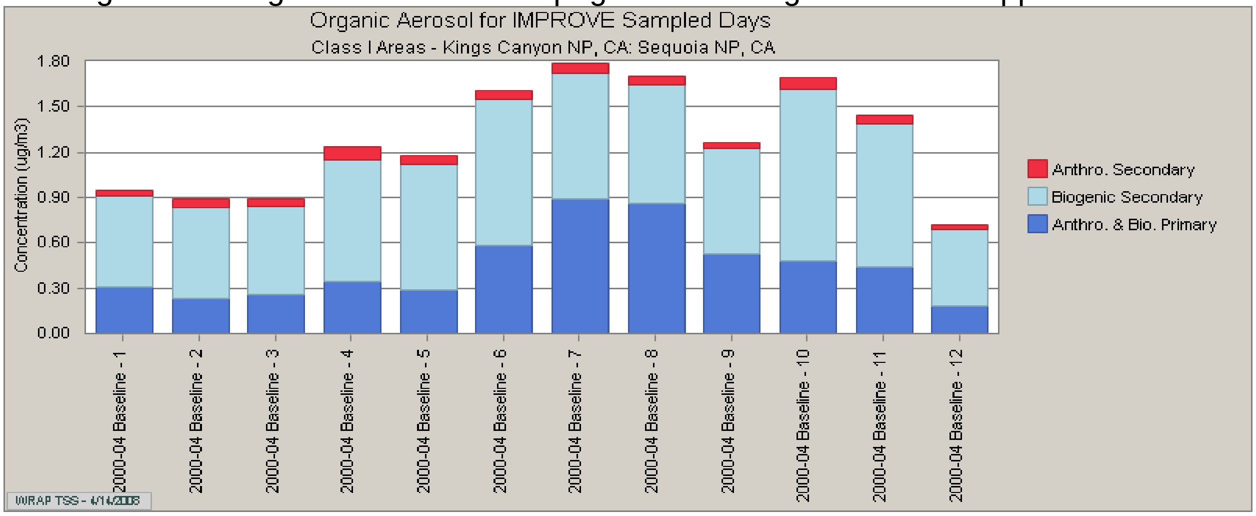


Figure 15. Regional Sulfate Contribution to Haze in 2002 and 2018

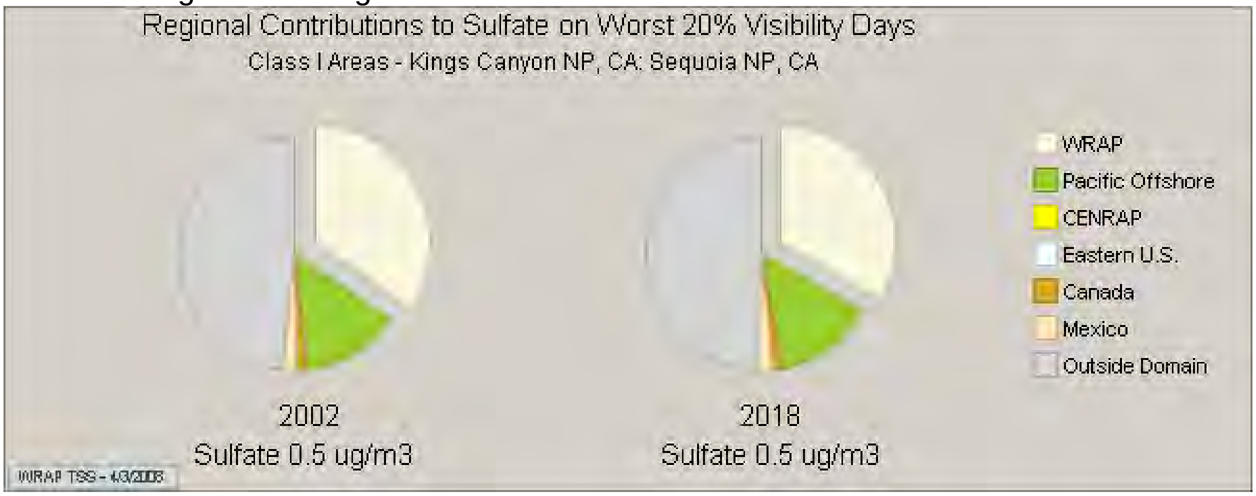
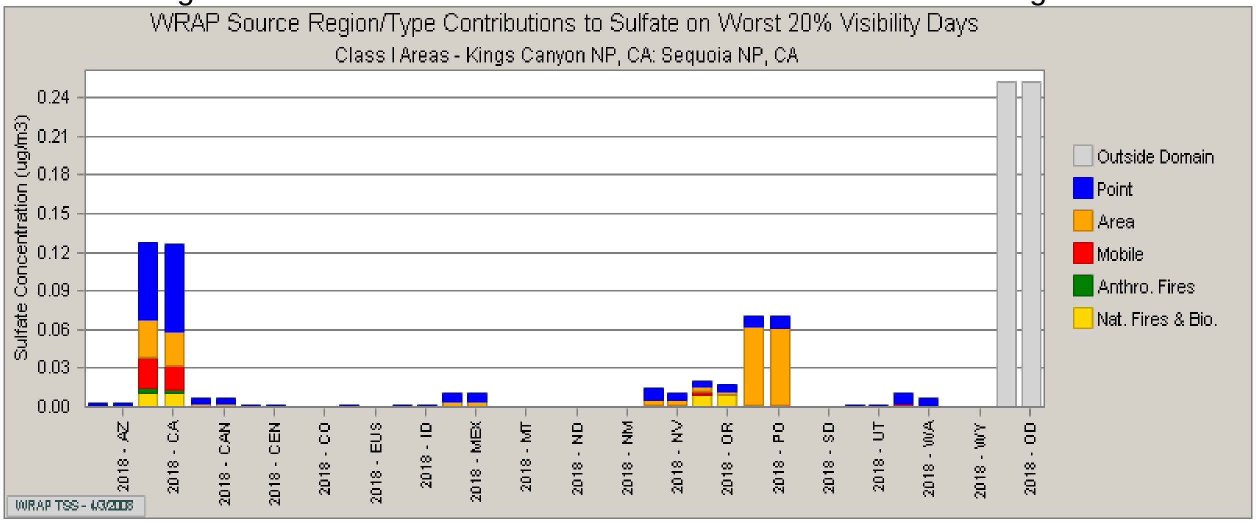


Figure 16. Sulfate source contribution from CA and outside regions



DOME1 Monitor

Section I. Description

Dome Land Wilderness Area (Dome Land) consists of about 131,000 acres of the southern end of the Kern Plateau, 70 miles northeast of Bakersfield. Elevations range from 914 to 2,966 meters. Dome Land Wilderness is bisected by the South Fork of the Kern River that flows southwest towards Bakersfield and the southern end of the San Joaquin Valley, where the elevation is near 152 meters and which is the nearest source region for anthropogenic emissions that may affect visibility in the Dome Land Wilderness Area.

Figure 1. DOME1 Monitor location

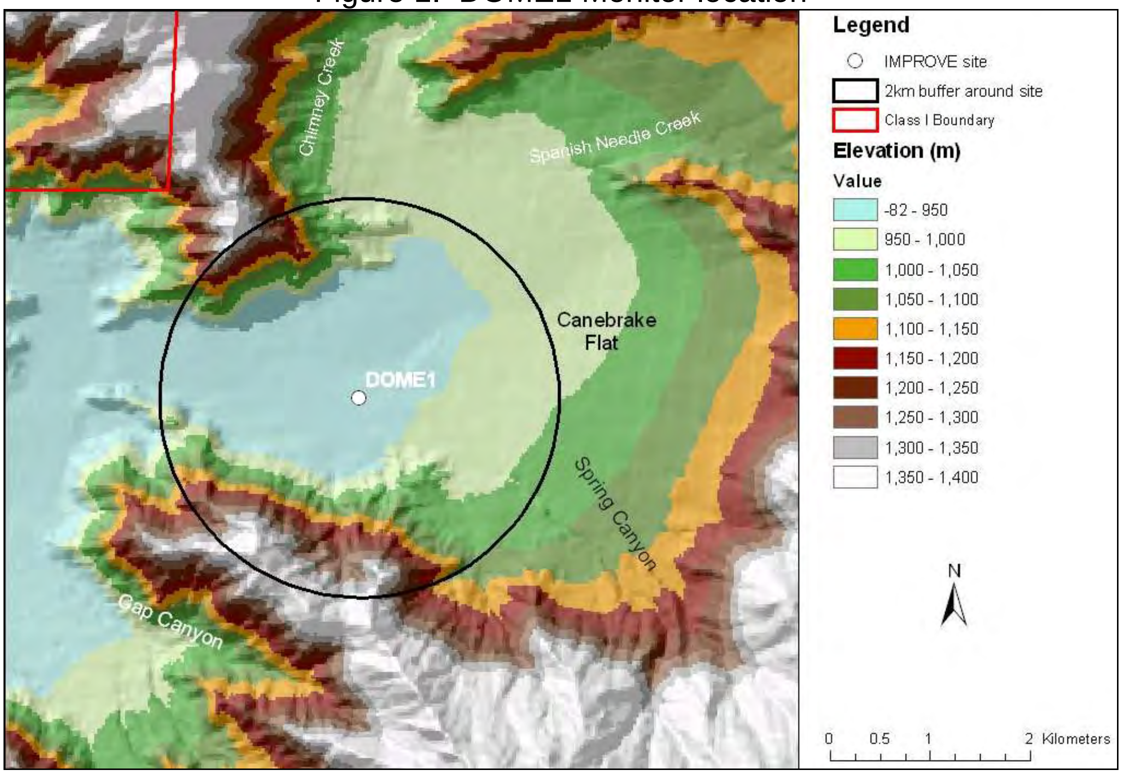


Figure 2. WINHAZE image of Dome Land Wilderness Area (5.1 vs. 19.4 deciviews)

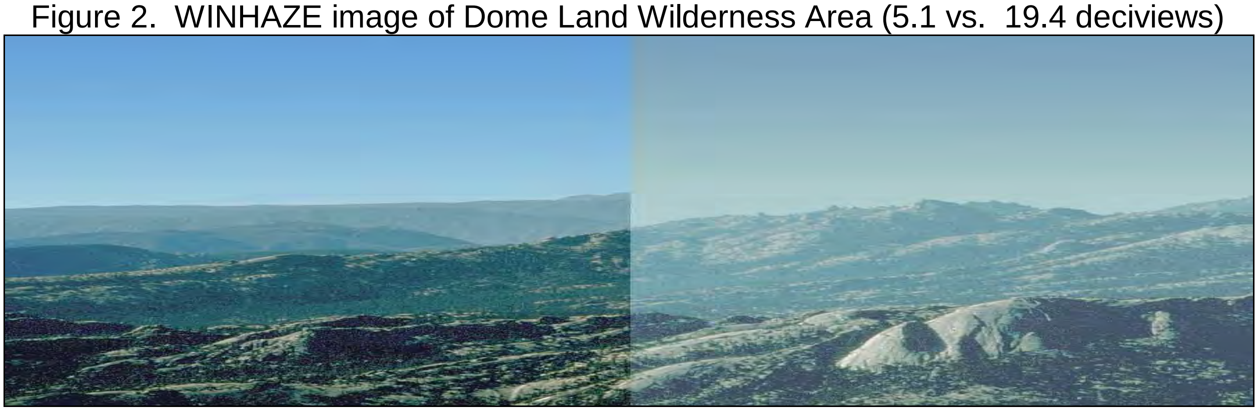


Figure 3. DOME1 Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for Dome Land Wilderness are currently monitored by the DOME1 IMPROVE monitor. The monitor is located at 35.7278 north latitude and 118.1377 west longitude in the valley of the South Fork of the Kern River a few miles downstream from its exit from the wilderness. The DOME1 site elevation is 927 meters, the lowest end of the range of Dome Land Wilderness elevations. The site has been operating since February 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

Aerosol data from DOME1 should be representative of locations in Dome Land Wilderness Area. The nearest population center is Bakersfield and the southern San Joaquin Valley, 70 miles southwest. This source region is the nearest source for emissions that could contribute to haze in Dome Land Wilderness, via low-level transport up the South Fork of the Kern River, via upward mixing and upper level transport by prevailing westerly winds, or trapped beneath a regional subsidence inversion.

The DOME1 location is adequate for assessing the 2018 reasonable progress goals for the Dome Land Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from DOME1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Dome Land Wilderness is calculated at 5.1 deciviews for the 20% best days and 19.4 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

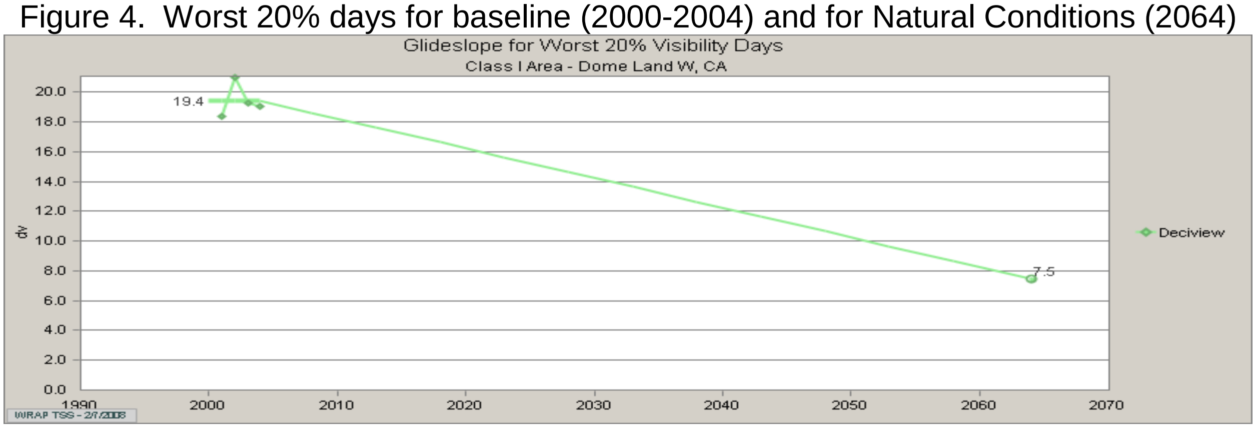
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Dome Land Wilderness is 1.2 deciviews for the 20% best days and 7.5 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.64 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 5.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at DOME1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

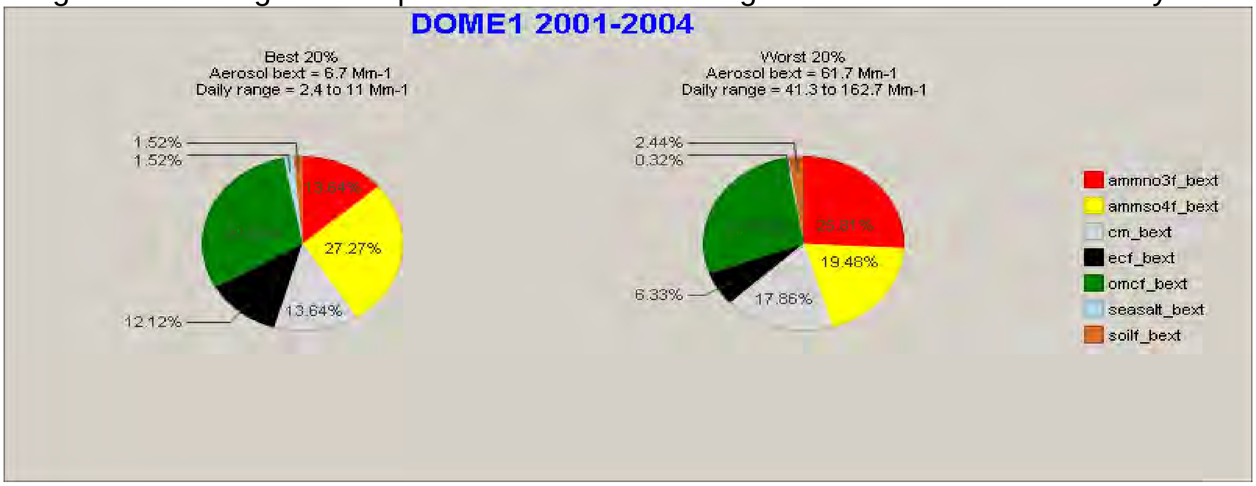
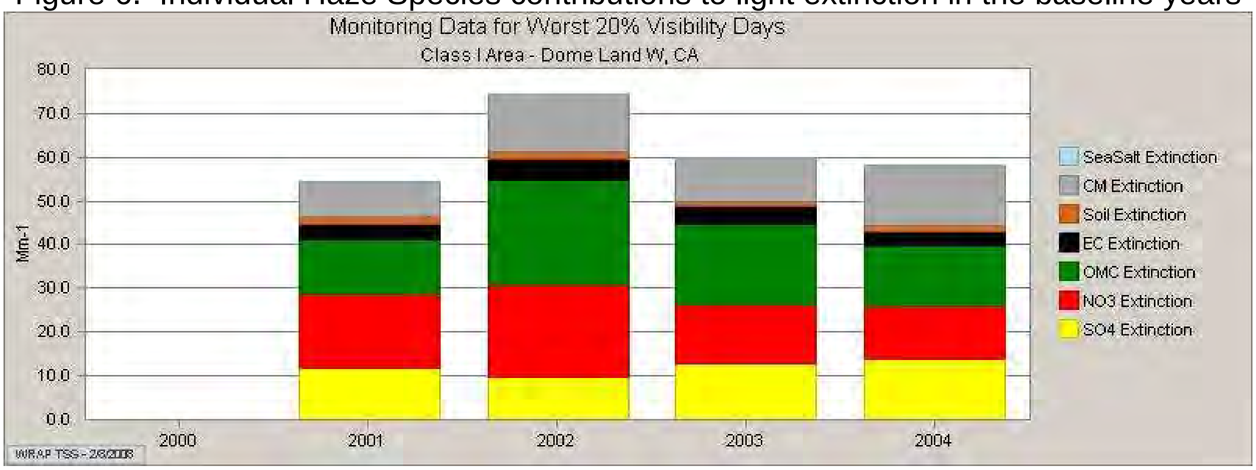


Figure 6. Individual Haze Species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, organic matter, nitrates, and sulfates have the strongest contributions to degrading visibility on worst days at Dome Land Wilderness Area. The worst and best days are dominated by organic matter. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution on worst days in 2003. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sulfates remain relatively stable throughout the year but see a slight increase in the early summer. Nitrates increase in the winter months and coarse mass increases slightly in the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, and coarse mass also contribute to the worst days throughout the year. There are only trace amounts of soil and sea salt present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2003

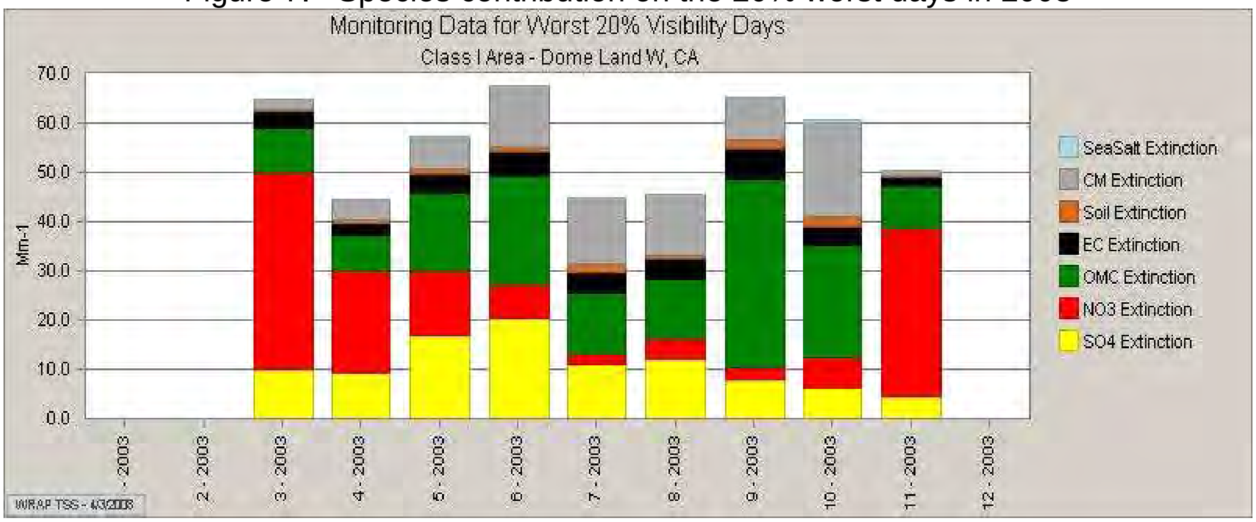
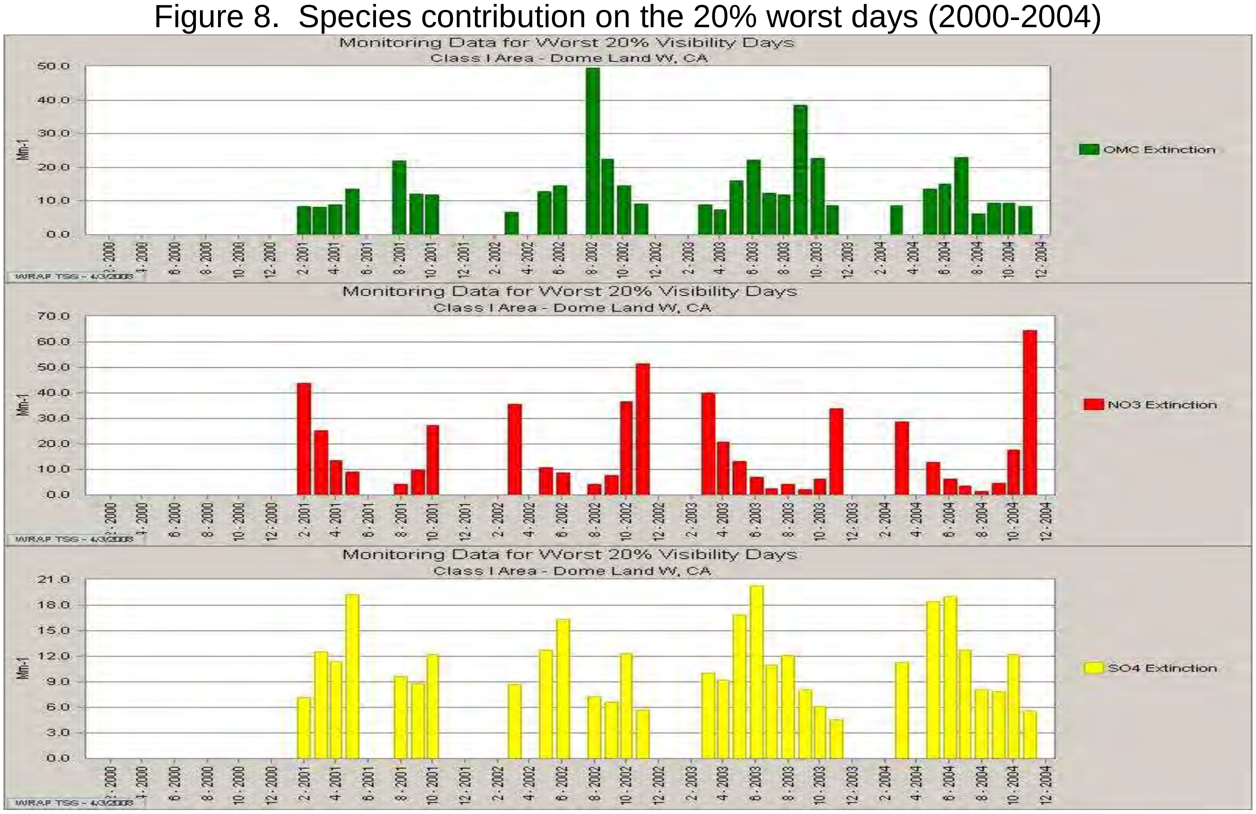


Figure 8. Species contribution on the 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at DOME1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 9 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the DOME1 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 10 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary emissions account for 67% of the total organic carbon. Biogenic secondary source emissions account for 31% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (86%), followed by the Outside Domain Region (11%) and emissions from Pacific Offshore (3%). Mobile sources within California contribute the most nitrates at the DOME1 monitor. In 2002, 81% of the nitrate at the DOME1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the DOME1 monitor in 2002 and 2018. Currently, California mobile sources are 68% of California contributions to nitrate at the DOME1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at DOME1. The Outside Domain region represents 42% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (38%) and the Pacific Offshore Region (15%). California contributes 26% of the total sulfate emissions seen at the DOME1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the DOME1 monitor. The next largest contributor to sulfate concentration is area sources in the Pacific Offshore.

Figure 9. Organic carbon source contribution from CA and outside regions

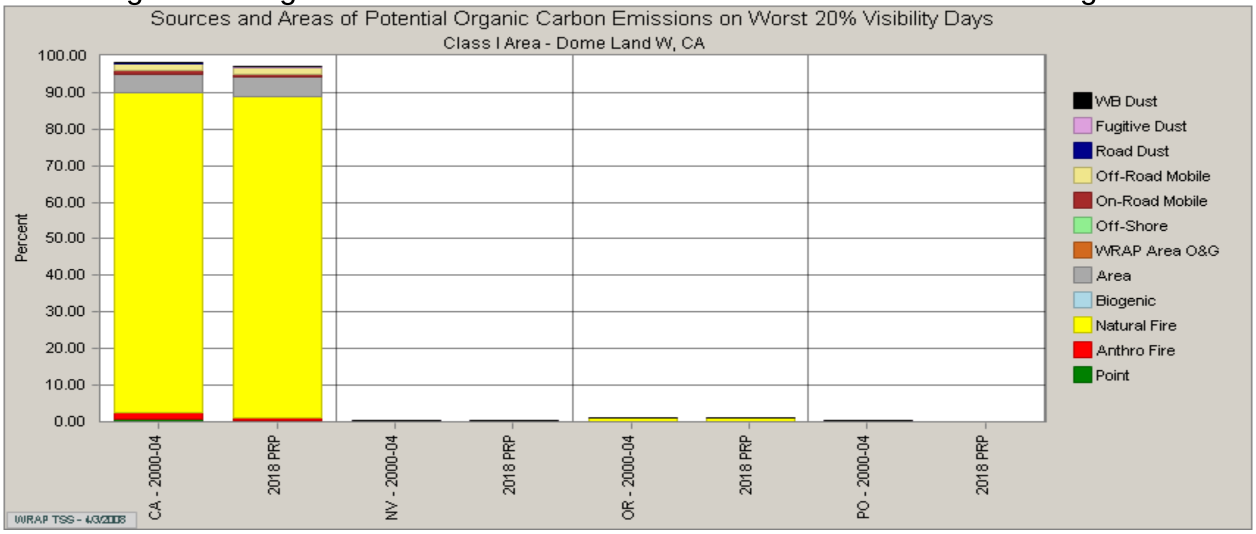


Figure 10. Organic carbon Anthropogenic and Biogenic Source Apportionment

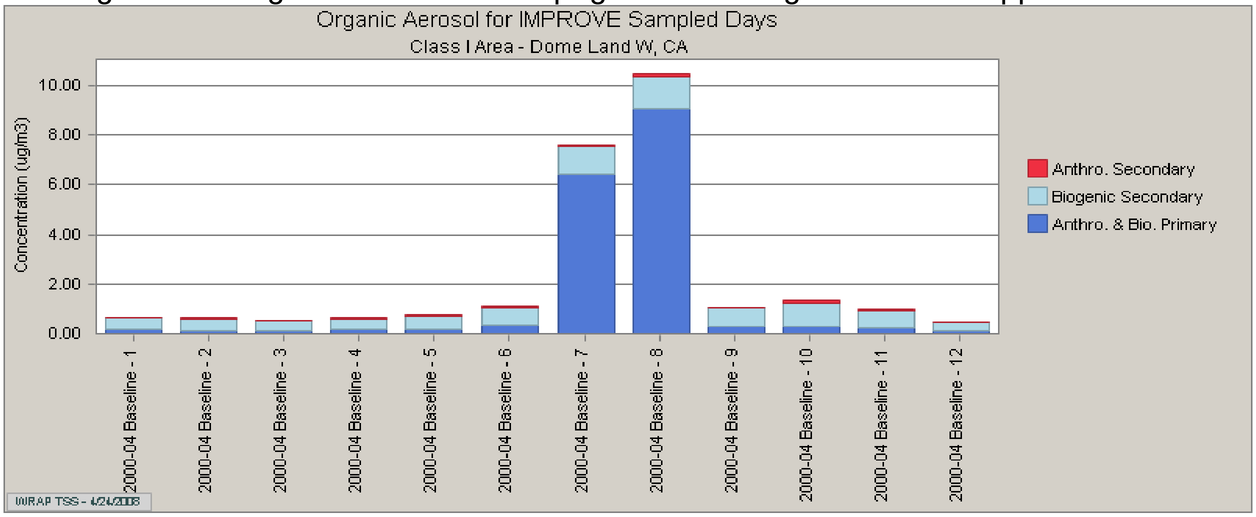


Figure 11. Regional Nitrate contribution to haze in 2002 and 2018

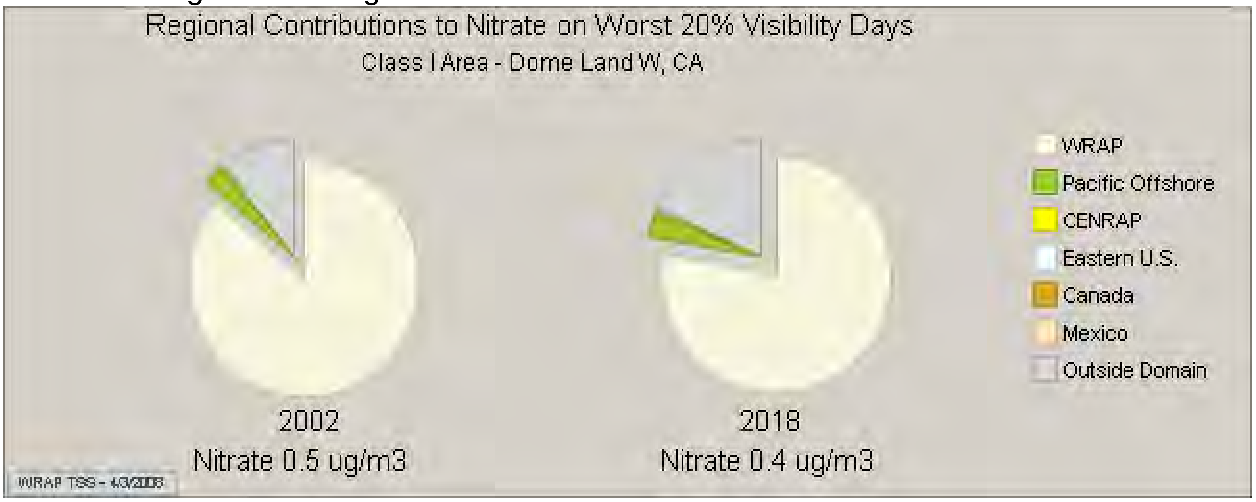


Figure 12. Nitrate source contribution from CA and outside regions

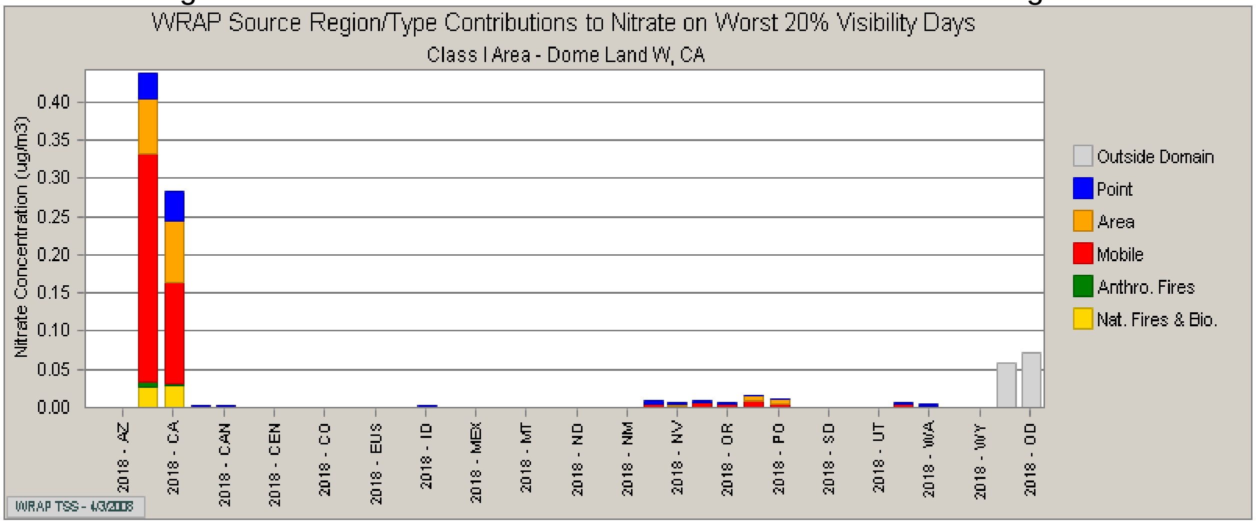


Figure 13. Regional Sulfate contribution to Haze in 2002 and 2018

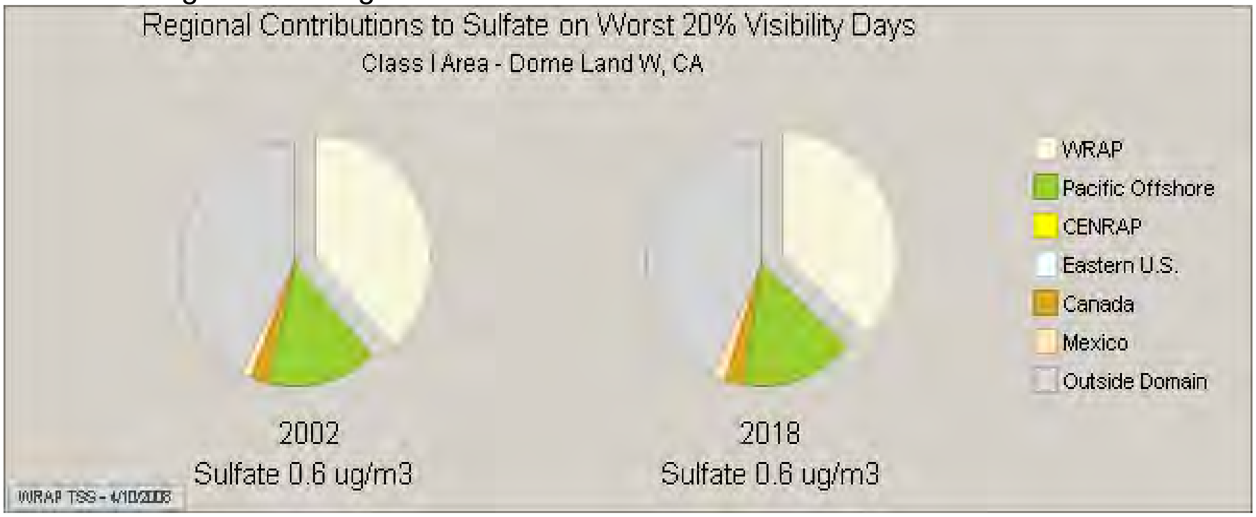
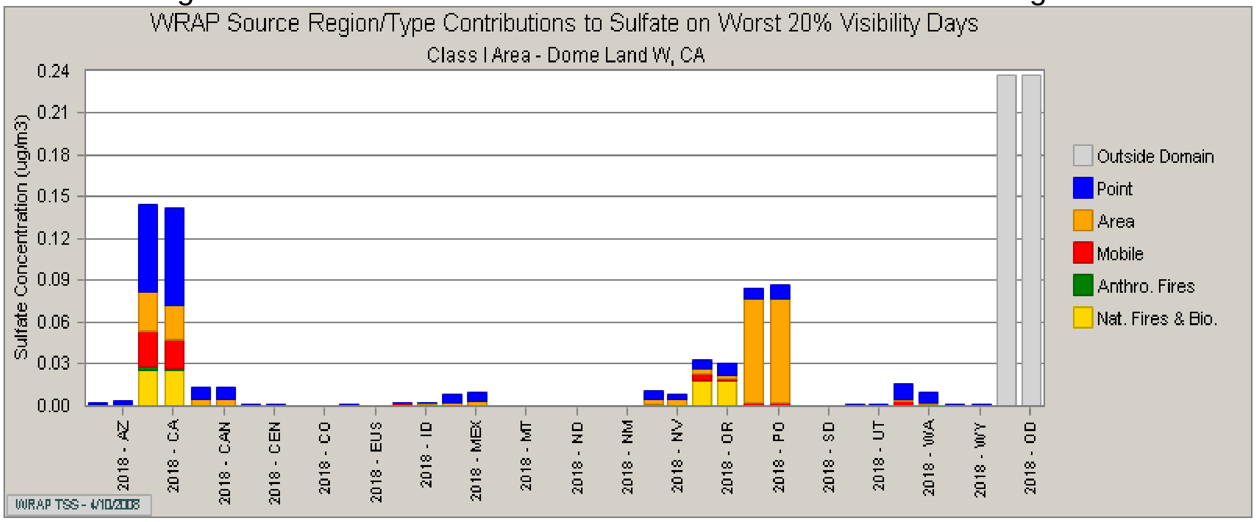


Figure 14. Sulfate source contribution from CA and outside regions



REDW1 Monitor

Section I. Description

Redwood National Park (Redwoods) consists of 27,792 acres of coast and coastal mountains in northern California. The several unconnected sections of the Park include 37 miles of coastline between the Oregon border and McKinleyville, California. Elevations range from sea level to about 914 meters. As part of the coast ranges that present the first obstruction to moist air from the Pacific, it has a relatively high annual average precipitation. Total annual precipitation on the northern California coast is about 120 inches, mostly during the winter when the Aleutian Low is at its most southerly position over the eastern Pacific. Precipitation varies considerably with inland distance and with elevation. The furthest inland extent of Redwoods is about 15 miles from the coast. Besides the coast and mountains, the most significant topographic features are the Smith and Klamath Rivers that empty into the Pacific in the northern and southern Redwoods areas, respectively.

Figure 1. REDW1 Monitor location

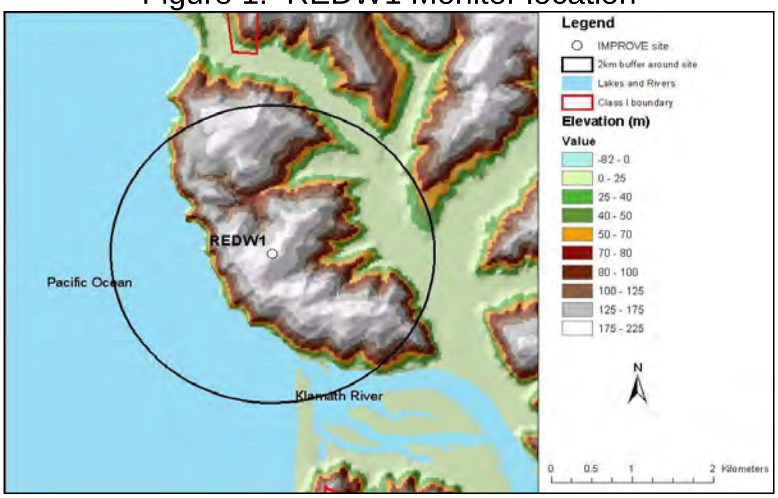


Figure 2. Image taken from Redwood monitor camera

Figure 3. REDW1 Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for Redwoods are currently monitored by the REDW1 IMPROVE monitor. The monitor is located at 41.5608 north latitude and 124.0839 west longitude, located outside of park boundaries, but in a central location with respect to Redwood park sections. It is near the mouth of the Klamath River at an elevation of 244 meters. The site has been operating since March 1988. This site has sufficient data for the five baseline years of 2000 – 2004.

The REDW1 IMPROVE site is centrally located with respect to Park locations at a midrange elevation and should be quite representative of aerosol concentration and composition within Redwoods. There may be some modest influence by airflow down the Klamath River, which may be a transport route for emissions from the interior such as wildfire emissions that could influence measurements at the monitoring site locally.

The nearest population center is the Crescent City area near the mouth of the Smith River and the northern boundary of Redwoods.

The REDW1 location is adequate for assessing the 2018 reasonable progress goals for the Redwood National Park Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from REDW1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Redwood National Forest is calculated at 6.1 deciviews for the 20% best days and 18.5 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

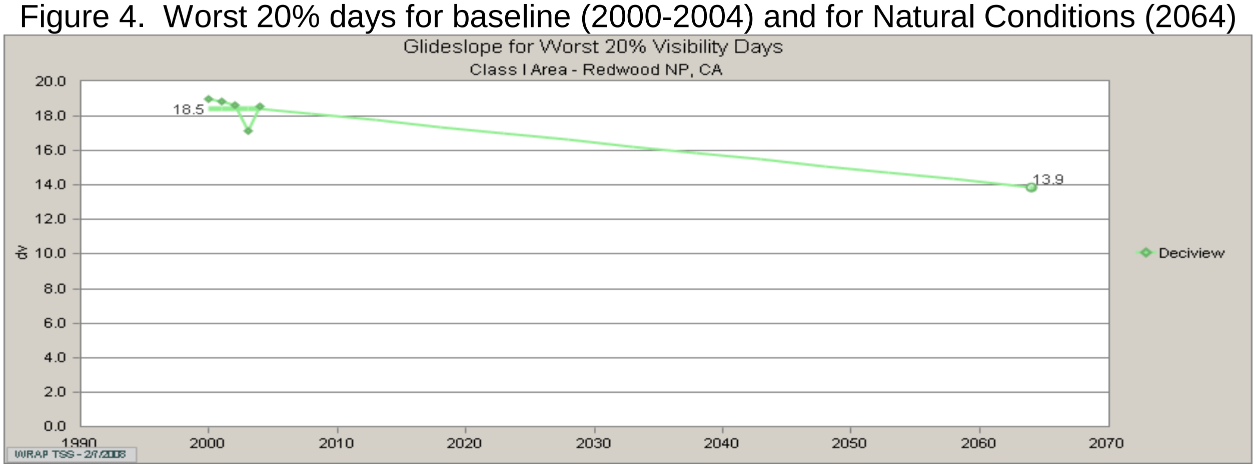
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Redwood National Forest is 3.5 deciviews for the 20% best days and 13.9 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 4 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 17.39 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at REDW1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

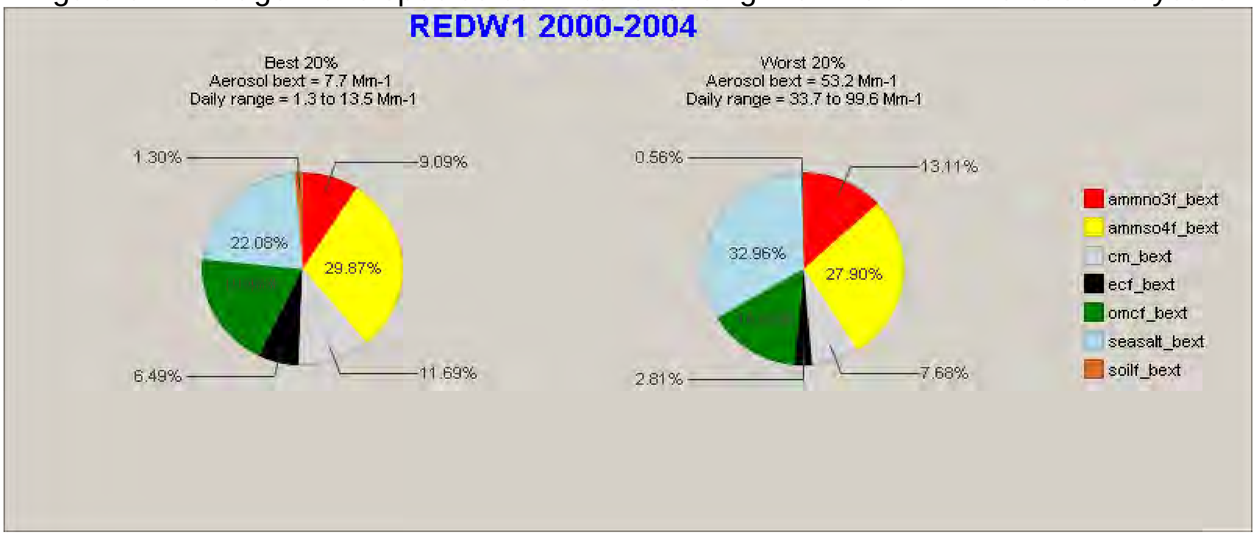
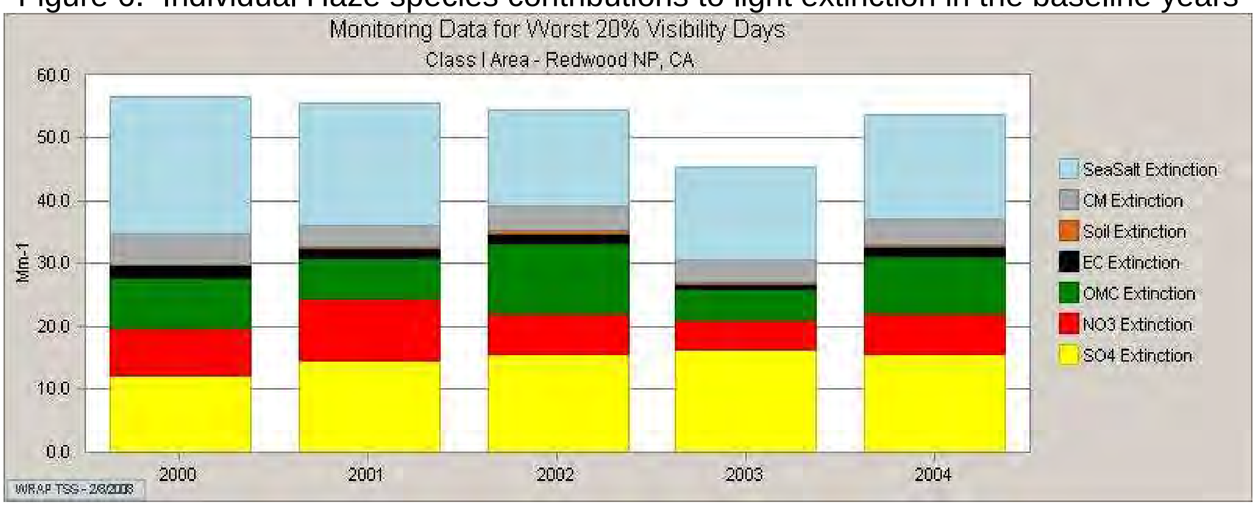


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, sea salt, sulfates, and organic matter have the strongest contributions to degrading visibility on worst days at Redwood National Park. The worst days are dominated by sea salt, while the best days are dominated by sulfate.

Figure 7 depicts the individual species contribution to worst days in 2002. Sea salt and sulfate increase in the summer months while organic matter increases in the winter months. Sea salt clearly dominates the other haze species on worst days, but sulfates, organic carbon, nitrates, and coarse mass also contribute to the worst days. Elemental carbon and soil are present in trace amounts at the REDW1 monitor.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sea salt, sulfates, organic matter, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

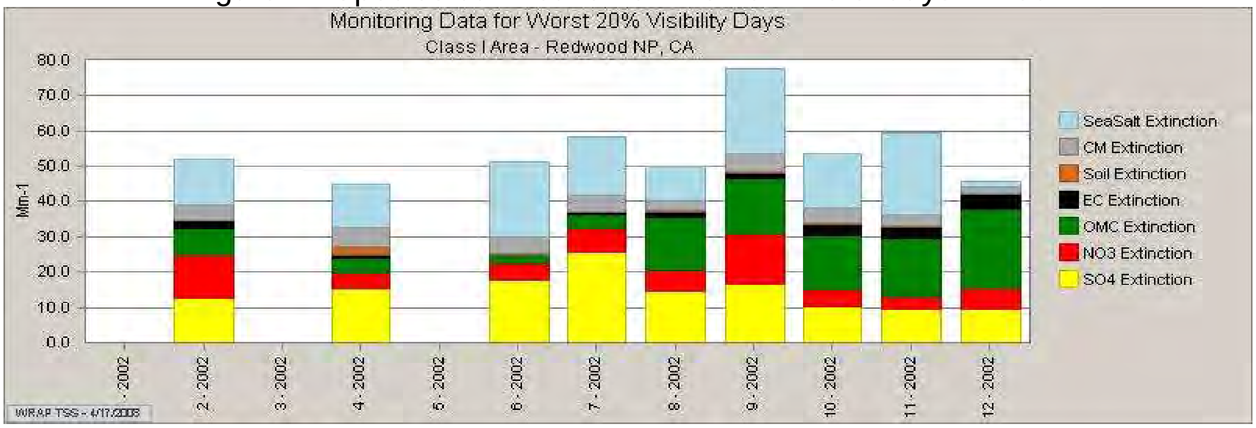
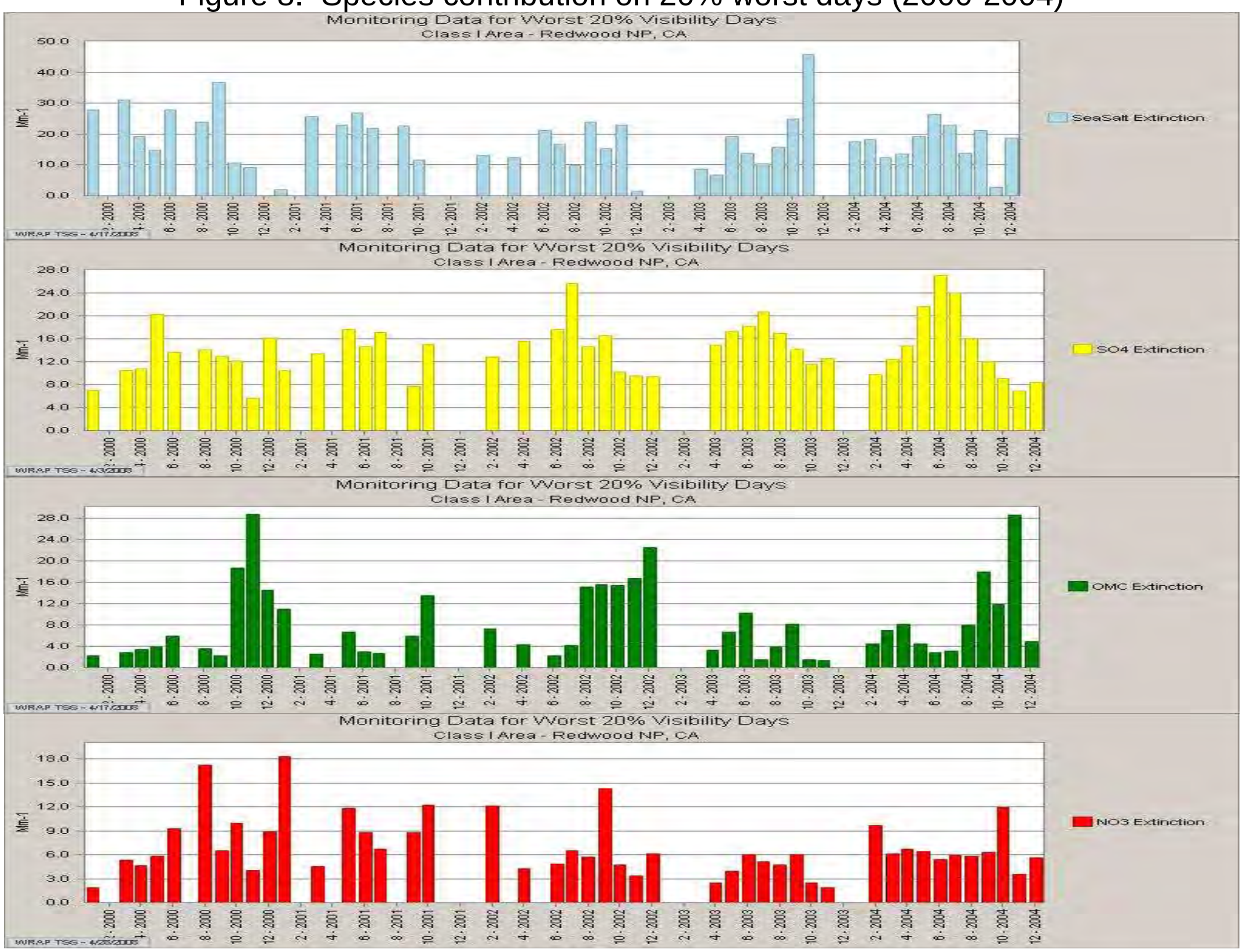


Figure 8. Species contribution on 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at REDW1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 9 illustrates the glide slope for the 20% worst visibility days at the REDW1 monitor. Sea salt are the only emissions that actually increase by 2064. This is because as anthropogenic emissions are removed, sea salt will play a larger role in contributing to the haze seen at the REDW1 monitor.

Figures 10 and 11 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at REDW1. The Outside Domain region represents 51% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (23%) and the WRAP Region (23%). California contributes 1% of the total sulfate emissions seen at the REDW1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the REDW1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the REDW1 monitor is from natural fire sources within Oregon. Oregon represents 95% of all natural fire source contributions.

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 52% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 46% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to nitrate on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (50%), followed by the Pacific Offshore Region (28%) and emissions from outside the modeling domain (20%). In 2002, 8% of the nitrate at the REDW1 monitor can be attributed to California.

From the WRAP region, Oregon is shown to contribute the most to nitrate concentrations at the REDW1 monitor in 2002 and 2018. Currently, Oregon mobile sources are 75% of Oregon contributions to nitrate at the REDW1 monitor. Oregon mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 9. REDW1 Glide slope for 20% worst visibility days

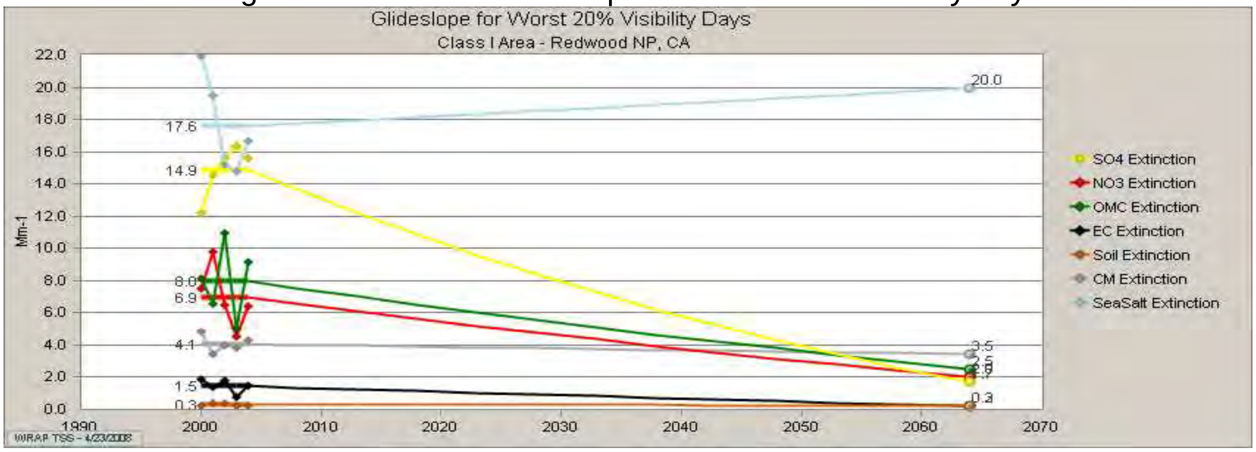


Figure 10. Regional Sulfate contribution to haze in 2002 and 2018

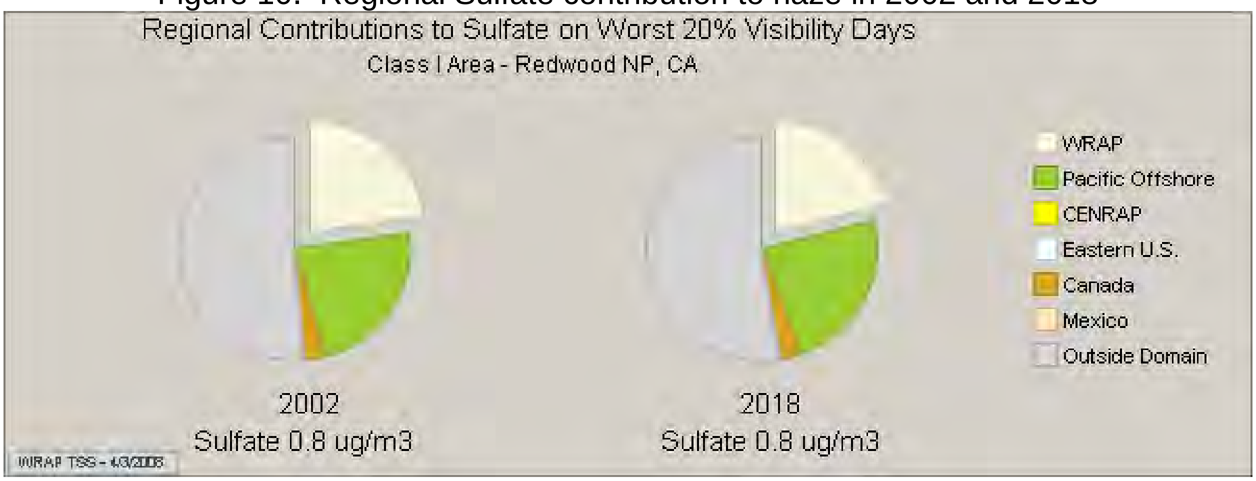


Figure 11. Sulfate source contribution from CA and outside regions

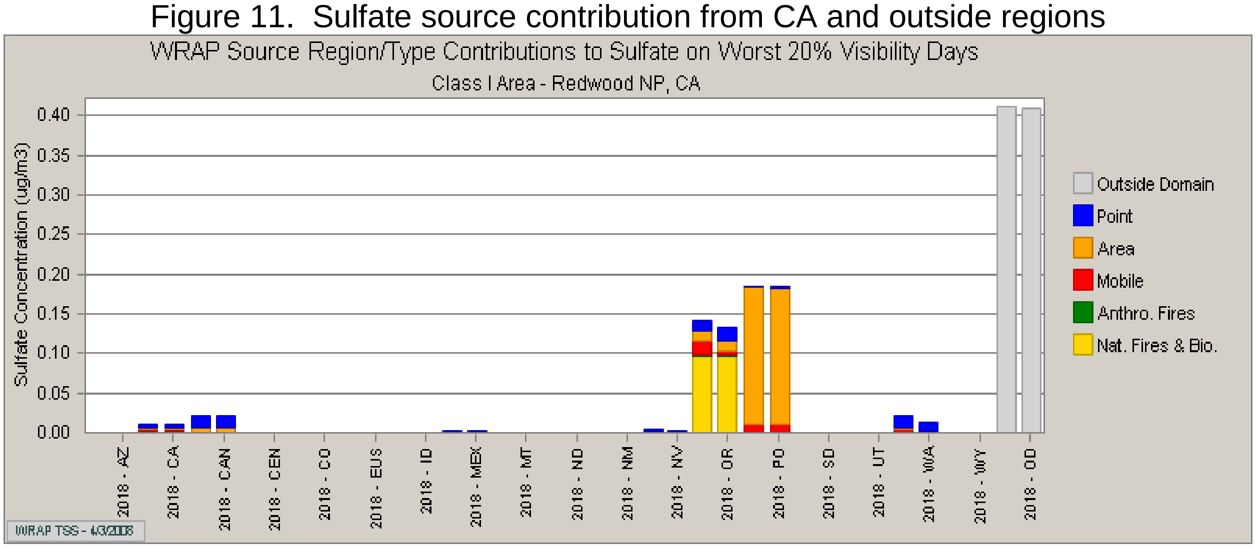


Figure 12. Organic carbon source contribution from CA and outside regions

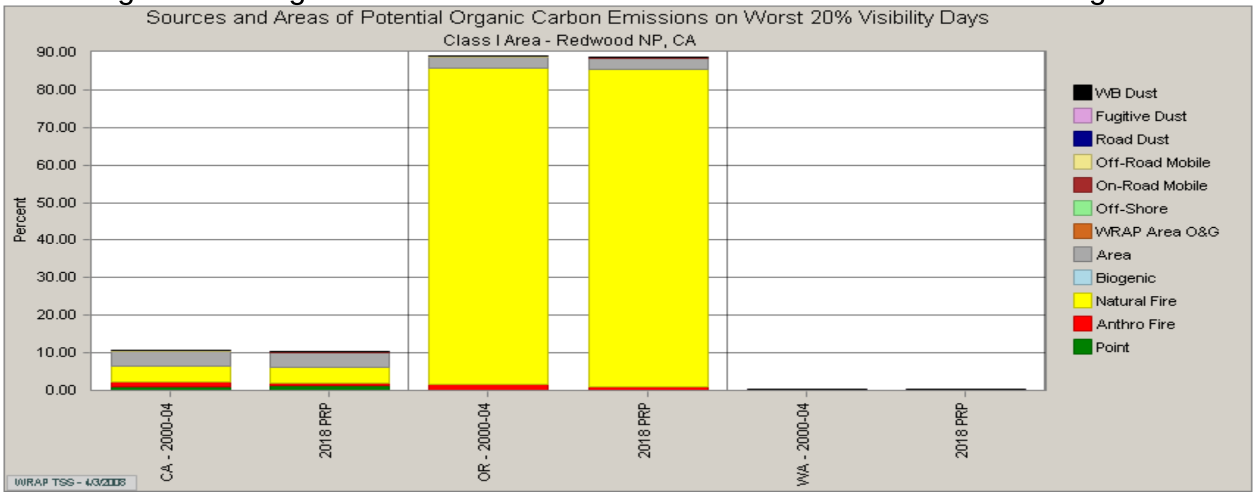


Figure 13. Organic carbon Anthropogenic and Biogenic source apportionment

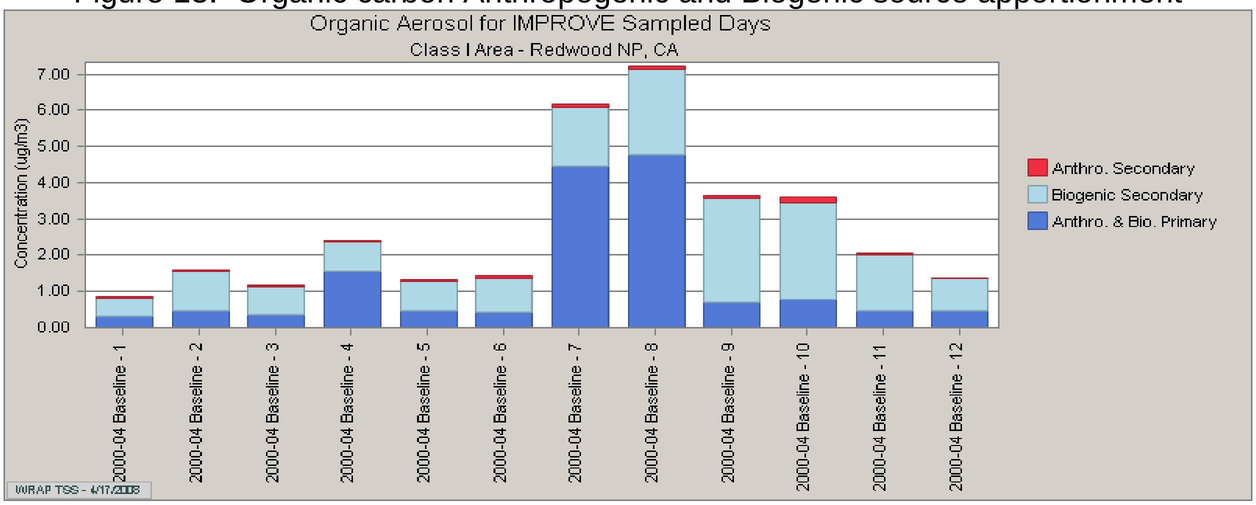


Figure 14. Regional Nitrate contribution to haze in 2002 and 2018

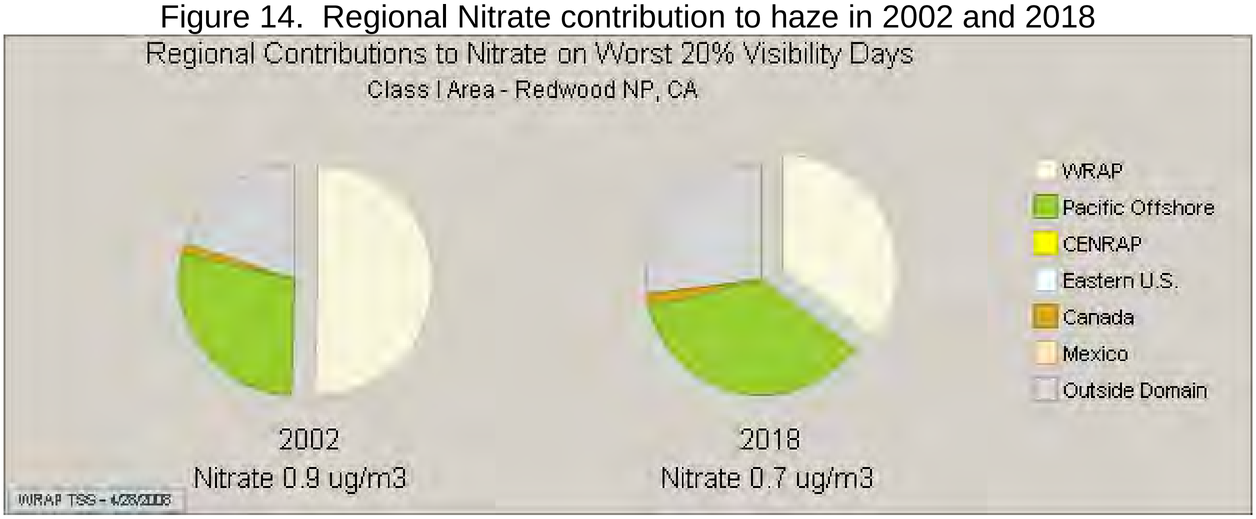
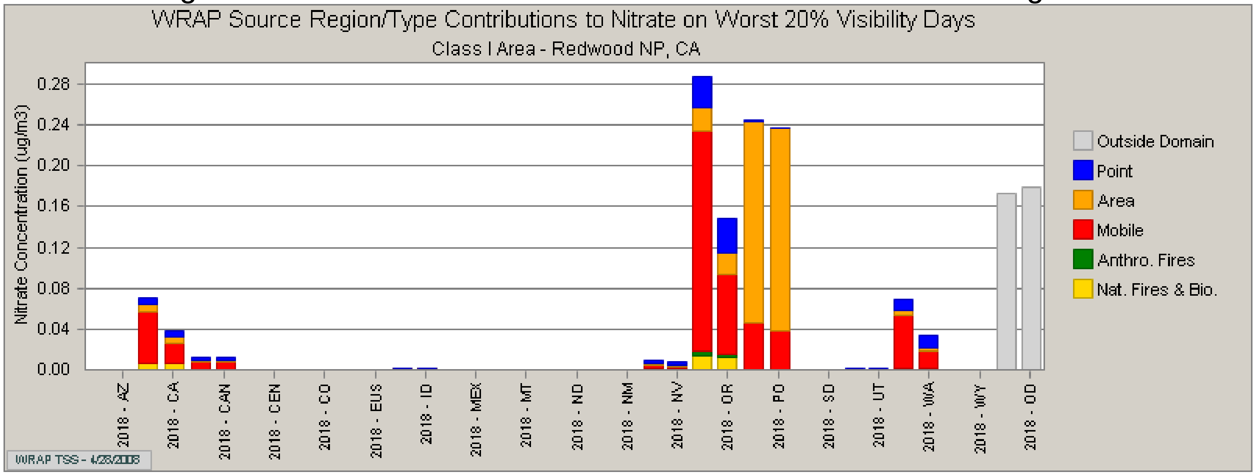


Figure 15. Nitrate source contribution from CA and outside regions



PORE1 Monitor

Section I. Description

Point Reyes Wilderness Area (Point Reyes) occupies 25,370 acres within the Point Reyes National Seashore situated just north of San Francisco. Point Reyes National Seashore is a peninsula that extends into the Pacific Ocean about 12 miles from the California mainland. The Wilderness consists primarily of the complex terrain section of the peninsula east of and parallel to Highway 1, with elevations ranging from sea level to nearly 427 meters at highest hilltops. The land is composed of estuaries, windswept beaches, coastal scrub grasslands, marshes, and some coniferous forest at higher elevations.

Figure 1. PORE1 Monitor location

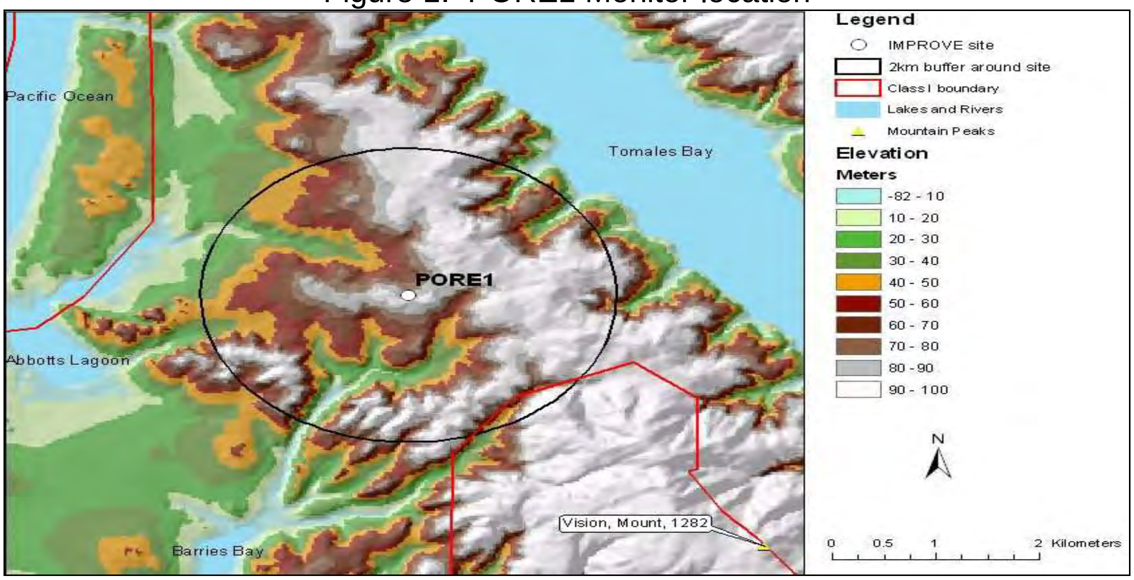


Figure 2. WINHAZE image of Point Reyes Wilderness Area (10.5 vs. 22.8 dv)

Figure 3. PORE Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for Point Reyes are currently monitored by the PORE1 IMPROVE monitor. The monitor is located at 38.1224 north latitude and 122.9085 west longitude, and located in the center of three distinct areas of the wilderness at an elevation of 97 meters. The site has been operating since March 1988. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2001 and 2003.

The PORE1 IMPROVE site is located centrally within the small range of Wilderness elevations. It is very representative of aerosol composition and concentration at Point Reyes Wilderness locations. The nearest major population and industrial center is the San Francisco Bay area to which Point Reyes is almost adjacent but separated from by the Marin Peninsula north of the Golden Gate. Downtown San Francisco is about 20 miles to the south. North Bay communities of Petaluma and San Rafael are about 15 miles east, on the east side of the Bolinas Ridge.

The PORE1 location is adequate for assessing the 2018 reasonable progress goals for the Point Reyes Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from PORE1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Point Reyes Wilderness Area is calculated at 10.5 deciviews for the 20% best days and 22.8 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

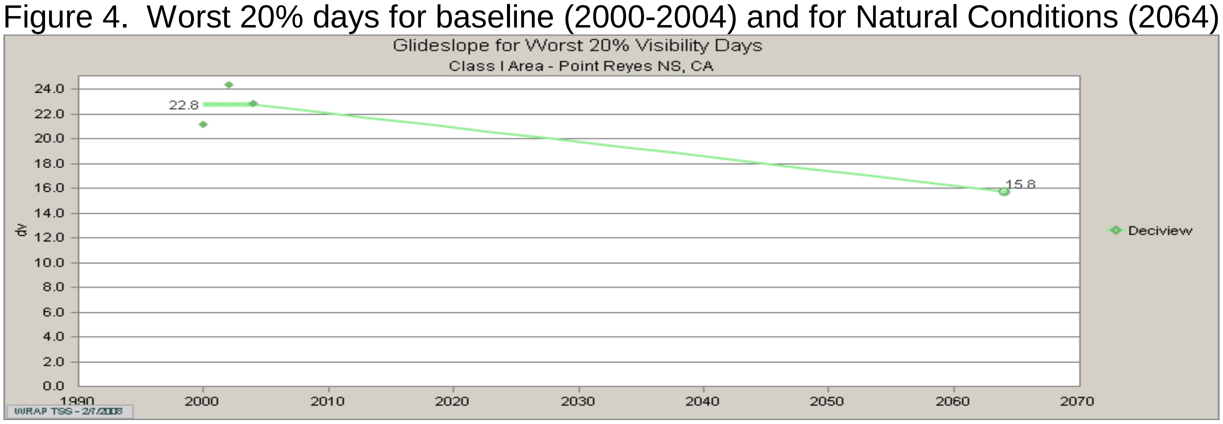
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Point Reyes Wilderness Area is 4.8 deciviews for the 20% best days and 15.8 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 21.17 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 10.5 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at PORE1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

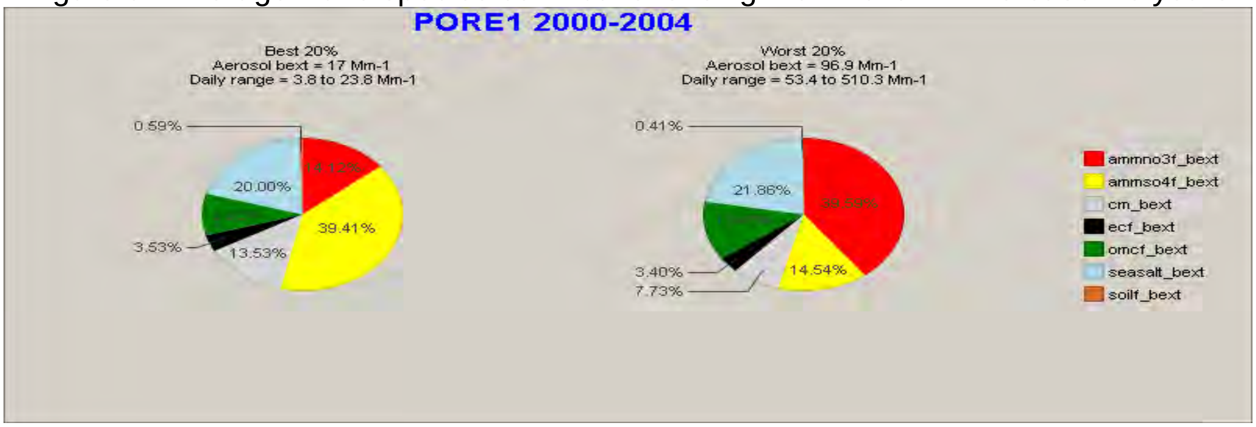
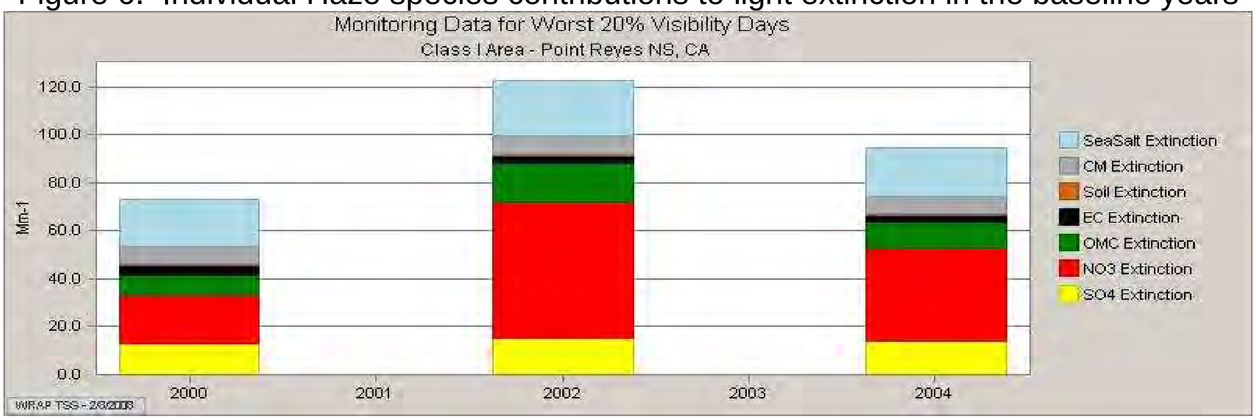


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, nitrates, sea salt, and sulfates have the strongest contributions to degrading visibility on worst days at Point Reyes Wilderness Area. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2001 and 2003 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter months and sea salt is always present but peaks in the months of March-June. The worst days occur when sea salt is elevated. Sulfates are slightly higher in the summer and they almost double from best to worst days. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sea salt is driving the worst days for most of the year in 2002. Nitrates clearly dominate the other haze species on worst days, but sea salt, sulfate, and organic matter also contribute to the worst days in the summer. There are only trace amounts of coarse mass and elemental carbon present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sea salt, nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires. For example, the elevated organic carbon concentrations in August 2002 can be attributed to the Biscuit Fire that burned extensive acreage in Southern Oregon and Northern California.

Figure 7. Species contribution on the 20% worst days in 2002

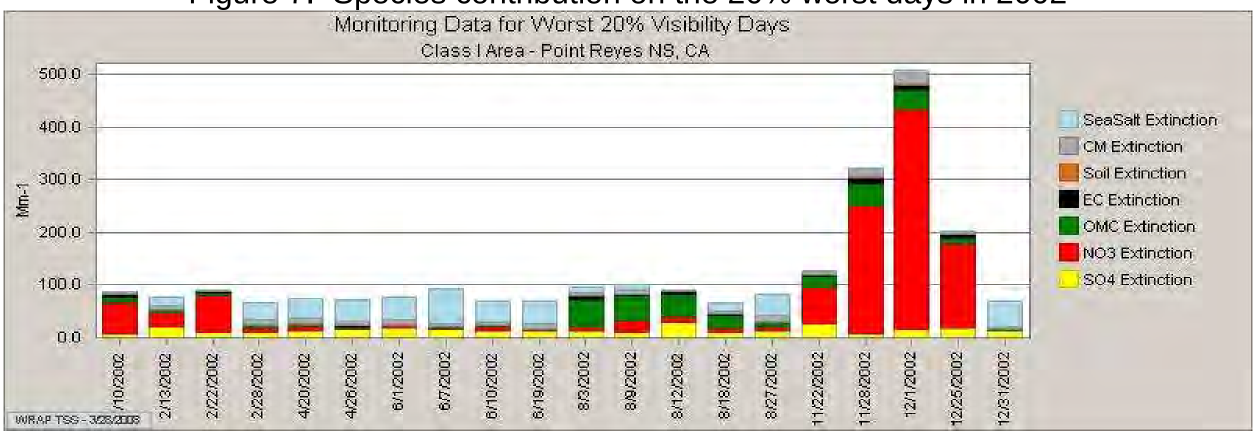
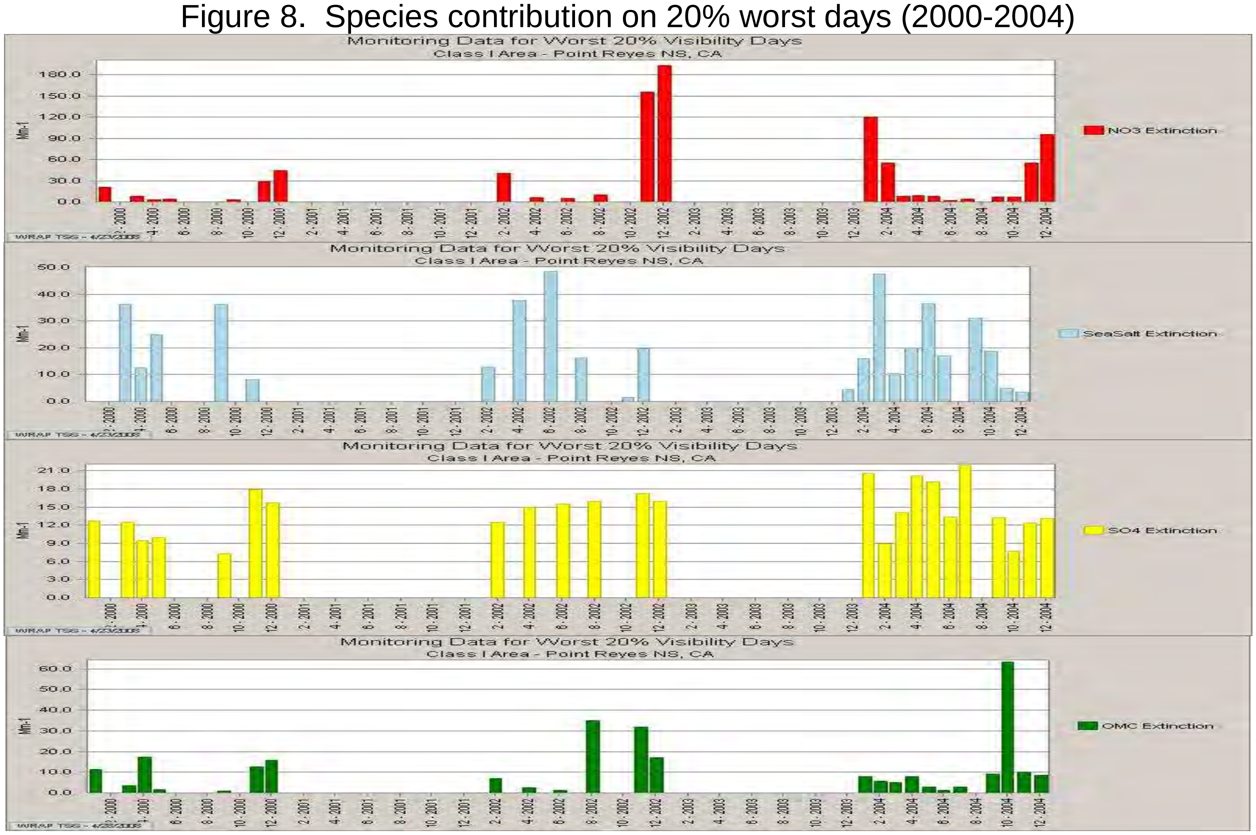


Figure 8. Species contribution on 20% worst days (2000-2004)



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II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at PORE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrate on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (85%), followed by the Pacific Offshore Region (9%) and emissions from outside the modeling domain (6%). In 2002, 76% of the nitrate at the PORE monitor can be attributed to California.

From the WRAP region, California is shown to contribute the most to nitrate concentrations at the PORE monitor in 2002 and 2018. Currently, California mobile sources are 75% of California contributions to nitrate at the PORE monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11 illustrates the 20% worst visibility days at the PORE1 monitor. Sea salt emissions are the only source that actually increases in 2064. This is because as anthropogenic emissions are removed, sea salt will play a larger role in contributing to the haze seen at the PORE1 monitor.

Figures 12 and 13 represent the regional contributions of sulfate on the 20% worst days in 2002 and 2018 at PORE. The WRAP region represents 38% of the sulfate contributions in 2002 and 2018, followed by the emissions from outside the domain (35%) and the Pacific Offshore Region (23%). California contributes 17% of the total sulfate emissions seen at the PORE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the PORE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figure 14 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the PORE1 monitor is from area sources within California. California represents 92% of all area source contributions.

Figure 15 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 57% of the total organic carbon. Biogenic secondary emissions account for 39% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figure 9. Regional Nitrate Contribution to Haze in 2002 and 2018

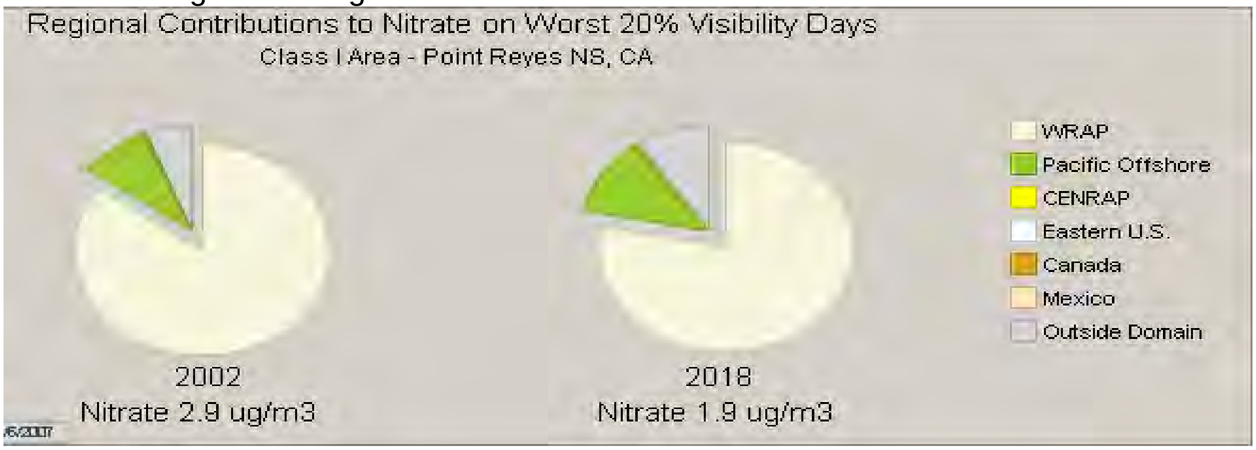


Figure 10. Nitrate source contribution from CA and outside regions

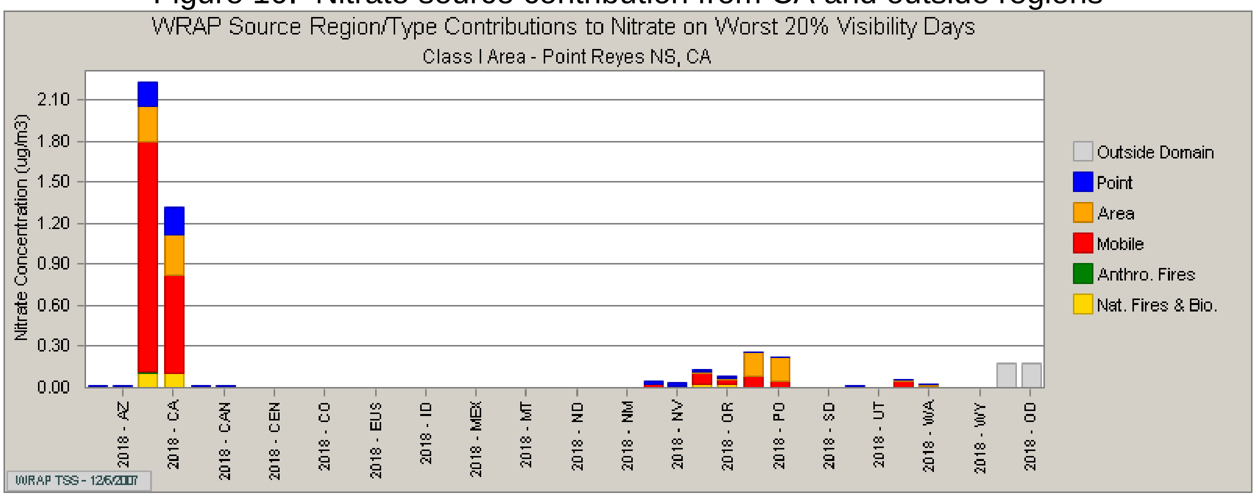


Figure 11. PORE1 glide slope for the 20% worst visibility days

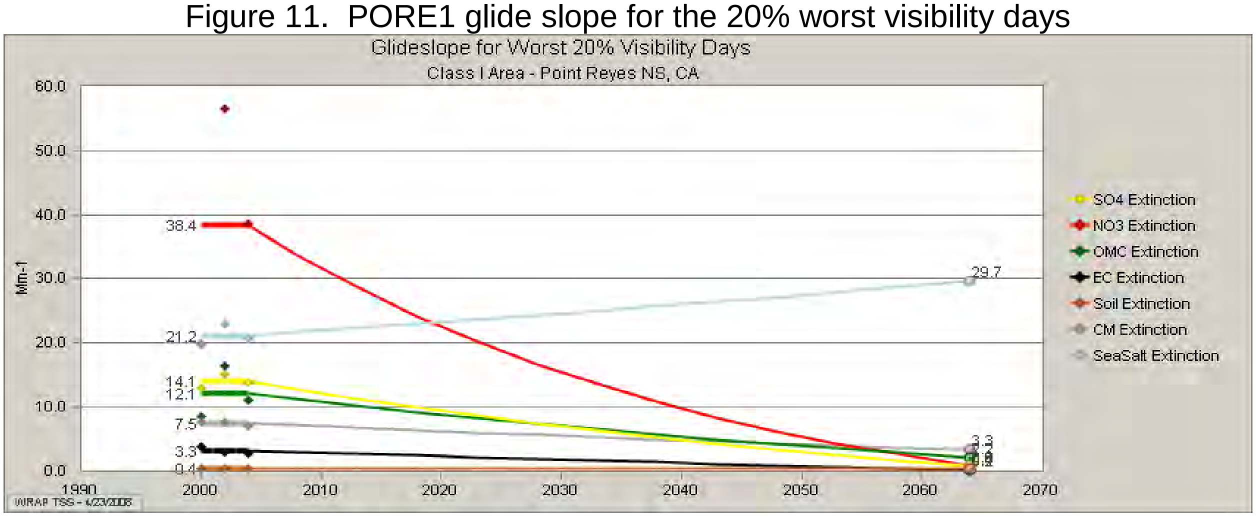


Figure 12. Regional Sulfate Contribution to Haze in 2002 and 2018

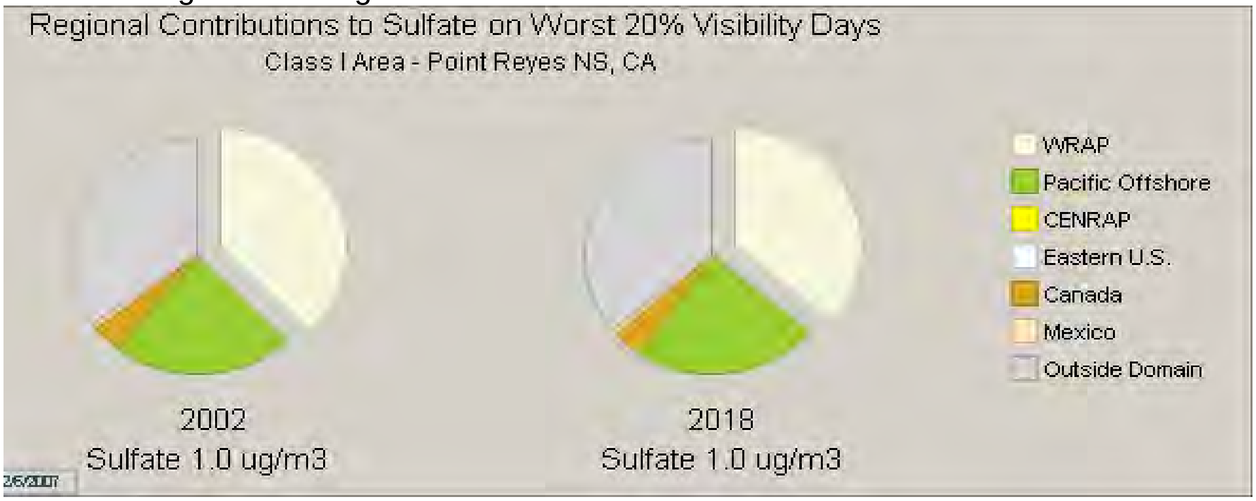


Figure 13. Sulfate source contribution from CA and outside regions

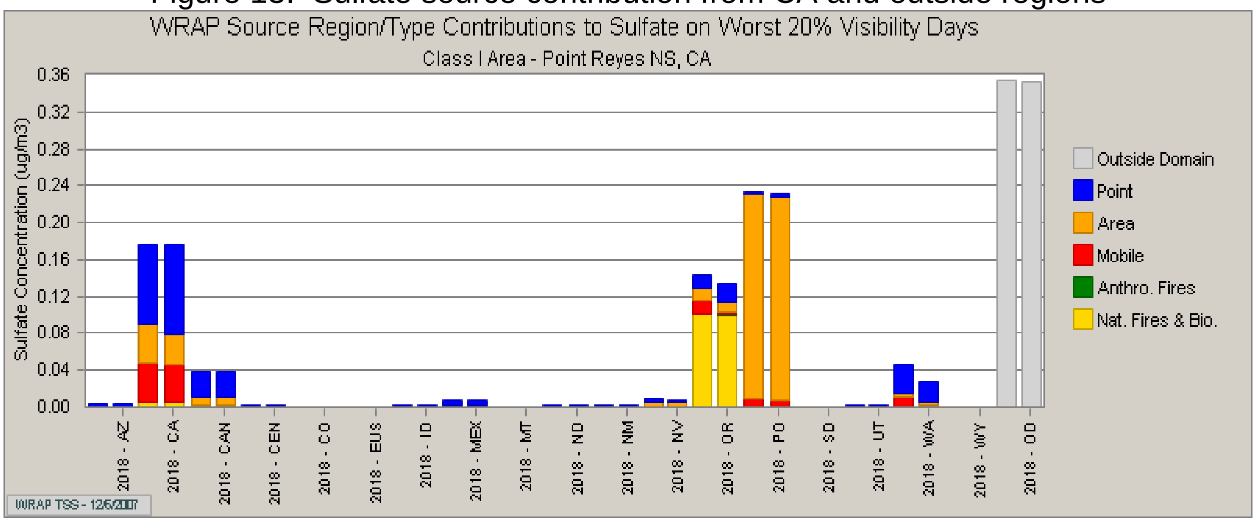


Figure 14. Organic carbon source contribution from CA and outside regions

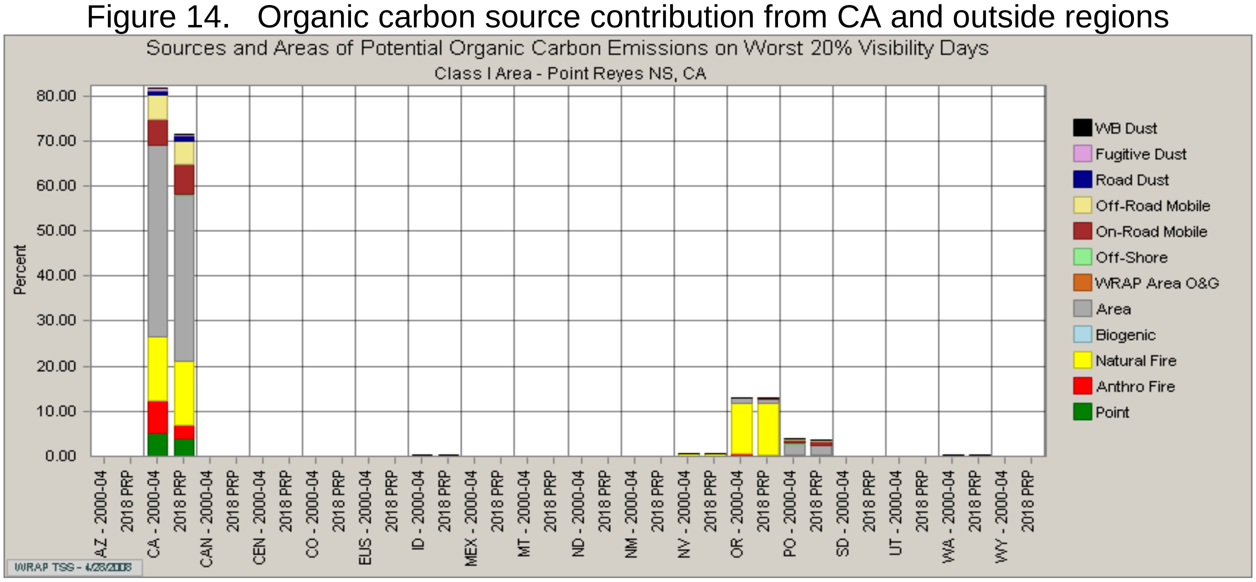
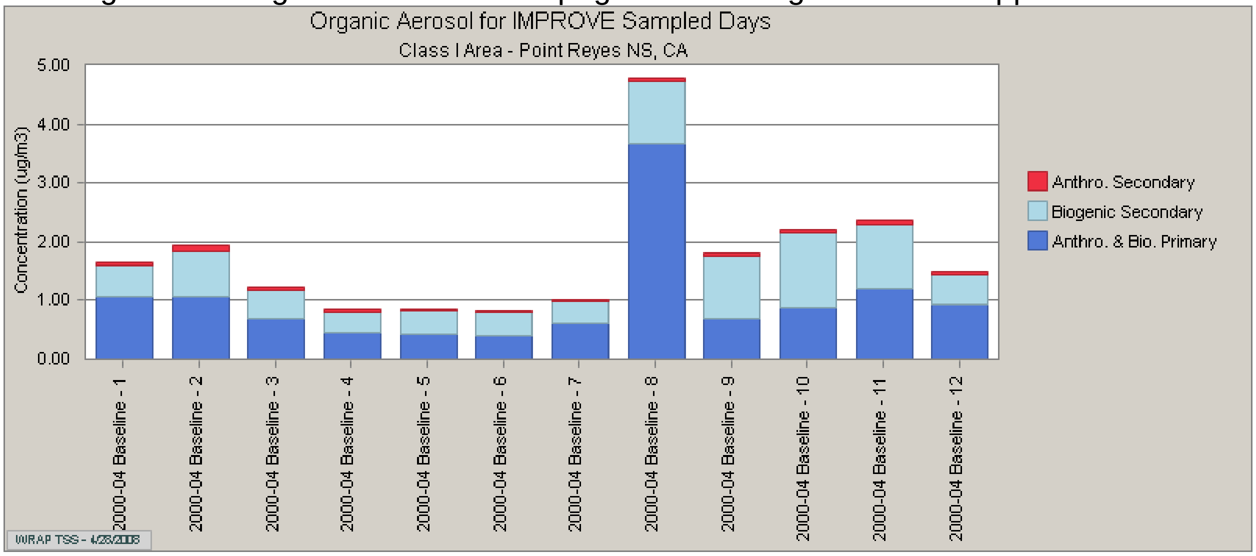


Figure 15. Organic carbon Anthropogenic and Biogenic source apportionment



PINN1 Monitor

The PINN1 monitor location represents two wilderness areas located near the Central Coast Range in California. The wilderness areas associated with the PINN1 monitor are Pinnacles National Monument and Ventana Wilderness area. The PINN1 site has been operating since March 1988. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2001.

Section I. PINN1 Wilderness Area Descriptions

I.a. Pinnacles Wilderness Area

The Pinnacles Wilderness Area (Pinnacles) comprises 12,952 acres within the Pinnacles National Monument. Pinnacles is located in the southern portion of the Gabilan Mountains, one of a series of parallel northwest-southeast ridges that make up the Central Coast Range. Within the Wilderness Area, elevations range from 251 meters along South Chalone Creek to 1007 meters at North Chalone Peak. Much of the terrain is rolling hills. It is about 40 miles inland from the Pacific Ocean, with the Santa Lucia Mountains between, which modifies the Ocean's influence. The Gabilan range is bounded on the west by the Salinas Valley which provides a conduit to the Pacific coast near Monterey, 40 miles east. It is bounded on the east by the San Benito Valley which is the southern extension of the Santa Clara valley at the southern end of the San Francisco Bay area 60 miles to the north.

Figure 1. PINN1 Monitor location

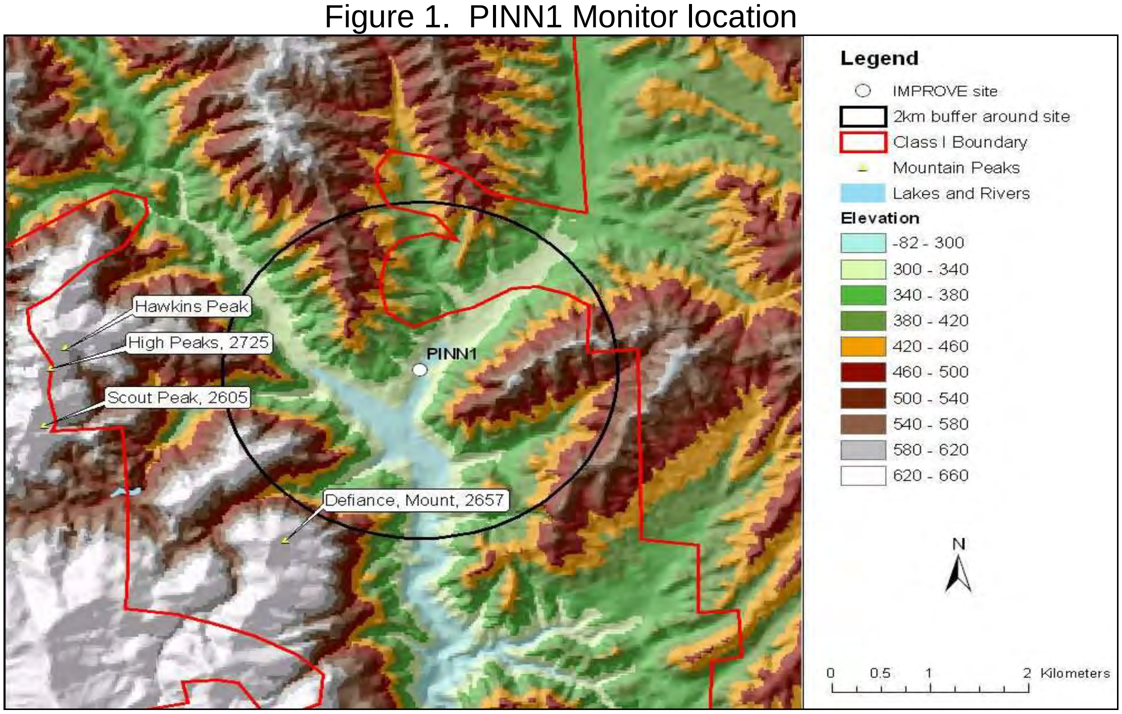
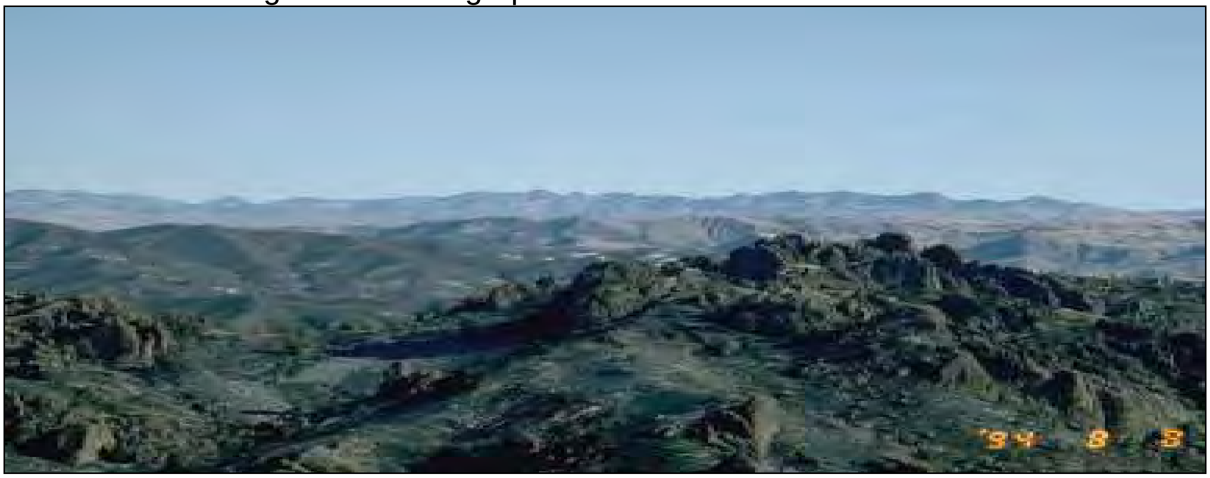


Figure 2. Photograph of Pinnacles Wilderness Area



I.b. Ventana Wilderness Area

The Ventana Wilderness Area (Ventana) consists of 95,152 acres straddling the Santa Lucia Mountains, about 15 miles south of Monterey Bay. The terrain is comprised of steep ridges and peaks. The Wilderness is in two sections, a large section consisting of most of the northwest Santa Lucias, and a smaller section to the southeast that includes Juniper Serra Peak. Elevations range from 183 meters where the Big Sur River exits the Wilderness on the west side, to 1,787 meters at the crest of Junipero Serra Peak, the highest point in the Santa Lucia range. The Santa Lucia range is the first barrier to westerly winds and presents a rain shadow over inland areas. Annual precipitation on the coast side totals up to 75 inches, mostly in the winter, with as little as 25 inches a few miles inland. Summertime fog can cover lower elevations on the west side, but seldom reaches more than a few miles inland. Ventana Wilderness and the Santa Lucia range are bordered on the west side by the Pacific Ocean and on the east side by Carmel Valley, Sierra de Salinas, and the Salinas Valley. Carmel Valley and Salinas Valley both exit into the Monterey Bay area to their northwest. The Santa Lucia range is thus within the maritime influence of the Pacific Ocean on the west and east side.

Figure 3. WINHAZE image of Ventana Wilderness Area (8.9 vs. 18.5 deciviews)

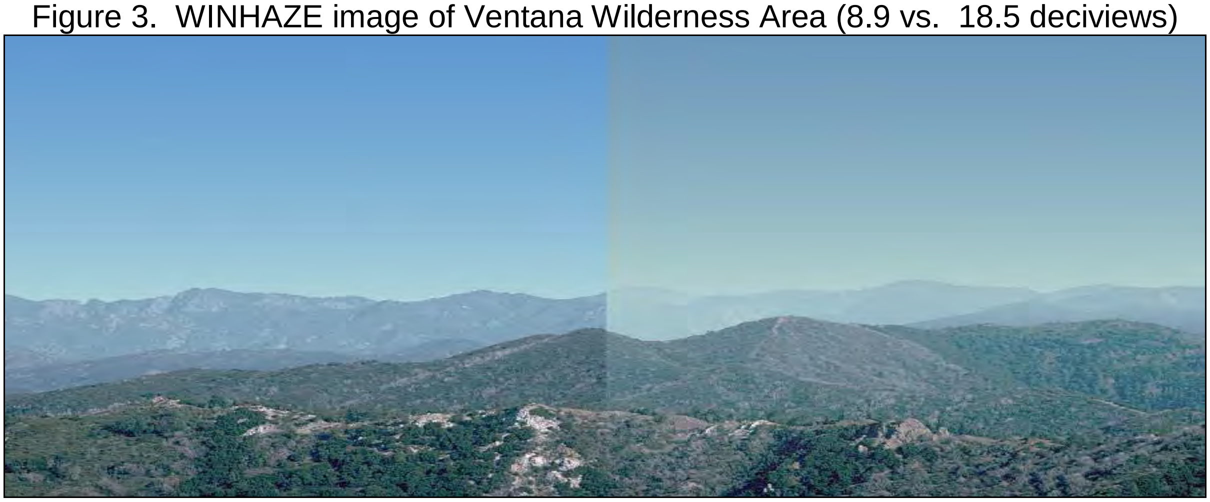


Figure 4. PINN1 Monitor location in California

Section II. Visibility Conditions:

II.a. Pinnacles National Monument

Visibility conditions for Pinnacles are currently monitored by the PINN1 IMPROVE monitor. The monitor is located at 36.4833 north latitude and 121.1568 west longitude in the Chalone Creek drainage near the eastern wilderness boundary at an elevation of 302 meters. This is very near the lower end of the Pinnacles Wilderness elevations and approximately 609 meters lower than the highest Wilderness elevation.

The PINN1 IMPROVE site is representative of Pinnacles locations in general, although it is in the Chalone Creek drainage at a relatively low elevation with respect to most of the Wilderness.

The monitor may be isolated from higher elevations if a summertime inversion exists, or by being within a low-level wintertime inversion. These are probably relatively infrequent conditions, given the modest range of Wilderness elevations that extend about 762 meters vertically. The Pinnacles Wilderness is potentially influenced by three California source regions: the San Francisco Bay area, the San Joaquin Valley, and the Monterey Bay area. Aerosol concentrations in Pinnacles may be most closely linked to Bay Area emissions during episodic conditions that lead to aerosol accumulations.

The PINN1 location is adequate for assessing the 2018 reasonable progress goals for the Pinnacles Wilderness Class 1 area.

II.b. Ventana Wilderness Area

Visibility conditions for Ventana are currently monitored by the PINN1 IMPROVE monitor on the eastern side of the Pinnacles Wilderness Area. The monitor is located at 36.4833 north latitude and 121.1568 west longitude, about 30 miles to the east of Ventana Wilderness, across the Salinas Valley, at an elevation of 302 meters.

PINN1 is likely much more influenced by the San Francisco Bay and San Joaquin Valley source regions, and less influenced by the Pacific Ocean. Its representation of the Ventana Wilderness may thus be marginal, and aerosol concentrations in the Ventana Wilderness are probably much less than indicated by measurements at PINN1. The nearest population center to the Ventana Wilderness Area is the Monterey Bay area. There may also be some impact from the Bay Area with transport southward via interior Santa Clara and Santa Bonita valleys, although emissions from those areas are likely pushed further east towards the Galiban Range and Pinnacles Wilderness area.

The PINN1 location is adequate for assessing the 2018 reasonable progress goals for the Ventana Wilderness Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from PINN1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the PINN1 monitor is calculated at 8.9 deciviews for the 20% best days and 18.5 deciviews for the 20% worst days. Figure 5 represents the worst baseline visibility conditions.

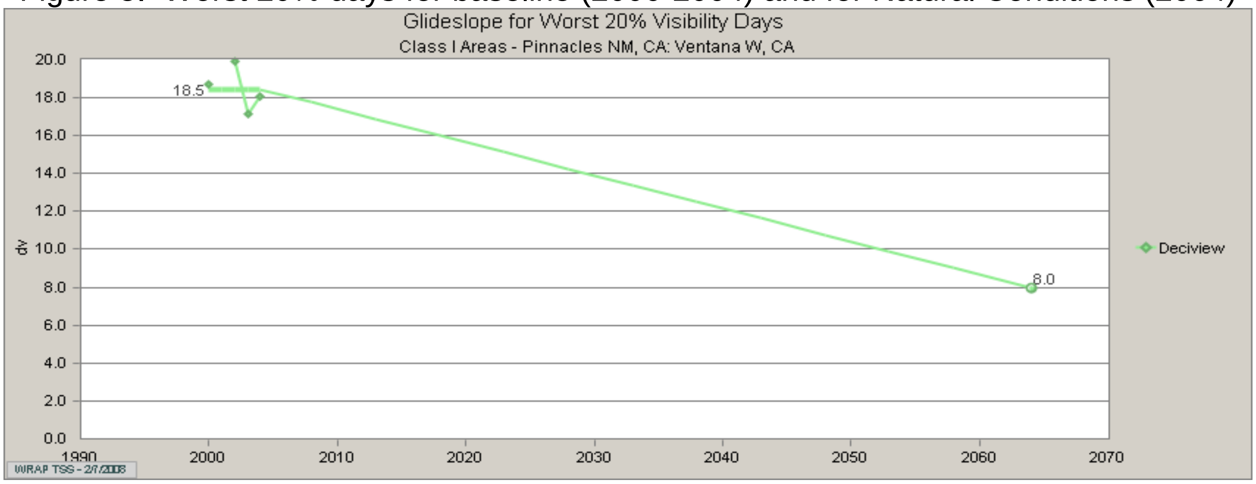
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the PINN1 monitor is 3.5 deciviews for the 20% best days and 8.0 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 5 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.02 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 8.9 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 5. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 6 shows the contribution of each species to the 20% best and worst days in the baseline years at PINN1.

Figure 6. Average Haze species contributions to light extinction in the baseline years

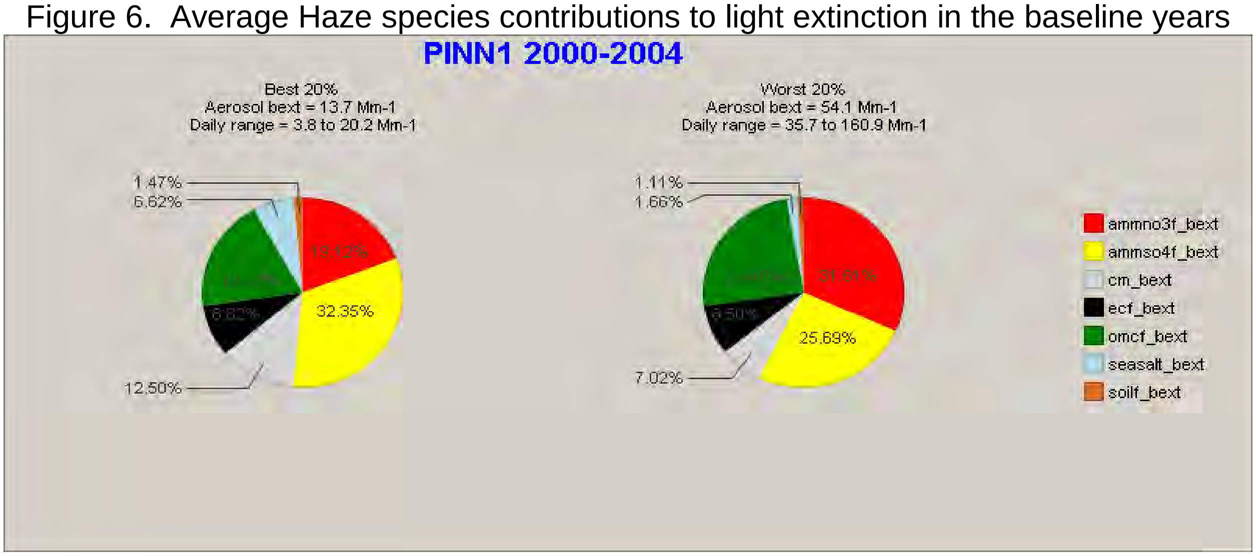
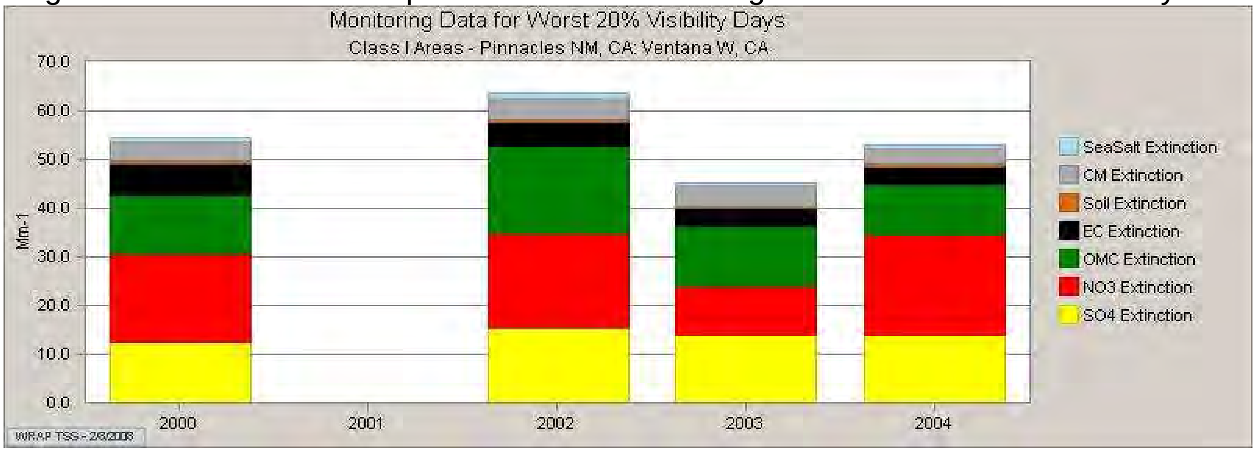


Figure 7. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 6 and 7, nitrates, sulfates, and organic matter have the strongest contributions to degrading visibility on worst days at the PINN1 monitor. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 8 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter time while sulfates increase slightly in the spring and summer time. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Nitrates clearly dominate the other haze species on worst days, but sulfates, organic matter, coarse mass, elemental carbon, and sea salt also contribute to the worst days. There are only trace amounts of sea salt and soil present throughout the years.

Figure 9 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 8 for nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 8. Species contribution on the 20% worst days in 2002

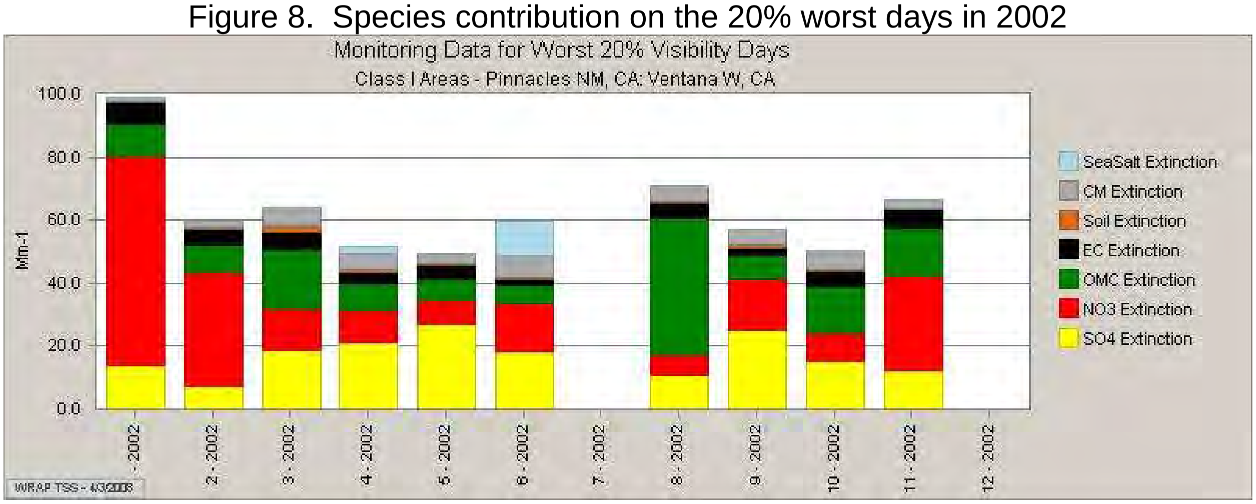
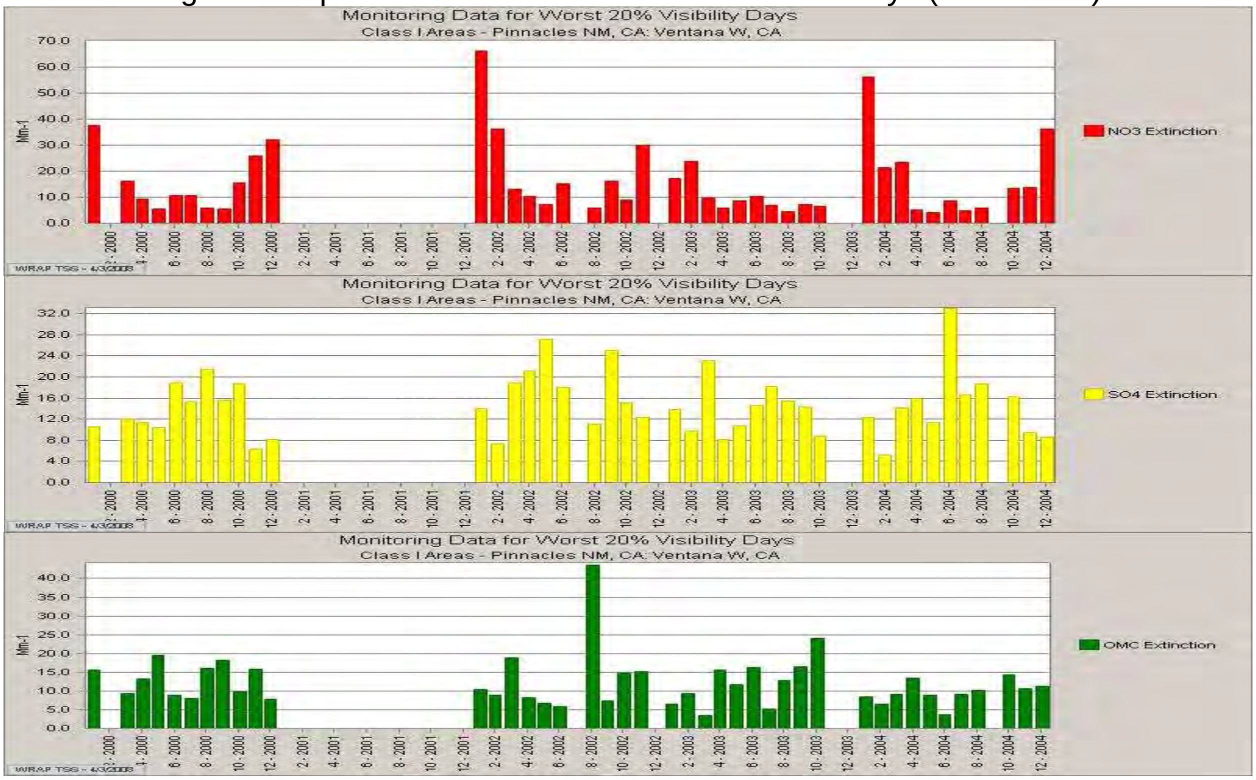


Figure 9. Species contribution on the 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at PINN1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 10 and 11 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (85%), followed by the Pacific Offshore Region (9%) and emissions from Outside Domain (5%). Mobile sources within California contribute the most nitrate at the PINN1 monitor. In 2002, 90% of the nitrate from mobile sources at the PINN1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 12 and 13 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at PINN1. The WRAP region represents 36% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Outside Domain Region (35%) and the Pacific Offshore Region (27%). California contributes 26% of the total sulfate emissions seen at the PINN1 monitor.

Individually, emissions from outside the modeling domain contribute the most sulfate concentrations at the PINN1 monitor. The next largest contributor to sulfate concentration is area sources in the Pacific Offshore Region.

Figure 14 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the PINN1 monitor is from area sources within California. California represents 96% of all area source contributions.

Figure 15 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 63% of the total organic carbon. Biogenic secondary emissions account for 31% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figure 10. Regional Nitrate contribution to Haze in 2002 and 2018

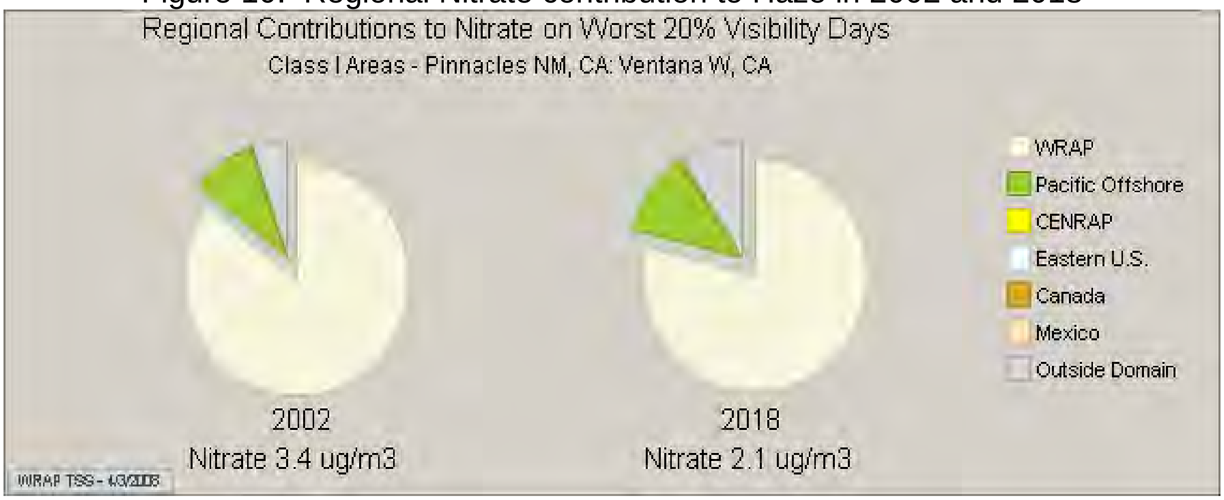


Figure 11. Nitrate source contribution from CA and outside regions

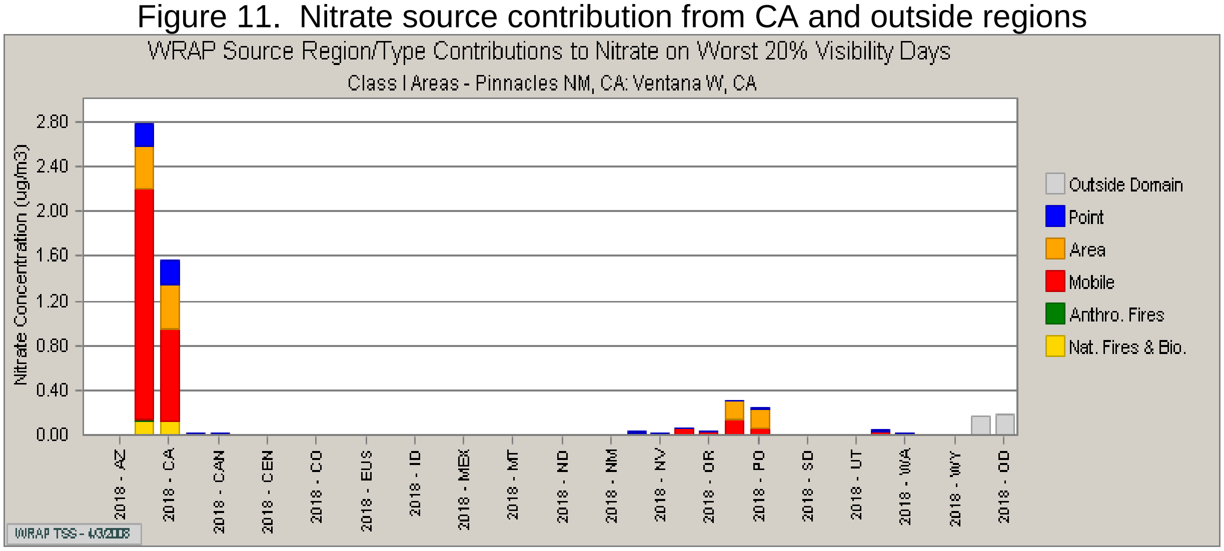


Figure 12. Regional Sulfate contribution to Haze in 2002 and 2018

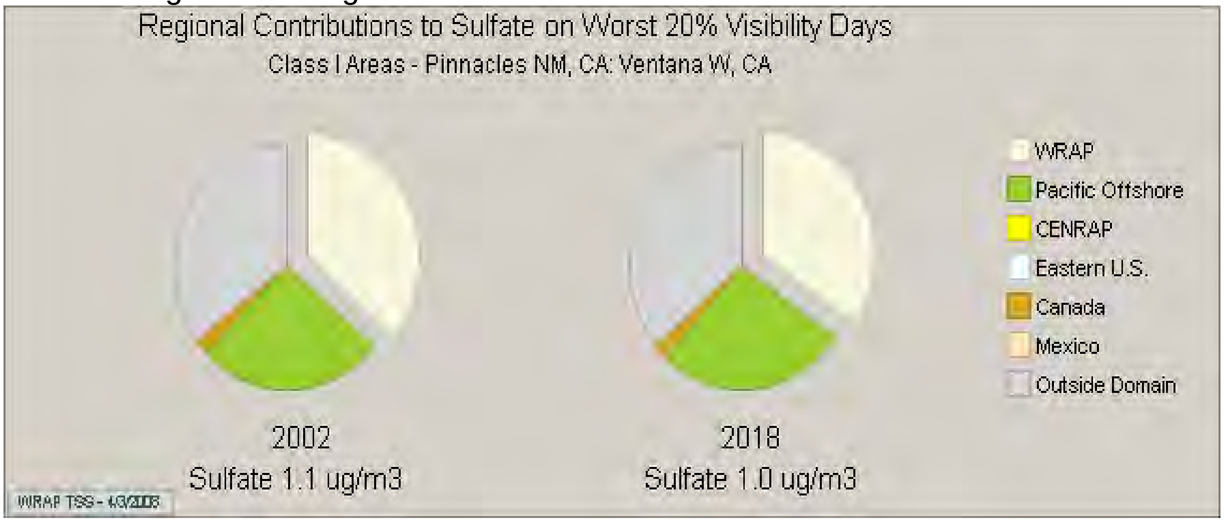


Figure 13. Sulfate source contribution from CA and outside regions

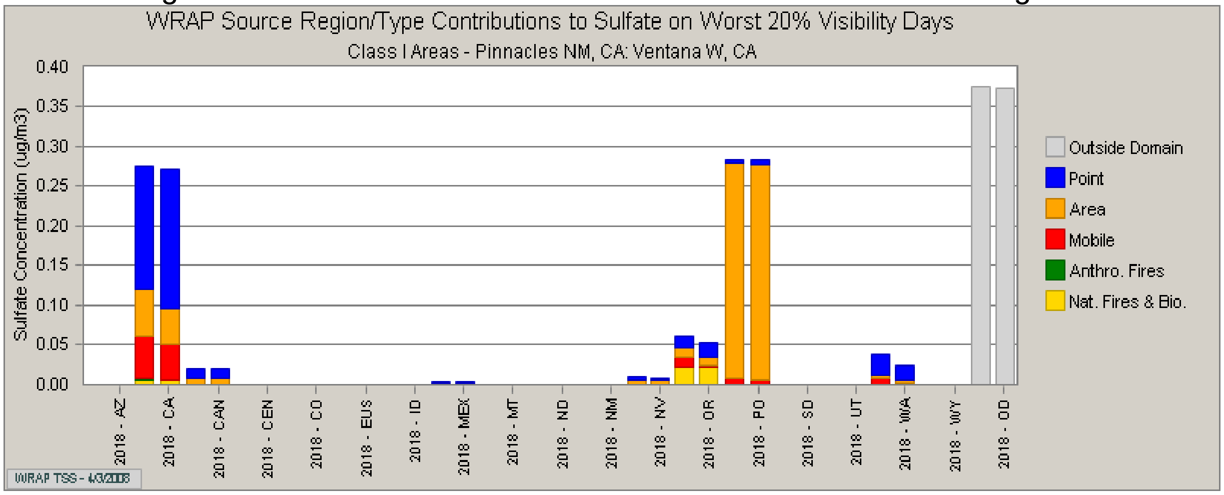


Figure 14. Organic carbon source contribution from CA and outside regions

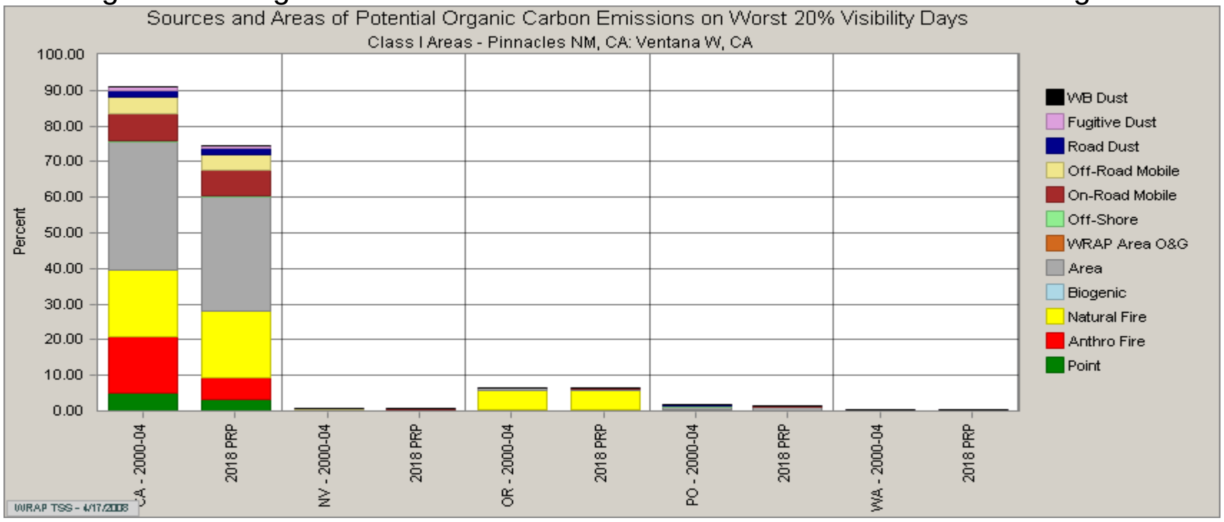
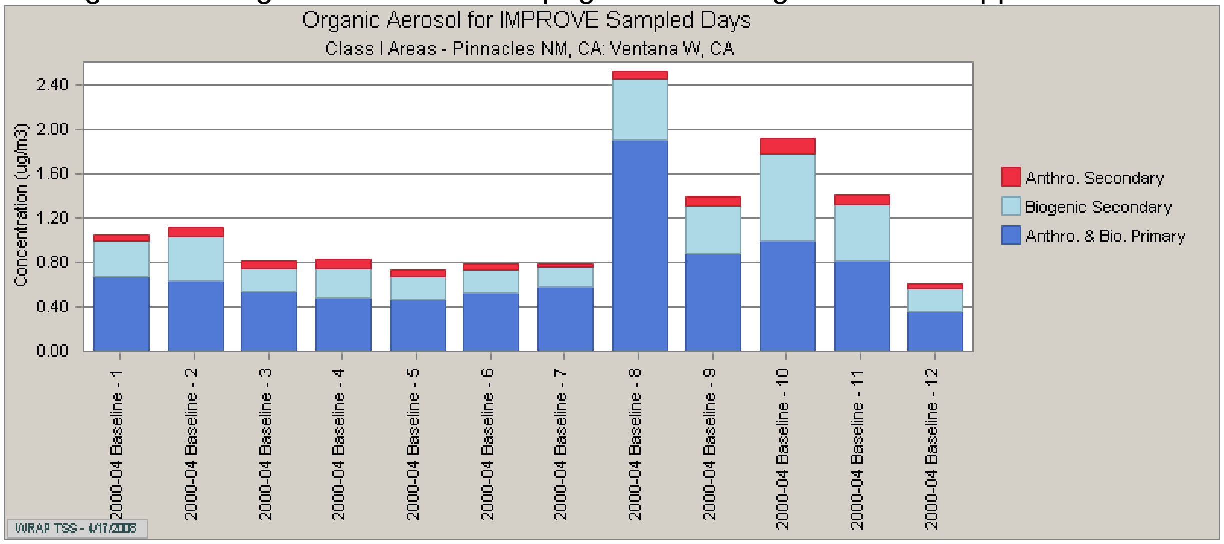


Figure 15. Organic carbon Anthropogenic and Biogenic source apportionment



RAFA1 Monitor

Section I. Description

The San Rafael Wilderness Area (San Rafael) consists of 200,000 acres in the San Rafael and Sierra Madre Mountain Ranges in southern California. It is near the southernmost extent of the Coast Ranges that separate the coast from the Central Valley and deserts of interior California. These east-west ranges form part of the barrier between the southernmost extent of the central valley and the Santa Barbara Coast 20 miles to the south of the southeastern Wilderness boundary. The Sisquoc River flows west towards the Pacific Ocean through the heart of the San Rafael Wilderness from its headwaters near the eastern boundary, between the Sierra Madre range on the north and the San Rafael range on the south. Elevations range from 355 meters near the confluence of the Sisquoc River with Manzana Creek in the west to over 2,073 meters on Big Pine Mountain near the eastern boundary.

Figure 1. RAFA1 Monitor location

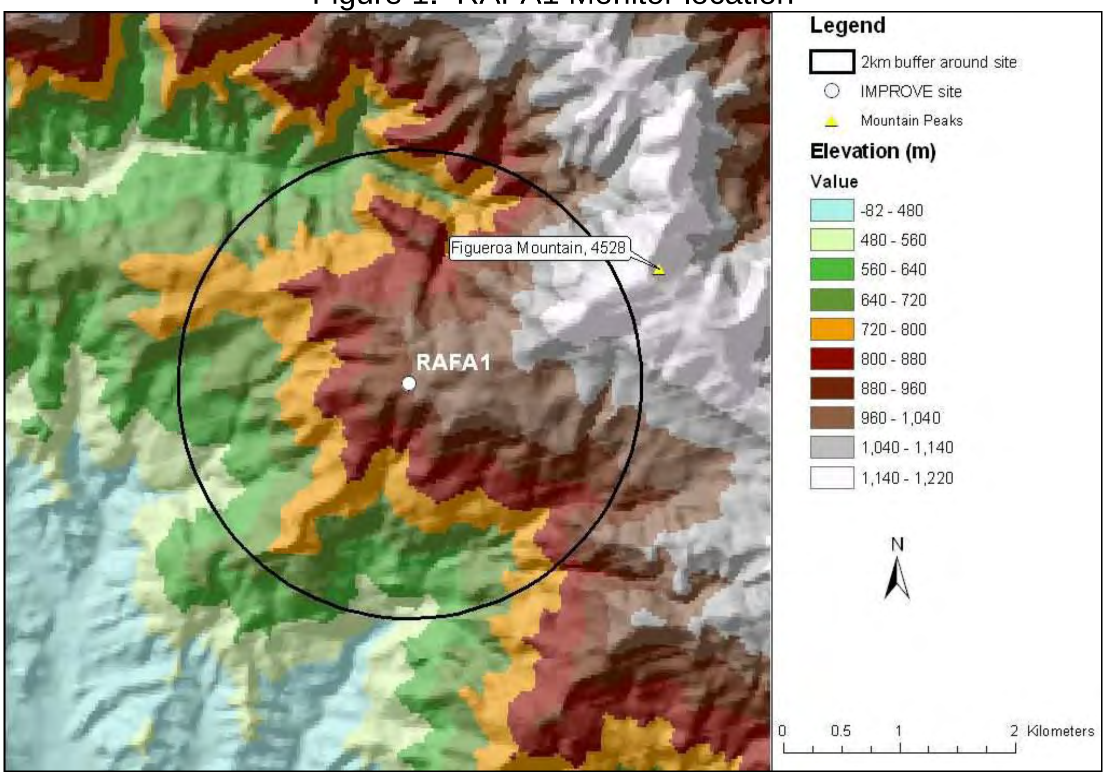


Figure 2. RAFA1 Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for San Rafael are currently monitored by the RAFA1 IMPROVE monitor. The monitor is located at 34.7339 north latitude and 120.0074 west longitude, near the crest of a low ridge outside of the southern wilderness boundary at an elevation of 957 meters. The site has been operating since February 2000. This site has sufficient data for the entire baseline period.

The RAFA1 IMPROVE site should be quite representative of Wilderness conditions in general. It is on a well-exposed ridge location near the southern boundary at an elevation near the midrange of Wilderness elevations. It may be less representative of lower Wilderness elevations along the Sisquoc River valley if a lower level valley inversion exists. The lower Sisquoc River is also subject to occasional onshore flow from the Pacific Ocean, which can bring high humidity and fog, although this may be a relatively infrequent occurrence. The San Rafael Wilderness is centrally located with respect to three areas with potential to impact visibility: the southern Central Valley, coastal areas of Santa Barbara County, and the Los Angeles basin. The southern Central Valley has potential for impacting visibility during Santa Ana conditions, while emissions from the Los Angeles basin may be channeled into the Wilderness via a coastal river valley near Ojai or transported aloft during easterly upper airflow during the winter.

The RAFA1 location is adequate for assessing the 2018 reasonable progress goals for the San Rafael Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from RAFA1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the San Rafael Wilderness Area is calculated at 6.4 deciviews for the 20% best days and 18.8 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the San Rafael Wilderness is 1.8 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 3 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.20 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 3. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

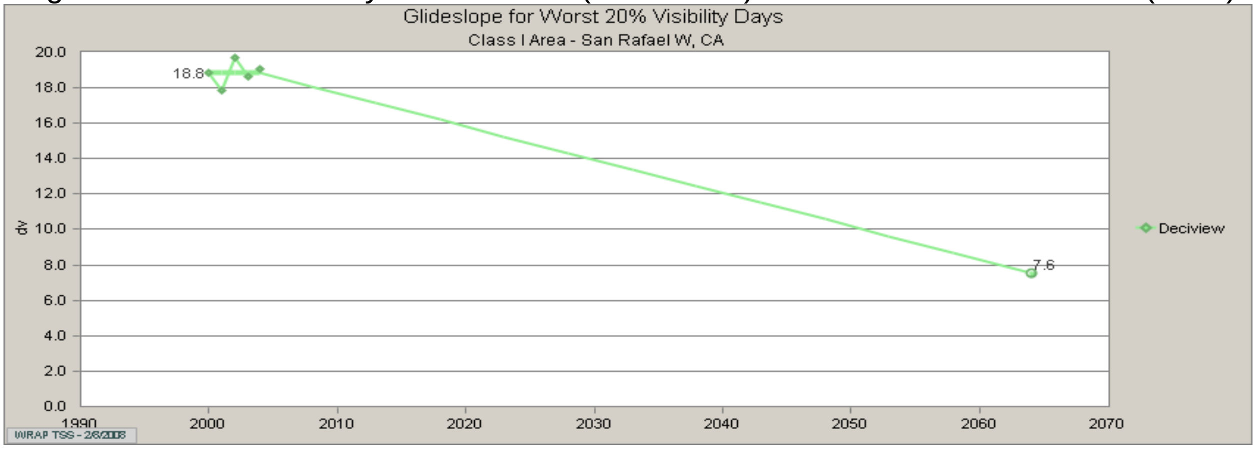
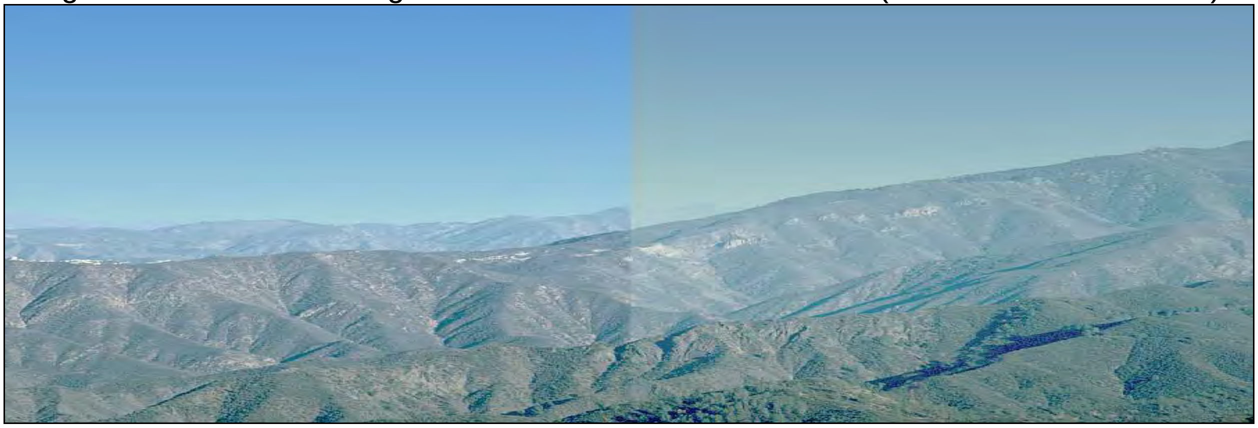


Figure 4. WINHAZE image of San Rafael Wilderness Area (6.4 vs. 18.8 decivewis)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at RAFA1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

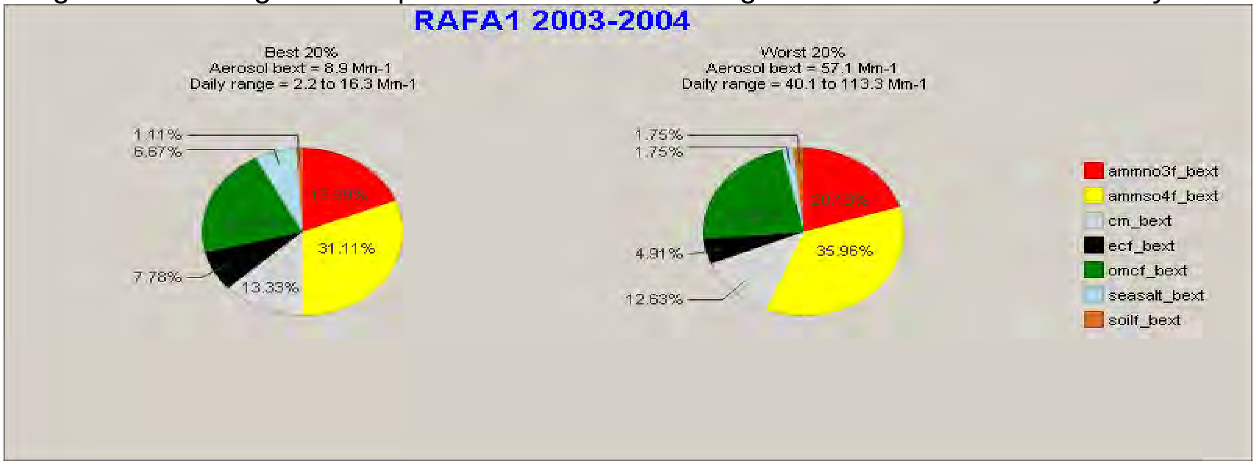
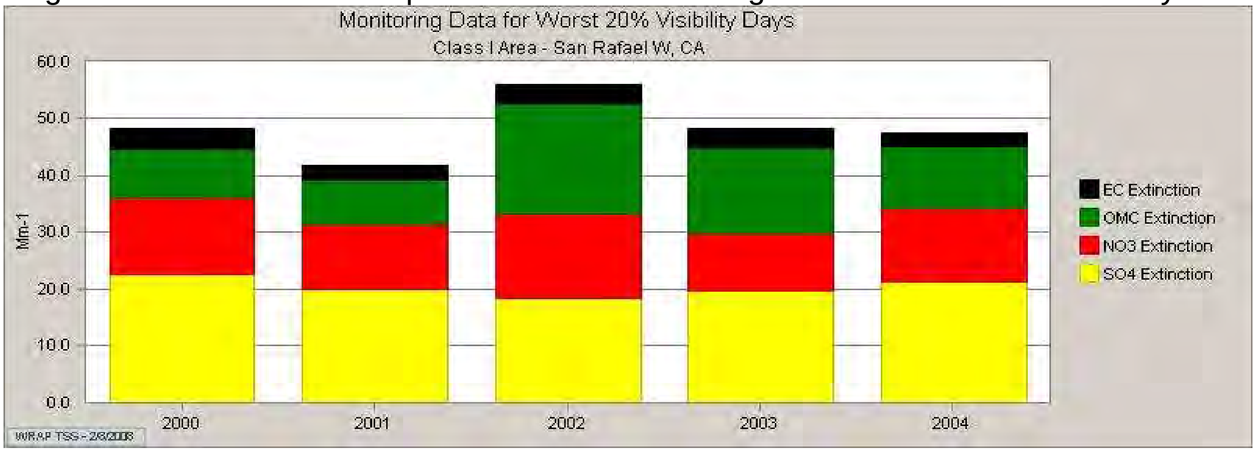


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, sulfates, organic matter, and nitrates have the strongest contributions to degrading visibility on worst days at San Rafael Wilderness Area. Sulfates dominate on both the worst and best days.

Figure 7 depicts the individual species contribution to worst days in 2002. Sulfates are seen to increase in the summer while nitrates increase in the winter months. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sulfates clearly dominate the other haze species on worst days, but organic matter, nitrates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of sea salt and soil present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sulfates, organic matter, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

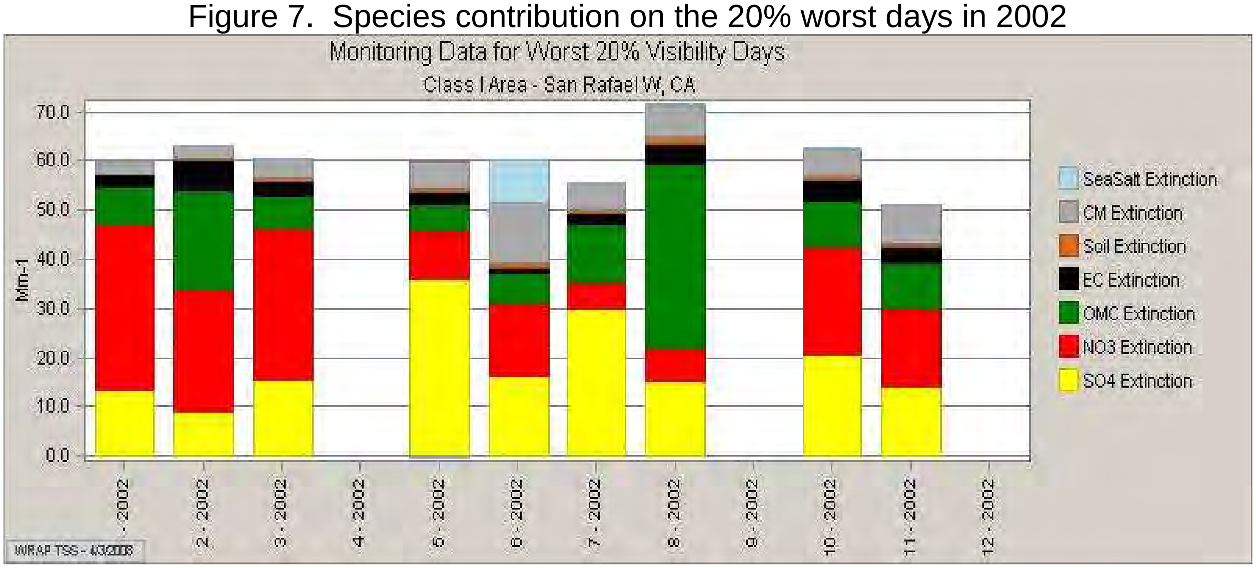
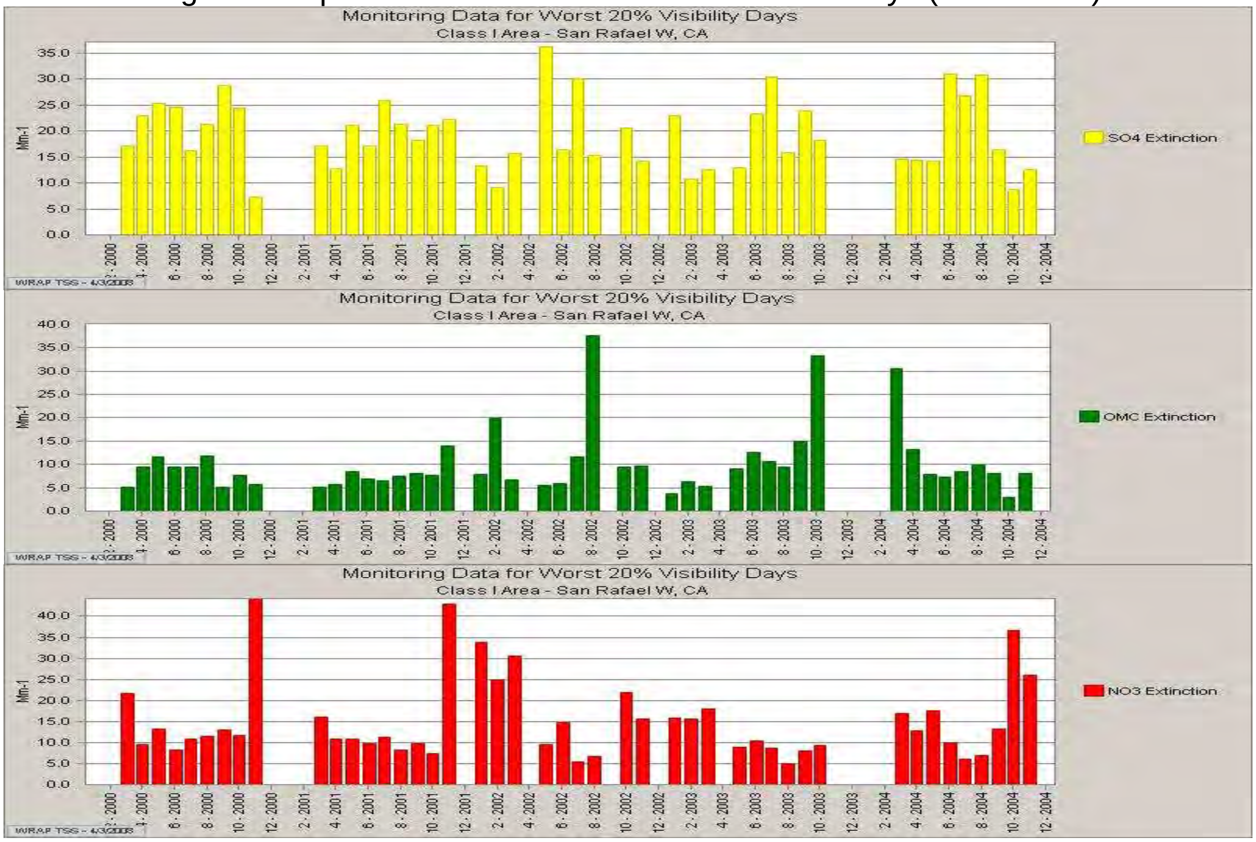


Figure 8. Species contribution on the 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at RAFA1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether or not they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at RAFA1. The Pacific Offshore region represents 34% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (32%) and the Outside Domain Region (30%). California contributes 20% of the total sulfate emissions seen at the RAFA1 monitor.

Individually, emissions from area sources in the Pacific Offshore contribute the most to sulfate concentrations at the RAFA1 monitor. The next largest contributor to sulfate concentrations is from outside the modeling domain.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the RAFA1 monitor is from natural fire sources within California. California represents 95% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 60% of the total organic carbon. Biogenic secondary emissions account for 33% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (82%), followed by the Pacific Offshore Region (10%) and emissions from Outside Domain (7%). Mobile sources within California contribute the most nitrate at the RAFA1 monitor. In 2002, 90% of the nitrate from mobile sources at the RAFA1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 9. Regional Sulfate contribution to haze in 2002 and 2018

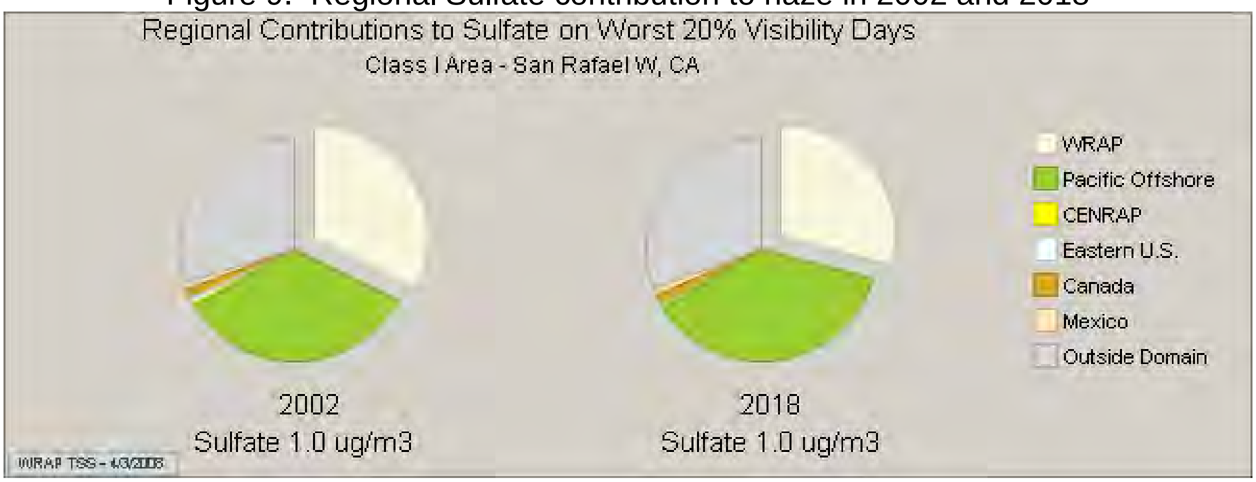


Figure 10. Sulfate source contribution from CA and outside regions

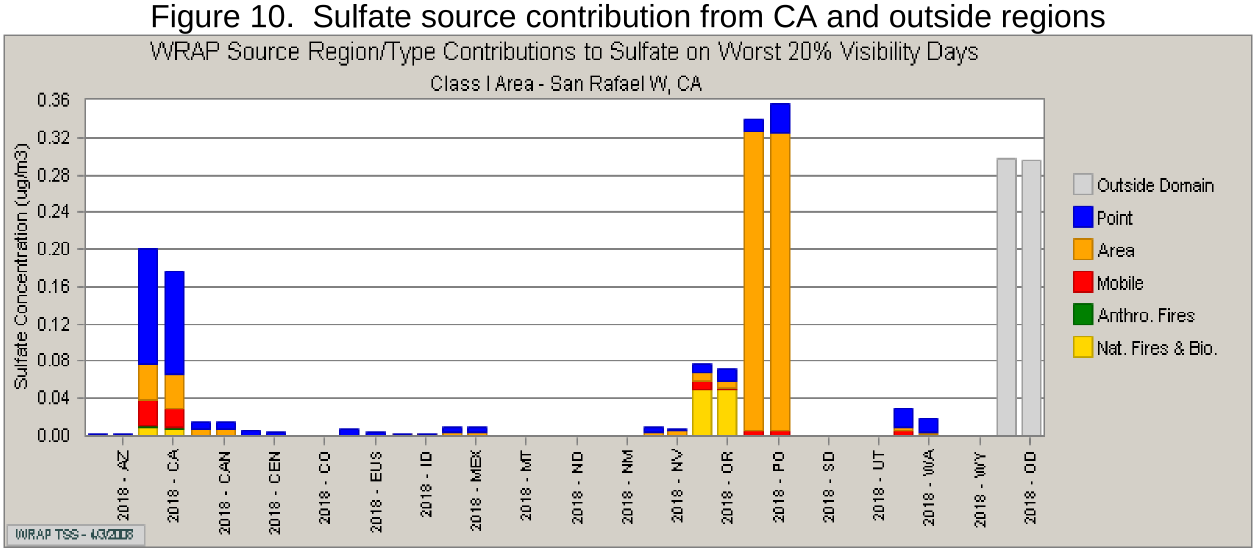


Figure 11. Organic carbon source contribution from CA and outside regions

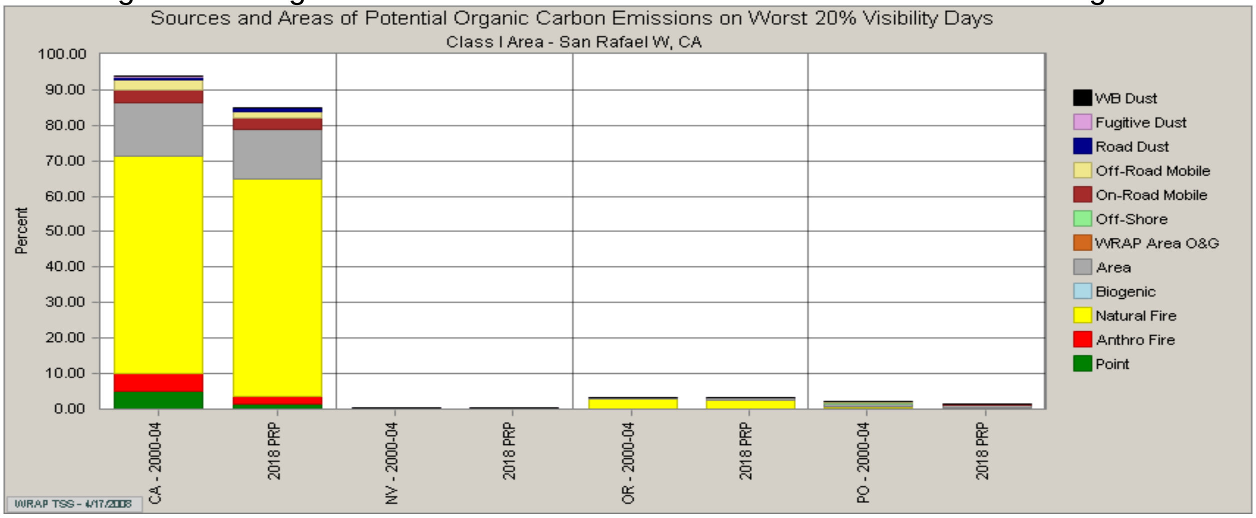


Figure 12. Organic carbon Anthropogenic and Biogenic Source apportionment

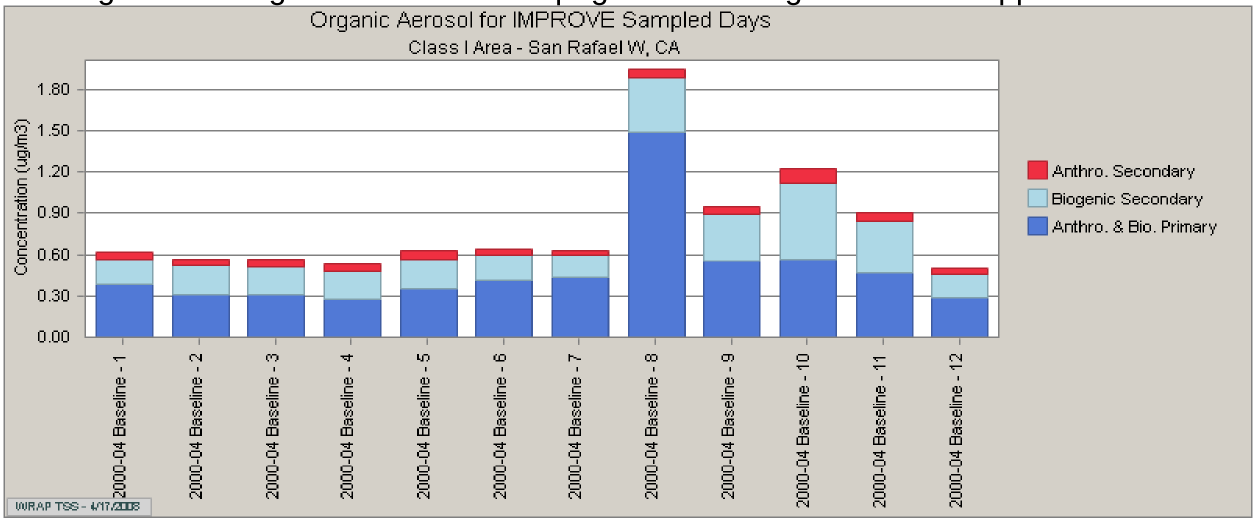


Figure 13. Regional Nitrate contribution to haze in 2002 and 2018

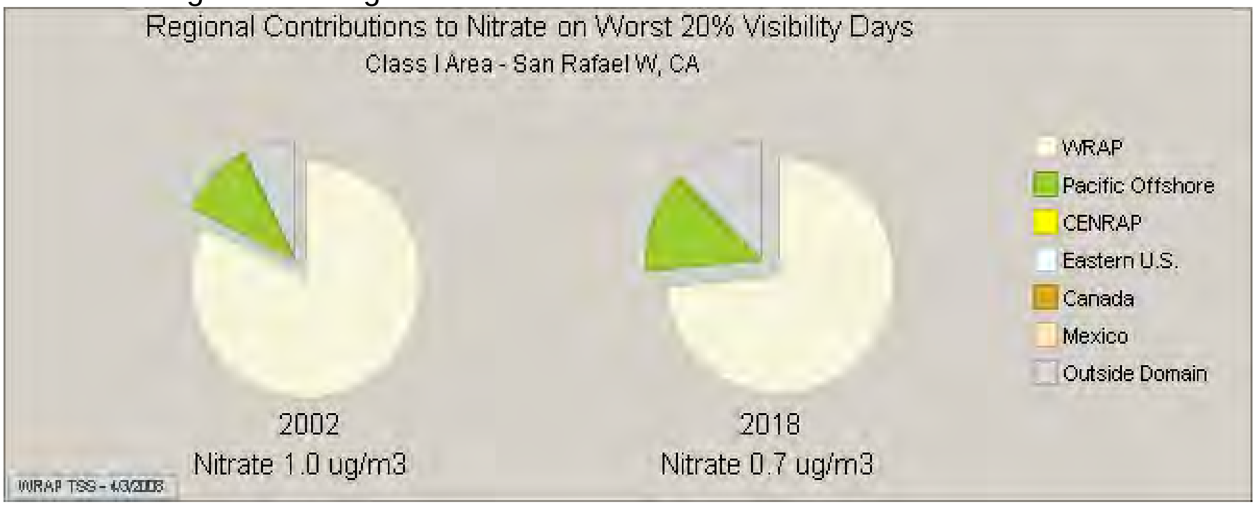
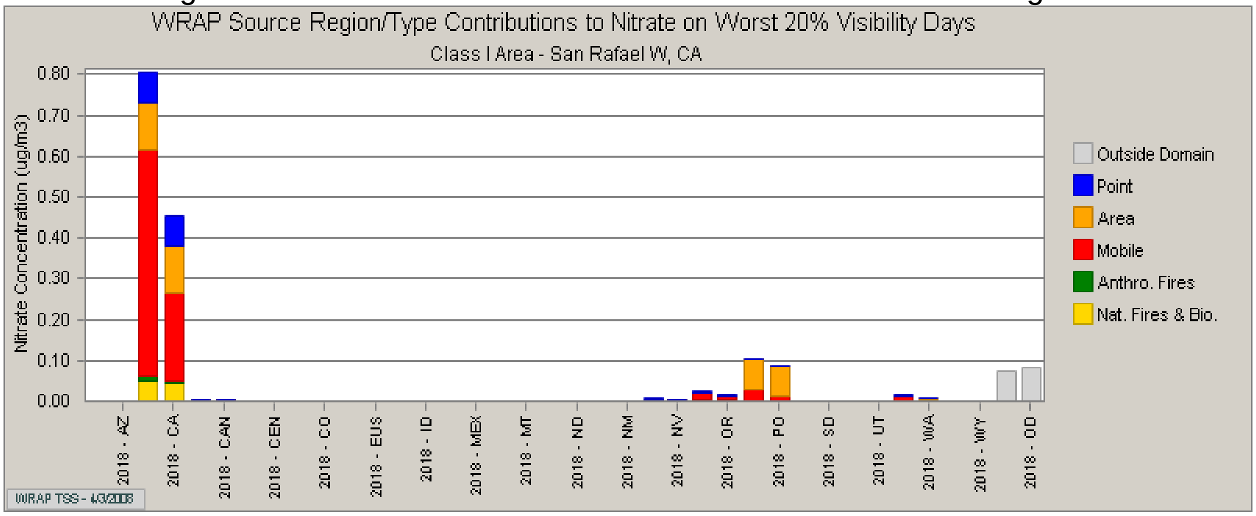


Figure 14. Nitrate source contribution from CA and outside regions



SAGA1 Monitor

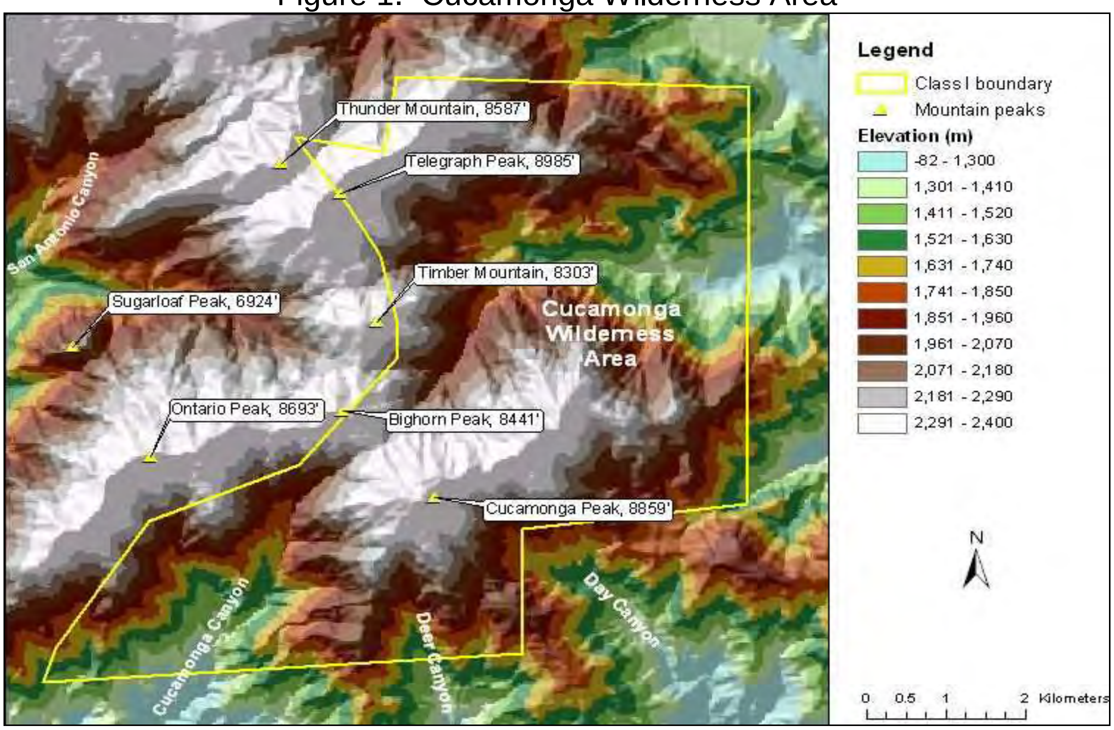
The SAGA1 monitor location represents two wilderness areas located in the San Gabriel Mountains. The wilderness areas associated with the SAGA1 monitor are Cucamonga Wilderness Area and San Gabriel Wilderness area. The SAGA1 site has been operating since December 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

Section I. SAGA1 Wilderness Area Descriptions

I.a. Cucamonga Wilderness Area

The Cucamonga Wilderness Area (Cucamonga) occupies 12,981 acres on the western end of the San Gabriel Mountains, one of the Transverse Ranges that lie along an east-west axis from the Santa Barbara coast to the Mojave Desert creating a natural barrier between central and southern California. Wilderness elevations range from about 1310 meters to 2500 meters, with highest elevations at the crests of Telegraph Peak (2738 meters) and Cucamonga Peak (2700 meters). Cucamonga and Deer Canyons drop south from Cucamonga Peak to the southern Wilderness boundary, then south 4 to 6 miles into the Los Angeles basin near the cities of Pomona, Ontario, and Rancho Cucamonga, forming the most direct route for low elevation urban pollution transport into the Wilderness.

Figure 1. Cucamonga Wilderness Area



I.b. San Gabriel Wilderness Area

The San Gabriel Wilderness Area (San Gabriel) occupies 34,118 acres on the southern slopes of the San Gabriel Mountains, one of the Transverse Ranges that lie along an east-west axis from the Santa Barbara coast to the Mojave Desert. Elevations range from 488 meters to 2500 meters. Highest elevations are along the ridge of the San Gabriel Mountains that forms the northern San Gabriel boundary. Lowest elevations are along the West Fork of the San Gabriel River that flows eastward in this area and forms the southern San Gabriel boundary. From the southeast corner of the Wilderness the San Gabriel River flows southward about 6 miles into the Los Angeles Basin between Pasadena and Pomona. This stretch of the San Gabriel Canyon includes San Gabriel and Morris Reservoirs. The San Gabriel River Valley thus forms the most direct conduit for low elevation urban pollution transport into the Wilderness.

Figure 2. SAGA1 Monitor location

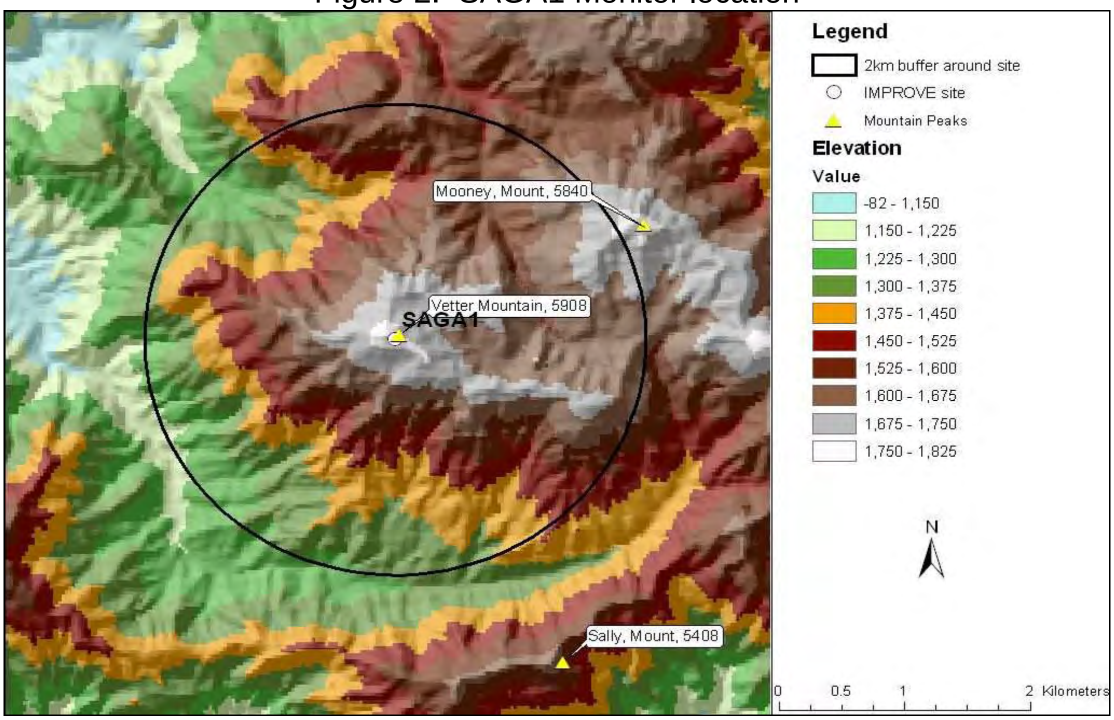


Figure 3. SAGA1 Monitor location in California

Section II. Visibility Conditions:

II.a. Cucamonga Wilderness Area

Visibility conditions for Cucamonga Wilderness are currently monitored by the SAGA1 IMPROVE monitor located just outside the western boundary of the San Gabriel Wilderness. The monitoring site is located at 34.2969 north latitude and 118.0282 west longitude, about 20 miles west of the Cucamonga Wilderness, with mountainous intervening terrain. It is a well-exposed ridge-top site at an elevation of 1791 meters, near the lower end of the range of elevations within the Cucamonga Wilderness.

The SAGA1 monitoring site is separated from the Cucamonga Wilderness by about 20 miles of intervening complex mountainous terrain. It should be representative of aerosol composition and concentration at Cucamonga locations when the atmosphere is well mixed and haze is uniform over the region. It should also be representative of the impact of Los Angeles basin emission on the San Gabriel Mountains in general.

Lowest Wilderness elevations are probably above the regional marine layer that frequently overlies the Los Angeles basin and that typically thickens and advances inland during the night and early morning hours, before burning off around midday. It will be less representative of Cucamonga locations when impacted by local sources.

The SAGAI location is adequate for assessing the 2018 reasonable progress goals for the Cucamonga Wilderness Class 1 area.

II.b. San Gabriel Wilderness Area

Visibility conditions for San Gabriel are currently monitored by the SAGA1 IMPROVE monitor. The monitor is located at 34.2969 north latitude 36.49 and 118.0282 west longitude, just outside the western San Gabriel boundary. The monitor is in a well-exposed ridge-top site at an elevation of 1,791 meters, which is in the middle of the range of San Gabriel elevations.

The SAGA1 IMPROVE site should be well representative of aerosol composition and concentration at San Gabriel Wilderness locations, especially higher locations. It should also be representative of the impact of Los Angeles basin emissions within the San Gabriel Mountains generally. There may be times when lower Wilderness elevations, especially within Devils Canyon in the western Wilderness and the Bear Creek drainage in the eastern Wilderness, are contained within the regional marine layer that covers the Los Angeles basin much of the year, especially from late spring to early fall. The Los Angeles basin marine layer typically extends vertically to 305-610 meters. Elevations in these canyon and valley bottoms are about 600 meters, or about 914 meters lower than the SAGA1 IMPROVE site. The San Gabriel Wilderness is within 6 miles of the sprawling and heavily populated and industrialized South Coast Air Basin and is subject to its influence. The nearest Los Angeles area communities are Pasadena, El Monte, and Pomona.

The SAGA1 location is adequate for assessing the 2018 reasonable progress goals for the San Gabriel Wilderness Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from SAGA1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SAGA1 monitor is calculated at 4.8 deciviews for the 20% best days and 19.9 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

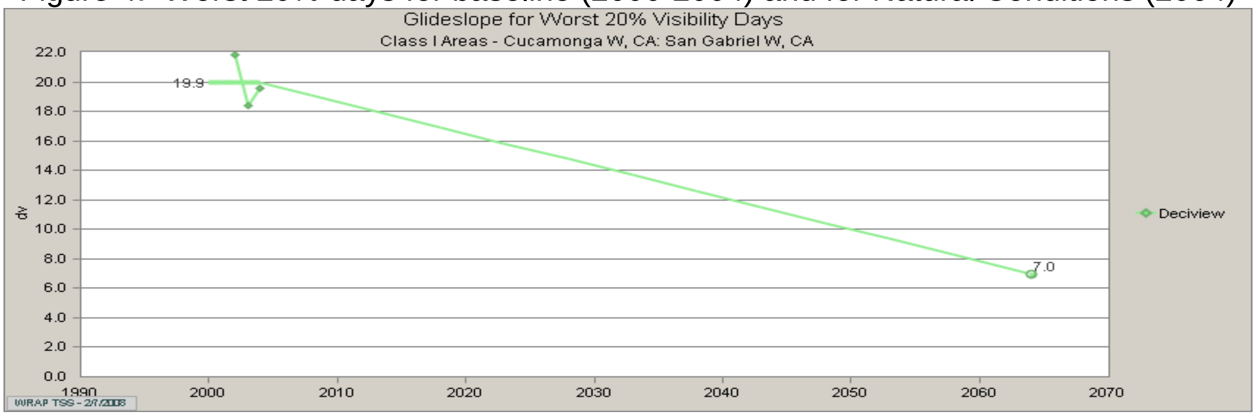
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the SAGA1 monitor is 0.4 deciviews for the 20% best days and 7.0 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.92 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 4.8 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at SAGA1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

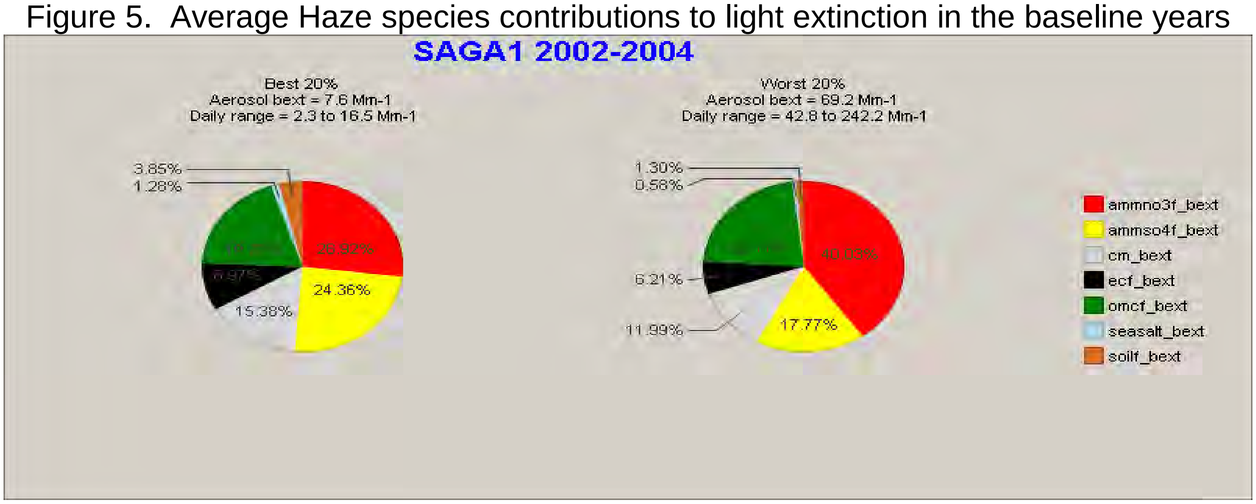
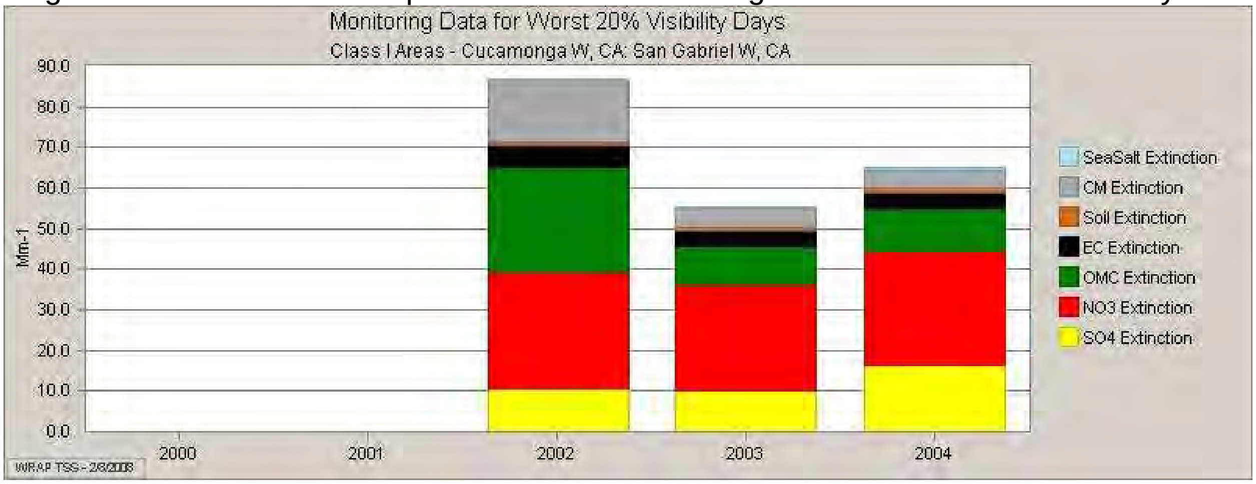


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, nitrates, organic matter, and sulfates have the strongest contributions to light extinction which degrade visibility on worst days at the SAGA1 monitor. The worst days and best days are dominated by nitrates. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring while sulfates increase slightly in the spring and summer. Organic matter remains stable throughout most of the year but then peaks in August and September of 2002. Nitrate clearly dominates the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days. Sea salt is present in trace amounts at the SAGA1 monitor.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, nitrates, sulfates, and coarse mass. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

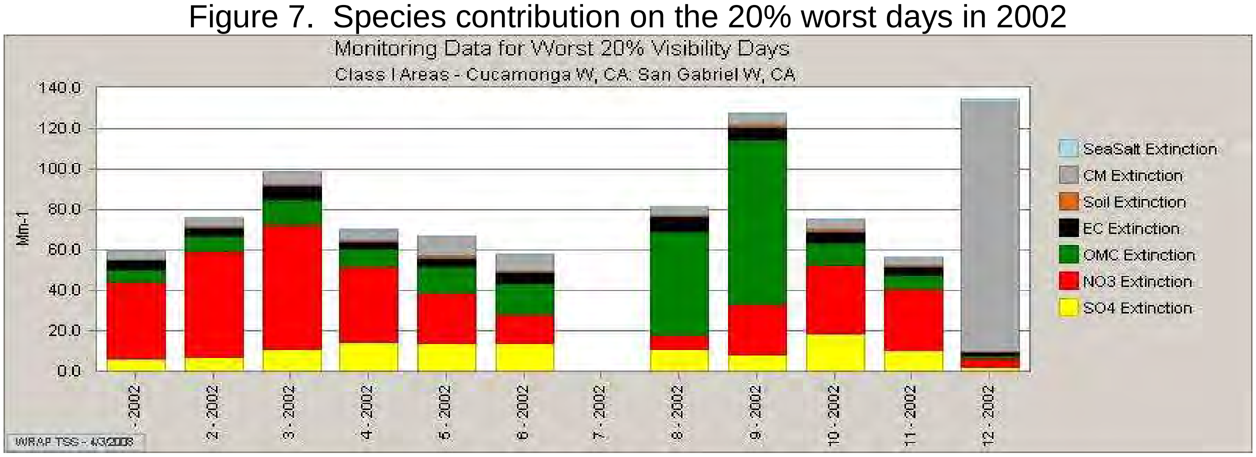
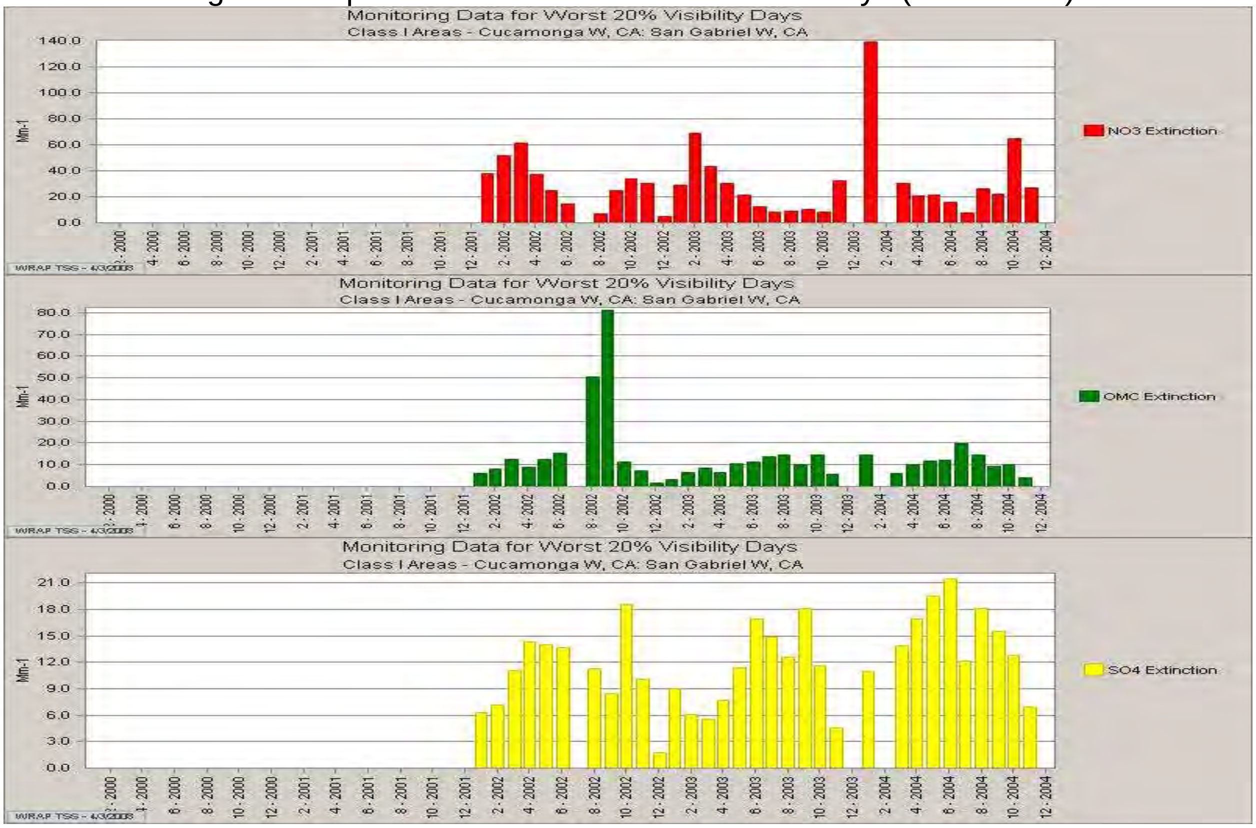


Figure 8. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at SAGA1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (78%), followed by the Pacific Offshore Region (18%) and emissions from the Outside Domain (4%). Mobile sources within California contribute the most nitrates at the SAGA1 monitor. In 2002, 76% of the nitrate at the SAGA1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the SAGA1 monitor in 2002 and 2018. Currently, California Mobile sources are 81% of California contributions to nitrate at the SAGA1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SAGA1 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 80% of the total organic carbon. Biogenic secondary emissions account for 14% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SAGA1. The WRAP region represents 43% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (33%) and the Outside Domain Region (22%). California contributes 36% of the total sulfate emissions seen at the SAGA1 monitor.

Individually, emissions from area sources in the Pacific Offshore contribute the most to sulfate concentrations at the SAGA1 monitor. The next largest contributor to sulfate concentrations is from outside the modeling domain.

Figure 9. Regional Nitrate Contribution to Haze in 2002 and 2018

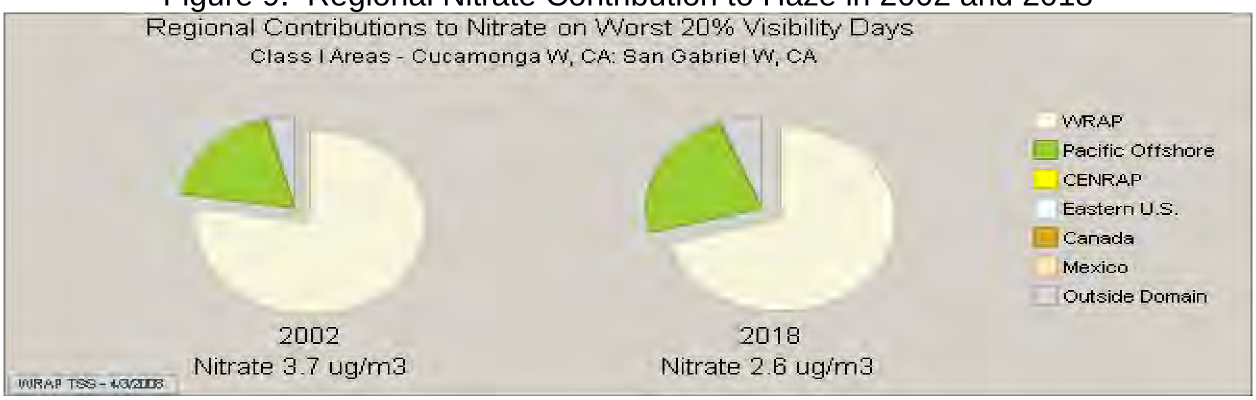


Figure 10. Nitrate source contribution from CA and outside regions

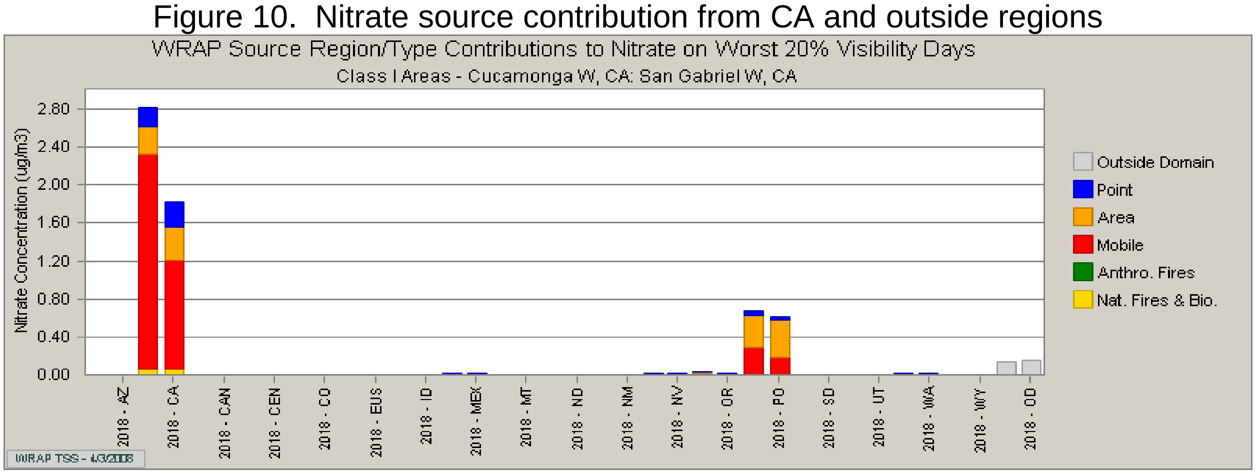


Figure 11. Organic carbon source contribution from CA and outside regions

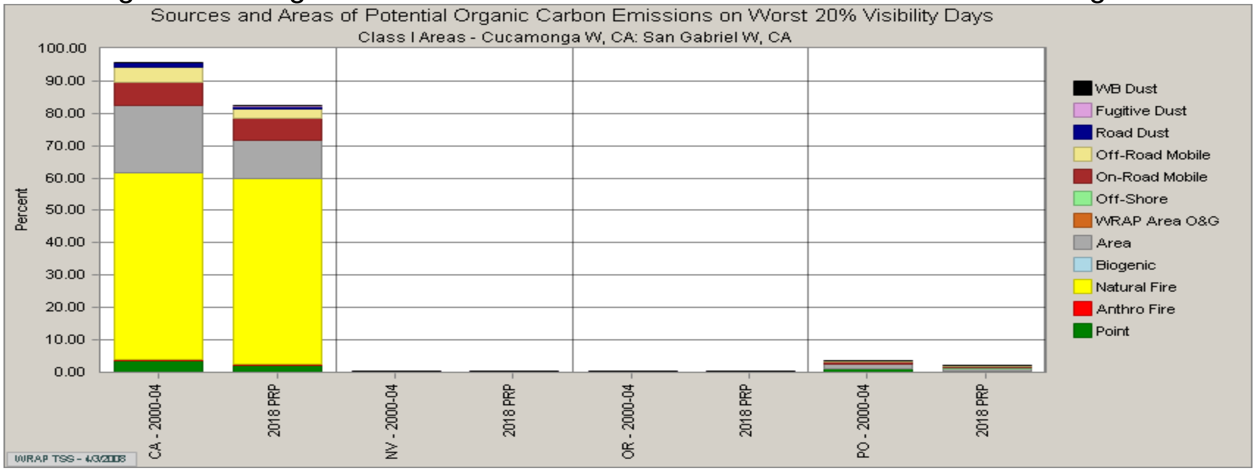


Figure 12. Organic carbon Anthropogenic and Biogenic Source Apportionment

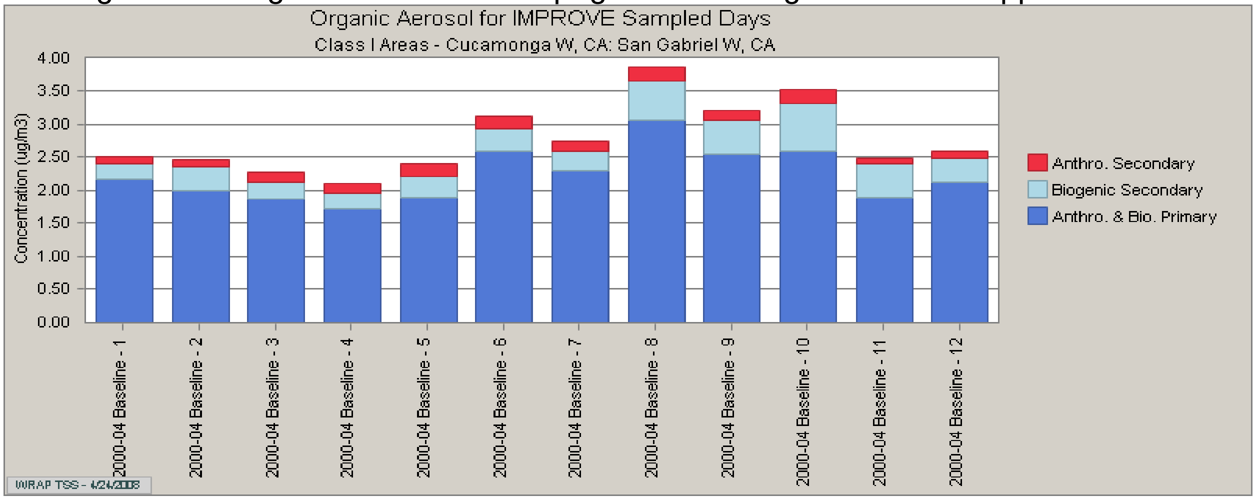


Figure 13. Regional Sulfate Contribution to Haze in 2002 and 2018

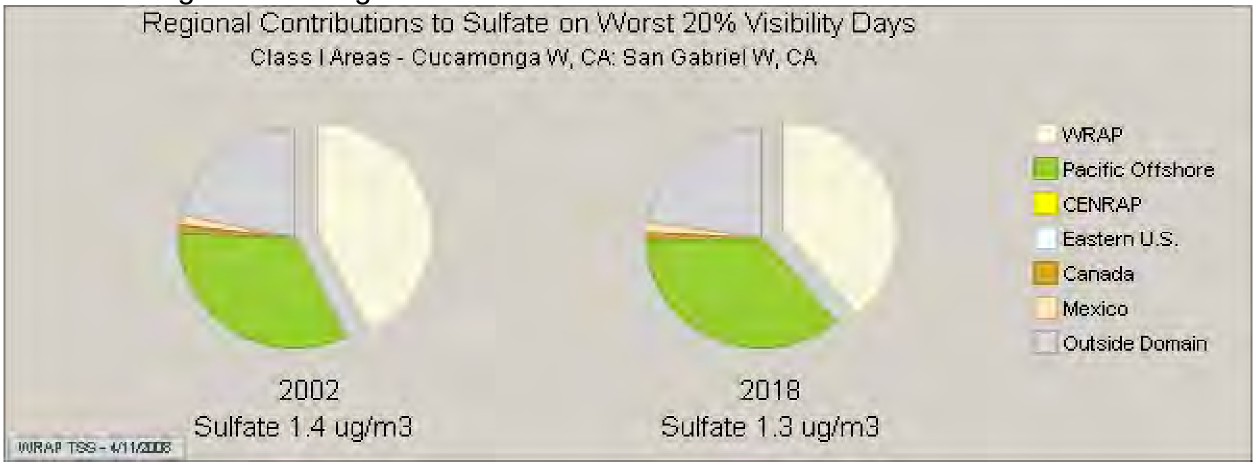
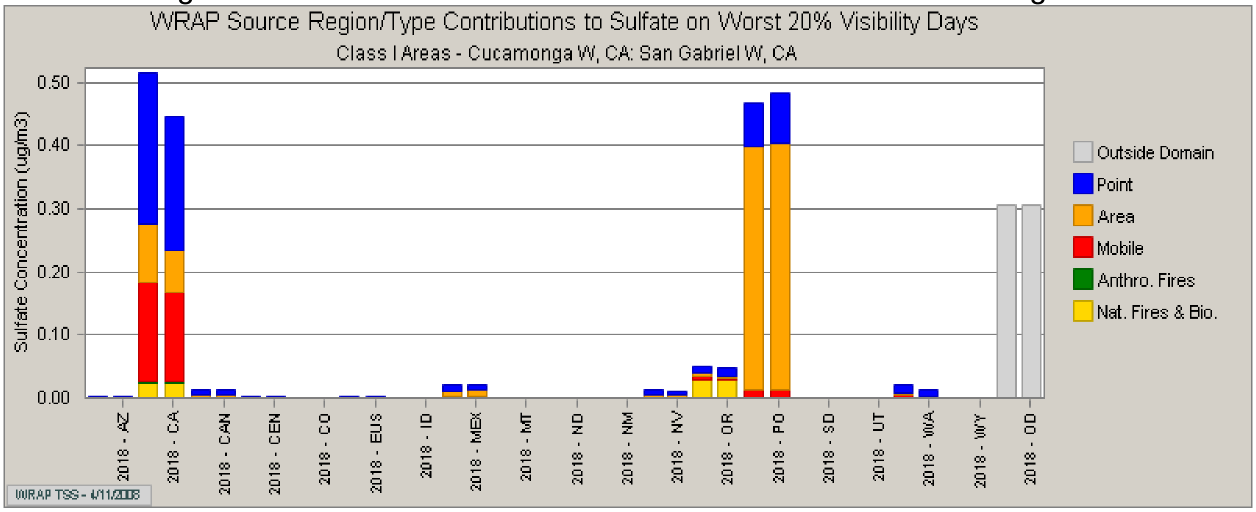


Figure 14. Sulfate source contribution from CA and outside regions



SAGO1 Monitor

The SAGO1 monitor location represents two wilderness areas located in the San Bernardino and San Jacinto Mountains in Southern California. The wilderness areas associated with the SAGO1 monitor are San Gorgonio Wilderness Area and San Jacinto Wilderness area. The SAGO1 site has been operating since March 1988. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

<u>Section I. SAGO1 Wilderness Area Descriptions</u>

I.a. San Gorgonio Wilderness Area

The San Gorgonio Wilderness Area (San Gorgonio) occupies 34,644 acres of the San Bernardino Mountains of southern California, approximately 75 miles east of Los Angeles. Elevations range from 1,341 meters to 3,505 meters at the crest of Mt. San Gorgonio; however most of the wilderness is above the 2,134 meter level. Eleven of the 12 peaks in the Wilderness are above 3,048 meters. Two rivers, the Santa Ana and the White, flow out of the Wilderness. Two small lakes, several meadows, and large, heavily forested areas provide a beautiful sub-alpine oasis in the dry lands that surround the mountain range.

Figure 1. SAGO1 Monitor location

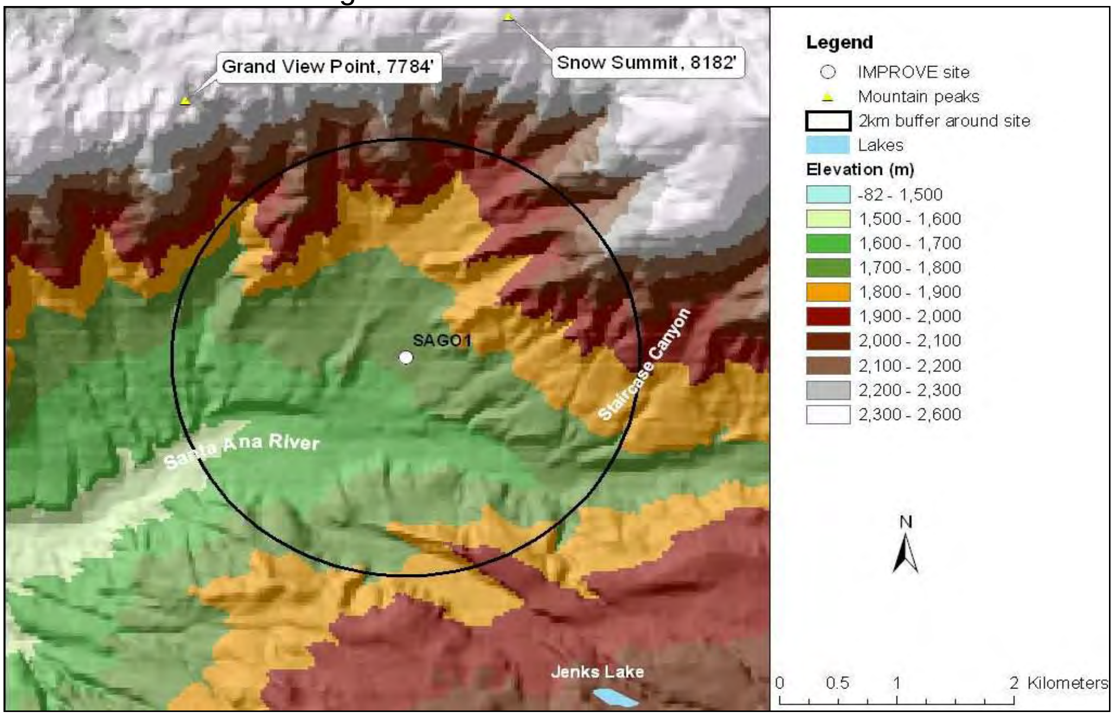


Figure 2. WINHAZE image of San Gorgonio Wilderness Area (5.4 vs. 22.2 dv)

I.b. San Jacinto Wilderness Area

The San Jacinto Wilderness Area (San Jacinto) is part of the San Jacinto Mountains in southern California, adjacent to the Los Angeles Basin to the west, which can be seen from its higher elevations. It is one of the Peninsular Ranges that extend south from the Los Angeles Basin to the tip of the Baja Peninsula and separate the Los Angeles Basin from the Mohave Desert to the east. It occupies 20,564 acres and is split into a north Wilderness and a south Wilderness, separated by the Mount San Jacinto State Park and Wilderness. It is separated from the San Bernardino Mountains and San Gorgonio Wilderness by San Gorgonio Pass. Elevations range from less than 610 meters on the north edge within San Gorgonio Pass to almost 3,353 meters at its higher peaks. The highest peak in the area is San Jacinto Peak located between the north and south Wilderness sections, at an elevation of 3,293 meters.

Figure 3. San Jacinto Wilderness Area

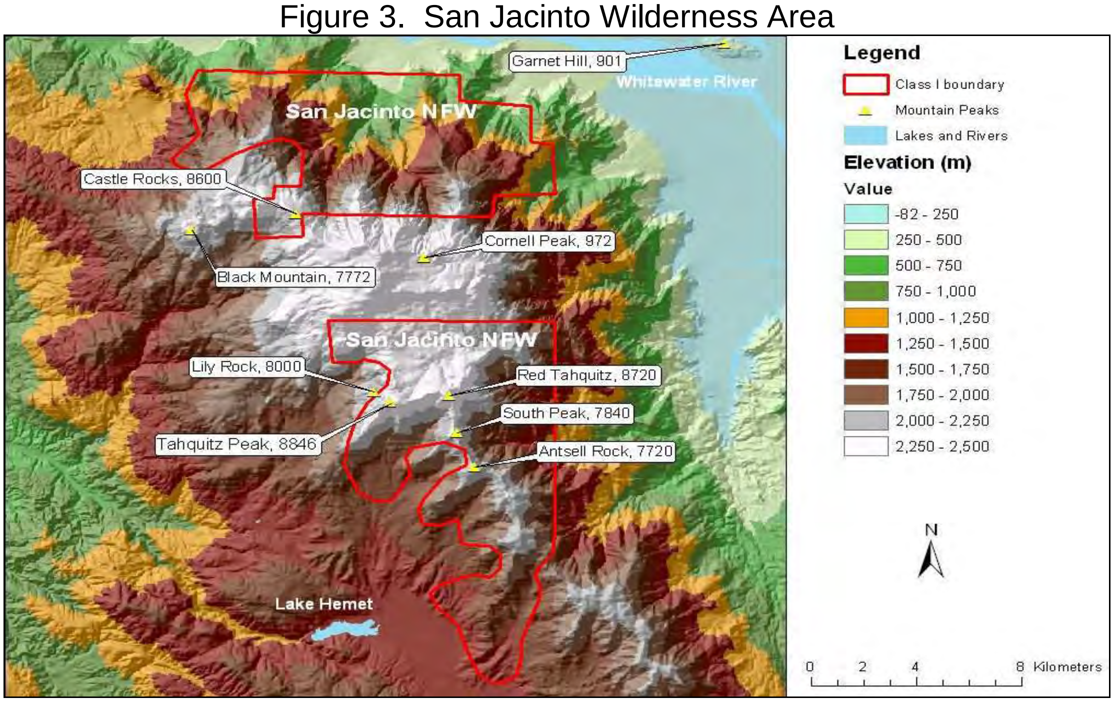


Figure 4. Photograph of San Jacinto Wilderness Area

Figure 5. SAGO1 Monitor location in California

Section II. Visibility Conditions:

II.a. San Gorgonio Wilderness Area

Visibility conditions for San Gorgonio are currently monitored by the SAGO1 IMPROVE monitor. The monitor is located at 34.1939 north latitude and 116.9132 west longitude, in the upper Santa Ana River valley north of the northern San Gorgonio boundary. The orientation of the Santa Ana River valley is west to east, with its mouth to the west, exiting into the Los Angeles basin. The valley bottom location nearest the site is about 1,646 meters, just south of the monitoring site. Elevations rise to about 2,347 meters at the ridge crest, about 2 miles north, and to about 2,987 meters at the ridge crest about 7 miles south of the site.

The SAGO1 IMPROVE site is near the bottom of the Santa Ana River valley at an elevation Off 1,726 meters. This is well below typical San Gorgonio elevations which extend to over 3,048 meters on some of the peaks. Aerosol composition and concentration measured at SAGO1 may not be representative of higher San Gorgonio elevations. When the atmosphere is well mixed to San Gorgonio elevations the SAGO1 site should be representative.

The SAGO1 location is adequate for assessing the 2018 reasonable progress goals for the San Gorgonio Wilderness Class 1 area.

II.b. San Jacinto Wilderness Area

Visibility conditions for San Jacinto are currently monitored by the SAGO1 IMPROVE monitor in the San Gorgonio Wilderness Area. The monitor is located at 34.1939 north latitude and 116.9132 west longitude north of San Gorgonio Pass in the upper Santa Ana River Valley. The monitor is at an elevation of 1726 meters and about 20 miles north of the Wilderness boundary across the San Gorgonio Pass. It is also separated from the San Jacinto Wilderness by the San Gorgonio Wilderness that includes the so-called “Ten Thousand Foot Ridge”, with elevations in excess of 3,048 meters.

The SAGO1 IMPROVE site is near the bottom of the Santa Ana River valley and is separated from the San Jacinto Wilderness by the San Gorgonio Wilderness, which presents a massive intervening obstruction. It should be representative of lower Wilderness elevations when the atmosphere is well mixed, but may not be as representative when it is within a local trapping inversion in the Santa Ana River Valley, or beneath a regional inversion between the SAGO1 elevation and San Jacinto elevations. The San Gorgonio Pass, a potential air pollution corridor between the Los Angeles Basin and the Mohave Desert to the east, also lies between SAGO1 and the San Jacinto Wilderness and could at times create a gradient in concentrations between the SAGO1 monitoring site and San Jacinto Wilderness locations. There could also be a difference in aerosol composition if and when the SAGO1 site is influenced by local sources such as wild land fires.

The SAGO1 location is adequate for assessing the 2018 reasonable progress goals for the San Jacinto Wilderness Class 1 area.

II.c. Baseline Visibility

Baseline visibility is determined from SAGO1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SAGO1 monitor is calculated at 5.4 deciviews for the 20% best days and 22.2 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

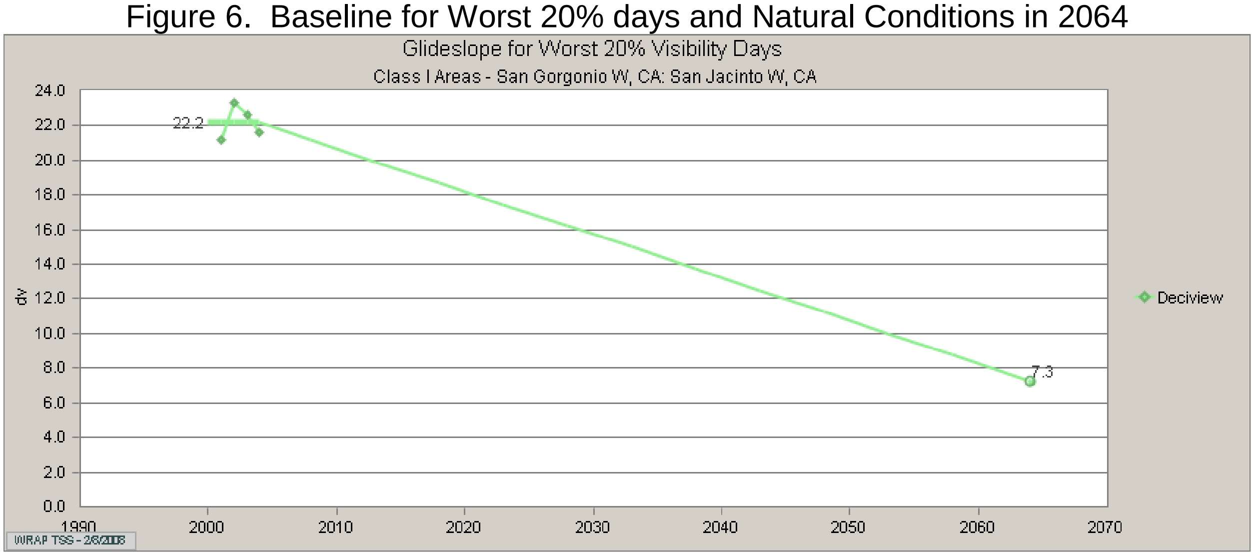
II.d. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the SAGO1 monitor is 1.2 deciviews for the 20% best days and 7.3 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.e. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 6 also shows the uniform rate of progress, or “glide slope.” The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 18.70 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 5.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Baseline for Worst 20% days and Natural Conditions in 2064



II.f. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at SAGO1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

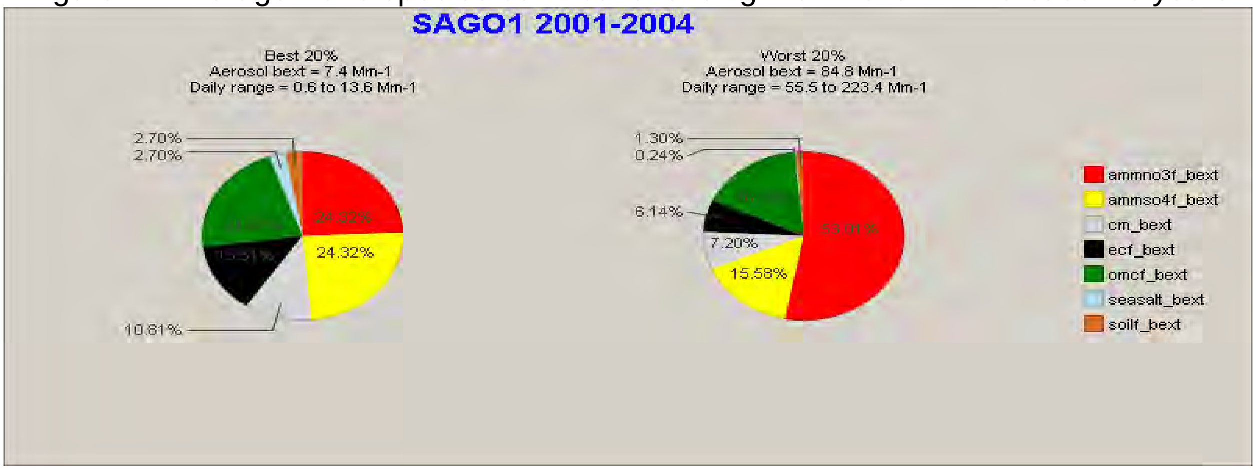
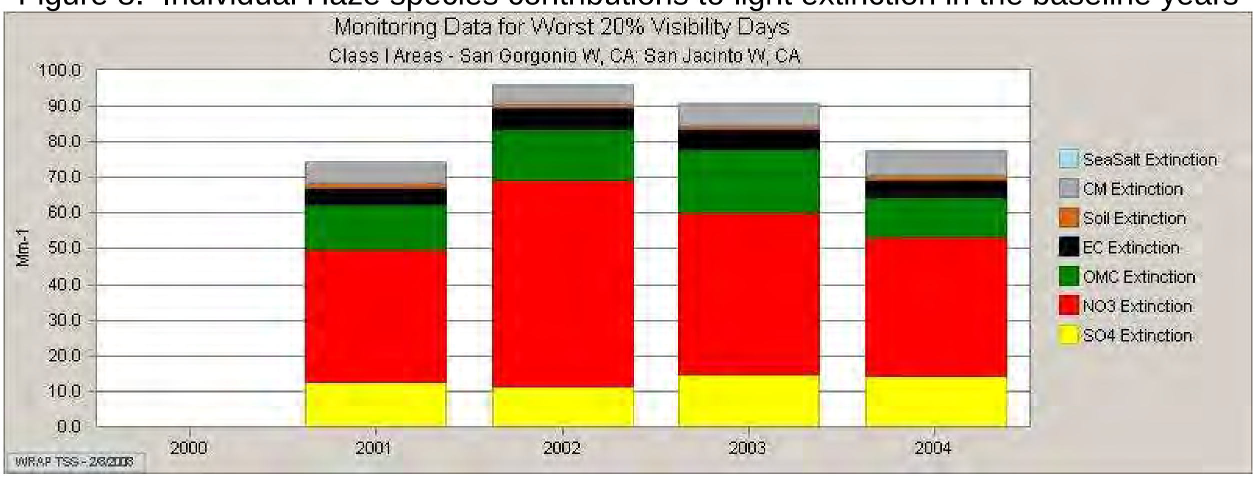


Figure 8. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 7 and 8, nitrates, organic matter, and sulfates have the strongest contributions to degrading visibility on worst days at the SAGO1 monitor. Nitrates clearly dominate on the worst days, but nitrates and sulfates equally contribute emissions on the best days. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months, while organic matter increases in the summer and fall. Sulfates remain relatively stable throughout the year. Nitrates clearly dominate the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of soil and sea salt present throughout the years.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for nitrates, organic matter, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

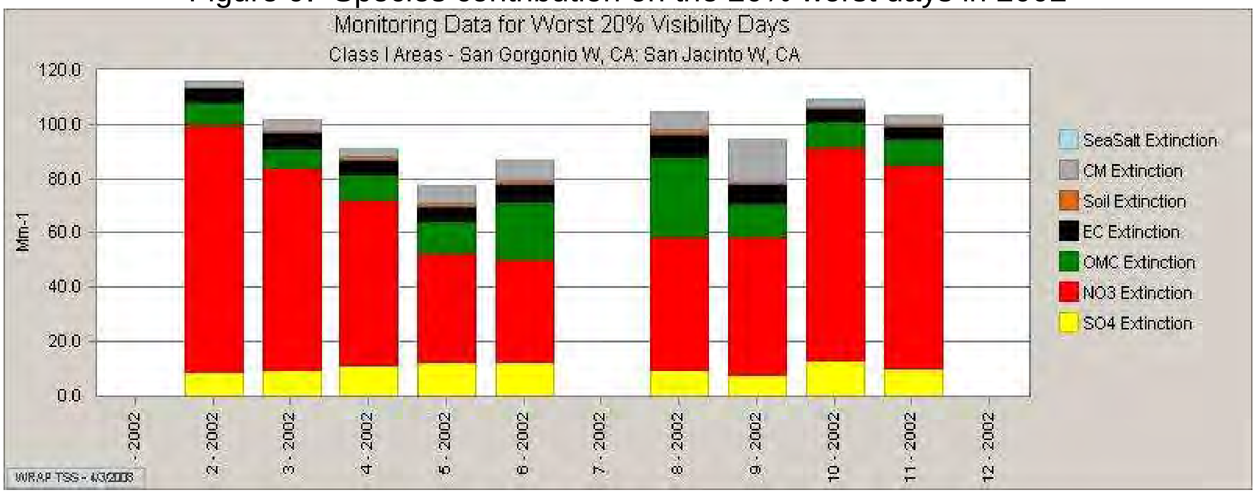
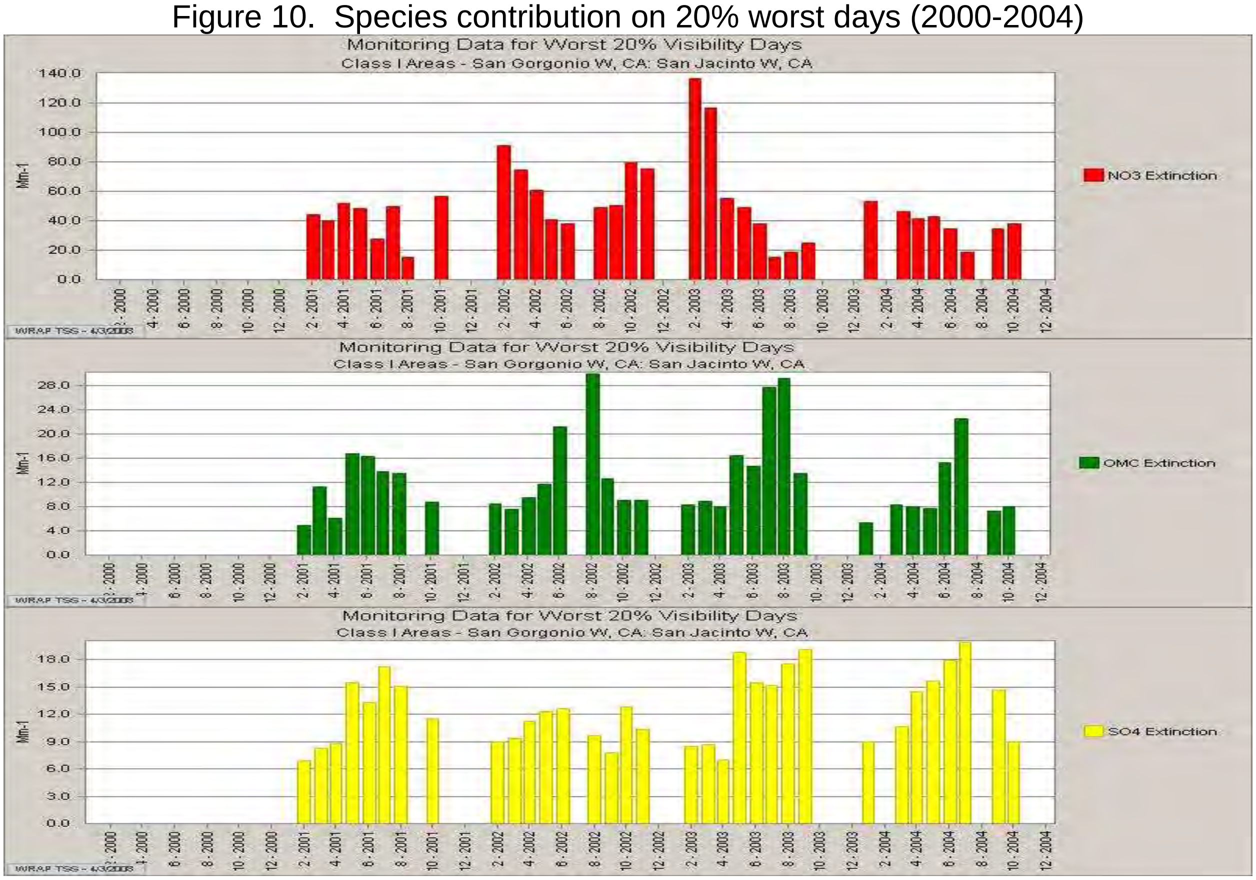


Figure 10. Species contribution on 20% worst days (2000-2004)



II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at SAGO1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether or not they from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (79%), followed by the Pacific Offshore Region (17%) and emissions from Outside Domain (3%). Mobile sources within California contribute the most nitrate at the SAGO1 monitor. In 2002, 87% of the nitrate from mobile sources at the SAGO1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SAGO1 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 59% of the total organic carbon. Biogenic secondary emissions account for 34% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 15 and 16 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SAGO1. The WRAP region represents 38% of the sulfate contributions in 2002 and 2018, followed by the emissions from Pacific Offshore (31%) and the Outside Domain Region (27%). California contributes 33% of the total sulfate emissions seen at the SAGO1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the SAGO1 monitor. The next largest contributor to sulfate concentrations is area sources in the Pacific Offshore.

Figure 11. Regional Nitrate contribution to haze in 2002 and 2018

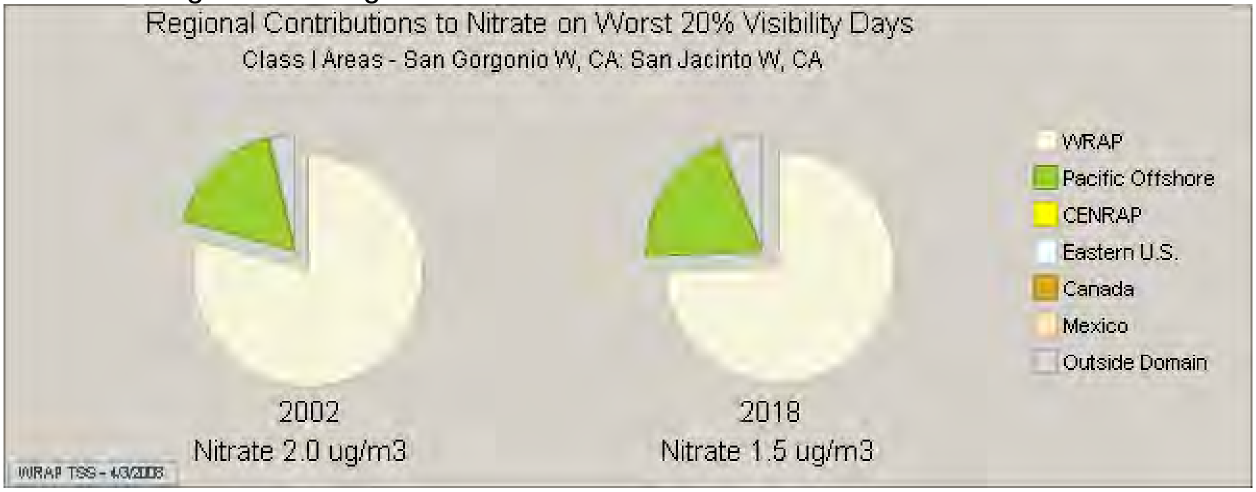


Figure 12. Nitrate source contribution from CA and outside regions

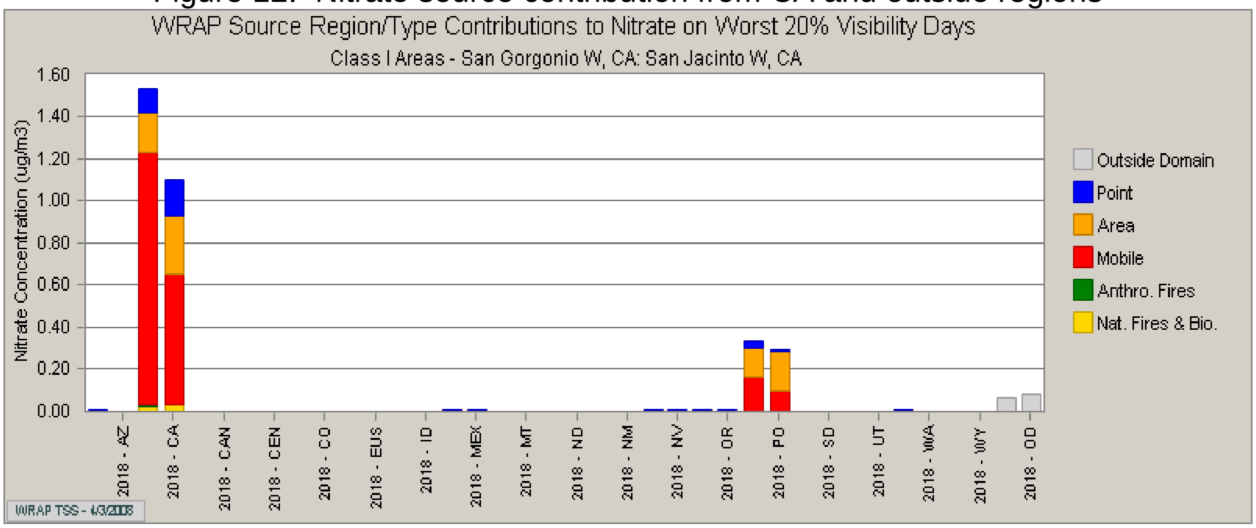


Figure 13. Organic carbon source contribution from CA and outside regions

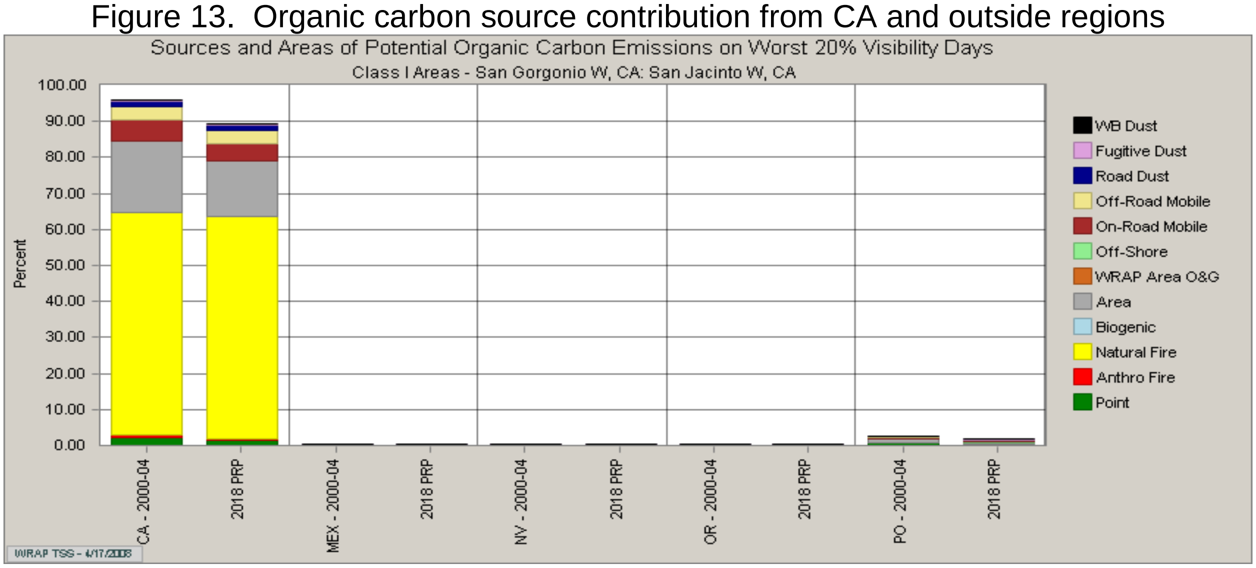


Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment

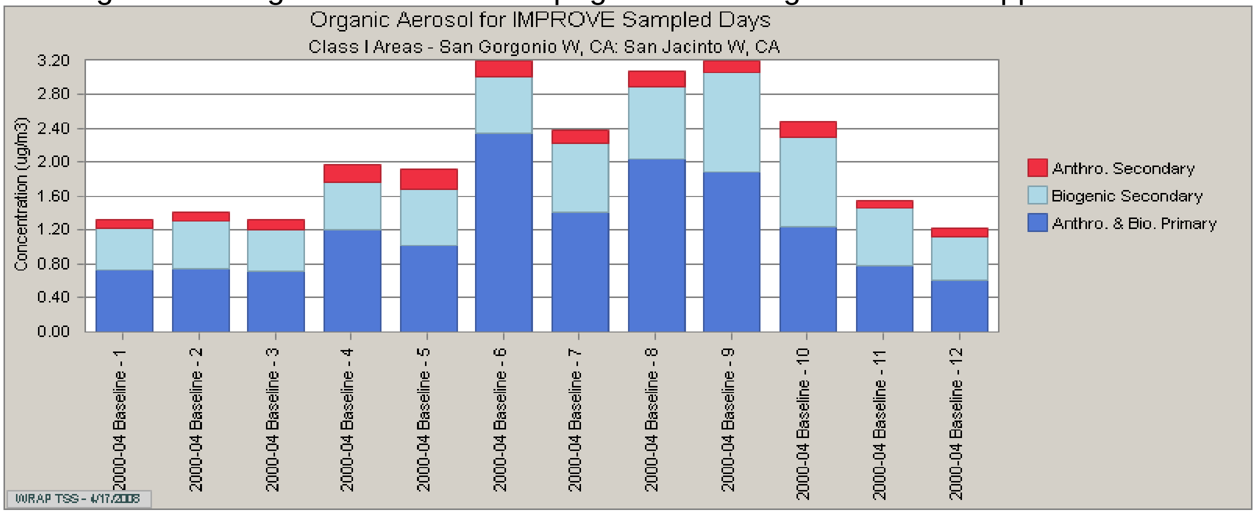


Figure 15. Regional Sulfate contribution to haze in 2002 and 2018

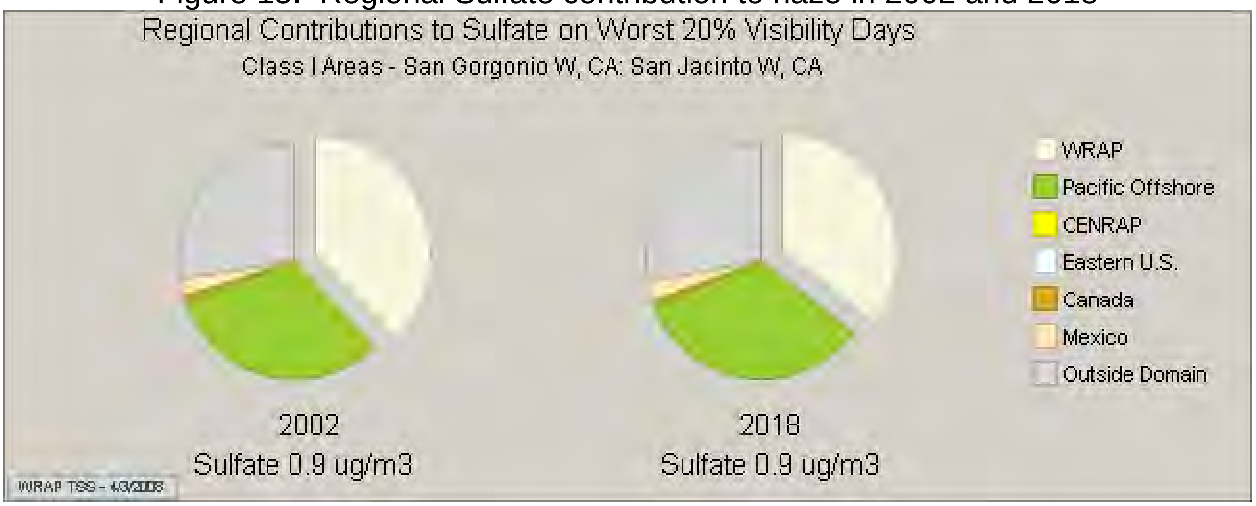
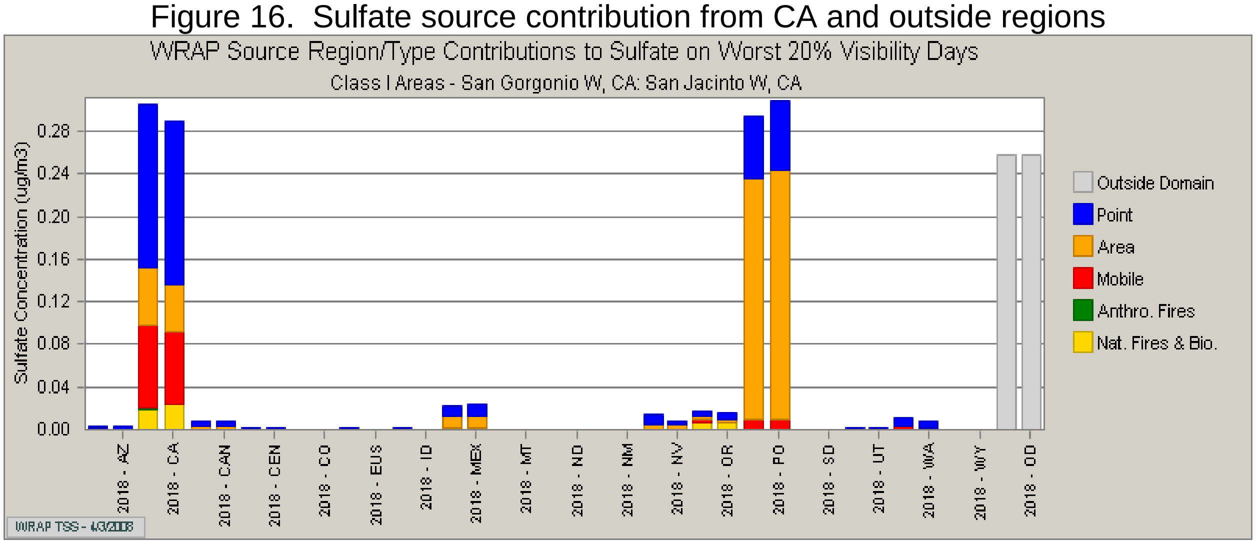


Figure 16. Sulfate source contribution from CA and outside regions



AGT1 Monitor

<u>Section I. Description</u>

The Agua Tibia Wilderness Area comprises most of the Cleveland National Forest, 15,934 acres, in the northwest part of the isolated Palomar Mountain Range of southern California. The area is mountainous, cut by many deep canyons that reach downward towards flatter terrain of coastal southern California between Los Angeles and San Diego. Elevations range from nearly 518 meters in the canyon bottoms, to the 1547 meters Eagle Crag Peak at the southeast corner of the Wilderness Area, although there are higher elevations along the main part of the Palomar Range extending further to the southeast. West of the Wilderness, canyons exit into the San Luis Rey River drainage that empties into the Pacific Ocean near Oceanside, about 30 miles southwest of the Wilderness.

Figure 1. AGT1 Monitor location

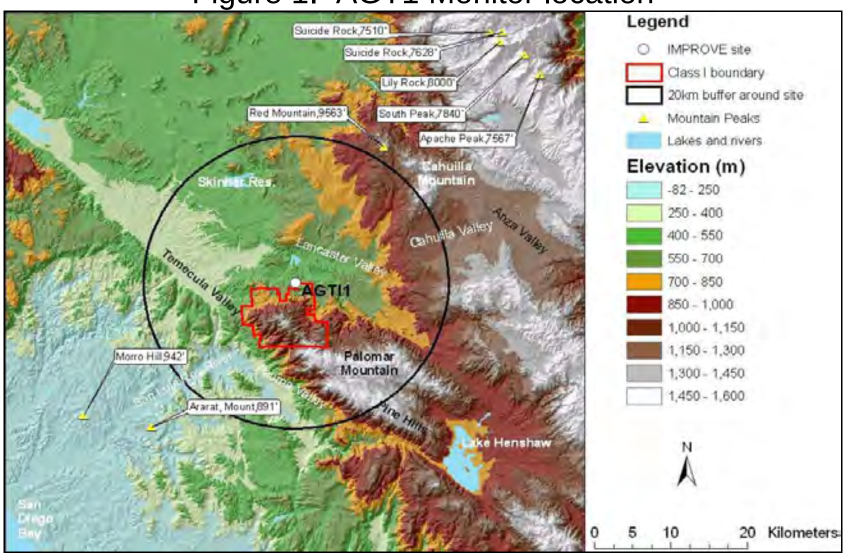


Figure 2. Image of Agua Tibia

Figure 3. AGT1 Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for Agua Tibia are currently monitored by the AGTI1 IMPROVE monitor. The monitor is located at 33.46 north latitude, 116.97 west longitude, close to Highway 79 near the northern Wilderness boundary at an elevation of 508 meters (which is near the lower end of the range of Wilderness elevations). It is also within the typical elevation range for the transition zone between the coastal marine layer and the drier air above. The elevation range for this transition zone is typically 305 to 610 meters. The site has been operating since November 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

The Agua Tibia monitoring site is at an elevation of 508 meters, thus very representative of lower Agua Tibia Wilderness elevations in general. At this elevation it may at times be within the coastal marine inversion, if and when the inversion extends inland to this site. In such cases it would be less representative of higher Wilderness elevations above the penetrating marine layer. The Wilderness is above the foothills of the sprawling and heavily populated and industrialized South Coast Air Basin immediately to the north. The Temecula Valley just to the west of the Wilderness is a rapidly growing area, and associated urban emissions may also have increasing impact on aerosol concentrations in the Agua Tibia Wilderness.

The AGTII location is adequate for assessing the 2018 reasonable progress goals for the Agua Tibia Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from AGTI1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Agua Tibia Wilderness is calculated at 9.6 deciviews for the 20% best days and 23.5 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

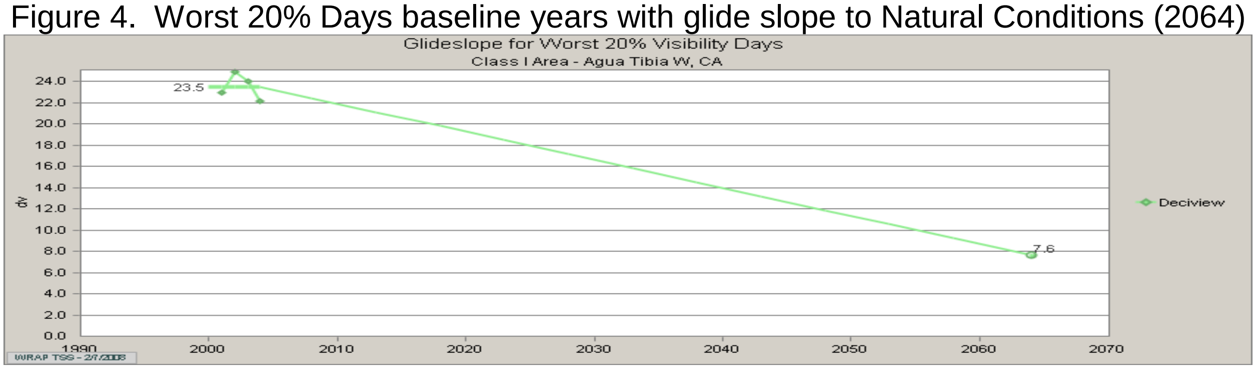
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Agua Tibia Wilderness is 2.9 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 19.8 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 9.6 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% Days baseline years with glide slope to Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at AGTI1.

Figure 5. Average Haze Species contributions to light extinction in the baseline years

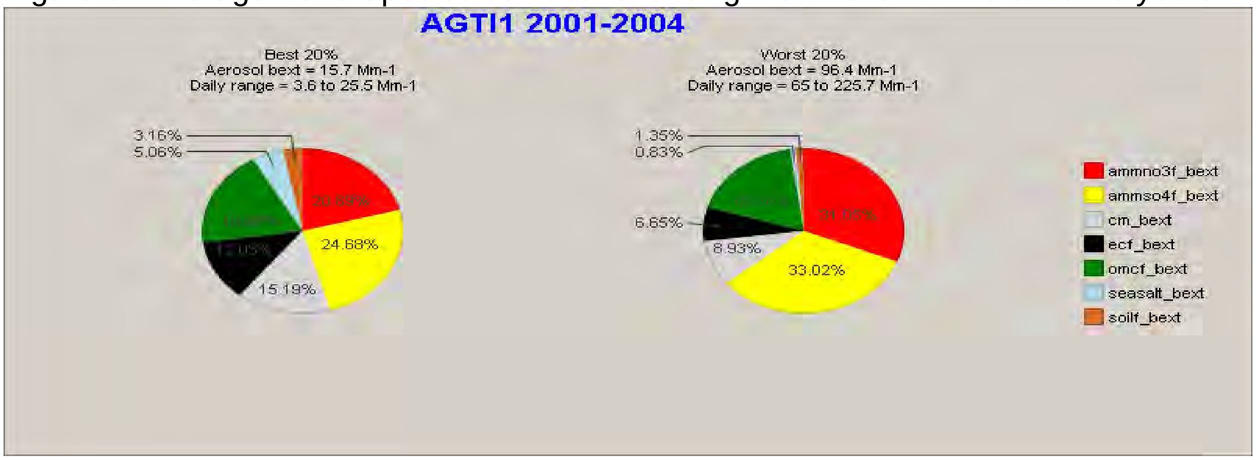
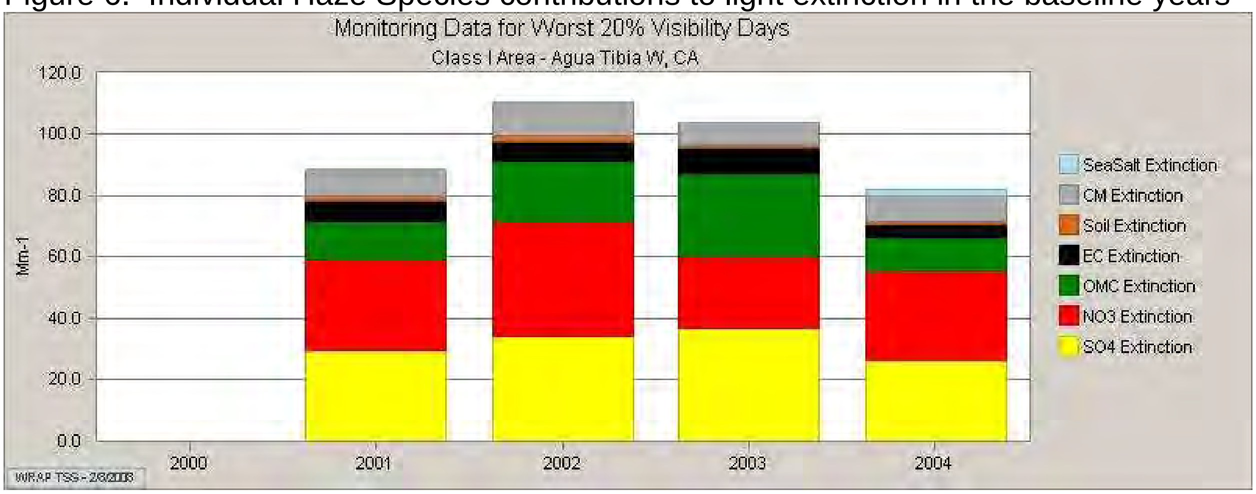


Figure 6. Individual Haze Species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, sulfates, nitrates, and organic matter have the strongest contributions to degrading visibility on worst days at Agua Tibia Wilderness Area. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months. Sulfates remain relatively stable throughout the year but do increase slightly in July and August. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Nitrates clearly dominate the other haze species on worst days, but sulfate and organic matter also contribute to the worst days in the summer. There are also small amounts of coarse mass and elemental carbon present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

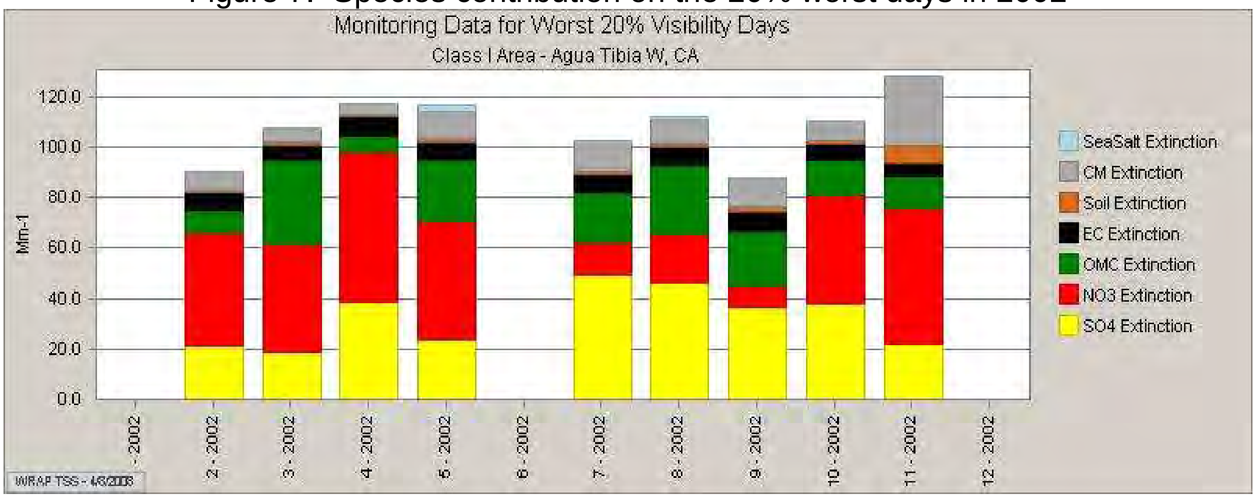
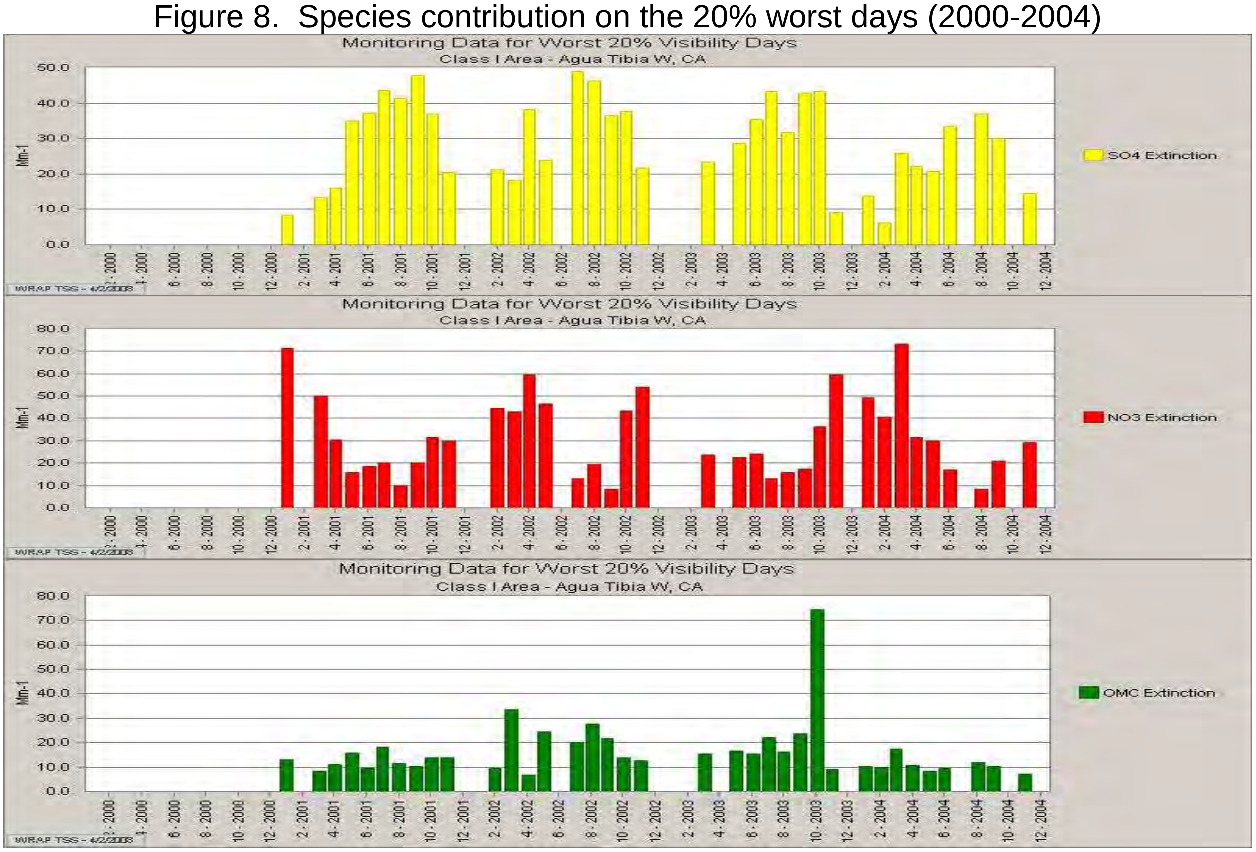


Figure 8. Species contribution on the 20% worst days (2000-2004)



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at AGTI1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to sulfate on the 20% worst days. The Pacific Offshore region represents the largest contribution to sulfate in 2002 and 2018 (50%), followed by the WRAP Region (28%) and emissions from outside the modeling domain (17%). In 2002, 23% of the sulfate at the AGT1 monitor can be attributed to California. From the WRAP region, California is shown to contribute the most to sulfate concentrations at the AGT1 monitor in 2002 and 2018. Area sources represent 39% of all sulfate categories at the AGT1 monitor.

Individually, emissions from area sources from the Pacific Offshore contribute the most to sulfate concentrations at the AGT11 monitor. The next largest contributor to sulfate concentrations is point sources in the Pacific Offshore.

Figures 11 and 12 represent the regional contributions of nitrate on the 20% worst days in 2002 and 2018 at AGT1. The WRAP Region represents the largest contribution to nitrate in 2002 and 2018 (72%) followed by the Pacific Offshore Region (24%) and emissions from outside the modeling domain (3%). In 2002, 70% of nitrate at the AGT1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most nitrate concentrations at the AGT1 monitor in 2002 and 2018. Currently, California mobile sources are 82% of California contributions to nitrate at the AGT1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the AGT1 monitor is from natural fire within California. California represents 98% of all natural fire source contributions.

Figure 14 illustrates the total Organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 59% of the total organic carbon. Biogenic secondary emissions account for 35% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining 6% of emissions.

Figure 9. Regional Sulfate contribution to Haze in 2002 and 2018

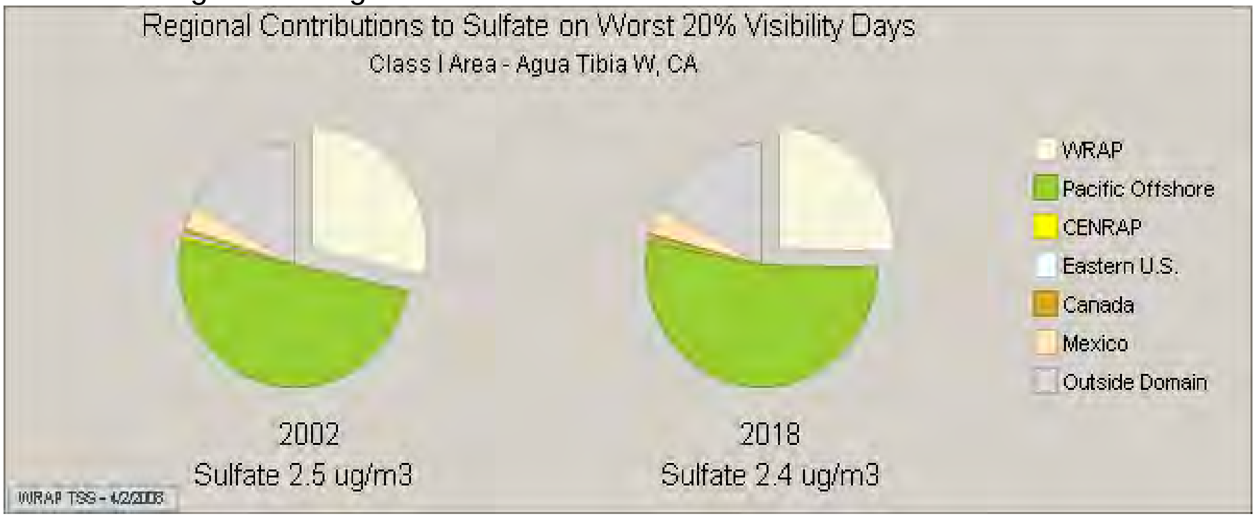


Figure 10. Sulfate source contribution from CA and outside regions

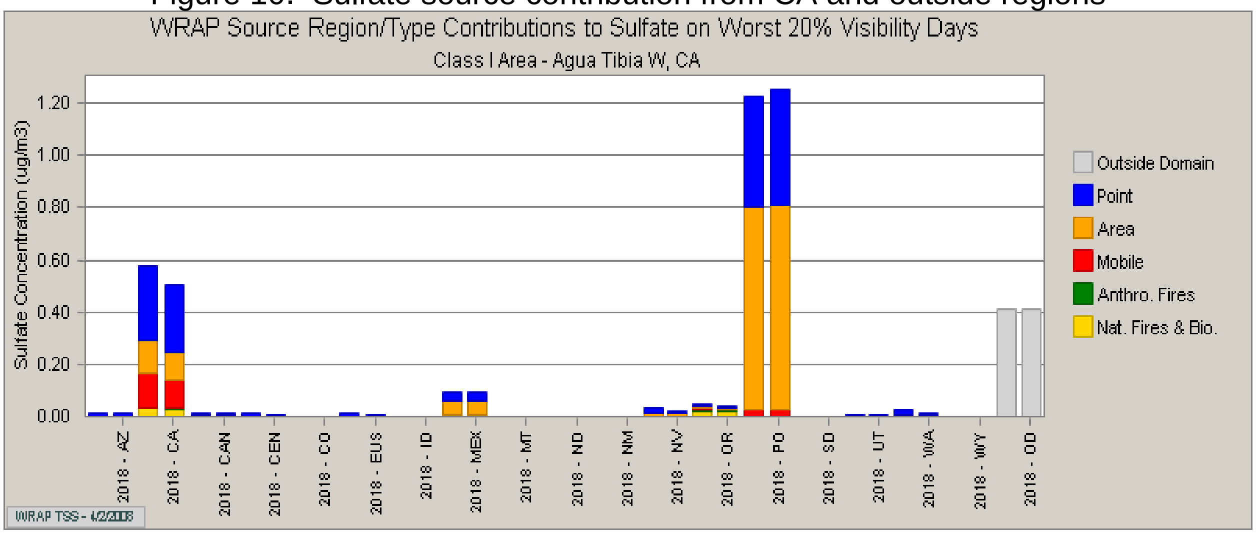


Figure 11. Regional Nitrate contribution to Haze in 2002 and 2018

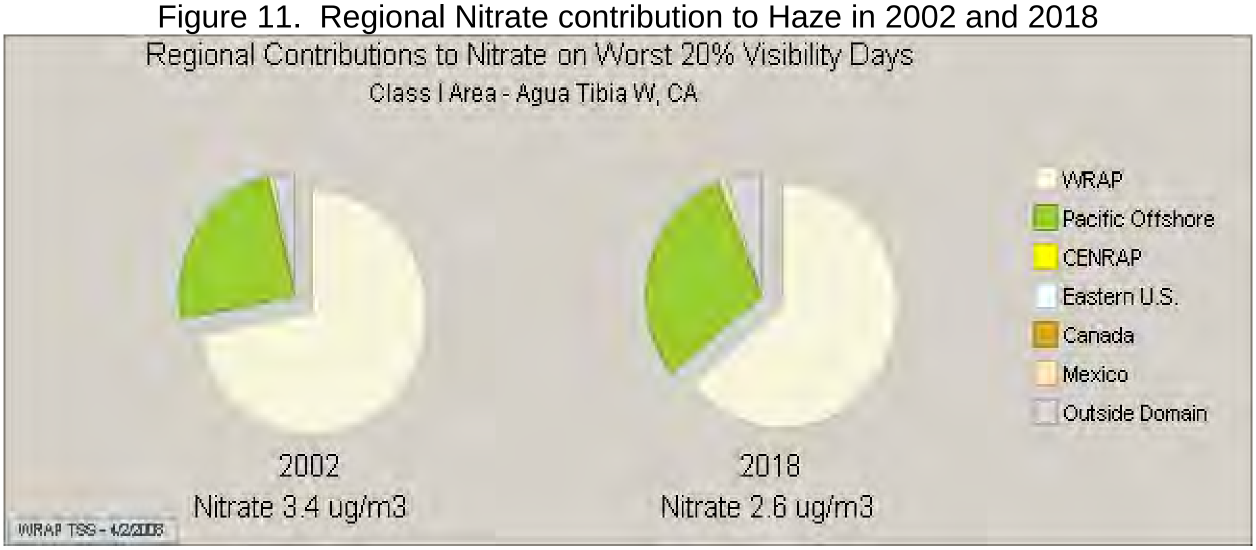


Figure 12. Nitrate source contribution from CA and outside regions

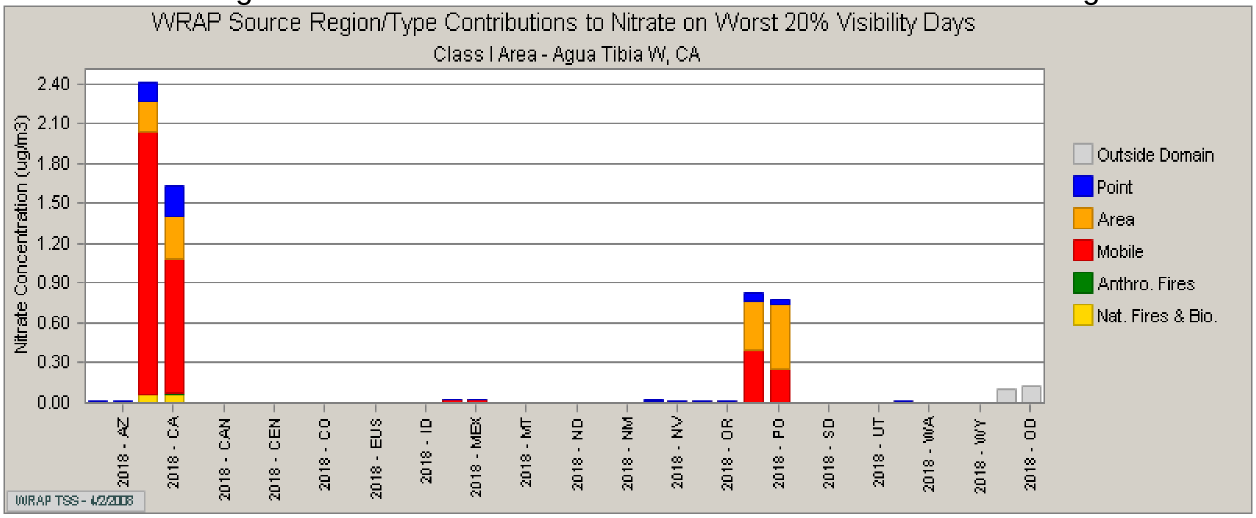


Figure 13. Organic carbon source contribution from CA and outside regions

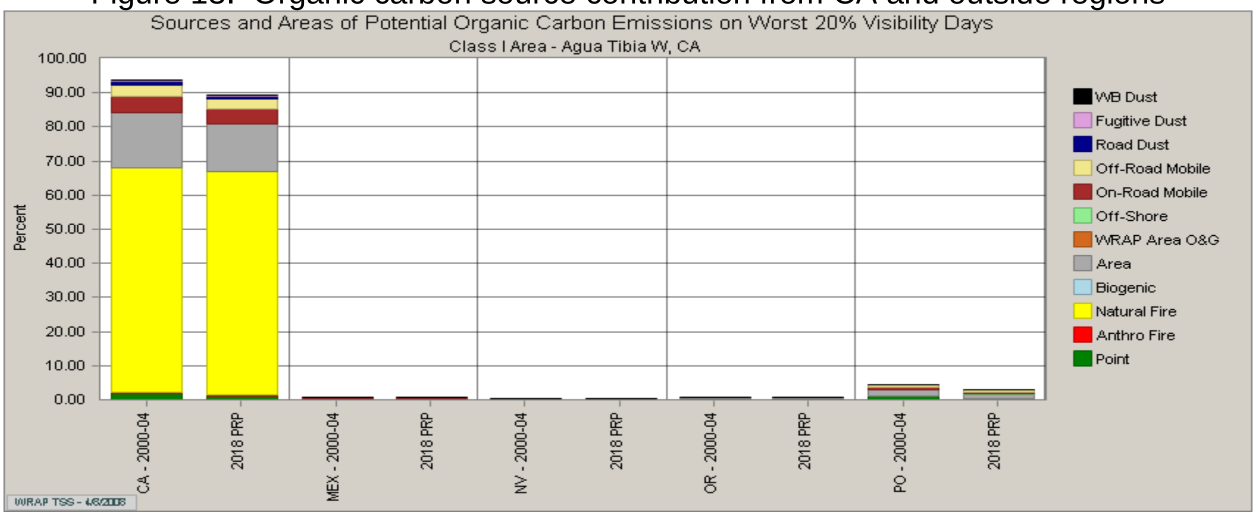
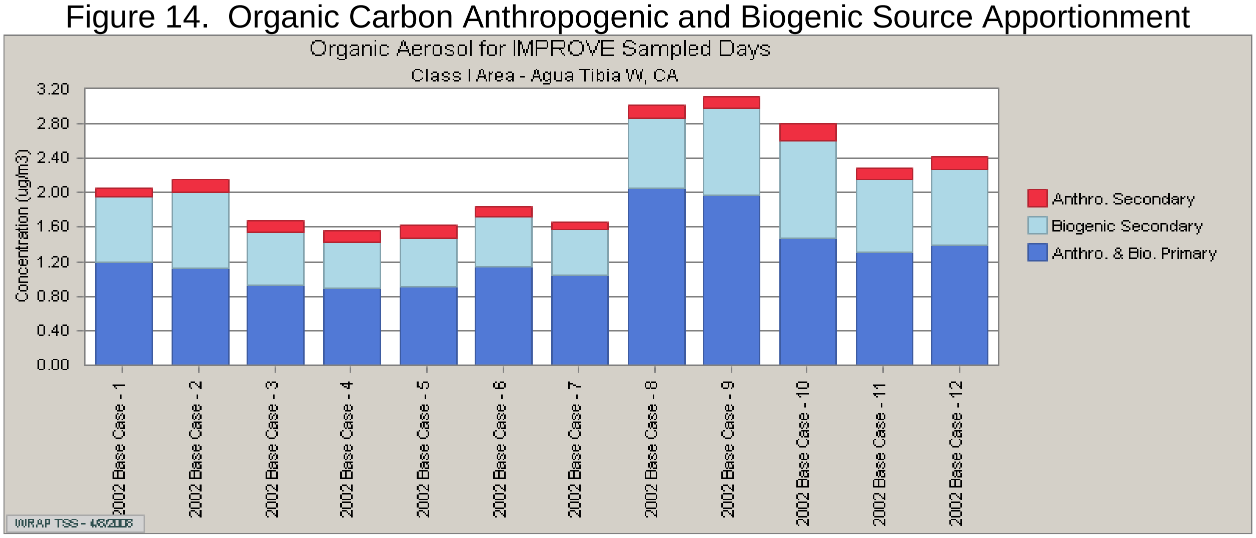


Figure 14. Organic Carbon Anthropogenic and Biogenic Source Apportionment



JOSH1 Monitor

Section I. Description

The Joshua Tree Wilderness Area consists of 429,690 acres within Joshua Tree National Park located in the eastern extent of the Mohave Desert of southern California, with the eastern portions also within the Sonoran Desert Physiographic province. It occupies a portion of the Little San Bernardino Mountains. Elevations range from just under 198 meters in the easternmost portions to near 960 meters at the highest peaks that include Quail Mountain in the west and Monument Mountain in the central portion. The eastern portion of the National Park consists of the dry Pinto Wash that drains to the east. Just to the west is the Whitewater River valley that includes the city of Palm Springs and urban areas near Banning. San Gorgonio Pass is also just west of the Wilderness and National Park. San Gorgonio Pass forms a break between the San Bernardino Mountains to the north and the San Jacinto Mountains to the south and is a natural corridor of air transport between the Mohave Desert and the eastern portions of the South Coast Air Basin.

Figure 1. Joshua Tree National Park

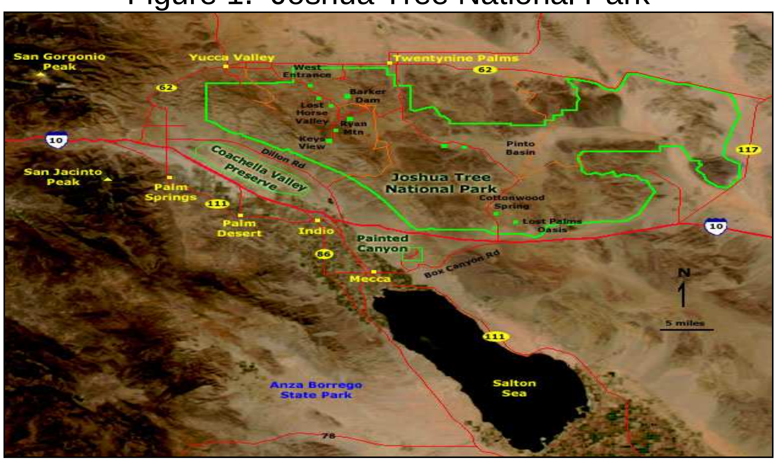


Figure 2. Joshua Tree National Park

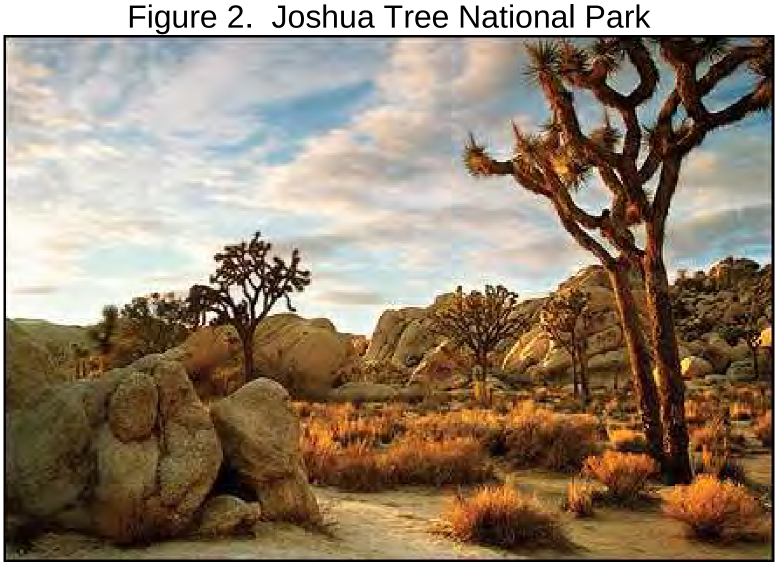


Figure 3. JOSH1 Monitor location in California

Section II. Visibility Conditions:

II.a. Visibility Monitor Location

Visibility conditions for the Joshua Tree Wilderness are currently monitored by the JOSH1 IMPROVE monitor. The monitor is located at 34.0695 north latitude and 116.3889 west longitude, near the northwestern Wilderness boundary at an elevation of 1235 meters. The site is close to the wilderness boundary on the west side and is at an elevation near the midrange of wilderness elevations. It should be very representative of aerosol characteristics within the Joshua Tree Wilderness Area. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

Nearby population centers include the Palm Springs area to the west and developed land near the northern boundary. Joshua Tree Wilderness is also near San Gorgonio Pass, which presents a potential corridor for emissions from the eastern South Coast Air Basin to the west. Potential transport routes into the Joshua Tree Wilderness include long distance transport via upward mixing from more distant source regions and transport into the region via upper level flow. Possible source regions include the South

Coast Air Basin to the west and surrounding desert terrain, especially to the north and east, as a source for windblown dust.

The JOSH1I location is adequate for assessing the 2018 reasonable progress goals for the Joshua Tree Wilderness Class 1 area.

II.b. Baseline Visibility

Baseline visibility is determined from JOSH1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Joshua Tree Wilderness Area is calculated at 6.1 deciviews for the 20% best days and 19.6 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

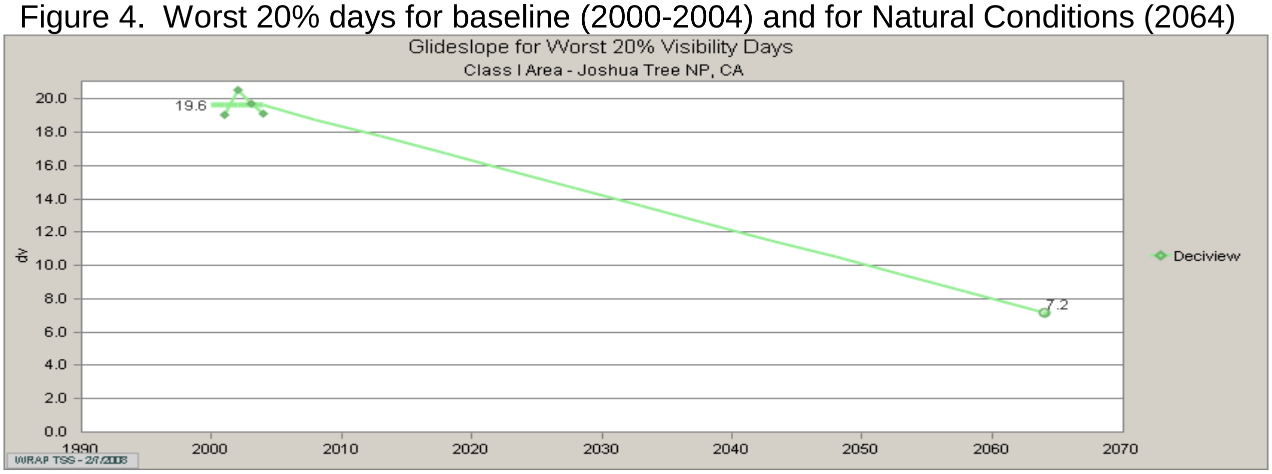
II.c. Natural Visibility

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Joshua Tree Wilderness Area is 1.7 deciviews for the 20% best days and 7.2 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

II.d. Presumptive Glide Slope and the Uniform Rate of Progress

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.72 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)



II.e. Species Contribution

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at JOSH1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

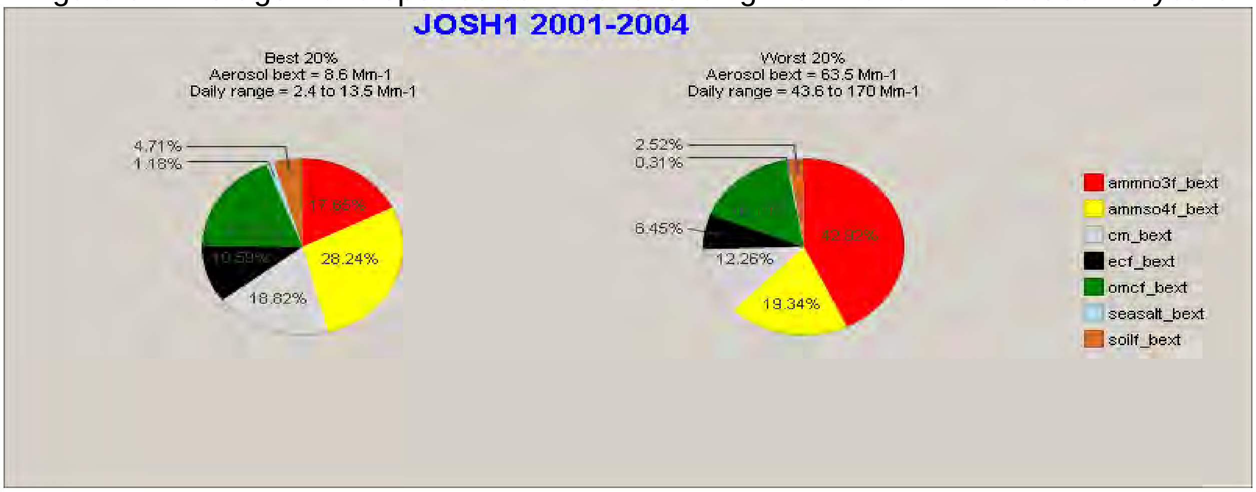
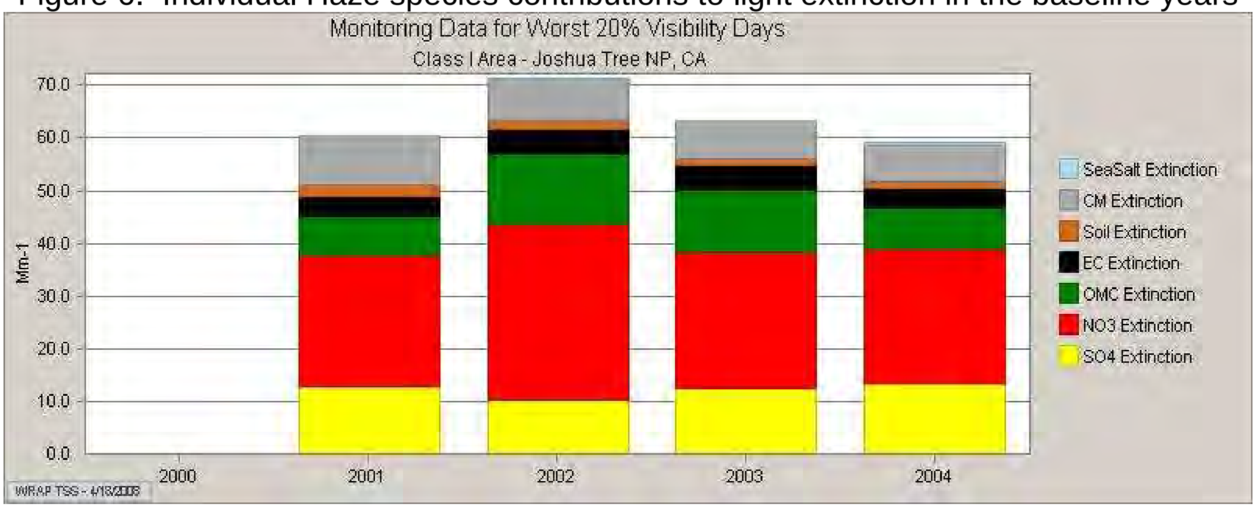


Figure 6. Individual Haze species contributions to light extinction in the baseline years



As shown in Figures 5 and 6, nitrates, sulfates, and organic matter have the strongest contributions to light extinction which degrade visibility on worst days at Joshua Tree National Park. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months, while sulfates increase slightly in the summer months. Organic matter increases in the summer. Nitrates clearly dominate the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of sea salt and soil seen throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

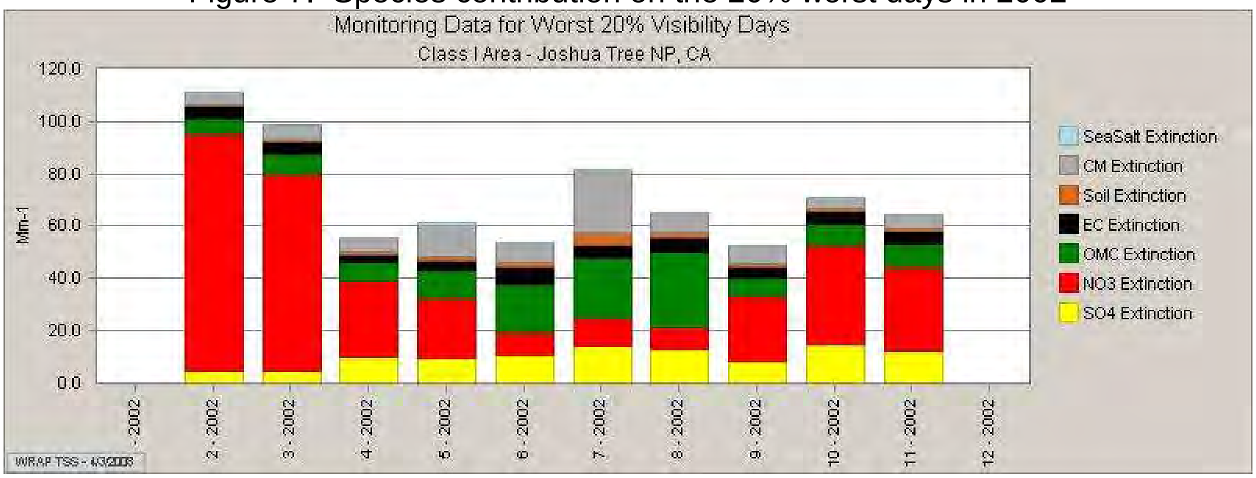
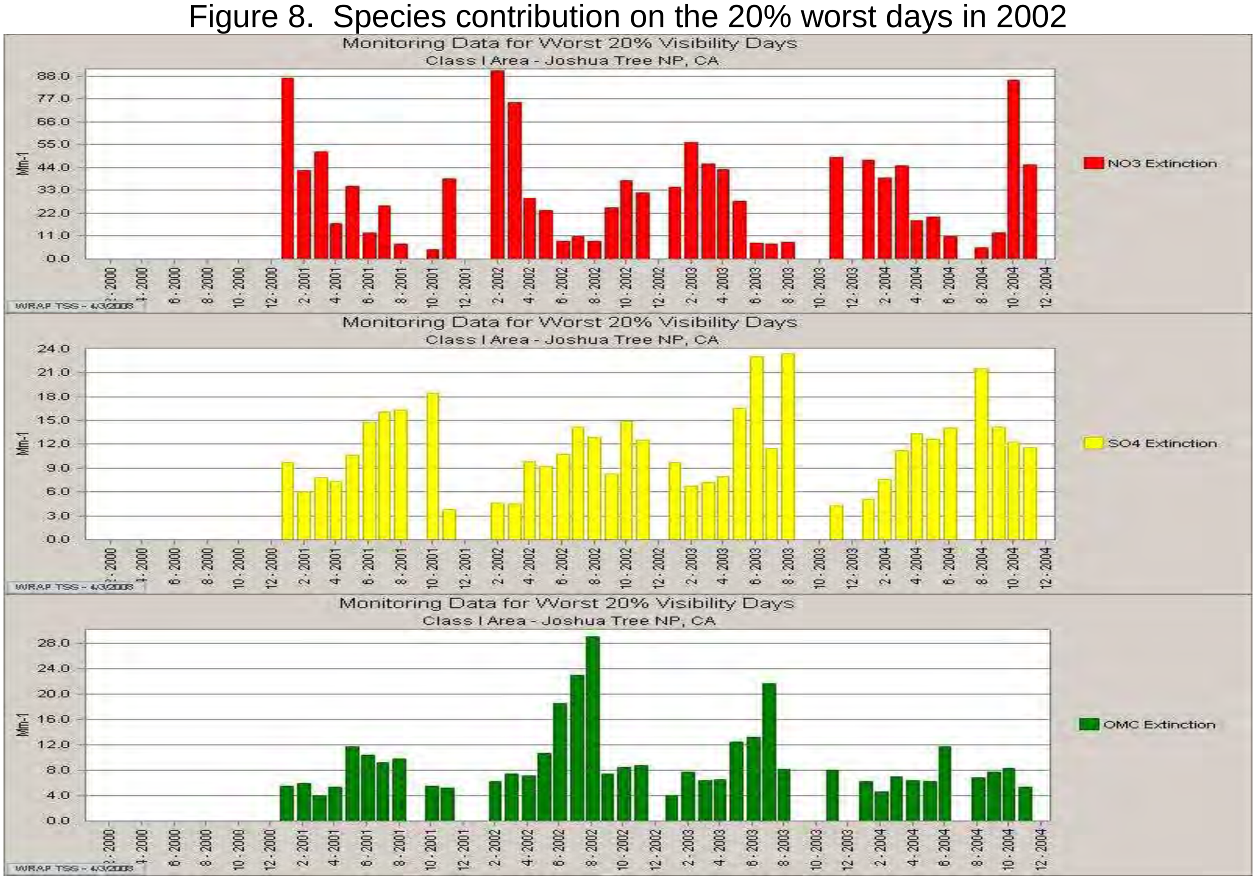


Figure 8. Species contribution on the 20% worst days in 2002



II.f. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at JOSH1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (81%), followed by the Pacific Offshore Region (15%) and emissions from Outside Domain (4%). Mobile sources within California contribute the most nitrate at the JOSH1 monitor. In 2002, 81% of the nitrate at the JOSH1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 11 and 12 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at JOSH1. The WRAP region represents 36% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (30%) and the Outside Domain Region (29%). California contributes 30% of the total sulfate emissions seen at the JOSH1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the JOSH1 monitor. The next largest contributor to sulfate concentrations is area sources in the Pacific Offshore Region.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the JOSH1 monitor is from natural fire sources within California. California represents 98% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 58% of the total organic carbon. Biogenic secondary emissions account for 36% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figure 9. Regional Nitrate contribution to Haze in 2002 and 2018

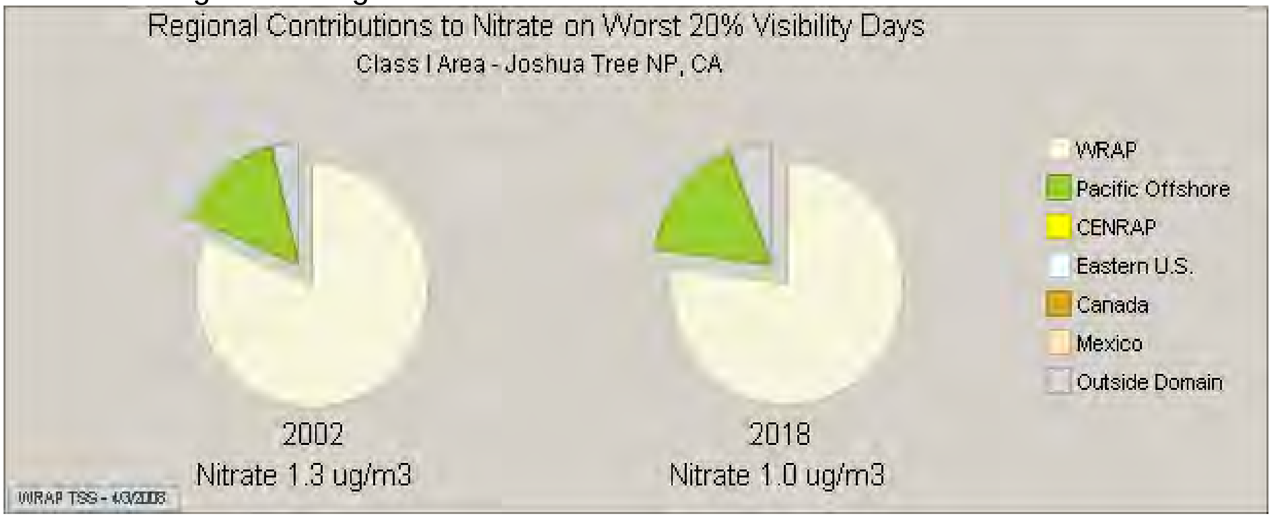


Figure 10. Nitrate source contribution from CA and outside regions

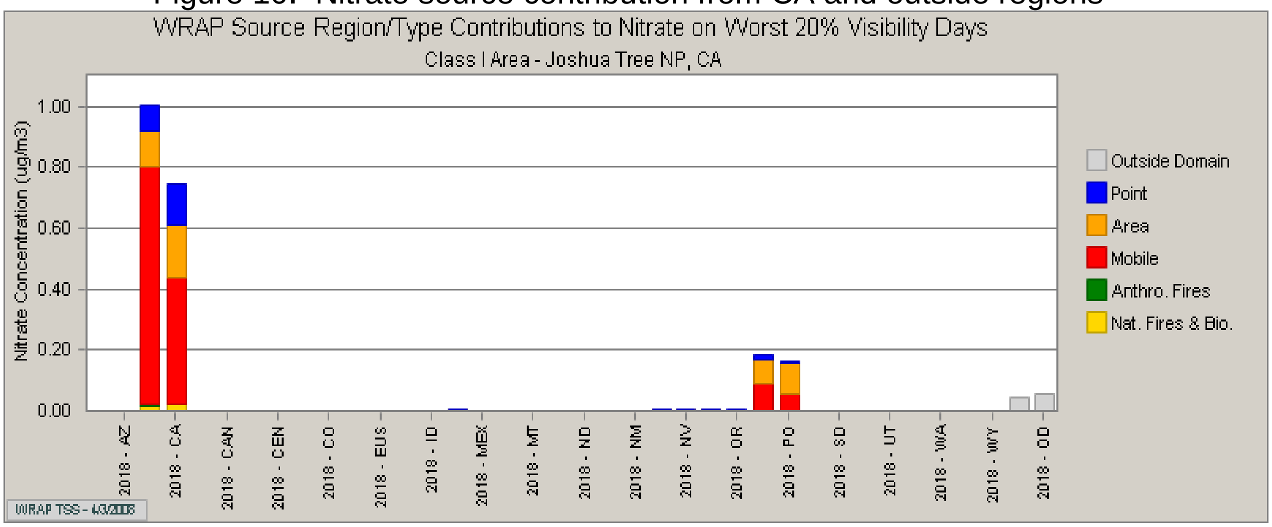


Figure 11. Regional Sulfate contribution to Haze in 2002 and 2018

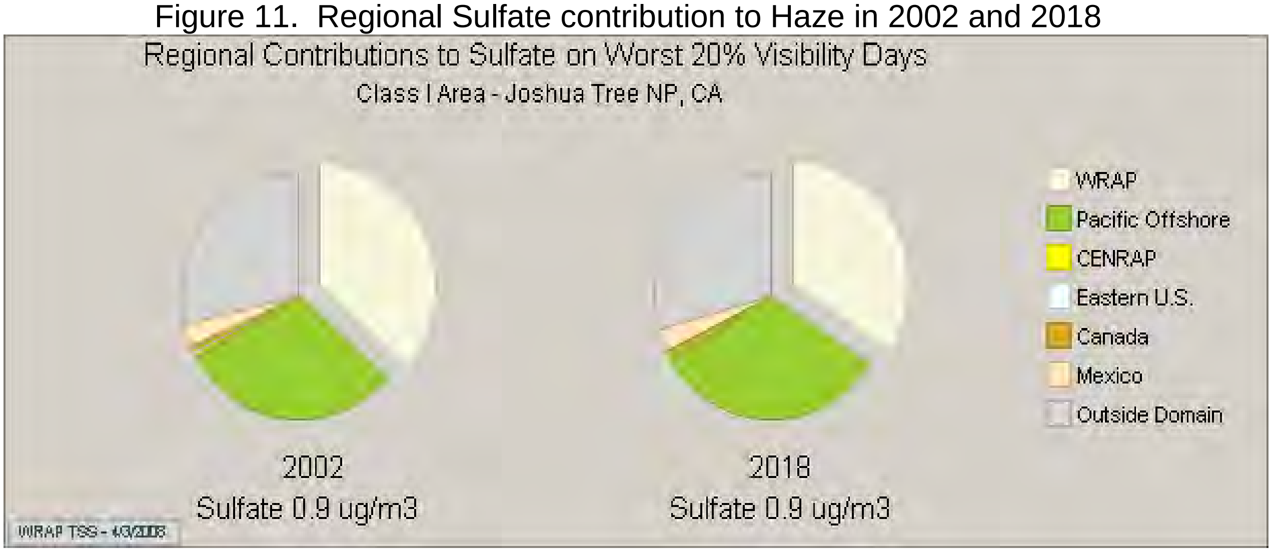


Figure 12. Sulfate source contribution from CA and outside regions

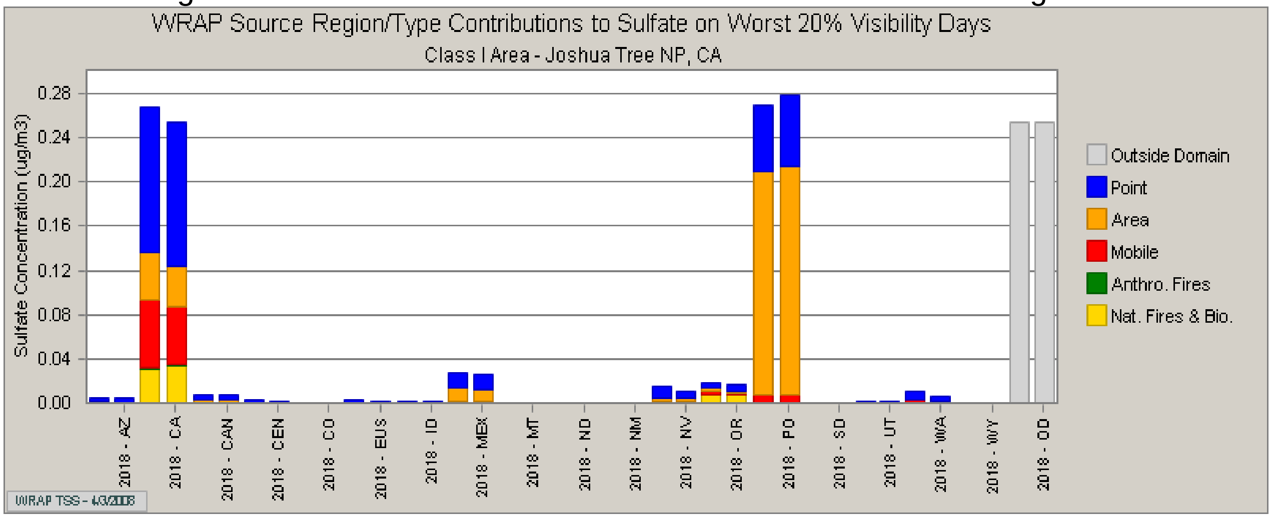


Figure 13. Organic carbon source contribution from CA and outside regions

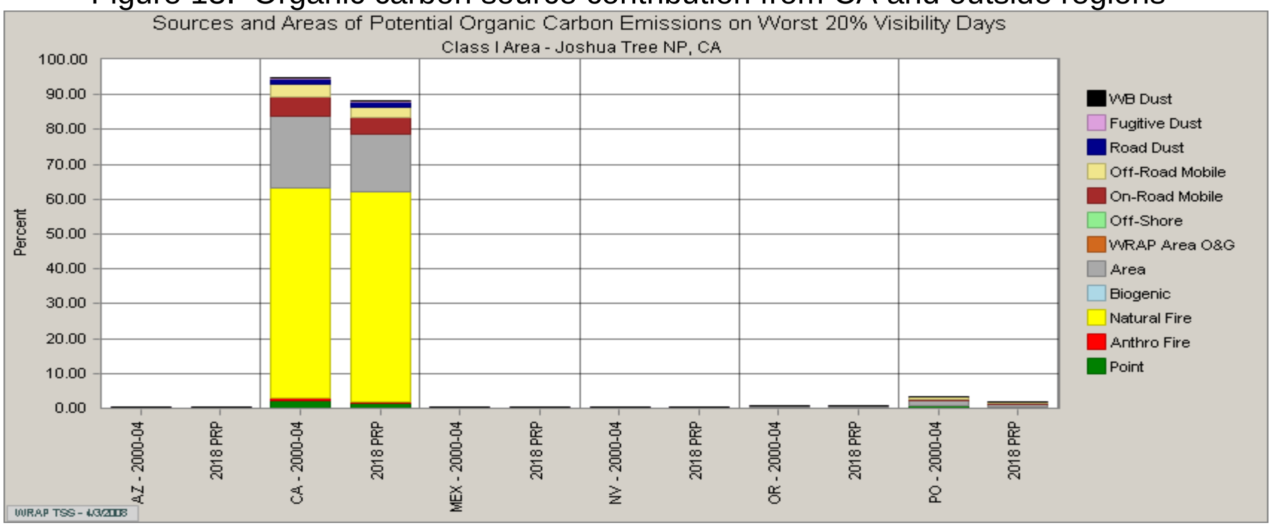
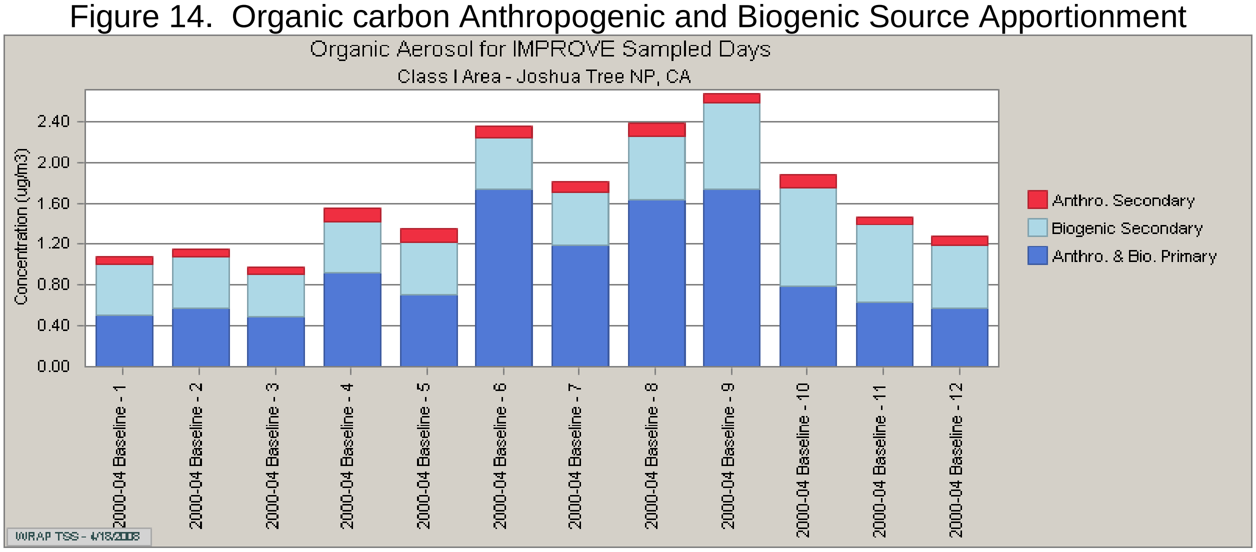


Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment



APPENDIX C

BART Cal-Puff Modeling

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Results of CALMET/CALPUFF BART Modeling for Class I Federal Area Individual Source Attribution Visibility Impairment

Prepared by:

Atmospheric Modeling and Support Section
Modeling and Meteorology Branch
Planning and Technical Support Division
California Air Resources Board

November 3, 2008

Acknowledgements:

The modeling results presented in this report are based on a modeling protocol (Appendix 1). The protocol is based on the EPA-approved modeling protocol submitted by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution control Division (APCD). The only major exception is that a different approach is taken to determine the natural background.

Table of Contents

1. Introduction

This document presents modeling results based on California Air Resources Board (ARB)'s modeling protocol for the initial phase of the Best Available Retrofit Technology (BART) modeling process, referred to as the "subject-to-BART" analysis, which includes SO_2, NO_x, and direct PM_{10} emissions from all BART-eligible units at a given facility.   A copy of the protocol is included in Appendix 1.

Code of Federal Regulations Title 40 Part 51 Appendix Y (hereafter referred to as the BART guideline) requires that the BART control equipment be used for any BART-eligible source that ''emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Federal Class I areas are defined in the Clean Air Act as national parks over 6,000 acres and wilderness areas and memorial parks over 5,000 acres, established as of 1977. Pursuant to the BART guideline, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area.

According to the BART guideline, a BART-eligible source is considered to "contribute" to visibility impairment in a Class I area if the modeled 98th percentile change in deciviews is equal to or greater than the "contribution threshold." Deciview (dv) is defined by and calculated directly from the total light extinction coefficient (b_{ext} expressed in inverse mega meters, Mm^{-1}):

$$dv = 10\ln(b_{ext} / 10Mm^{-1})$$

The deciview scale is nearly zero for a pristine atmosphere, and each deciview change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. Any BART-eligible source determined to cause or contribute to visibility impairment in any Class I area is subject to BART. Federal regulations implementing the BART requirement afford states some latitude in the criteria for determining whether a BART-eligible source is subject to BART. The ARB uses the "contribution threshold" of 0.5 deciviews for the 98th percentile 24-hour change in visibility (delta-deciview) because the BART guideline requires that the threshold is not higher than 0.5 deciviews.

Pursuant to the BART guideline and to prepare the submittal of a state implementation plan for regional haze, ARB staff performed air quality modeling with the CALPUFF modeling system to assess which BART-eligible sources in California are likely to be subject to BART. ARB staff applied CALPUFF with three years of meteorological data to determine if the 98th percentile 24-hour change in visibility (delta-deciview) from a BART-eligible source is equal to or greater than a contribution threshold of 0.5 deciviews (dv) at any Class I area.

The results presented in this initial subject-to-BART modeling cover eight BART-eligible sources. As such, additional modeling performed by ARB staff or source operators (with ARB's approval) may supersede these results. Subsequent modeling should use modeling techniques consistent with the recommendations in ARB's protocol and the BART guideline. ARB may approve deviations from this protocol for a specific source if the changes are acceptable to U.S. EPA and improve model performance while retaining consistency with the BART guideline. All modeling will be subject to ARB review and approval.

2. Short Description of Modeling Procedures

The modeling protocol was followed during the entire modeling process. The following is a short description of the steps involved in the modeling.

The modeling domain is shown in Figure 1. Also shown are locations of emission sources and receptors placed in Class I areas. The Lambert Conformal Conic projection modeling domain covers all Class I areas in California and the locations of California's BART-eligible sources that are required to do detailed modeling and analysis. The domain also includes Class I areas in nearby states that are potentially impacted by California BART-eligible sources. The modeling domain is extended by 50-km beyond all sources and Class I areas to capture potential recirculation of pollutants. The CALMET/CALPUFF domain is 1332 km x 1332 km in the longitudinal and meridional directions, respectively, with 4-kilometer grid resolution.

CALMET meteorological modeling has been conducted with three years of meteorological data. In the CALMET modeling, surface observational data collected at 279 stations and MM5 data generated by the prognostic meteorological model, MM5, along with geophysical data, are used.

CALPUFF uses CALMET output data and hourly ozone observational data as its input. CALPUFF generates hourly concentration data for visibility impact analysis.

The visibility impact analysis is performed with CALPOST. CALPOST processes the hourly, model-simulated concentration data. CALPOST calculates the visibility impact taking into account background concentrations of visibility-impairing pollutants and a relative humidity adjustment factor published by the U.S. EPA (1993).

3. Emission Data and Modeling Results

This section is organized by subject-to-BART facilities: each subsection describes emission data for an individual facility along with the corresponding visibility impairment modeling results. Visibility impairment pollutants included in the modeling are SO_2, NO_x and PM_{10}. Emission rates of sulfate, nitrate, elemental carbon, organic carbon, coarse particulates and soil are all set to zero but the background concentrations of these pollutants are considered in the post-processing stage so that their effects on visibility are taken into account to characterize natural conditions in Class I areas. Figure 1 gives an overview of the eight source locations and Class I areas.

The BART guideline requires that the 98^{th} percentile daily (24-hour) average of visibility impact be lower than 0.5 dv. Because there are 365 or 366 days in a year, 2 percent of total number of days in a year is 7 days plus a fraction of a day. Therefore the 98^{th} percentile of daily average will be the 8^{th} highest in a year.

Table 3.0.1 summarizes the maximum visibility impact on Class I areas from the BART-eligible sources, during the baseline years (2000-2002.)

Table 3.0.1. Summary of Visibility Impact

Facility	Maximum Impact (in deciviews)	Outcome (exceeds the 0.500 dv threshold?)
Conoco-Phillips Refinery and Carbon Plant in Bay Area	0.366	Does not exceed
Reliant Alta Boilers in Mojave Desert	0.489	Does not exceed
Searles Valley Minerals in Mojave Desert	0.208	Does not exceed
Rhodia Sulfuric Acid Plant in Bay Area	0.092	Does not exceed
Valero Refining Company in Bay Area	0.758*	Exceeds
Shell Refining Company in Bay Area	0.169	Does not exceed
Tesoro Marketing and Refining in Bay Area	0.069	Does not exceed
Chevron USA Inc in Bay Area	0.393	Does not exceed

* does not reflect proposed emission controls

BART sources and receptors placed in Class I areas

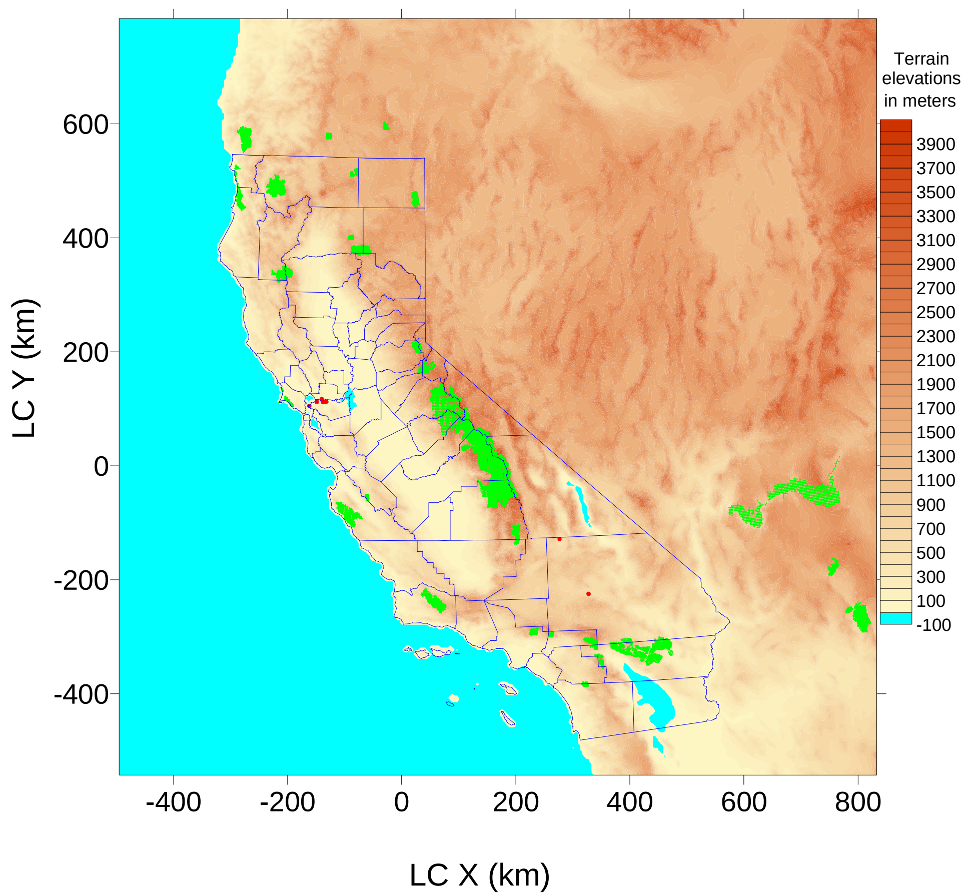

Figure 1. Class I areas and subject-to-BART sources for which initial visibility impairment analysis has been conducted.

3.1. Conoco-Phillips Refinery and Carbon Plant in Bay Area

3.1.1. Description of Emission Sources

The Conoco-Phillips Refinery and Carbon Plant is located at 2101 Franklin Canyon Road in Rodeo, California. There are 17 emission units that are considered as BART-eligible, of which the most significant emission source is a kiln that releases SO_2, NO_x and PM_{10}. The latitude and longitude of the kiln are 38°01'11.04" and 122°14'14.7'', respectively. Specifications of the major unit needed in the modeling are listed in Table 3.1.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.1.1. Source and Emission Parameters of Conoco-Phillips Refinery and Carbon Plant

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Kiln	42.98	45.72	4.17	4.35	505.3	31.528	11.035	5.044

3.1.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Conoco Phillips Refinery and Carbon Plant does not exceed 0.5 dv. Table 3.1.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Table 3.1.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.366	None
2001	0.343	None
2002	0.307	None

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination

3.2. Reliant Alta (Coolwater) Boilers in Mojave Desert

3.2.1. Description of Emission Sources

The Reliant Alta (Coolwater) Boilers are located at 37072 East Sante Fe Road in Daggett, California. Five emission units are considered as BART-eligible: a group of one boilers and turbines with five stacks that release SO2, NOx and PM10. The latitude and longitude of the units are 34°50’17.88” and 116°47’53.52’’, respectively. Specifications of the units needed in the modeling are listed in Table 3.2.1.

Table 3.2.1. Source and Emission Parameters of Alta (Coolwater) Boiler

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Boiler 1078	597.4	44.50	3.2	12.8	394.3	0.0657	12.698	0.214
Turbine 1079	597.4	21.64	5.49	10.61	449.8	0.102	19.65	0.315
Turbine 1080	597.4	21.64	5.49	10.61	449.8	0.0883	16.87	0.315
Turbine 1081	597.4	21.64	5.49	10.61	449.8	0.105	19.2	0.315
Turbine 1082	597.4	21.64	5.49	10.61	449.8	0.106	19.7	0.315

3.2.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Reliant Alta (Coolwater) Units does not exceed 0.5 dv. Table 3.2.2 lists the 8th highest visibility impact, name of the Class I area that is mostly impacted and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.5 dv.

Table 3.2.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.489	None
2001	0.406	None
2002	0.288	None

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

3.3. Searles Valley Minerals in Mojave Desert

3.3.1. Description of Emission Sources

The Searles Valley Minerals facility is located at 12801 Maripose Street in Trona, California. Two emission units are considered BART-eligible: two boilers with two stacks that release SO_2, NO_x and PM_{10}. The latitude and longitude of the boilers are 35°46'8.04" and 117°22'53.76'', respectively. Specifications of the units needed in the modeling are listed in Table 3.3.1.

Table 3.3.1. Source and Emission Parameters of Searles Valley Minerals

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Argus 554	510.5	64.01	3.505	13.589	325.9	2.748	23.262	0.930
Argus 555	510.8	64.31	3.505	13.594	326.5	3.195	23.252	0.967

3.3.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Searles Valley Minerals' boilers does not exceed 0.5 dv. Table 3.3.2 lists the 8th highest visibility impact, name of the Class I area that is mostly impacted and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.5 dv.

Table 3.3.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.192	None
2001	0.103	None
2002	0.208	None

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

3.4. Rhodia Sulfuric Acid Plant in Bay Area

3.4.1. Description of Emission Sources

The Rhodia Sulfuric Acid Plant is located at 100 Macoco Road in Martinez, California. Two emission units are considered as BART-eligible, one of which is a sulfuric acid plant stack that releases SO_2, NO_x and PM_{10}. The other emission unit, a combination of cooling towers, is included in the modeling but not shown in the following table because of its low emissions. The latitude and longitude of the plant are 38°01'59.8" and 122°06'59.8", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.4.1.

Table 3.4.1. Source and Emission Parameters of Rhodia Sulfuric Acid Plant

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Sulfuric acid plant	19.81	28.96	2.13	9.75	308.15	18.29	0.513	0.397

3.4.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Rhodia Acid Plant does not exceed 0.5 dv. Table 3.4.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.5 dv.

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

Table 3.4.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.092	None
2001	0.069	None
2002	0.081	None

3.5. Valero Refining Company in Bay Area

3.5.1. Description of Emission Sources

The Valero Refining Company is located at 3400 East 2nd Street in Benicia, California. There are 12 stacks collecting emissions from 17 units that are considered BART-eligible, of which the most significant emission source is a single stack, which is referred to as p1 main stack, collecting emissions from a crude preheat process furnace, a reduced crude preheat process furnace, a FCCU regenerator, and a coker. The latitude and longitude of the plant are 38°04'25.83" and 122°07'57.43'', respectively. Specifications of the major unit needed in the modeling are listed in Table 3.5.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table. In the table the source 'P1 main stack' received the SO_2, NO_x, and PM_{10} emissions from several units including the coker, crude preheat F-101, reduced preheat F-102, and FCCU regenerator R702.

Table 3.5.1. Source and Emission Parameters of Valero Refining Company

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
P1 main stack	28.96	141.73	4.57	22.31	607.6	179.18	21.754	5.15

3.5.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Valero Refining Company exceeds 0.5 dv. Table 3.5.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most, and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Because of the exceedance of the 0.5 dv threshold, control options must be evaluated for the source. A visibility impact analysis must be conducted for each proposed emission control measure. This analysis is part of the BART determination.

Table 3.5.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.758	Point Reyes National Seashore
2001	0.547	Point Reyes National Seashore
2002	0.524	Point Reyes National Seashore

Two emission reduction strategies were proposed for evaluation of their visibility impact. The maximum 24-hour emissions for normal operations were provided by the Bay Area Air Quality Management District. One emission reduction strategy (g1) was to reduce SO2, NOx and PM10 emissions from the coker, crude preheat F-101, reduced preheat F-102, and FCCU regenerator R702 that would be routed to a new main stack, and NO_x control on units that would be routed to the p30 west stack and the p31 stack. The other emission reduction strategy (g2) would, beyond g1, further reduce NO_x emissions from units that would be routed to the p19 west stack, p20 west stack, p17 west stack, p18 east stack, p24 stack and p25 stack. After the controls are placed, the emission unit with highest emissions is the new main stack, but the SO_2 emission rate is significantly reduced. For both g1 and g2, a new main stack will replace the existing p1 main stack. Therefore, some of the emission parameters will be different from what are shown in Table 3.5.1. Emission parameters for the new main stack are shown in Table 3.5.3.

Table 3.5.3. Emission Parameters of the New p1 Main Stack

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)
New main stack	17.53	65.53	4.57	25.07	378.98

Table 3.5.4 provides emission changes in grams/second while Table 3.5.5 provides percentage changes from baseline. Blank cells under the g1 or g2 columns denote that emissions are the same as baseline. The highlighted areas of the tables show that the g1 and g2 scenarios differ only in the treatment of NO_x from stacks P17-P20 and P24-P25.

Modeling analyses were conducted with the two emission reduction strategies. For g1 and g2, Tables 3.5.6 and 3.5.7 list, respectively, the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Table 3.5.4. Existing Emission Rates with Corresponding G1 and G2 **Rate (g/s)** Changes* from Existing

<table>
<tr><th rowspan="2">Source Description</th><th colspan="2">SO2 (g/s)</th><th colspan="2">PM10 (g/s)</th><th colspan="3">NOx (g/s)</th></tr>
<tr><th>Existing</th><th>g1 & g2</th><th>Existing</th><th>g1 & g2</th><th>Existing</th><th>g1</th><th>g2</th></tr>
<tr><td>Cooling Tower</td><td>0.00</td><td></td><td>1.16</td><td></td><td>0.00</td><td colspan="2"></td></tr>
<tr><td>New Main Stack</td><td>179.18</td><td>-167.20</td><td>5.15</td><td>-0.32</td><td>21.75</td><td colspan="2">-4.52</td></tr>
<tr><td>P30</td><td>0.21</td><td>0.11</td><td>0.21</td><td></td><td>1.37</td><td colspan="2">-0.95</td></tr>
<tr><td>P31</td><td>0.21</td><td>0.11</td><td>0.21</td><td>-0.11</td><td>1.37</td><td colspan="2">-1.05</td></tr>
<tr><td>P47</td><td>0.21</td><td></td><td>0.42</td><td></td><td>1.16</td><td colspan="2"></td></tr>
<tr><td>P50</td><td>0.00</td><td></td><td>0.00</td><td></td><td>0.02</td><td colspan="2"></td></tr>
<tr><td>P17</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.42</td><td></td><td>-2.10</td></tr>
<tr><td>P18</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.42</td><td></td><td>-2.10</td></tr>
<tr><td>P19</td><td>0.11</td><td></td><td>0.11</td><td></td><td>2.83</td><td></td><td>-2.41</td></tr>
<tr><td>P20</td><td>0.11</td><td></td><td>0.11</td><td></td><td>2.83</td><td></td><td>-2.41</td></tr>
<tr><td>P24</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.10</td><td></td><td>-1.79</td></tr>
<tr><td>P25</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.10</td><td></td><td>-1.79</td></tr>
</table>

* Blank cells have no change from baseline.

Table 3.5.5. Existing Emission Rates with Corresponding g1 and g2 **Percentage (%)** Changes* from Existing

<table>
<tr><th rowspan="2">Source Description</th><th colspan="2">SO2 (g/s)</th><th colspan="2">PM10 (g/s)</th><th colspan="3">NOx (g/s)</th></tr>
<tr><th>Existing</th><th>g1 & g2</th><th>Existing</th><th>g1 & g2</th><th>Existing</th><th>g1</th><th>g2</th></tr>
<tr><td>Cooling Tower</td><td>0.00</td><td></td><td>1.16</td><td></td><td>0.00</td><td colspan="2"></td></tr>
<tr><td>New Main Stack</td><td>179.18</td><td>-93%</td><td>5.15</td><td>-6%</td><td>21.75</td><td colspan="2">-21%</td></tr>
<tr><td>P30</td><td>0.21</td><td>+50%</td><td>0.21</td><td></td><td>1.37</td><td colspan="2">-69%</td></tr>
<tr><td>P31</td><td>0.21</td><td>+50%</td><td>0.21</td><td>-50%</td><td>1.37</td><td colspan="2">-77%</td></tr>
<tr><td>P47</td><td>0.21</td><td></td><td>0.42</td><td></td><td>1.16</td><td colspan="2"></td></tr>
<tr><td>P50</td><td>0.00</td><td></td><td>0.00</td><td></td><td>0.02</td><td colspan="2"></td></tr>
<tr><td>P17</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.42</td><td></td><td>-87%</td></tr>
<tr><td>P18</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.42</td><td></td><td>-87%</td></tr>
<tr><td>P19</td><td>0.11</td><td></td><td>0.11</td><td></td><td>2.83</td><td></td><td>-85%</td></tr>
<tr><td>P20</td><td>0.11</td><td></td><td>0.11</td><td></td><td>2.83</td><td></td><td>-85%</td></tr>
<tr><td>P24</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.10</td><td></td><td>-85%</td></tr>
<tr><td>P25</td><td>0.05</td><td></td><td>0.11</td><td></td><td>2.10</td><td></td><td>-85%</td></tr>
</table>

* Blank cells have no change from baseline.

Table 3.5.6. Visibility Impact Calculated with Three Years Worth of Meteorological Data (with emission reduction strategy g1)

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.225	None
2001	0.291	None
2002	0.259	None

Table 3.5.7 shows that g2 provides an additional reduction of 0.091 dv over g1 for modeling year 2001.

Table 3.5.7. Visibility Impact Calculated with Three Years Worth of Meteorological Data (with emission reduction strategy g2)

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.189	None
2001	0.200	None
2002	0.160	None

3.6. Shell Refining Company in Bay Area

3.6.1. Description of Emission Sources

The Shell Refining Company is located at 3485 Pacheco Blvd in Martinez, California. Four emission units are considered BART-eligible, of which the most significant emission source is a boiler that releases SO_2, NO_x and PM_{10}. The latitude and longitude of the boiler are 38°00’49.93” and 122°06’46.48’’, respectively. Specifications of the major unit needed in the modeling are listed in Table 3.6.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.6.1. Source and Emission Parameters of Shell Refining Company

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Boiler	17.00	49.00	2.40	15.44	550.2	18.843	9.784	0.546

3.6.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Shell Refining Company does not exceed 0.5 dv. Table 3.6.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Table 3.6.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.126	None
2001	0.169	None
2002	0.139	None

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

3.7. Tesoro Marketing and Refining in Bay Area

3.7.1. Description of Emission Sources

The Tesoro Marketing and Refining is located at 150 Solano Way in Martinez, California. There are four emission units that are considered as BART-eligible, of which the most significant emission source is a sulfur recovery unit with one stack that releases SO_2, NO_x and PM_{10}. The latitude and longitude of the sulfur recovery unit are 38°01'39.07" and 122°03'25.20'', respectively. Specifications of the major unit needed in the modeling are listed in Table 3.7.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.7.1. Source and Emission Parameters of Tesoro Marketing and Refining

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
Sulfur Recovery	7.01	106.68	1.83	0.82	535.9	10.648	0.016	0.00

3.7.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Tesoro Marketing and Refining does not exceed 0.5 dv. Table 3.7.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

Table 3.7.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.068	None
2001	0.055	None
2002	0.069	None

3.8. Chevron USA Inc. in Bay Area

3.8.1. Description of Emission Sources

The Chevron USA Inc. is located at 841 Chevron Way in Richmond, California. There are 38 emission units emitting to 31 stacks that are considered BART-eligible, of which the most significant emission source is a H2 reforming furnace that releases SO_2, NO_x and PM_{10}. The latitude and longitude of the H2 reforming furnace are 37°56'49.87" and 122°23'43.19'', respectively. Specifications of the major unit needed in the modeling are listed in Table 3.8.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.8.1. Source and Emission Parameters of Chevron USA Inc.

Source Description	Base Ev. (m)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	SO_2 (g/s)	NO_x (g/s)	PM_{10} (g/s)
H2 Reforming Furnace	2.70	49.38	2.80	16.20	644.3	0.339	20.494	0.722

3.8.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Chevron USA Inc. does not exceed 0.5 dv.
Table 3.8.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination. Also, controls will be placed on the reforming furnace reducing the baseline emissions from what was modeled. A consent decree imposes a limit on the H2 Reforming Furnace of 0.021 lb NOx/MMbtu.

Table 3.8.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

Modeling Year	The 8th highest visibility impact (in deciview)	Names of Class I areas with impact greater than 0.500 dv
2000	0.385	None
2001	0.393	None
2002	0.371	None

Reference:

"Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule." U.S. EPA, EPA-454/B-03-005. September 2003.

Appendix 1. Modeling Protocol: CALMET/CALPUFF BART Protocol for Class I Federal Area Individual Source Attribution Visibility Impairment Modeling Analysis

CALMET/CALPUFF BART Protocol for Class I Federal Area Individual Source Attribution Visibility Impairment Modeling Analysis

Prepared by:

Atmospheric Modeling and Support Section
Modeling and Meteorology Branch
Planning and Technical Support Division

August 2007

Acknowledgements:

This modeling protocol is based on the EPA-approved modeling protocol submitted by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution control Division (APCD). The only major exception is that a different approach is taken to determine the natural background.

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4. Introduction

Federal law requires Best Available Retrofit Technology (BART) for any BART-eligible source that ‘‘emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility” in any mandatory Class I federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area.

According to 40 CFR Part 51, Appendix Y (BART guideline), a BART-eligible source is considered to “contribute” to visibility impairment in a Class I area if the modeled 98th percentile change in deciviews is equal to or greater than the “contribution threshold.” Deciview (dv) is defined by and calculated directly from the total light extinction coefficient (b_{ext} expressed in Mm^{-1}):

$$dv = 10 \ln(b_{ext} / 10 Mm^{-1})$$

The deciview scale is nearly zero for a pristine atmosphere, and each deciview change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. Any BART-eligible source determined to cause or contribute to visibility impairment in any Class I area is subject to BART. Federal regulations implementing the BART requirement afford states some latitude in the criteria in determining whether a BART-eligible source is subject to BART. The ARB sets a “contribution threshold” of 0.5 deciviews for the 98th percentile 24-hour change in visibility (delta-deciview) because the BART guideline requires that the threshold not be higher than 0.5 deciviews.

This document serves as ARB’s modeling protocol for the initial phase of the BART modeling process, referred to as the “subject-to-BART” analysis, which includes SO_2, NO_x, and direct PM_{10} emissions from all BART-eligible units at a given facility.

Pursuant to the BART guideline and to prepare the submittal of a state implementation plan for regional haze, ARB staff will perform air quality modeling with the CALPUFF modeling system to assess which BART-eligible sources in California are likely to be subject to BART. ARB staff will apply CALPUFF with three years of meteorological data to determine if the 98th percentile 24-hour change in visibility (delta-deciview) from a BART-eligible source is equal to or greater than a contribution threshold of 0.5 deciviews at any Class I area.

ARB staff will use this protocol for the initial subject-to-BART modeling. However, additional modeling performed by ARB staff or source operators may supersede the results. Subsequent modeling should use modeling techniques consistent with the recommendations in this protocol and the BART guideline. ARB may approve deviations from this protocol for a specific source if the changes are acceptable to U.S. EPA and improve model performance while retaining consistency with the BART guideline. All modeling will be subject to ARB review and approval.

Relevant language from the BART guideline is included to show the modeling recommendations in context. Other sections of this protocol explain how the ARB proposes to implement the recommendations. The BART guidelines set out in 40 CFR Part 51, Appendix Y, are provided in part in Appendix _.

4.1. Visibility Calculations

The general theory for performing visibility calculations with the CALPUFF modeling system is described in several documents, including:

- "Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts" (IWAQM, 1998)
- "Federal Land Manager's Air Quality Related Values Workgroup (FLAG): Phase I Report" (FLAG, 2000)
- "A User's Guide for the CALPUFF Dispersion Model" (Scire, 2000)

In general, visibility is characterized either by visual range (the greatest distance that a large object can be seen) or by the light extinction coefficient, which is a measure of the light attenuation per unit distance due to scattering and absorption by gases and particles.

Visibility is impaired when light is scattered in and out of the line of sight and by light absorbed along the line of sight. The light extinction coefficient (b_{ext}) considers light extinction by scattering (b_{scat}) and light extinction by absorption (b_{abs}):

$$b_{ext} = b_{scat} + b_{abs}$$

The scattering components of extinction (b_{scat}) can be represented by these components:

- light scattering due to air molecules = Rayleigh scattering = $b_{rayleigh}$
- light scattering due to particles = b_{sp}

Additionally, particle scattering, b_{sp}, can be expressed by its components:

$$b_{sp} = b_{SO4} + b_{NO3} + b_{OC} + b_{SOIL} + b_{Coarse}$$

where:

b_{SO4} = scattering coefficient due to sulfates = $3[(NH_4)_2SO_4]f(RH)$
b_{NO3} = scattering coefficient due to nitrates = $3[NH_4NO_3]f(RH)$
b_{OC} = scattering coefficient due to organic aerosols = 4[OC]
b_{SOIL}= scattering coefficient due to fine particles = 1[Soil]
b_{Coarse}= scattering coefficient due to coarse particles = 0.6[Coarse Mass]

The f(RH) term is the relative humidity adjustment factor. The Federal Land Manager's Air Quality Related Values Workgroup (FLAG) (1999) recommends using historic averages of f(RH) for the Class I area(s) of concern. There exist several tabulations of monthly f(RH) values. In this modeling protocol we recommend using the US EPA 2003 tabulation (U.S. EPA, 2003, EPA-454/B-03-005) of f(RH).

The absorption components of extinction (b_{abs}) can be represented by these components:

- light absorption due to gaseous absorption = b_{ag}
- light absorption due to particle absorption = b_{ap}

According to FLAG (2000), nitrogen dioxide is the only major light-absorbing gas in the lower atmosphere; it generally does not affect hazes. Therefore only particle absorption is considered in the visibility analysis. Particle absorption from soot is defined as:

- b_{ap} = absorption due to elemental carbon (soot) = 10[EC]

The concentration values (in brackets) are expressed in micrograms per cubic meter. The numeric coefficient at the beginning of each equation is the dry scattering or absorption efficiency in meters-squared per gram.

Based on the discussion of scattering and absorption components above, the simple total atmospheric extinction equation provided on the prior page can be expanded and expressed as:

$$b_{ext} = (b_{SO4} + b_{NO3} + b_{OC} + b_{SOIL} + b_{Coarse}) + 10[EC] + b_{rayleigh}$$

In this equation, the sulfate (SO_4) and nitrate (NO_3) components are referred to as hygroscopic components because the extinction coefficient depends upon relative humidity. The other components are non-hygroscopic.

The CALPUFF modeling will provide ground level concentrations of visibility impairing pollutants such as sulfate and nitrate. These ground level concentrations will be used to calculate the extinction coefficient, b_{ext}, with the equations described above. Similarly, an extinction coefficient can be calculated for background concentrations of visibility impairing pollutants. If the extinction coefficient due to pollutants emitted from the BART source of concern is denoted as b_{source}, and the extinction coefficient due to background concentrations is denoted as $b_{background}$, then the delta-deciview, Δdv, value can be calculated as follows:

$$\Delta dv = 10\, ln((b_{background} + b_{source}) / b_{background}).$$

The delta-deciview is the change in visibility caused by the visibility impairing pollutants from the BART source of concern.

5. Emission Estimates

According to the BART guideline,

> "*The emissions estimates used in the models are intended to reflect steady-state operating conditions during periods of high capacity utilization. We do not generally recommend that emissions reflecting periods of start-up, shutdown, and malfunction be used, as such emission rates could produce higher than normal effects than would be typical of most facilities. We recommend that States use the 24 hour average actual emission rate from the highest emitting day of the meteorological period modeled, unless this rate reflects periods start-up, shutdown, or malfunction*."

Short-term emission rates (≤ 24-hours) should be modeled since visibility impacts are calculated for a 24-hour averaging period. SO_2, NO_x, and PM_{10} (including condensable and filterable direct PM_{10}[1]) should be modeled from all BART-eligible units at the facility. ARB staff will initially use allowable emission rates or federally enforceable emission limits. If 24-hour emissions limits do not exist, limits of a different averaging period may be used. Specifically, if limits do not exist, maximum hourly emissions based on emission factors and design capacity may be used.

If the source operator elects to develop emission rates for subject-to-BART modeling, case-by-case procedures should be developed in consultation with ARB staff. In general, the following emission rates are acceptable:

[1] Common speciated PM species for CALPUFF include fine particulate matter (PMF), coarse particulate matter (PMC), soot or elemental carbon (EC), organic aerosols (SOA), and sulfate (SO_4). H_2SO_4, for example, is a PM_{10} species emitted from coal-fired units that is typically modeled as SO_4 in CALPUFF.

- Short-term (≤ 24-hours) allowable emission rates (e.g., emission rates calculated using the maximum rated capacity of the source).
- Federally enforceable short-term limits (≤ 24-hours).
- Peak 24-hour actual emission rates (or calculated emission rates) from the most recent 3 to 5 years of operation that account for “high capacity utilization” during normal operating conditions and fuel/material flexibility allowed under the source's permit. In situations where a unit is allowed to use more than one fuel, the fuel resulting in the highest emission rates should be used for the modeling, even if that fuel has not been used in the last 3 to 5 years.

If short-term rates are not available, emissions rates based on averaging periods longer than 24-hours are acceptable only in cases where the modeling shows that the source has impacts equal to or greater than the contribution threshold.

6. CALMET/CALPUFF Modeling Methodology

For the subject-to-BART modeling, ARB staff will follow recommendations made by the CALPUFF developer to set model parameters and adjust some default settings to be more representative of terrain features in California.

ARB staff will use this protocol in the initial subject-to-BART modeling. However, the initial modeling may be superseded by additional modeling performed by ARB staff or the source operator. Subsequent modeling should use modeling techniques consistent with the recommendations in this protocol and the BART guideline. All modeling will be subject to review and approval by the ARB. The ARB may approve deviations from this protocol for a specific source if the changes are acceptable to U.S. EPA and improve model performance while retaining consistency with the BART guideline. This protocol is intended to provide sufficient technical documentation to support the application of CALPUFF at distances up to 300 kilometers. Impacts at Class I areas greater than 300 km may be used, but it should be recognized that the use of puff splitting in CALPUFF would provide more accurate results for Class I areas beyond 300km.

According to the “*Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*” (IWAQM Phase 2 Report):

In the context of the Phase 2 recommendation, the focus of the visibility analysis is on haze. These techniques are applicable in the range of thirty to fifty kilometers and beyond from a source. At source-receptor distances less than thirty to fifty kilometers, the techniques for analyzing visual plumes (sometimes referred to as 'plume blight') should be applied.

6.1. CALMET/CALPUFF Model Selection

The following versions will be used:

CALPUFF: version 5.754, level 060202,
CALMET: version 5.724, level 060414,
CALPOST: version 5.6393, level 060202.

This version of the CALPUFF modeling system is recommended by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) for BART analyses. The use of CALPUFF is recommended in 40 CFR 51 Appendix Y (BART guideline). The primary niche for CALPUFF is as a long-range transport model. It is a multi-layer, non-steady-state puff dispersion model that can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, chemical transformations, vertical wind shear, and deposition (Scire, 2000).

6.1.1. CALMET

CALMET is a diagnostic meteorological model. It has been under constant update and improvement by the developer (Scire, 2000). For this particular study, the model uses a Lambert Conformal Projection coordinate system to account for the Earth's curvature.

CALMET uses a two-step approach to calculate wind fields. In the first step, an initial-guess wind field is adjusted for slope flows and terrain blocking effects, for example, to produce a Step 1 wind field. In the second step, an objective analysis is performed to introduce observational data into the Step 1 wind field.

In this application, the initial guess wind fields are based on 12-km resolution MM5 meteorological fields for 2000 and 2002 and 36-km MM5 data for 2001 (i.e., in CALMET IPROG is set to 14). The MM5 files for 2000 were generated by ARB staff and the MM5 files for 2001 and 2002 were provided by WRAP. Because the 2000 MM5 data were generated specifically for applications in California, the data may be more reliable and more representative of the meteorological conditions of California. If modeling results for visibility impairment are substantially different for different years, more weight should be given to the year 2000 result.

The BART guideline does not specify the exact number of years of mesoscale meteorological data to be used in CALPUFF for subject-to-BART determination, but according to 40 CFR 51 Appendix W, at least three years of meteorological data should be used. Five years of meteorological data is preferable. At the time of developing this protocol and during the process of carrying out CALPUFF modeling and analysis, five years of mesoscale meteorological data will not be readily available at reasonable grid resolutions for California; therefore this protocol proposes to use three years of meteorological data for the CALMET/CALPUFF modeling.

6.1.1.1. CALMET Modeling Domain

The modeling domain is shown in Figure 1. Also shown are locations of receptors to be placed in Class I areas. It is based on a Lambert Conformal Conic projection. The domain covers all Class I areas in California and the locations of Californa's BART-eligible sources that are required to do detailed modeling and analysis. The domain also includes Class I areas in nearby states that are potentially impacted by California BART-eligible sources. The modeling domain is extended by 50-km beyond all sources and Class I areas to capture potential recirculation of pollutants. The CALMET domain is 1332 km x 1332 km in the longitudinal and meridional directions, respectively, with 4-kilometer grid resolution. This modeling domain will be used to generate a unified meteorological data set so that it can be used in CALPUFF modeling for all BART-eligible sources.

If a source operator elects to perform additional subject-to-BART modeling beyond ARB's initial modeling using a different CALMET/CALPUFF setup, the ARB may approve a smaller modeling domain on a case-by-case basis.
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BART sources and receptors placed in Class I areas

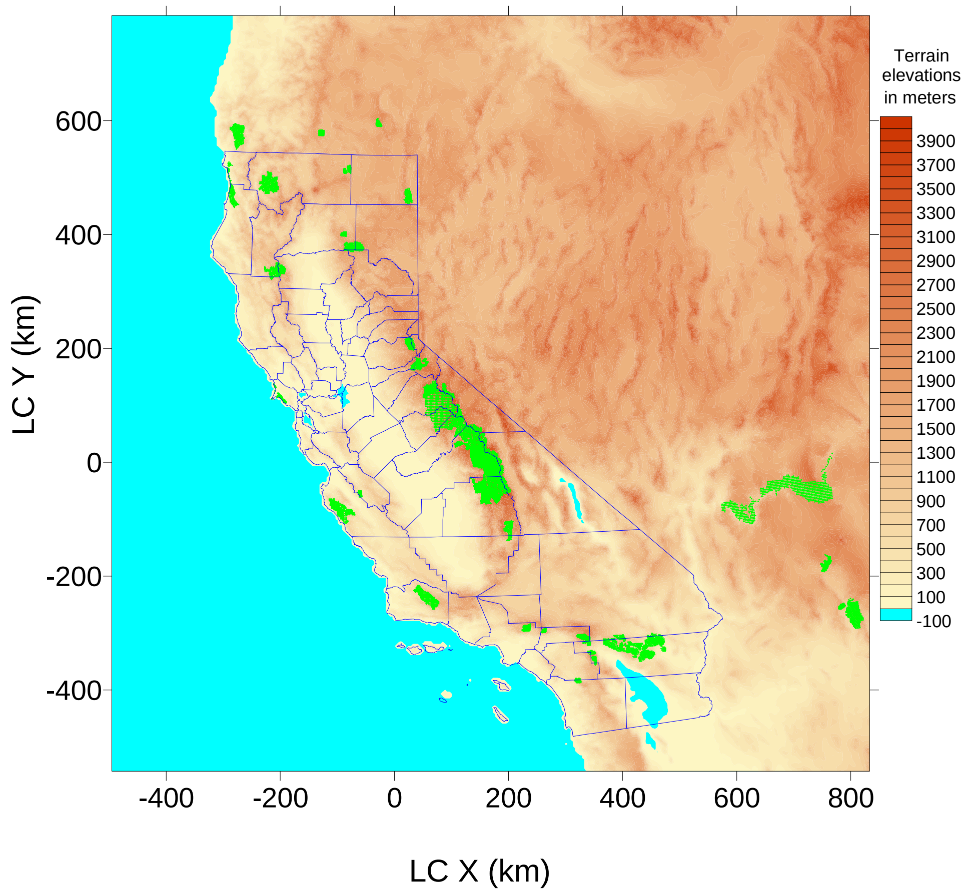

Figure 1. CALMET/CALPUFF modeling domain.

6.1.1.2. CALMET Performance Evaluation

The meteorological fields developed by the MM5/CALMET modeling system will be checked selectively as well as randomly for reasonableness using visualization tools. The reasonableness includes consistency of wind fields with terrain forcing, and diurnal variations of both wind and temperature fields. A comprehensive evaluation will not be conducted because of the lack of model performance evaluation guidelines

6.1.1.3. Terrain

Gridded terrain elevations for the modeling domain are derived from 3 arc-second digital elevation models (DEMs) produced by the United States Geological Survey (USGS). The files cover 1-degree by 1-degree blocks of latitude and longitude. USGS 1:250,000 scale DEMs were used. These DEM data have a resolution of about 90 meters. Terrain elevations are shown in Figure 1.

6.1.1.4. Land Use

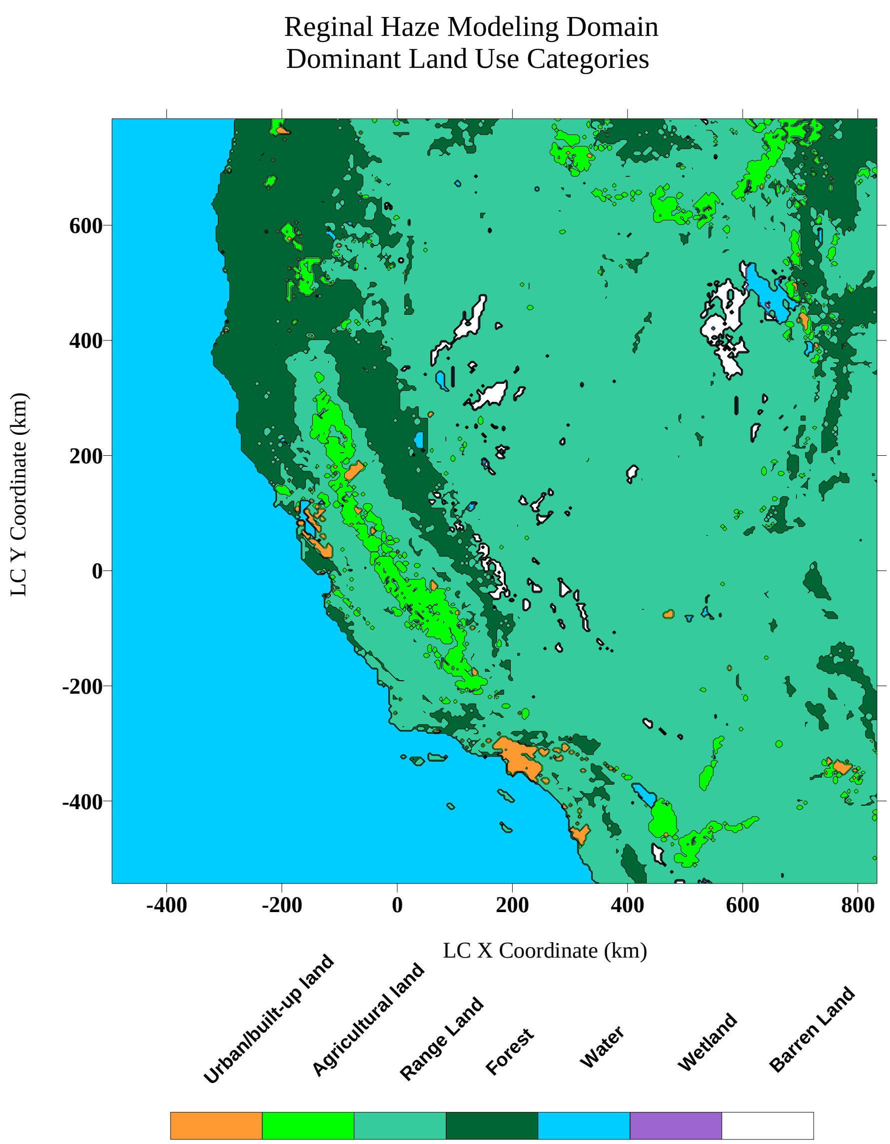

Figure 2. CALMET land use categories.

The land use data are based on the Composite Theme Grid format (CTG) using Level I USGS land use categories. The USGS land use categories will be mapped into 14 CALMET land use categories. Land use categories in the modeling domain are shown in Figure 2. The land use categories are described in Table 1.

Default CALMET Land Use Categories and Associated Geophysical Parameters
Based on the U.S. Geological Survey Land Use Classification System
(14-Category System)

Land Use Type	Description	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (W/m²)	Leaf Area Index
10	Urban or Built-up Land	1.0	0.18	1.5	.25	0.0	0.2
20	Agricultural Land - Unirrigated	0.25	0.15	1.0	.15	0.0	3.0
-20*	Agricultural Land - Irrigated	0.25	0.15	0.5	.15	0.0	3.0
30	Rangeland	0.05	0.25	1.0	.15	0.0	0.5
40	Forest Land	1.0	0.10	1.0	.15	0.0	7.0
51	Small Water Body	0.001	0.10	0.0	1.0	0.0	0.0
54	Bays and Estuaries	0.001	0.10	0.0	1.0	0.0	0.0
55	Large Water Body	0.001	0.10	0.0	1.0	0.0	0.0
60	Wetland	1.0	0.10	0.5	.25	0.0	2.0
61	Forested Wetland	1.0	0.1	0.5	0.25	0.0	2.0
62	Nonforested Wetland	0.2	0.1	0.1	0.25	0.0	1.0
70	Barren Land	0.05	0.30	1.0	.15	0.0	0.05
80	Tundra	.20	0.30	0.5	.15	0.0	0.0
90	Perennial Snow or Ice	.20	0.70	0.5	.15	0.0	0.0

* Negative values indicate "irrigated" land use

Table 1. Land use categories table from CALMET User's Guide.

6.1.1.5. CALMET ZFACE and ZIMAX Settings

Eleven vertical layers will be used with vertical cell face (ZFACE) heights at: 0, 20, 100, 200, 350, 500, 750, 1000, 2000, 3000, 4000, and 5000 meters. The minimum mixing height will be set to 50 m, and the maximum mixing height will be set to 3000 m.

6.1.1.6. CALMET BIAS Setting

The BIAS settings for each vertical cell determine the relative weight given to the vertically extrapolated surface meteorological observations and upper air soundings. The initial guess field is computed with an inverse distance weighting of the surface and upper air data. It can be modified by the layer-dependent bias factor (BIAS). The values for BIAS can range from –1.0 to 1.0. For example, if BIAS is set to +0.25, the weight of the surface wind observation is reduced by 25%. If BIAS is set to –0.25, the weight of the upper air wind observation is reduced by 25%. If BIAS is set to zero, there is no change in the weighting from the normal inverse distance squared weighting. As recommended by the National Park Service (NPS), the default values of 0.0 will be used for all 11 vertical layers in this analysis.

6.1.1.7. CALMET RMIN2 and IXTERP Settings

Vertical extrapolation of data from a surface station is skipped if the surface station is close to the upper air station. The variable RMIN2 sets the distance between an upper air station and a surface station that must be exceeded in order for the extrapolation to take place. RMIN2 will be set to the default value of 4, as recommended by the NPS. The default value of –4 for IEXTRP is used. By setting IEXTRP to –4 (as opposed to +4), layer 1 data at upper air stations is ignored. When IEXTRP=±4, the van Ulden and Holtslag wind extrapolation method is used. The method uses similarity theory and observed data to extend the influence of the surface wind speed and direction aloft.

6.1.1.8. CALMET Settings: R1, R2, RMAX1, RMAX2, RMAX3

An inverse-distance method is used to determine the influence of observations in the Step 1 wind field. R1 controls weighting of the surface layer and R2 controls weighting of the layers aloft. For example, R1 is the distance from an observational station at which the observation and first guess field are equally weighted. In addition, RMAX1, RMAX2, and RMAX3 determine the radius of influence over land in the surface layer, over land in layers aloft, and over water, respectively. That is, an observation is excluded if the distance from the observational site to a given grid point exceeds the maximum radius of influence. As recommended by the NPS, R1 and RMAX1 will be set to 30 km so that the initial guess field does not overwhelm the surface observations. R2 is set to 50 km and RMAX2 is set to 100 km. For over water surface observation both R3 and RMAX3 are set to 30 km, the same as the parameters for over land stations.

6.1.1.9. CALMET Surface Stations

The National Climatology Data Center (NCDC) surface observational data at 279 stations will be used in this initial analysis. The locations of these surface meteorological stations are shown in Figure 3.

6.1.1.10. CALMET Upper Air Stations

The initial analysis will not consider upper air observational data for mainly two reasons. The first reason is that a substantial amount of data are missing, and there exists no rigorous method to fill in missing data. Filling in missing data arbitrarily will likely alter the meteorological field generated by the CALMET model. The other reason is that, since the output of the MM5 mesoscale meteorological model provides an adequate coverage of upper air meteorology, neglecting upper air observational data will have an insignificant effect on the CALMET meteorological field. Future analyses may consider upper air observational data.

6.1.1.11. *CALMET Precipitation Stations*

The initial analysis will not consider precipitation data. Future analyses may consider observational precipitation data.

Locations of surface meteorological stations

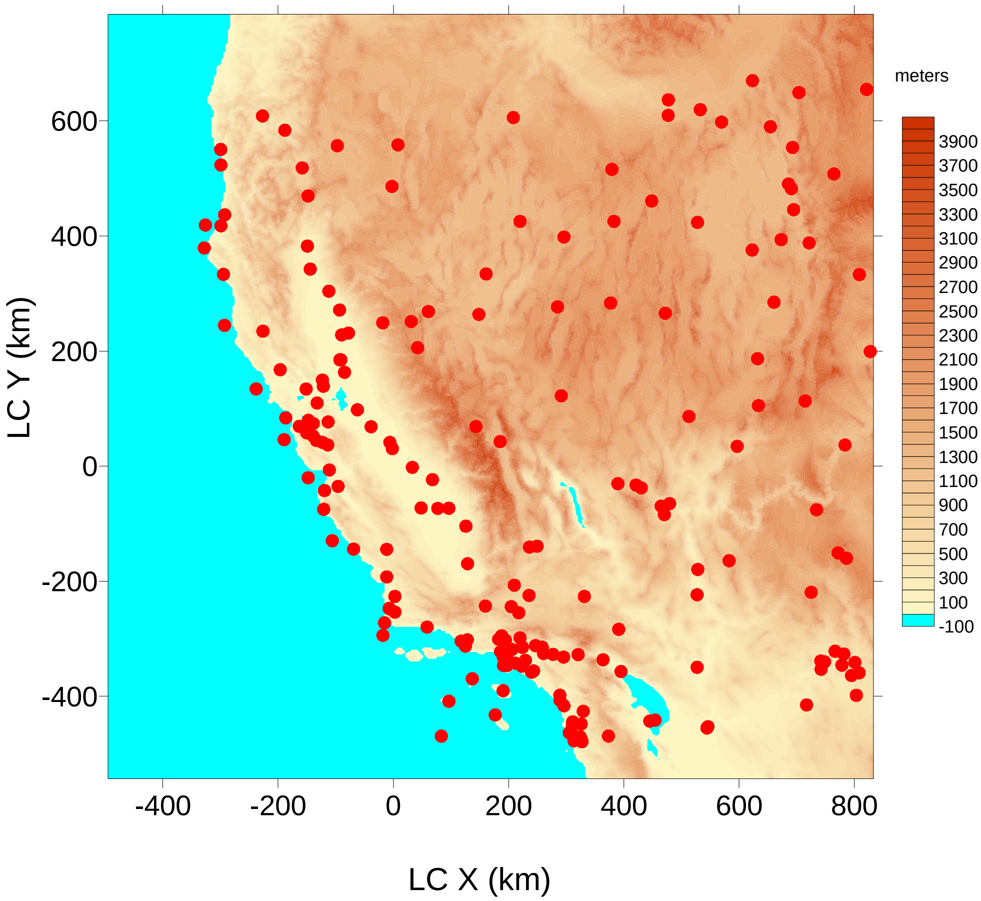

Figure 3. Locations of surface meteorological stations.

6.1.1.12. *CALMET Parameter Summary*

Table 2 summarizes some of the key CALMET parameters.

Variable	Description	EPA Default	Our Values
GEO.DAT	Name of Geophysical data file	GEO.DAT	GEO.DAT
SURF.DAT	Name of Surface data file	SURF.DAT	SURF.DAT
PRECIP.DAT	Name of Precipitation data file	PRECIP.DAT	NA
NUSTA	Number of upper air data sites	User Defined	0
UPn.DAT	Names of NUSTA upper air data files	UPn.DAT	NA
IBYR	Beginning year	User Defines	User Defines
IBMO	Beginning month	User Defines	User Defines

Variable	Description	EPA Default	Our Values
IBDY	Beginning day	User Defines	User Defines
IBHR	Beginning hour	User Defines	User Defines
IBTZ	Base time zone	User Defines	8
IRLG	Number of hours to simulate	User Defines	User Defines
IRTYPE	Output file type to create (must be 1 for CALPUFF)	1	1
LCALGRD	Are w-components and temperature needed?	T	T
NX	Number of east-west grid cells	User Defines	333
NY	Number of north-south grid cells	User Defines	333
DGRIDKM	Grid spacing	User Defines	4
XORIGKM	Southwest grid cell X coordinate	User Defines	-497.152
YORIGKM	Southwest grid cell Y coordinate	User Defines	-544.910
XLATO	Southwest grid cell latitude	User Defines	31.856
YLONO	Southwest grid cell longitude	User Defines	125.797
IUTMZN	UTM Zone	User Defines	NA
XLAT1	Latitude of 1st standard parallel	30	30
XLAT2	Latitude of 2nd standard parallel	60	60
RLON0	Longitude used if LLCONF = T	90	120.5
RLAT0	Latitude used if LLCONF = T	40	37
NZ	Number of vertical Layers	User Defines	12
ZFACE	Vertical cell face heights (NZ+1 values)	User Defines	0,20,40,80,160,300,600,1000,1500,2000,3000,4000, and 5000
LSAVE	Save met. Data fields in an unformatted file?	T	T
IFORMO	Format of unformatted file (1 for CALPUFF)	1	1
NSSTA	Number of stations in SURF.DAT file	User Defines	279
NPSTA	Number of stations in PRECIP.DAT	User Defines	0
ICLOUD	Is cloud data to be input as gridded fields? 0=No)	0	0
IFORMS	Format of surface data (2 = formatted)	2	2
IFORMP	Format of precipitation data (2= formatted)	2	2
IFORMC	Format of cloud data (2= formatted)	2	2
IWFCOD	Generate winds by diagnostic wind module? (1 = Yes)	1	1
IFRADJ	Adjust winds using Froude number effects? (1= Yes)	1	1
IKINE	Adjust winds using Kinematic effects? (1 = Yes)	0	0
IOBR	Use O'Brien procedure for vertical winds? (0 = No)	0	0
ISLOPE	Compute slope flows? (1 = Yes)	1	1
IEXTRP	Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data)	-4	-4

Variable	Description	EPA Default	Our Values
ICALM	Extrapolate surface calms to upper layers? (0 = No)	0	0
BIAS	Surface/upper-air weighting factors (NZ values)	NZ*0	NZ*0
IPROG	Using prognostic or MM-FDDA data? (0 = No)	0	14
LVARY	Use varying radius to develop surface winds?	F	F
RMAX1	Max surface over-land extrapolation radius (km)	User Defines	30
RMAX2	Max aloft over-land extrapolations radius (km)	User Defines	30
RMAX3	Maximum over-water extrapolation radius (km)	User Defines	50
RMIN	Minimum extrapolation radius (km)	0.1	0.1
RMIN2	Distance (km) around an upper air site where vertical extrapolation is excluded (Set to –1 if IEXTRP = ±4)	4	4
TERRAD	Radius of influence of terrain features (km)	User Defines	50
R1	Relative weight at surface of Step 1 field and obs	User Defines	1.0
R2	Relative weight aloft of Step 1 field and obs	User Defines	1.0
DIVLIM	Maximum acceptable divergence	5.E-6	5.E-6
NITER	Max number of passes in divergence minimization	50	50
NSMTH	Number of passes in smoothing (NZ values)	2,4*(NZ-1)	2,4*(NZ-1)
NINTR2	Max number of stations for interpolations (NA values)	99	99
CRITFN	Critical Froude number	1	1
ALPHA	Empirical factor triggering kinematic effects	0.1	0.1
IDIOPT1	Compute temperatures from observations (0 = True)	0	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	User Defines	1
IDIOPT2	Compute domain-average lapse rates? (0 = True)	0	0
IUPT	Station for lapse rates (between 1 and NUSTA)	User Defines	NA
ZUPT	Depth of domain-average lapse rate (m)	200	200
IDIOPT3	Compute internally initial guess winds? (0 = True)	0	0
IUPWND	Upper air station for domain winds (-1 = 1/r**2 interpolation of all stations)	-1	-1
ZUPWND	Bottom and top of layer for 1st guess winds (m)	1,1000	1,1000

Variable	Description	EPA Default	Our Values
IDIOPT4	Read surface winds from SURF.DAT? (0 = True)	0	0
IDIOPT5	Read aloft winds from UPn.DAT? (0 = True)	0	0
CONSTB	Neutral mixing height B constant	1.41	1.41
CONSTE	Convective mixing height E constant	0.15	0.15
CONSTN	Stable mixing height N constant	2400	2400
CONSTW	Over-water mixing height W constant	0.16	0.16
FCORIOL	Absolute value of Carioles parameter	1.E-4	1.E-4
IAVEXZI	Spatial averaging of mixing heights? (1 = True)	1	1
MNMDAV	Max averaging radius (number of grid cells)	1	1
HAFANG	Half-angle for looking upwind (degrees)	30	30
ILEVZI	Layer to use in upwind averaging (between 1 and NZ)	1	1
DPTMIN	Minimum capping potential temperature lapse rate	0.001	0.001
DZZI	Depth for computing capping lapse rate (m)	200	200
ZIMIN	Minimum over-land mixing height (m)	50	50
ZIMAX	Maximum over-land mixing height (m)	3000	3000
ZIMINW	Minimum over-water mixing height (m)	50	50
ZIMAXW	Maximum over-water mixing height (m)	3000	3000
IRAD	Form of temperature interpolation (1 = 1/r)	1	1
TRADKM	Radius of temperature interpolation (km)	500	500
NUMTS	Max number of stations in temperature interpolations	5	5
IAVET	Conduct spatial averaging of temperature? (1 = True)	1	0
TGDEFB	Default over-water mixed layer lapse rate (K/m)	-0.0098	-0.0098
TGDEFA	Default over-water capping lapse rate (K/m)	-0.0045	-0.0045
JWAT1	Beginning landuse type defining water	999	999
JWAT2	Ending landuse type defining water	999	999
NFLAGP	Method for precipitation interpolation (2= 1/r**2)	2	2
SIGMAP	Precip radius for interpolations (km)	100	100
CUTP	Minimum cut off precip rate (mm/hr)	0.01	0.01

Variable	Description	EPA Default	Our Values
SSn	NSSTA input records for surface stations	User Defines	NA
Usn	NUSTA input records for upper-air stations	User Defines	NA
PSn	NPSTA input records for precipitations stations	User Defines	NA

NA = Not Applicable

Table 2. CALMET parameter summary.

6.1.2. CALPUFF

CALPUFF is a multi-layer, multi-species non-steady-state Gaussian puff dispersion which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, subgrid scale terrain interactions as well as longer range effects such as pollutant removal (wet scavenging and dry deposition), chemical transformation, vertical wind shear, overwater transport and coastal interaction effects.

The default technical options in CALPUFF should be used, unless specified otherwise in this protocol. If non-default options or values are used, the reason should be explained and justified in the modeling report.

6.1.2.1. Receptor Network and Class I Federal Areas

The modeling domain should contain all Class I federal areas in California within 300 kilometers of the BART-eligible source. Class I areas outside California within 300 kilometers of any California BART-eligible sources should be included. The setup will include 29 Class I federal areas in California:

Agua Tibia Wilderness Area	Ansel Adams Wilderness Area
Caribou Wilderness Area	Cucamonga Wilderness Area
Desolation Wilderness Area	Domeland Wilderness Area
Emigrant Wilderness Area	Hoover Wilderness Area
John Muir Wilderness Area	Joshua Tree National Park
Kaiser Wilderness Area	Kings Canyon National Park
Lassen Volcanic National Park	Lava Beds National Monument
Marble Mountain Wilderness Area	Mokelumne Wilderness Area
Pinnacles National Monument	Point Reyes National Seashore
Redwood National Park	San Gabriel Wilderness Area
San Gorgonio Wilderness Area	San Jacinto Wilderness Area
San Rafael Wilderness Area	Sequoia National Park

South Warner Wilderness Area	Thousand Lakes Wilderness Area
Ventana Wilderness Area	Yolla Bolly-Middle Eel Wilderness Area
Yosemite National Park	

Another seven Class I areas outside of California will also be included in the modeling because they are potentially affected by California BART-eligible sources. These Class I areas are:

Kalmiopsis Wilderness Area	Grand Canyon National Park
Mountain Lakes Wilderness Area	Sycamore Canyon Wilderness Area
Gearhart Mountain Wilderness Area	Mazatzal Wilderness Area
Pine Mountain Wilderness Area	

The receptors for all of the Class I federal areas were generated by the National Park Service (NPS) using the *NPS Convert Class I Areas* (NCC) computer program. All receptor locations and the computer program are available for download at http://www2.nature.nps.gov/air/maps/Receptors/index.cfm#top. Receptor elevations provided by the NPS conversion program will be used in the modeling.

All receptors will be included in a single CALPUFF simulation. To calculate the visibility impacts in CALPOST for each Class I area, the NCRECP parameter can be used. It specifies the receptor range to be processed in CALPOST.

6.1.2.2. CALPUFF Meteorology

Refer to the CALMET section of the report for details.

6.1.2.3. CALPUFF Modeling Domain

The CALPUFF modeling domain is identical to the CALMET modeling domain.

6.1.2.4. CALPUFF Parameter Summary

Table 3 summarizes some of the key CALPUFF settings.

Variable	Description	EPA Default	Our Values
METDAT	CALMET input data filename	CALMET.DAT	CALMET.DAT
PUFLST	Filename for general output from CALPUFF	CALPUFF.LST	CALPUFF.LST
CONDAT	Filename for output concentration data	CONC.DAT	CONC.DAT
DFDAT	Filename for output dry deposition fluxes	DFLX.DAT	DFLX.DAT
WFDAT	Filename for output wet deposition fluxes	WFLX.DAT	WFLX.DAT
VISDAT	Filename for output relative humidities (for	VISB.DAT	VISB.DAT

Variable	Description	EPA Default	Our Values
	visibility)		
METRUN	Do we run all periods (1) or a subset (0)?	0	0
IBYR	Beginning year	User Defined	User Defined
IBMO	Beginning month	User Defined	User Defined
IBDY	Beginning day	User Defined	User Defined
IBHR	Beginning hour	User Defined	User Defined
IRLG	Length of runs (hours)	User Defined	User Defined
NSPEC	Number of species modeled (for MESOPUFF II chemistry)	5	6
NSE	Number of species emitted	3	3
MRESTART	Restart options (0 = no restart), allows splitting runs into smaller segments	0	1
METFM	Format of input meteorology (1 = CALMET)	1	1
AVET	Averaging time lateral dispersion parameters (minutes)	60	60
MGAUSS	Near-field vertical distribution (1 = Gaussian)	1	1
MCTADJ	Terrain adjustments to plume path (3 = Plume path)	3	3
MCTSG	Do we have subgrid hills? (0 = No), allows CTDM-like treatment for subgrid scale hills	0	0
MSLUG	Near-field puff treatment (0 = No slugs)	0	0
MTRANS	Model transitional plume rise? (1 = Yes)	1	1
MTIP	Treat stack tip downwash? (1 = Yes)	1	1
MSHEAR	Treat vertical wind shear? (0 = No)	0	0
MSPLIT	Allow puffs to split? (0 = No)	0	0
MCHEM	MESOPUFF-II Chemistry? (1 = Yes)	1	1
MWET	Model wet deposition? (1 = Yes)	1	1
MDRY	Model dry deposition? (1 = Yes)	1	1
MDISP	Method for dispersion coefficients (3 = PG & MP)	3	3
MTURBVW	Turbulence characterization? (Only if MDISP = 1 or 5)	3	3
MDISP2	Backup coefficients (Only if MDISP = 1 or 5)	3	3
MROUGH	Adjust PG for surface roughness? (0 = No)	0	0
MPARTL	Model partial plume penetration? (0 = No)	1	1
MTINV	Elevated inversion strength (0 = compute from data)	0	0
MPDF	Use PDF for convective dispersion? (0 = No)	0	0
MSGTIBL	Use TIBL module? (0 = No) allows treatment of subgrid scale coastal areas	0	0
MREG	Regulatory default checks? (1 = Yes)	1	1
CSPECn	Names of species modeled (for MESOPUFF II, must be SO2, SO4, NOx, HNO3, NO3)	User Defined	SO2, SO4, NOX, HNO3, NO3 and PM10
NX	Number of east-west grids of input meteorology	User Defined	333

Variable	Description	EPA Default	Our Values
NY	Number of north-south grids of input meteorology	User Defined	333
NZ	Number of vertical layers of input meteorology	User Defined	12
DGRIDKM	Meteorology grid spacing (km)	User Defined	4
ZFACE	Vertical cell face heights of input meteorology	User Defined	Same as Table 2
XORIGKM	Southwest corner (east-west) of input meteorology	User Defined	-497.152
YORIGIM	Southwest corner (north-south) of input meteorology	User Defined	-544.910
IUTMZN	UTM zone	User Defined	NA
XLAT	Latitude of center of meteorology domain	User Defined	37
XLONG	Longitude of center of meteorology domain	User Defined	120.50
XTZ	Base time zone of input meteorology	User Defined	PST
IBCOMP	Southwest of Xindex of computational domain	User Defined	1
JBCOMP	Southwest of Y-index of computational domain	User Defined	1
IECOMP	Northeast of Xindex of computational domain	User Defined	333
JECOMP	Northeast of Y- index of computational domain	User Defined	333
LSAMP	Use gridded receptors (T -= Yes)	F	F
IBSAMP	Southwest of Xindex of receptor grid	User Defined	1
JBSAMP	Southwest of Y-index of receptor grid	User Defined	1
IESAMP	Northeast of Xindex of receptor grid	User Defined	333
JESAMP	Northeast of Y-index of receptor grid	User Defined	333
MESHDN	Gridded receptor spacing = DGRIDKM/MESHDN	1	1
ICON	Output concentrations? (1 = Yes)	1	1
IDRY	Output dry deposition flux? (1 = Yes)	1	1
IWET	Output wet deposition flux? (1 = Yes)	1	1
IVIS	Output RH for visibility calculations (1 = Yes)	1	1
LCOMPRS	Use compression option in output? (T = Yes)	T	T
ICPRT	Print concentrations? (0 = No)	0	0
IDPRT	Print dry deposition fluxes (0 = No)	0	0
IWPRT	Print wet deposition fluxes (0 = No)	0	0
ICFRQ	Concentration print interval (1 = hourly)	1	1
IDFRQ	Dry deposition flux print interval (1 = hourly)	1	1
IWFRQ	Wet deposition flux print interval (1 = hourly)	1	1
IPRTU	Print output units (1 = g/m**3; g/m**2/s)	1	1
IMESG	Status messages to screen? (1 = Yes)	1	1
Output Species	Where to output various species	User Defined	All modeled species
LDEBUG	Turn on debug tracking? (F = No)	F	F
Dry Gas Dep	Chemical parameters of gaseous deposition species	User Defined	SO2,NOx,HNO3

Variable	Description	EPA Default	Our Values
Dry Part. Dep	Chemical parameters of particulate deposition species	User Defined	SO4,NO3,PM10
RCUTR	Reference cuticle resistance (s/cm)	30.	30.
RGR	Reference ground resistance (s/cm)	10.	10.
REACTR	Reference reactivity	8	8
NINT	Number of particle-size intervals	9	9
IVEG	Vegetative state (1 = active and unstressed)	1	1
Wet Dep	Wet deposition parameters	User Defined	HNO3,SO4,NO3, PM10
MOZ	Ozone background? (1 = read from ozone.dat)	1	1
BCKO3	Ozone default (ppb) (Use only for missing data)	80	80
BCKNH3	Ammonia background (ppb)	10	10
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2	2
SYTDEP	Horizontal size (m) to switch to time dependence	550.	550.
MHFTSE	Use Heffter for vertical dispersion? (0 = No)	1	1
JSUP	PG Stability class above mixed layer	5	5
CONK1	Stable dispersion constant (Eq. 2.7-3)	0.01	0.01
CONK2	Neutral dispersion constant (Eq. 2.7-4)	0.1	0.1
TBD	Transition for downwash algorithms (0.5 = ISC)	0.5	0.5
IURB1	Beginning urban landuse type	10	10
IURB2	Ending urban landuse type	19	19

Table 3. CALPUFF parameter summary.

6.1.2.5. Chemical Mechanism

The MESOPUFF II pseudo-first-order chemical reaction mechanism (MCHEM=1) is used for the conversion of SO_2 to sulfate (SO_4) and NO_x to nitrate (NO_3). Refer to the CALPUFF User's Guide for a description of the mechanism (Scire, 2000). Further discussion about the chemical mechanism is presented in Appendix _.

Ammonia-limiting methods will be used for repartitioning nitric acid and nitrate on a receptor-by-receptor and hour-by-hour basis to account for over prediction due to overlapping puffs in CALPUFF. Specifically, the use of the MNIRATE=1 option in POSTUTIL is recommended. At this time, other ammonia-limiting methods, including iterative techniques that use observational data to resolve backward the thermodynamic equilibrium equation between NO_3/HNO_3 for each hour to minimize available ammonia, are not acceptable. Generally, for regulatory CALPUFF modeling in California, techniques that assume the atmosphere is always ammonia poor are not acceptable.

6.1.2.6. Chemical Mechanism – Ammonia Sensitivity Tests

A sensitivity test of the effect of background ammonia was conducted by the Air Pollution Control Division of the Colorado Department of Public Health & Environment. Details are presented in Appendix _.

6.1.2.7. Ammonia Assumptions - Discussion

In CALPUFF, as used in this application, the background ammonia concentration is temporally and spatially uniform. It is likely that some portions of the modeling domain are ammonia poor and some are ammonia rich. Thus, setting a domain-wide background is problematic. As discussed in the previous section, when modeling a single large source with high SO_2 emission rates relative to NO_x, the assumed background ammonia concentration is not a critical parameter for determining visibility impacts.

According to the IWAQM Phase 2 Report,

> *A further complication is that the formation of particulate nitrate is dependent on the ambient concentration of ammonia, which preferentially reacts with sulfate. The ambient ammonia concentration is an input to the model. Accurate specification of this parameter is critical to the accurate estimation of particulate nitrate concentrations. Based on a review of available data, Langford et al. (1992) suggest that typical (within a factor of 2) background values of ammonia are: 10 ppb for grasslands, 0.5 ppb for forest, and 1 ppb for arid lands at 20 C. Langford et al. (1992) provide strong evidence that background levels of ammonia show strong dependence with ambient temperature (variations of a factor of 3 or 4) and a strong dependence on the soil pH. However, given all the uncertainties in ammonia data, IWAQM recommends use of the background levels provided above, unless specific data are available for the modeling domain that would discredit the values cited. It should be noted, however, that in areas where there are high ambient levels of sulfate, values such as 10 ppb might overestimate the formation of particulate nitrate from a given source, for these polluted conditions. Furthermore, areas in the vicinity of strong point sources of ammonia, such as feedlots or other agricultural areas, may experience locally high levels of background ammonia.*

Ideally a background ammonia input to CALPUFF needs to characterize spatial and temporal variations. However ammonia data obtained from the existing air quality monitoring network are not adequate to develop a characterization of those variations. Ammonia concentrations collected in special studies are not adequate either to fulfill the need.

6.1.2.8. Ammonia Assumptions

Because of the lack of a comprehensive ammonia data set, it is impossible in this study to develop a background ammonia input to CALPUFF that can reliably represent the temporal and spatial variations in the modeling domain. Domain-wide ammonia background concentrations will be set to 10 ppb which is recommended by the CALPUFF developer as the default value.

6.1.2.9. Ozone Assumptions

According to the IWAQM Phase 2 Report,

> *CALPUFF provides two options for providing the ozone background data: (1) a single, typical background value appropriate for the modeling region, or (2) hourly ozone data from one or more ozone monitoring stations. The second and preferred option requires the creation of the OZONE.DAT file containing the necessary data. For the Demonstration Assessment, the domain was large (700 km by 1000 km) such that the second option was necessary. The IWAQM does not anticipate such large domains as being the typical application. Rather, it is anticipated that the more typical application will involve domains of order 400 km by 400 km or smaller. But even for smaller domains, the ability to provide at least monthly background values of ozone is deemed desirable. The problem in developing time (and perhaps spatial) varying background ozone values is having access to representative background ozone data. Ozone data are available from EPA's Aerometric Information Retrieval System (AIRS); however, AIRS data must be used with caution. Many ozone sites are located in urban and suburban centers and are not representative of oxidant levels experienced by plumes undergoing long range transport.*

Hourly ozone values from ARB's ozone monitoring network will be used as input to CALPUFF.

6.1.3. CALPOST Settings and Visibility Post-Processing

The CALPUFF results will be post-processed with a version of CALPOST (version 5.6393 level 060202) that contains a postprocessor for visibility impairment calculations. POSTUTIL or its functional equivalents may also be used. These programs may be modified to output the correct values needed for BART analysis.

For the initial modeling analysis, all PM_{10} may be assumed to have a extinction efficiency of 1.0 since the contribution of direct PM_{10} emissions is expected to be relatively small compared to visibility impairment caused by SO_2 and NO_x emissions. However, if modeled impacts are below the contribution threshold, condensable and filterable PM_{10} emissions should be quantified and speciated. Alternatively, a sensitivity test could be performed to determine if speciation would change the outcome of the subject-to-BART demonstration. For example, if all PM_{10} is modeled as PMF in CALPOST, the extinction efficiency for PMF could be changed from 1.0 to 10.0 to simulate a worst-case speciation scenario. If this type of sensitivity test or another analysis suggests that PM_{10} speciation could change the outcome of the analysis, then speciation should be performed. If speciated PM_{10} emissions are modeled, the following species should be considered: fine particulates (PMF), coarse particulates (PMC), elemental carbon (EC), organic carbon (SOA), and sulfate (SO_4).

To calculate background light extinction, MVISBK should be set to 6. That is, monthly RH adjustment factors are applied directly to the background and modeled sulfate and nitrate concentrations, as recommended by the BART guideline. The RHMAX parameter, which is the maximum relative humidity factor used in the particle growth equation for visibility processing, is not used when method 6 is selected. Similarly, the relative humidity adjustment factor (f(RH)) curves in CALPOST (e.g., IWAQM growth curve and the 1996 IMPROVE curve) are not used when MVISBK is equal to 6.

f(RH) values listed in Table A-2 of US EPA's 'Guidance for Tracking Progress Under the Regional Haze Rule (EPA, 2003a)' will be used in the modeling. These values are site-specific for each Federal Class I area.

EPA lists three types of Natural Conditions (natural background) in their guidance document, annual average, Best 20% Days and Worst 20% Days (EPA, 2003a). The EPA BART Guidance recommends that the Natural Conditions corresponding to the Best 20% Days be used. However, this issue was challenged by the Utility Air Regulatory Group (UARG) and in a settlement EPA agreed that States could use Annual Average Natural Conditions (Paise, 2006a,b). In BART modeling analyses, the visibility impacts will be calculated using annual average of Natural Conditions and provided to the ARB to make the subject to BART determinations. The Natural Conditions are available on website (http://vista.cira.colostate.edu/improve/Data/IMPROVE/summary_data.htm).

Based on the latest three years' (2001, 2002 and 2003) background concentration measurements, domain wide averaged background concentrations have been calculated from data collected at all Class I areas located in California and will be used in the post-processing for visibility impairment analysis. The background concentrations to be used are listed as follows: BKSO4 = 1.168235 $\mu g/m^3$, BKNO3 = 1.05942 $\mu g/m^3$, BKPMC = 5.713125 $\mu g/m^3$, BKOC = 1.846471 $\mu g/m^3$, BKSOIL = 0.664706 $\mu g/m^3$, BKEC = 0.216471 $\mu g/m^3$.

6.1.3.1. 98th Percentile Methods

According to the BART guideline:

> ...*you should compare your "contribution" threshold against the 98th percentile of values. If the 98th percentile value from your modeling is less than your contribution threshold, then you may conclude that the source does not contribute to visibility impairment and is not subject to BART.* (70 FR 39162)

The U.S.EPA recommends using the 98th percentile value from the distribution of values containing the highest modeled delta-deciview value for each day of the simulation from all modeled receptors at a given Class I area. The 98th percentile delta-deciview value should be determined as the highest of the 8th highest values for each year modeled among all three modeled years.

The 98th percentile value at each Class I area should be compared to the contribution threshold. The contribution threshold has an implied level of precision equal to the level of precision reported from CALPOST. Specifically, the 98th percentile results should be reported to three decimal places.

The U.S. EPA recommended method is referred to as the "day-specific method" or "method 1." The first step in the method is to find the highest modeled delta-deciview value for each day of the simulation from all modeled receptors for the selected time period. Next, daily delta-deciview maxima are ranked in descending order for the number of days processed in CALPOST. Then, the 98th percentile value is determined from the distribution of ranked modeled daily maximum values, irrespective of receptor location. For both a 365-day and a 366-day simulations, the 98th percentile value would be the 8th highest modeled delta-deciview value from the list of ranked delta-deciview values. That is, the top 7 days are ignored, even though the values being ignored may be at different receptors.

A different method, referred to as "receptor-specific method" or "method 2" can also be used to calculate 98th percentile values. The 8th high (for one year) and 22nd high (for 3 years) values recommended by U.S. EPA are consistent with the values that would be generated from the equations in 40 CFR 50 Appendix N - "Interpretation of the National Ambient Air Quality Standards for $PM_{2.5}$" – for determining 98th percentile values for $PM_{2.5}$ monitoring.

7. Results

The CALPUFF modeling results will be reported in a separate document. The results will include 29 Class I federal areas in California and 7 Class I federal areas outside California.

The results for source-to-receptor distances beyond 300 kilometers may be used, but they may overestimate impacts because puff splitting is not used. The model setup used here should provide reasonable estimates for source-to-receptor distances up to 300 kilometers.

8. References

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Appendix – The BART Guidelines From 40 CFR Part 51, Appendix Y

III. HOW TO IDENTIFY SOURCES "SUBJECT TO BART"

Once you have compiled your list of BART-eligible sources, you need to determine whether (1) to make BART determinations for all of them or (2) to consider exempting some of them from BART because they may not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area. If you decide to make BART determinations for all the BART-eligible sources on your list, you should work with your regional planning organization (RPO) to show that, collectively, they cause or contribute to visibility impairment in at least one Class I area. You should then make individual BART determinations by applying the five statutory factors discussed in Section IV below.

On the other hand, you also may choose to perform an initial examination to determine whether a particular BART-eligible source or group of sources causes or contributes to visibility impairment in nearby Class I areas. If your analysis, or information submitted by the source, shows that an individual source or group of sources (or certain pollutants from those sources) is not reasonably anticipated to cause or contribute to any visibility impairment in a Class I area, then you do not need to make BART determinations for that source or group of sources (or for certain pollutants from those sources). In such a case, the source is not "subject to BART" and you do not need to apply the five statutory factors to make a BART determination. This section of the Guideline discusses several approaches that you can use to exempt sources from the BART determination process.

A. What Steps Do I Follow to Determine Whether A Source or Group of Sources Cause or Contribute to Visibility Impairment for Purposes of BART?

1. How Do I Establish a Threshold?

One of the first steps in determining whether sources cause or contribute to visibility impairment for purposes of BART is to establish a threshold (measured in deciviews) against which to measure the visibility impact of one or more sources. A single source that is responsible for a 1.0 deciview change or more should be considered to "cause" visibility impairment; a source that causes less than a 1.0 deciview change may still contribute to visibility impairment and thus be subject to BART.

Because of varying circumstances affecting different Class I areas, the appropriate threshold for determining whether a source "contributes to any *visibility impairment" for the purposes of BART may reasonably differ across States. As a general matter, any threshold that you use for determining whether a source "contributes" to visibility impairment should not be higher than 0.5 deciviews.*

In setting a threshold for "contribution," you should consider the number of emissions sources affecting the Class I areas at issue and the magnitude of the individual sources' impacts[2] In general, a larger number of sources causing impacts in a Class I area may warrant a lower contribution threshold. States remain free to use a threshold lower than 0.5 deciviews if they conclude that the location of a large number of BART eligible sources within the State and in proximity to a Class I area justify this approach.[3]

2. What Pollutants Do I Need to Consider?

You must look at SO_2, NO_x, and direct particulate matter (PM) emissions in determining whether sources cause or contribute to visibility impairment, including both PM_{10} and $PM_{2.5}$. Consistent with the approach for identifying your BART-eligible sources, you do not need to consider less than de minimis emissions of these pollutants from a source.

As explained in section II, you must use your best judgement to determine whether VOC or ammonia emissions are likely to have an impact on visibility in an area. In addition, although as explained in Section II, you may use PM_{10} an indicator for particulate matter in determining whether a source is BART eligible, in determining whether a source contributes to visibility impairment, you should distinguish between the fine and coarse particle components of direct particulate emissions. Although both fine and coarse particulate matter contribute to visibility impairment, the long-range transport of fine particles is of particular concern in the formation of regional haze. Air quality modeling results used in the BART determination will provide a more accurate prediction of a source's impact on visibility if the inputs into the model account for the relative particle size of any directly emitted particulate matter (i.e. PM_{10} vs. $PM_{2.5}$).

3. What Kind of Modeling Should I Use to Determine Which Sources and Pollutants Need Not Be Subject to BART?

This section presents several options for determining that certain sources need not be subject to BART. These options rely on different modeling and/or emissions analysis approaches. They are provided for your guidance. You may

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[2] *We expect that regional planning organizations will have modeling information that identifies sources affecting visibility in individual class I areas.*

[3] *Note that the contribution threshold should be used to determine whether an individual source is reasonably anticipated to contribute to visibility impairment. You should not aggregate the visibility effects of multiple sources and compare their collective effects against your contribution threshold because this would inappropriately create a "contribute to contribution" test.*

also use other reasonable approaches for analyzing the visibility impacts of an individual source or group of sources.

Option 1: Individual Source Attribution Approach (Dispersion Modeling)

You can use dispersion modeling to determine that an individual source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area and thus is not subject to BART. Under this option, you can analyze an individual source's impact on visibility as a result of its emissions of SO_2, NO_x and direct PM emissions. Dispersion modeling cannot currently be used to estimate the predicted impacts on visibility from an individual source's emissions of VOC or ammonia. You may use a more qualitative assessment to determine on a case-by-case basis which sources of VOC or ammonia emissions may be likely to impair visibility and should therefore be subject to BART review, as explained in section II.A.3. above.

You can use CALPUFF[4] or other appropriate model to predict the visibility impacts from a single source at a Class I area. CALPUFF is the best regulatory modeling application currently available for predicting a single source's contribution to visibility impairment and is currently the only EPA-approved model for use in estimating single source pollutant concentrations resulting from the long range transport of primary pollutants.[5].[8] It can also be used for some other purposes, such as the visibility assessments addressed in today's rule, to account for the chemical transformation of SO_2 and NO_x.

There are several steps for making an individual source attribution using a dispersion model:

1. Develop a modeling protocol.

Some critical items to include in the protocol are the meteorological and terrain data that will be used, as well as the source-specific information (stack height, temperature, exit velocity, elevation, and emission rates of applicable pollutants) and receptor data from appropriate Class I areas. We recommend following EPA's Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts[6] for parameter settings and meteorological data inputs. You may use

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[4] *The model code and its documentation are available at no cost for download from* http://www.epa.gov/scram001/tt22.htm#calpuff .

[5] *The Guideline on Air Quality Models, 40 CFR part 51, appendix W, addresses the regulatory application of air quality models for assessing criteria pollutants under the CAA, and describes further the procedures for using the CALPUFF model, as well as for obtaining approval for the use of other, nonguideline models.*

[6] *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*, U.S. Environmental Protection Agency, EPA-454/R-98-019, December 1998.

other settings from those in IWAQM, but you should identify these settings and explain your selection of these settings.

One important element of the protocol is in establishing the receptors that will be used in the model. The receptors that you use should be located in the nearest Class I area with sufficient density to identify the likely visibility effects of the source. For other Class I areas in relatively close proximity to a BART-eligible source, you may model a few strategic receptors to determine whether effects at those areas may be greater than at the nearest Class I area. For example, you might chose to locate receptors at these areas at the closest point to the source, at the highest and lowest elevation in the Class I area, at the IMPROVE monitor, and at the approximate expected plume release height. If the highest modeled effects are observed at the nearest Class I area, you may choose not to analyze the other Class I areas any further as additional analyses might be unwarranted.

You should bear in mind that some receptors within the relevant Class I area may be less than 50 km from the source while other receptors within that same Class I area may be greater than 50 km from the same source. As indicated by the Guideline on Air Quality Models, 40 CFR part 51, appendix W, this situation may call for the use of two different modeling approaches for the same Class I area and source, depending upon the State's chosen method for modeling sources less than 50 km. In situations where you are assessing visibility impacts for source-receptor distances less than 50 km, you should use expert modeling judgment in determining visibility impacts, giving consideration to both CALPUFF and other appropriate methods.

In developing your modeling protocol, you may want to consult with EPA and your regional planning organization (RPO). Up-front consultation will ensure that key technical issues are addressed before you conduct your modeling.

2. [Run model in accordance] with the accepted protocol and compare the predicted visibility impacts with your threshold for "contribution."

You should calculate daily visibility values for each receptor as the change in deciviews compared against natural visibility conditions. You can use EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule," EPA-454/B-03-005 (September 2003) in making this calculation. To determine whether a source may reasonably be anticipated to cause or contribute to visibility impairment at Class I area, you then compare the impacts predicted by the model against the threshold that you have selected.

The emissions estimates used in the models are intended to reflect steady-state operating conditions during periods of high capacity utilization. We do not generally recommend that emissions reflecting periods of start-up, shutdown, and malfunction be used, as such emission rates could produce higher than normal effects than would be typical of most facilities. We recommend that States *use the 24 hour average actual emission rate from the highest emitting day of the meteorological period modeled, unless this rate reflects periods start-up, shutdown, or malfunction. In addition, the monthly average relative humidity is used, rather than the daily average humidity – an approach that effectively lowers the peak values in daily model averages.*

For these reasons, if you use the modeling approach we recommend, you should compare your "contribution" threshold against the 98th percentile of values. If the 98th percentile value from your modeling is less than your contribution threshold, then you may conclude that the source does not contribute to visibility impairment and is not subject to BART.

Appendix - The MESOPUFF II Mechanism

In the MESOPUFF II mechanism, the ammonia background concentration affects the equilibrium between nitric acid, ammonia, and ammonium nitrate. The equilibrium constant for the reaction is a non-linear function of temperature and relative humidity (Scire, 2000). Unlike sulfate, the calculated nitrate concentration is limited by the amount of available ammonia, which is preferentially scavenged by sulfate (Scire, 2000). In particular, the amount of ammonia available for the nitric acid, ammonium nitrate, and ammonia reactions is determined by subtracting sulfate from total ammonia.

While the chemical mechanism simulates both the gas phase and aqueous phase conversion of SO_2 to sulfate, the aqueous phase method, which is important when the plume interacts with clouds and fog, can significantly underestimate sulfate formation. In this report, as recommended by the IWAQM Phase 2 report, the “nighttime SO_2 loss rate (RNITE1)” is set to 0.2 percent per hour. The “nighttime NOx loss rate (RNITE2)” is set to 2.0 percent per hour and the “nighttime HNO_3 formation rate (RNITE3)” is set to 2.0 percent per hour.

According to the 1996 “Mt. Zirkel Wilderness Area Reasonable Attribution Study of Visibility Impairment. Volume II: Results of Data Analysis and Modeling - Final Report,”

The CALPUFF chemical module is formulated around linear transformation rates for SO_2 to sulfate and NO_x to total nitrate. There are two options for specifying these transformation rates:

Option 1: An internal calculation of rates based on local values for several controlling variables (e.g., solar radiation, background ozone, relative humidity, and plume NO_x) as used in MESOPUFF-II. The parametric transformation rate relationships employed were derived from box model calculations using the mechanism of Atkinson et al. (1982).

Option 2: A user-specified input file of diurnally varying but spatially uniform conversion rates.

Morris et al. (1987) reviewed the MESOPUFF-II mechanism as part of the U.S. EPA Rocky Mountain Acid Deposition Model Assessment study. They found that it provided physically plausible responses to many of the controlling environmental parameters. However, the mechanism had no temperature dependence, which is an important factor in the Rocky Mountain region where there are wide variations in temperature. Furthermore, the

MESOPUFF-II transformation scheme was based on box model simulations for conditions more representative of the Eastern U.S. than of the Rocky Mountains.

The largest deficiency in the MESOPUFF-II chemical transformation algorithm is the lack of explicit treatment for in-cloud (aqueous-phase) enhanced oxidation of SO_2 to sulfate. The MESOPUFF-II chemical transformation algorithm includes a surrogate reaction rate to account for aqueous-phase oxidation of SO_2 to sulfate as follows:

$$K_{aq} = 3 \times 10^{-8} \times RH^{4} \; (\%/hr) \quad (B.2\text{-}1)$$

Thus, at 100% relative humidity (RH), the MESOPUFF-II aqueous-phase surrogate SO_2 oxidation rate will be 3% per hour. Measurements in generating station plumes suggest spatially- and temporally-integrated SO_2 oxidation rates due to oxidants in clouds to be 10 times this value.

Another issue is the amount of ammonia available for nitrate chemistry. According to a paper by Escoffier-Czaja and Scire (2002),

"In the CALPUFF model, total nitrate ($TNO_3 = HNO_3 + NO_3$) is partitioned into each species according to the equilibrium relationship between HNO_3 and NO_3. This equilibrium varies as a function of time and space, in response to both the ambient temperature and relative humidity. In addition, the formation of nitrate is subject to the availability of NH_3 to form ammonium nitrate (NH_4NO_3), the assumed form of nitrate in the model. In CALPUFF, a continuous plume is simulated as a series of puffs, or discrete plume elements. The total concentration at any point in the model is the sum of the contribution of all nearby puffs from each source. Because CALPUFF allows the full amount of the specified background concentration of ammonia to be available to each puff for forming nitrate, the same ammonia may be used multiple times in forming nitrate, resulting in an overestimate of nitrate formation. In order to properly account for ammonia consumption, a program called POSTUTIL was introduced into the CALPUFF modeling system in 1999. POSTUTIL allows total nitrate to be repartitioned in a post-processing step to account for the total amount of sulfate scavenging ammonia from all sources (both project and background sources) and the total amount of TNO_3 competing for the remaining ammonia. In POSTUTIL, ammonia availability is computed based on receptor concentrations of total sulfate and TNO_3, not on a puff-by-puff basis."

Appendix. Sensitivity test of the effect of ammonia background

To better understand the response of the modeling system to background ammonia when a single point source with significant emissions of SO_2 and NO_x is modeled, the Air Pollution Control Division of the Colorado Department of Public Health & Environment (hereafter in this appendix referred to as the Division) performed sensitivity tests for a source in northeast Colorado and a source in northwest Colorado using the 2002 MM5/CALMET meteorology. In the test case, SO_2, NO_x, and filterable PM_{10} emissions were modeled. The ammonia background value was varied from 0 to 100 ppb. In the northeast Colorado test case, the SO_2 emission rate is about 3 times higher than the NO_x emission rate. In the northwest Colorado test case, the modeled NO_x emission rate is about 4.4 times higher than the SO_2 rate.

In both cases, when the background ammonia concentration is zero, the model produces no nitrate, as expected; however, it produces sulfate.

For the northeast Colorado sensitivity test, where the modeled SO_2 emission rate is significantly higher than the NO_x emission rate, the change in visibility (delta-deciview) is not very sensitive to the background ammonia concentration across the range from 1.0 ppb to 100.0 ppb because of the high SO_2 emission rates relative to NO_x and the way sulfate is produced in the MESOPUFF II chemical mechanism. Visibility impacts drop significantly when the ammonia background is less than 1.0 ppb, but even at 0.0 ppb of ammonia, sulfate impacts remain relative high.

For the northeast Colorado case, on days with the highest visibility impacts, the relative contribution of nitrate and sulfate vary, but most of the modeled visibility impairment is due to sulfate.

For the northwest Colorado sensitivity test, where the modeled NO_x emission rate is significantly higher than the SO_2 emission rate, the change in visibility (delta-deciview) is not sensitive to the background ammonia concentration across the range from 10 ppb to 100 ppb. While there is a moderate drop in impacts when ammonia is dropped from 10 ppb to 1.0 ppb, the model is very sensitive to ammonia when the background ammonia level is less than 1.0 ppb.

For the northwest Colorado test case, according to CALPUFF implemented by the Division, impairment is primarily due to nitrate, but the contribution due to nitrate varies significantly depending on the assumed ammonia background level. For the 100 ppb background case, the nitrate contribution is greater than

90% for the top 20 days. However, for the 0.1 ppb case, the nitrate contribution varies from 43% to 81% for the top 20 days.

Caution should be used when extrapolating the results of these tests to other CALPUFF applications.

Since the MESOPUFF II chemical mechanism used in this analysis depends on several parameters, including ozone and ammonia background concentrations, the methods for determining the background ozone and ammonia concentration fields are discussed in more detail in sections 3.1.2.7 and 3.1.2.8

APPENDIX D

District BART Determination

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November 6, 2008

Ms. Lynn Terry
Deputy Executive Officer
California Air Resources Board
1001 "I" Street
P.O. Box 2815
Sacramento, California 95812

Dear Ms. Terry:

As you know, Bay Area Air Quality Management District staff has been working on addressing the requirement of Best Available Retrofit Technology (BART) for certain existing sources within our jurisdiction. BART is one of the principle elements of federal regional haze regulations, and your staff will be including the necessary BART determinations in the State Implementation Plan (SIP) that addresses visibility protection requirements.

We have enclosed our BART determination for the Bay Area sources that your staff indicates are subject to these requirements, based on the results of your visibility modeling analyses. We understand that the SIP-approval process involves the opportunity for review and comment from Federal Land Managers, other interested stakeholders, and the public, and we may subsequently revise the write-up based on comments received before the SIP is submitted to EPA.

Finally, we would like to express our appreciation to your staff for working with us on this project. In particular, we would like to acknowledge the assistance of Christine Suarez-Murias. We look forward to continuing to work together as the SIP process is finalized.

If you have any questions regarding this letter, please contact Brian Bateman, the District's Director of Engineering, at (415) 749-4653.

Sincerely,

Jack P. Broadbent
Executive Officer/APCO

Enclosure

cc: Karen Magliano, CARB Air Quality Data Branch Chief

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Summary of Bay Area Air Quality Management District Best Available Retrofit Technology Determinations

By:

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Bay Area Air Quality Management District

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Modeling was performed for the Best Available Retrofit Technology (BART)-eligible sources by the California Air Resources Board (CARB) at the following six facilities in the San Francisco Bay Area:

Chevron Richmond Refinery
ConocoPhillips Rodeo Refinery
Rhodia Martinez Sulfuric Acid Plant
Shell-Martinez Refinery
Tesoro-Avon Refinery
Valero-Benicia Refinery

Of these, only the Valero Benicia Refinery (Valero) had an impact on visibility that was over 0.5 deciview and therefore high enough pursuant to the Regional Haze regulations in 40 CFR 51, Subpart P, Protection of Visibility, to require a BART determination.

The following BART-eligible sources at Valero were included in the modeling: the "Main Stack," a hydrogen plant reformer furnace, four turbine/boiler sets, two Claus units, and a cooling tower. The refinery flares were not included in the modeling because refinery flares in the Bay Area are used only for startup, shutdown, upset and malfunction.

The table below summarizes the BART determinations for the Valero sources.

Proposed BART Determinations for Valero

Unit	NOx Control Type	NOx Emission Limit	SO2 Control Type	SO2 Emission Limit	Particulate Type and Limit
"Main Stack:" Valero Coker, FCCU, CO Boilers (Units S3, S4, S5, S6)	SCR	50 ppm on 365-day basis (est. annual emissions: 611 tpy)	CANSOLV regenerative amine scrubber (SO2 removal) with BELCO pre-scrubber (PM10 and SO3 removal)	50 ppm SO2 @ 0% O2 on a 7-day average basis, 25 ppm SO2 @ 0% O2 on a 365 day basis (est. annual emissions: 416 tpy)	Scrubber: 116 tpy
Valero Reformer Furnace (S21); (S21 or S22 may be replaced with S1061)	Low NOx burners	0.033 lb/MMbtu on a refinery-wide basis; 60 ppmdv @ 3% O2, 24-hr average	Sulfur removal from fuel gas using amine stripping	51 ppm total reduced sulfur (TRS) in refinery fuel gas on a rolling consecutive 365-day average, 100 ppm TRS on a rolling 24-hr average	Use of gaseous fuel

Proposed BART Determinations for Valero

Unit	NOx Control Type	NOx Emission Limit	SO2 Control Type	SO2 Emission Limit	Particulate Type and Limit
Valero Reformer Furnace (S22); S21 or S22 may be replaced with S1061	Low NOx burners	0.033 lb/MMbtu on a refinery-wide basis; 60 ppmdv @ 3% O2, 24-hr average	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling consecutive 365-day average, 100 ppm TRS on a rolling 24-hr average	Use of gaseous fuel
Valero S43, Turbine (associated w/S56, Waste Heat Boiler)	Water injection	55 ppm @ 15% O2 (no additional control)	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 7 tpy
Valero S44, Turbine (Associated with S36, Waste Heat Boiler)	Water injection	55 ppm @ 15% O2 (no additional control)	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 8 tpy
Valero S45, Turbine, S37, Waste Heat Boiler	SCR	9 ppm @ 15% O2; 28 tpy (no additional control)	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 12 tpy
Valero S46, Turbine (Associated w/S48, Waste Heat Boiler)	Water injection	55 ppm @ 15% O2 (no additional control)	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 5 tpy

Proposed BART Determinations for Valero

Unit	NOx Control Type	NOx Emission Limit	SO2 Control Type	SO2 Emission Limit	Particulate Type and Limit
Valero S56, Waste Heat Boiler (associated w/S43, Turbine)	No additional controls	55 ppm @ 15% O2	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 2 tpy
Valero S36, Waste Heat Boiler (associated w/S44, Turbine)	No additional controls	55 ppm @ 15% O2	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 3 tpy
Valero S48, Waste Heat Boiler (associated w/S46, Turbine)	No additional controls	55 ppm @ 15% O2	Sulfur removal from fuel gas using amine stripping	51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis	Use of gaseous fuel; 3 tpy
S1, S2, Claus Units	No additional controls		No additional controls		No additional controls
S29, Cooling Tower					No additional controls

A discussion of the technological feasibility and cost effectiveness of the controls, and other considerations required by 40 CFR 51, Subpart P, is presented below, organized by source.

1. “Main Stack”

A. Discussion of controls and technological feasibility

The fluidized coker, the fluidized catalytic cracker unit or FCCU, and two CO boilers are vented to the “Main Stack.” The current potential to emit for the Main Stack is:

SO2: 6,222 tons per year (tpy)
NOx: 756 tpy
PM10: 179 tpy

Valero is under a consent decree that requires control of SO_2 from the main stack. This reduction will be completed by the 2012 BART deadline. Valero has submitted Application No. 16937 to incorporate this requirement into its District permit. The District's evaluation of this application is close to completion as of November 5, 2008. The consent decree also specifies that the requirement for control has to be incorporated into Valero's Title V permit. The requirement is expected to be incorporated into the Title V permit during the renewal, which should be issued by December 1, 2009.

In order to install the SO_2 control, Valero had to replace the existing CO boilers (S5 and S6). The new CO boilers are subject to Best Available Control Technology for NOx.

After the controls are installed, the emissions will be:

SO_2: 416 tpy
NOx: 611 tpy
PM10: 106.5 tpy

SO_2 will be controlled by use of a regenerative amine scrubber for SO_2 removal and a BELCO pre-scrubber for PM10 and SO_3 removal. The SO_2 will be sent to a sulfur recovery unit, resulting in about 2,900 tpy of additional sulfur recovery.

The use of a regenerative amine scrubber is preferable to a caustic scrubber for SO_2 control because a caustic scrubber would use a large amount of water and generate an additional waste stream.

PM10 is currently controlled with an electrostatic precipitator. Use of the scrubber will result in lower PM10 emissions than use of the electrostatic precipitator in this case. The annual emission rate will be limited by a permit condition and monitored with an annual source test.

NOx is currently controlled with non-selective catalytic reduction (NSCR). After the SO_2 scrubber is installed, NOx will be controlled by use of selective catalytic reduction (SCR) at the main stack and by use of low NOx burners at the CO boilers. Additional control of NOx by SCR is not feasible because the stream contains a high concentration of sulfur at the point where the SCR will be installed. The SCR cannot be installed downstream of the SO_2 scrubber because the SCR must run at a higher temperature than the SO_2 scrubber.

The improvements at the Main Stack will result in a 0.476 deciview improvement at Point Reyes on the eighth highest day per CalPuff modeling by CARB. The cost of the improvement is $202 million/deciview/yr.

Use of scrubbers for SO2 and PM10 and SCR for NOx is considered to be the highest practical level of control available. Therefore, lesser controls were not evaluated. This level of control will be far superior to the NSCR and electrostatic precipitator that are currently installed.

B. Costs of compliance

The capital cost for the scrubbers is estimated to be $413 million, and the annual operating costs will be $7 million, for a total annual cost of $80 million. Based on reductions of 5806 tpy SO2 and 72.5 tpy PM10, the cost/ton of reductions is $11,780, which is above any reasonable BART threshold for cost-effectiveness.

NOx will be controlled by use of SCR at the Main Stack and by use of low NOx burners at the CO boilers.

The capital cost for the SCR will be approximately $110 million, and the annual operating costs will be $1.5 million, for a total annual cost of $16.5 million.

NOx is currently controlled by NSCR. The amount of NOx currently generated before control is estimated at 1,466 tpy. The limit after installation of the SCR will be 600 tpy. Using a reduction of 866 tpy NOx to calculate cost-effectiveness, the cost/ton is $20,760. Using the incremental reduction of 156 tpy NOx, the incremental cost-effectiveness is $115, 240. The costs of NOx control at this stack are above any reasonable BART threshold for cost-effectiveness.

These estimates are based on an interest rate of 7% and an equipment life of 15 years, as suggested by the EPA Concost manual.

C. Energy and non-air quality environmental impacts of compliance

A non-air quality related impact of SCR is the risk associated with the transport of ammonia for use in the SCR. The cost of ammonia for SCR is included in the cost estimate. In this case, the amount of ammonia emitted will go down by approximately 346 tons/yr because the ammonia slip will be more tightly controlled. Therefore, the number of ammonia shipments to the facility will be reduced.

The use of a regenerative amine scrubber is preferable to a caustic scrubber for SO2 control because a caustic scrubber would use a large amount of water and generate an additional waste stream.

The CO boilers will have to be replaced due to the installation of the SO2 scrubber because the system will operate at a higher pressure than the CO boilers' design pressure.

D. Any existing pollution control technology in use at the source
NSCR currently controls an estimated 1,022 tons NOx/yr at the Main Stack. An electrostatic precipitator controls particulate matter. There are no existing SO2 controls. The proposed controls will be superior to the existing controls.

E. The remaining useful life of the source
None of Bay Area BART-eligible sources are expected to be retired over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations. The cost-effectiveness calculations were based on a 15-year amortization period, as suggested by the EPA OAQPS Control Cost Manual.

F. The degree of visibility improvement that may reasonably be anticipated from the use of BART
The visibility improvement that will result from the proposed reductions in SO2, NOx, and PM10 at the Main Stack will be 0.476 deciview at Point Reyes on the eighth highest day per CalPuff modeling by CARB. The modeling for the BART-eligible sources at this facility originally showed a maximum visibility impact of 0.758 deciview. The resulting visibility impairment is 0.282 deciview.

This improvement would drop the facility below the 0.5 deciview threshold in Appendix Y to 40 CFR 51, Subpart P, where a source is considered to contribute significantly to visibility impairment.

G. Conclusion
The controls on the "Main Stack" sources that are included in the consent decree are considered to be the highest practical level that is technologically achievable. Although the controls exceed reasonable thresholds for BART cost effectiveness, the resulting emission reductions are significant, as is the potential improvement in visibility at Point Reyes. These controls are therefore deemed to be adequate for meeting BART requirements.

2. Hydrogen Plant Reformer Furnaces (S21 and S22)

The capacity of the reformer furnaces is 614 MMbtu/hr furnaces each. S21 or S22 may be replaced in the next four years with a 984 MMbtu/hr furnace, depending on the economics of the project. The new furnace would be subject to BACT for NOx, PM10, and SO2. If the furnace were replaced, reductions of NOx and PM10 of 70 tpy and 9 tpy, and an increase of 10 tpy SO2 would be anticipated. An application has been submitted to replace one of the reformer furnaces, but the project may not be built.

The BART discussion below is based on the existing equipment and assumes that one of the furnaces will not be replaced.

A. Discussion of controls and technological feasibility
PM10 is controlled by the use of gaseous fuel.

SO_2 is controlled by the use of low-sulfur refinery fuel gas. Hydrogen sulfide in the gas is scrubbed by amine stripping and converted to elemental sulfur in the sulfur recovery units. The furnaces have a limit of TRS in fuel of 51 ppm on a rolling consecutive 365-day average and 100 ppm TRS on a rolling 24-hr average. This limit is close to the 45-ppm BACT limit that is imposed on new sources.

NOx at the reformer furnaces is controlled by low NOx burners. Valero operates under a federal consent decree that requires control of NOx from most boilers and furnaces at the facility, including the reformer furnaces. The limit is 0.033 lb NOx/MMbtu on a refinery-wide basis. The reformer furnaces also have a short-term limit of 60 ppmv NOx @ 3% O_2 averaged over 24 hours, which is roughly equivalent to 0.076 lb/MMbtu. The actual emissions are about 0.036 lb NOx/MMbtu on an annual basis.

The controls above are existing controls. No further reductions are planned.

It is feasible to control additional NOx at the furnaces with SCR, but additional control would not necessarily result in facility-wide NOx emission reductions, because the consent decree limit is on a refinery-wide basis. Additional control at the reformer furnaces would allow higher emissions at other refinery heaters or boilers. The refinery generally emits most of the NOx allowed on a daily basis. Any excess emissions are managed with the use of interchangeable emission reduction credits (IERC), which is allowed by the consent decree.

If controlled with SCR, concentrations of 10 ppmv NOx @ 3% O_2 (equivalent to 0.012 lb/MMbtu) might be achievable.

B. Costs of compliance

No additional costs will be incurred for the existing controls.

If SCR were required for the furnaces, the cost/ton can be estimated at $14,000/ton. This estimate is derived from Table 13, "Cost Effectiveness Data for Boilers Rated at 200 MMbtu/hr" in the California Air Resources Board's (CARB's) "Report to the Legislature: Implications of Future Oxides of Nitrogen Controls From Seasonal Sources in the San Joaquin Valley."

During the years 2005-2008, the actual emissions were about 126 tons NOx/yr total. A reduction of 56 tpy NOx could cost about $784,000 per year.

C. Energy and non-air quality environmental impacts of compliance

A non-air quality related impact of SCR would be the risk associated with the transport of ammonia for use in the SCR. The risk would be considered insignificant because the refinery already imports ammonia for use in other SCR units at the facility.

D. Any existing pollution control technology in use at the source
As described above, the furnaces are currently controlled with low-NOx burners, use of gaseous fuel, and use of low-sulfur refinery fuel gas.

E. The remaining useful life of the source
According to the plant contacts, none of Valero BART sources are expected to retire over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations.

F. The degree of visibility improvement that may reasonably be anticipated from the use of BART
No additional visibility improvement is expected from the existing controls.

No additional visibility improvement would be anticipated from additional control of NOx at the furnaces because a decrease in NOx at the furnaces could be offsets by an increase at another source.

The actual emissions are about 63 tons NOX/yr each (based on a 3-year baseline calculated for Application 16937) for a total of 126 tpy NOx. If the sources were controlled by SCR, a reasonable concentration limit would be 10 ppmv @ 3% O2 or 0.013 lb/MMbtu. The furnaces would be allowed to emit about 70 ton NOx/yr total, for a reduction of 56 tpy NOx.

A hypothetical reduction of 268 tons NOx/yr was modeled by CARB for the turbine/boiler sets. The hypothetical improvement in visibility would have been 0.091 deciview. If the improvement in visibility were proportional, the improvement obtained by further controlling the furnaces would be 0.019 deciview, which is too small to make these controls reasonable.

A 56-tpy reduction in NOx at the reformer furnaces has not been included in the model as of December 2, 2009, so the above estimate of the visibility improvement is an approximation. The stack heights for the reformer furnaces are about 250 feet and the stack heights for the turbine/boiler sets are between 60 and 80 feet. The exit velocities for the boiler/turbine sets are about twice as high as the exit velocities for the furnaces. The exit temperatures are similar. Modeling would have to be performed to determine the magnitude of an improvement achievable by a 56-tpy reduction in NOx, but it is likely to be insignificant.

G. Conclusion
No further controls are proposed because additional controls would provide an insignificant amount of visibility improvement.

3. Turbine/Boiler Sets

A. Discussion of controls and technological feasibility

Valero has four turbine/boiler sets that were installed in 1969. The emissions of SO_2 are low because the sources use low-sulfur fuel. They will be subject to a 51-ppm limit on TRS in fuel. The combined potential to emit for SO_2 is 15 tpy. NO_x at the largest set is controlled by SCR to 9 ppmv @ 15% O_2. The combined NO_x emissions of the remaining three sets are about 341 tpy.

These turbine/boiler sets are different than most turbine/duct burner sets because the boilers have their own air source and can be fired separately from the turbines. Duct burners cannot be fired when the turbines are not operated.

CARB modeled a hypothetical reduction for these sources to 73 tpy NO_x, which is equivalent to a 10 ppmv NO_x concentration achievable by SCR. The modeling result for the hypothetical reduction was 0.091 deciview, which is an insignificant improvement. BAAQMD is not proposing SCR because it is not cost-effective.

NSCR is not feasible due to the cycling nature of the operation. Valero uses other more efficient sources of steam first, then these sources, so these sources are not always in use and the load is variable when they are in use. The operation is not stable enough to ensure that the temperature at an ammonia or urea injection site will be in the right range for NSCR to operate.

Low NO_x burners were also considered, but low NO_x burners are not available for turbines in this size range (8.9 MW), and are not feasible at the boilers because they operate at a very high turndown (the boilers are used at about 25% of capacity). The refinery operates more efficient sources of steam at the facility whenever possible.

Even if low NO_x burners were feasible at the boilers, the visibility improvement at Point Reyes would be extremely low. The boilers use only about 38% of the fuel burned by the system, based on 2007 data. Assuming that 130 tpy NO_x is attributable to the boilers, and that the low NO_x burners would reduce emissions from 40 ppmv to 30 ppmv, a reduction of only 32 tpy would result, which would be roughly equivalent to 0.01 deciview, an insignificant reduction.

Water injection is already being used at the turbines to lower NO_x. The turbine/boiler sets are subject to BAAQMD Regulation 9, Rule 9, which imposes a 55 ppmv @ 15% O_2 limit for NO_x. The sources currently operate at around 40 ppmv NO_x @ 15% O_2, which is about 0.15 lb NO_x/MMbtu.

B. Costs of compliance

BAAQMD proposes no additional control for the three turbine/boiler sets (S43/S56, S44/S36, S46/S48).

BAAQMD determined the cost-effectiveness for SCR based on recent rule development data and determined that the estimated cost is between $5000 and $7000/ton, which is above reasonable thresholds for BART cost-effectiveness. The energy usage is included in this estimate

NSCR and low-NOx burners were determined not to be feasible at these sources because no low-NOx burners are available for the Frame Size 3 turbines.

NOx emissions at the turbines are controlled by water injection.

C. Energy and non-air quality environmental impacts of compliance

A non-air quality related impact of SCR or NSCR would be the risk associated with the transport of ammonia for use in the SCR or NSCR. The risk would be considered insignificant because the refinery already imports ammonia for use in other SCRs at the facility.

D. Any existing pollution control technology in use at the source

NOx is controlled at one turbine/boiler set (S37/S45) with SCR.

NOx is controlled at the other three turbine/boiler sets by use of water injection. The existing NOx limit in BAAQMD Regulation 9, Rule 9, for these turbines is 55 ppmvd @ 15% O2. In 2010, the limits will be to 50 ppmvd @ 15% O2. The turbine/boiler sets currently operate between 40 and 46 ppmvd @ 15% O2.

SO2 and PM10 emissions are controlled at all four turbine/boiler sets by use of low-sulfur refinery fuel gas. The TRS limit for the refinery fuel gas will be 51 ppm on an annual basis.

E. The remaining useful life of the source

According to the plant contacts, none of Bay Area BART sources are expected to retire over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations. The cost-effectiveness calculations were based on a 15-year amortization period, as suggested by the EPA OAQPS Control Cost Manual.

F. The degree of visibility improvement that may reasonably be anticipated from the use of BART

CARB modeled a hypothetical reduction for these sources from 503 to 73 tpy NOx, which is equivalent to a 10 ppmv NOx concentration achievable by SCR. The modeling result for the hypothetical reduction was 0.091 deciview, which is an insignificant improvement.

G: Conclusion

No further controls are proposed because additional controls are either not cost-effective or would provide an insignificant amount of visibility improvement.

4. Claus Units

A. Discussion of controls and technological feasibility
The potential to emit for the Claus units is about 1 tpy NOx. They have no SO2 or PM10 emissions.

B. Any existing pollution control technology in use at the source
The Claus units are controlled by use of a reduction control system, which results in a very low potential to emit for SO2.

C. Conclusion
No further controls are proposed because the emissions are very low.

5. Cooling Tower

A. Discussion of controls and technological feasibility
The calculated potential to emit for the cooling tower based on AP-42 chapter 13.4 is about 41 tpy PM10. The calculation method has an "E" rating. It is estimated that the PM10 emissions may be overstated by an order of magnitude.

B. Conclusion
No further controls are proposed since the emissions are very low.

APPENDIX E

Report from

WRAP Regional Modeling Center

for Air Quality Modeling

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Overview

Visibility impairment occurs when fine particulate matter ($PM_{2.5}$) in the atmosphere scatters and absorbs light, thereby creating haze. $PM_{2.5}$ can be emitted into the atmosphere directly as primary particulates, or it can be produced in the atmosphere from photochemical reactions of gas-phase precursors and subsequent condensation to form secondary particulates. Examples of primary $PM_{2.5}$ include crustal materials and elemental carbon; examples of secondary PM include ammonium nitrate, ammonium sulfates, and secondary organic aerosols (SOA). Secondary $PM_{2.5}$ is generally smaller than primary $PM_{2.5}$, and because the ability of $PM_{2.5}$ to scatter light depends on particle size, with light scattering for fine particles being greater than for coarse particles, secondary $PM_{2.5}$ plays an especially important role in visibility impairment. Moreover, the smaller secondary $PM_{2.5}$ can remain suspended in the atmosphere for longer periods and is transported long distances, thereby contributing to regional-scale impacts of pollutant emissions on visibility.

The sources of $PM_{2.5}$ are difficult to quantify because of the complex nature of their formation, transport, and removal from the atmosphere. This makes it difficult to simply use emissions data to determine which pollutants should be controlled to most effectively improve visibility. Photochemical air quality models offer opportunity to better understand the sources of $PM_{2.5}$ by simulating the emissions of pollutants and the formation, transport, and deposition of $PM_{2.5}$. If an air quality model performs well for a historical episode, the model may then be useful for identifying the sources of $PM_{2.5}$ and helping to select the most effective emissions reduction strategies for attaining visibility goals. Although several types of air quality modeling systems are available, the gridded, three-dimensional, Eulerian models provide the most complete spatial representation and the most comprehensive representation of processes affecting $PM_{2.5}$, especially for situations in which multiple pollutant sources interact to form $PM_{2.5}$. For less complex situations in which a few large point sources of emissions are the dominant source of $PM_{2.5}$, trajectory models (such as the California Puff Model [CALPUFF]) may also be useful for simulating $PM_{2.5}$.

Air Quality Models

The WRAP RMC utilized two regulatory air quality modeling systems to conduct all regional haze modeling. A brief discussion of each of these models is provided below.

Community Multi-Scale Air Quality Model

EPA initially developed the Community Multi-Scale Air Quality (CMAQ) modeling system in the late 1990s. The model source code and supporting data can be downloaded from the Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.org/), which is funded by EPA to distribute and provide limited support for CMAQ users. CMAQ was designed as a “one atmosphere” modeling system to encompass modeling of multiple pollutants and issues, including ozone, PM, visibility, and air toxics. This is in contrast to many earlier air quality models that focused on single-pollutant issues (e.g., ozone modeling by the Urban Airshed Model). CMAQ is an Eulerian model—that is, it is a grid-based model in which the frame of reference is a fixed, three-dimensional (3-D) grid with uniformly sized horizontal grid cells and variable vertical layer thicknesses. The number and size of grid cells and the number and thicknesses of layers are defined by the user, based in part on the size of the modeling domain to be used for each modeling project. The key science processes included in CMAQ are emissions, advection and dispersion, photochemical transformation, aerosol thermodynamics and phase transfer, aqueous chemistry, and wet and dry deposition of trace species. CMAQ offers a variety of choices in the numerical algorithms for treating many of these processes, and it is designed so that new algorithms can be included in the model. CMAQ offers a choice of three photochemical mechanisms for solving gas-phase chemistry: the Regional Acid Deposition Mechanism version 2 (RADM2), a fixed coefficient version of the SAPRC90 mechanism, and the Carbon Bond IV mechanism (CB-IV).

Comprehensive Air Quality Model with Extensions

The Comprehensive Air Quality Model with extensions (CAMx) model was initially developed by ENVIRON in the late 1990s as a nested-grid, gas-phase, Eulerian photochemical grid model. ENVIRON later revised CAMx to treat PM, visibility, and air toxics. While there are many similarities between the CMAQ and CAMx systems, there are also some significant differences in their treatment of advection, dispersion, aerosol formation, and dry and wet deposition.

Model Versions

Both EPA and ENVIRON periodically update and revise their models as new science or other improvements to the models are developed. For CMAQ, EPA typically provides a new release about once per year. The initial 2002 MPE for WRAP used CMAQ version 4.4, which was released in October 2004. In October 2005 EPA released CMAQ version 4.5, which includes the following updates and improvements to the modeling system:

- A new vertical advection algorithm with improved mass conservation
- Changes in deposition velocities for some PM species
- A new sea-salt emissions model and inclusion of sea salt in the aerosol thermodynamics
- An option to make vertical mixing parameters vary as a function of land use type

The RMC completed the initial CMAQ MPE using CMAQ v.4.4. When version 4.5 was released in October, the modeling was revised and a comparison of the model performance using the two versions was compared. Note that some of the new features in CMAQ v4.5 (e.g., sea salt in the AE4 aerosol dynamics module, and percent urban minimum vertical diffusivity) require the reprocessing of the MM5 data using the new version of MCIP (MCIP v3.0). However, because such reprocessing could potentially jeopardize the WRAP modeling schedule, WRAP elected to operate CMAQ v4.5 using the MM5 data processed using a previous MCIP version, MCIP v2.3, and the AE3 aerosol module that does not include active sea salt chemistry.

ENVIRON releases updated versions of CAMx approximately every two years, or as new features become available. The version used for the comparison of CMAQ and CAMx was CAMx v4.3. There are many similarities between CMAQ and CAMx regarding the science algorithms and chemical mechanisms used, including the CB-IV gas-phase and RADM aqueous-phase chemistries, ISORROPIA aerosol thermodynamics, and PPM horizontal advection scheme.

In the past, the treatment of vertical advection was a major difference between the two models; however, the incorporation of the new mass conservation scheme in CMAQ v4.5 makes its vertical advection algorithm much more similar to that of CAMx.

Major differences between the two models that still exist are in the basic model code, in the treatment of horizontal diffusion SOA formation mechanisms, and in grid nesting (CAMx supports one-way and two-way nesting, whereas CMAQ supports just one-way grid nesting). Both models include process analysis for the gas-phase portions of the model. The publicly released version of CAMx supports ozone and PM source apportionment through its Ozone and PM Source Apportionment Technology (OSAT/PSAT) probing tools, while for CMAQ there are research versions of the model that include Tagged Species Source Apportionment (TSSA) for some PM species (e.g., sulfate and nitrate). There are also research versions of CMAQ and CAMx that support the Decoupled Direct Method (DDM) sensitivity tool for PM and ozone.

The CAMx model is computationally more efficient than CMAQ. However, CAMx is currently supported for use on only a single central processing unit (CPU) and can perform multiprocessing using Open Multi-Processing (OMP) parallelization (i.e., shared memory multiprocessors). CMAQ parallelization, on the other hand, is implemented using Message Passing Interface (MPI) multiprocessing and therefore can be run using any number of CPUs. Depending on the number of model simulations to be performed and the manner in which they are set up, there can be a slight advantage either to CAMx or to CMAQ in regard to computational efficiency.

Model Simulations

In support of the WRAP Regional Haze air quality modeling efforts, the RMC developed air quality modeling inputs including annual meteorology and emissions inventories for a 2002 actual emissions base case, a planning case to represent the 2000-04 regional haze baseline period using averages for key emissions categories, and a 2018 base case of projected emissions determined using factors known at the end of 2005. All emission inventories were developed using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Each of these inventories has undergone a number of revisions throughout the development process to arrive at the final versions used in CMAQ and CAMx air quality modeling. The development of each of these emission scenarios is documented under the emissions inventory sections of the TSS. In addition to various sensitivities scenarios, the WRAP performed air quality model simulations for each of the emissions scenarios as follows:

- The 2002 base case emissions scenario, referred to as “2002 Base Case” or “Base02”. The purpose of the Base02 inventory is to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of criteria and particulate matter air pollutants. The Base02 emissions inventories are used to validate the air quality model and associated databases and to demonstrate acceptable model performance with respect to replicating observed particulate matter air quality.
- The 2000-04 baseline period planning case emissions scenario is referred to as “Plan02”. The purpose of the Plan02 inventory is to represent baseline emission patterns based on average, or “typical”, conditions. This inventory provides a basis for comparison with the

future year 2018 projected emissions, as well as to gauge reasonable progress with respect to future year visibility.

- The 2018 future-year base case emissions scenario, referred to as "2018 Base Case" or "Base18". These emissions are used to represent conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

Data Sources

The CMAQ model requires inputs of three-dimensional gridded wind, temperature, humidity, cloud/precipitation, and boundary layer parameters. The current version of CMAQ can only utilize output fields from the PSU/NCAR MM5 meteorological model. MM5 is a state-of-the-science atmosphere model that has proven useful for air quality applications and has been used extensively in past local, state, regional, and national modeling efforts. MM5 has undergone extensive peer-review, with all of its components continually undergoing development and scrutiny by the modeling community. In-depth descriptions of MM5 can be found in Dudhia (1993) and Grell et al. (1994), and at http://www.mmm.ucar.edu/mm5. All meteorological data used for the WRAP air quality modeling efforts are derived from MM5 model simulations. The development of these data is documented in (Kemball-Cook, S. et al., 2005)

Emission inventories for all WRAP air quality simulations were developed using the Matrix Operator Kernel Emissions (SMOKE) modeling system. The development of these data has been discussed and documented elsewhere (Tonnesen, G. et al., 2006)

Initial conditions (ICs) are specified by the user for the first day of a model simulation. For continental-scale modeling using the RPO Unified 36-km domain, the ICs can affect model results for as many as 15 days, although the effect typically becomes very small after about 7 days. A model spin-up period is included in each simulation to eliminate any effects from the ICs. For the WRAP modeling, the annual simulation is divided into four quarters, and included a 15-day spin-up period for the quarters beginning in April, July, and October. For the quarter beginning in January 2002, a spin-up period covering December 16-31, 2001, using meteorology and emissions data developed for CENRAP were used..

Boundary conditions (BCs) specify the concentrations of gas and PM species at the four lateral boundaries of the model domain. BCs determine the amounts of gas and PM species that are transported into the model domain when winds flow is into the domain. Boundary conditions have a much larger effect on model simulations than do ICs. For some areas in the WRAP region and for clean conditions, the BCs can be a substantial contributor to visibility impairment.

For this study BC data generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob et al. (http://www-as.harvard.edu/chemistry/trop/geos/) for calendar year 2002 were applied. Additional data processing of the GEOS-Chem data was required before using them in CMAQ and CAMx. The data first had to be mapped to the boundaries of the WRAP domain, and the gas and PM species had to be remapped to a set of species used in the CMAQ and CAMx models. This work was completed by Byun and coworkers (http://www-as.harvard.edu/chemistry/trop/geos/meetings/2005/ppt/Expanding_Model_Capabilities/GEOS-CMAQ_april_4_Byun.ppt

The CMAQ model options and configuration used for the WRAP 36-km model simulations are described in Tonnesen, G. et al., 2006.

Model Run Specification Sheets

In order to provide documentation for each of the CMAQ and CAMx air quality model simulations conducted by the WRAP RMC during Calendar year 2006, a series of Model Run Specification Sheets were developed. These "Spec Sheets" provide a description of each simulation, the various air quality model options and configurations used and detailed listing and description of the meteorological data and emission inventories for each scenario. These Spec Sheets also provide a means for the RMC to track the development of each of the input data sets and defined the modeling schedule. The purpose of each simulation, and expected results, including their implications, are also included. A link to each of the individual Specification Sheets for the model simulations can be found on the RMC web site at: http://pah.cert.ucr.edu/aqm/308/cmaq.shtml.

2002 Base Case Modeling

Base02 Sensitivity Simulations

The purpose of the 2002 Base Case modeling efforts was to evaluate air quality/visibility modeling systems for a historical episode—in this case, for calendar year 2002—to demonstrate the suitability of the modeling systems for subsequent planning, sensitivity, and emissions control strategy modeling. Model performance evaluation is performed by comparing output from model simulations with ambient air quality data for the same time period. After creating emissions and meteorology inputs for the two air quality models, CMAQ and CAMx, the next step was to perform the visibility modeling and the model performance evaluations, which are described below. A detailed discussion of the results of the CMAQ and CAMx model simulations can be found in Tonnesen, G. et al., 2006. Also documented in Tonnesen, G. et al., 2006 are the results of the model performance evaluation, a model inter-comparison and discussion of various sensitivity simulations. This information was used as the basis for recommending the selection of CMAQ and/or CAMx to complete the remaining modeling efforts in RMC's support of WRAP.

Model Performance Evaluation

The objective of a model performance evaluation (MPE) is to compare model-simulated concentrations with observed data to determine whether the model's performance is sufficiently accurate to justify using the model for simulating future conditions. There are a number of challenges in completing an annual MPE for regional haze. The model must be compared to ambient data from several different monitoring networks for both PM and gaseous species, for an annual time period, and for a large number of sites. The model must be evaluated for both the worst visibility conditions and for very clean conditions. Finally, final guidance on how to perform an MPE for fine-particulate models is not yet available from EPA. Therefore, the RMC experimented with many different approaches for showing model performance results. The plot types that were found to be the most useful are the following:

- Time-series plots comparing the measured and model-predicted species concentrations
- Scatter plots showing model predictions on the *y*-axis and ambient data on the *x*-axis
- Spatial analysis plots with ambient data overlaid on model predictions
- Bar plots comparing the mean fractional bias (MFB) or mean fractional error (MFE) performance metrics
- "Bugle plots" showing how model performance varies as a function of the PM species concentration
- Stacked-bar plots of contributions to light extinction for the average of the best-20% visibility days or the worst-20% visibility days at each site; the higher the light extinction, the lower the visibility

Examples of each of these MPE metrics and analysis products can be found in Tonnesen, G. et al., 2006. The results of the MPE are available from the WRAP RMC website (http://pah.cert.ucr.edu/aqm/308/eval.shtml)

2002 Planning Scenario

The 2000-04 baseline period planning case scenario is referred to as "Plan02". The purpose of the Plan02 scenario is to simulation the air quality representative of baseline emission patterns based on average, or "typical", conditions. This scenario provides a basis for comparison with the future year 2018 scenario based on projected emissions, as well as to gauge reasonable progress with respect to future year visibility.

Plan02 Simulations Input Data

Input data used for the 2002 Planning model simulations consisted of the same meteorology as for the 2002 Base Case and the Plan02 emission inventories described under the Emissions Modeling section of the TSS.

The setup of the CMAQ model (including science options, run scripts, simulation periods, and ancillary data) for the Plan02 cases was identical to that used in the Base02 modeling, as described in the 2002 MPE report (Tonnesen et al., 2006). In summary, CMAQ v4.5 (released by EPA in October 2005) was used on the RPO Unified 36-km domain. The Carbon Bond Mechanism version 4 (CB4) with RADM aqueous chemistry, the SORGAM organic aerosol algorithm, and all other science algorithms detailed in Tonnesen et al., 2006 were used. Initial condition (IC) data for January 1, 2002, were developed using a 15-day spin-up period (December 16-31, 2001). Boundary condition (BC) data were generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob et al. (http://www-as.harvard.edu/chemistry/trop/geos/) for calendar year 2002.

Comparison With Base02 Simulations

For each of the three Plan02 emissions datasets, annual visibility modeling was performed using the CMAQ model. This was a key aspect of the QA procedure, since errors in the emissions inventories that might not be apparent during the emissions QA steps might be more readily detected in the results from the CMAQ modeling.

In our initial analysis of the Plan02 scenario, plots were prepared for QA purposes that compared the Plan02a CMAQ results with the Base02a CMAQ results for daily and monthly averages. After revising Plan02a to create Plan02b and Plan02c, additional QA plots were prepared to compare the CMAQ results of each revised Plan02 case to the previous iteration. These were prepared as Program for the Analysis and Visualization of Environmental data (PAVE) spatial plots showing the change in individual $PM_{2.5}$ species concentrations as daily, monthly, and annual averages. The final set of analysis products, available on the RMC web site, include PAVE difference plots comparing the CMAQ-predicted annual average species concentrations from the Plan02c case with those from the Base02b case. Note that these plots are not useful for visibility planning purposes, but are being provided to show the magnitudes of changes when moving from the 2002 Base Case to the 2002 Planning Case—in other words, from the actual emissions for the year 2002 to the “typical-year” emissions created for the final Plan02 scenario. The primary analysis “product” from the Plan02 CMAQ modeling is the use of its output in combination with the CMAQ output from the 2018 modeling to develop the visibility progress calculations and glide path plots, described below.

2018 Model Simulations

The 2018 future-year base case scenario is referred to as “2018 Base Case” or “Base18”. The purpose of the Base18 scenario is to simulation the air quality representative of conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

Base18 Simulation Input Data

Input data used for the 2018 Base Case model simulations consisted of the same meteorology as for the 2002 Base Case and the Base18 emission inventories described under the Emissions Modeling section of the TSS.

The setup of the CMAQ model (including science options, run scripts, simulation periods, and ancillary data) for the Base18 cases was identical to that used in the Base02 modeling, as described in the 2002 MPE report (Tonnesen et al., 2006). In summary, CMAQ v4.5 (released by EPA in October 2005) was used on the RPO Unified 36-km domain. The Carbon Bond Mechanism version 4 (CB4) with RADM aqueous chemistry, the SORGAM organic aerosol algorithm, and all other science algorithms detailed in Tonnesen et al., 2006 were used. Initial condition (IC) data for January 1, 2002, were developed using a 15-day spin-up period (December 16-31, 2001). Boundary condition (BC) data were generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob et al. (http://www-as.harvard.edu/chemistry/trop/geos/) for calendar year 2002.

Base18 Simulation Results

The purpose of modeling 2018 visibility is to compare the 2018 visibility predictions to the 2002 typical-year visibility modeling results, as discussed below. Some improvements in visibility by 2018 are expected because of reductions in emissions due to currently planned regulations and technology improvements. A brief summary is provided here of the comparison between the 2018 and 2002 results using annual average PAVE spatial plots. The goal of this summary is to convey the scale and spatial extent of changes in key $PM_{2.5}$ species from 2002 to 2018. For planning purposes, on the other hand, states and tribes should focus on the visibility projections and glide path calculations at individual Class I Areas.

Figures 1 through 4 show the annual average concentrations for sulfate, nitrate, $PM_{2.5}$ and model-reconstructed visibility (in deciviews), respectively. In each figure, the bottom two plots show the modeled concentration or deciviews for the Plan02b and Base18b cases, while the top plot shows the change in visibility calculated as Base18b minus Plan02b. The Plan02b results are presented here instead of Plan02c results because these plots had previously been prepared with version B. As the differences between Plan02b and Plan02c are extremely small, new plots prepared using Plan02c would be essentially identical to the results in Figure 1 through 4.

In each of the top plots in the four figures, cool colors indicate areas in which model-predicted visibility improved from 2002 to 2018, while warm colors indicate areas where modeled visibility became worse over that period. Figure 1 shows that reductions in sulfate were largest in the southwest corner of the WRAP region and in Texas and Oklahoma. This results from planned SO_x emissions reductions in the CENRAP region. There were smaller reductions in sulfate in the Los Angeles area, western Washington state, and southern Nevada. There were small increases of sulfate, mostly in Wyoming, due to growth in SO_x emissions. Most regions of the WRAP domain had low concentrations of sulfate in 2002 and little change in sulfate by 2018.

Figure 2 shows the results for nitrate. In the both 2002 and 2018, the modeled nitrate was greatest in California, and there were reduction in nitrate in that state in 2018 because of reductions in mobile-source NO_x emissions. There were small reductions in the Phoenix area as well, also from reductions in mobile-source NO_x emissions.

Figure 3 shows the comparison of $PM_{2.5}$ for 2002 and 2018. In most areas of the WRAP region, changes in $PM_{2.5}$ were less than 1 $\mu g/m^3$. Locations with increases in $PM_{2.5}$ correspond to areas of increased sulfate (see Figure 3-1). Areas with the largest reductions in $PM_{2.5}$ were the areas in California that had large reductions in modeled nitrate in 2018 (see Figure 3-2). Results for other species that contribute to $PM_{2.5}$ are available on the RMC web site at http://pah.cert.ucr.edu/aqm/308/cmaq.shtml#base18bvsplan02b.

Figure 4 compares model-reconstructed visibility for 2002 and 2018. Note that these results are calculated using the modeled relative humidity (RH), so they differ from the results that use site-specific monthly average RH. Nonetheless, the results in Figure 4 are indicative of the direction and magnitude of visibility changes in from 2002 to 2018. Although the largest improvements are in California and the Pacific Northwest, there were improvements throughout the WRAP region. The change in deciviews is more dramatic than the change in $PM_{2.5}$ mass (Figure 3) because the visibility in deciviews is a relative metric, so small mass changes in $PM_{2.5}$ in good visibility areas can result in large relative improvements in visibility.

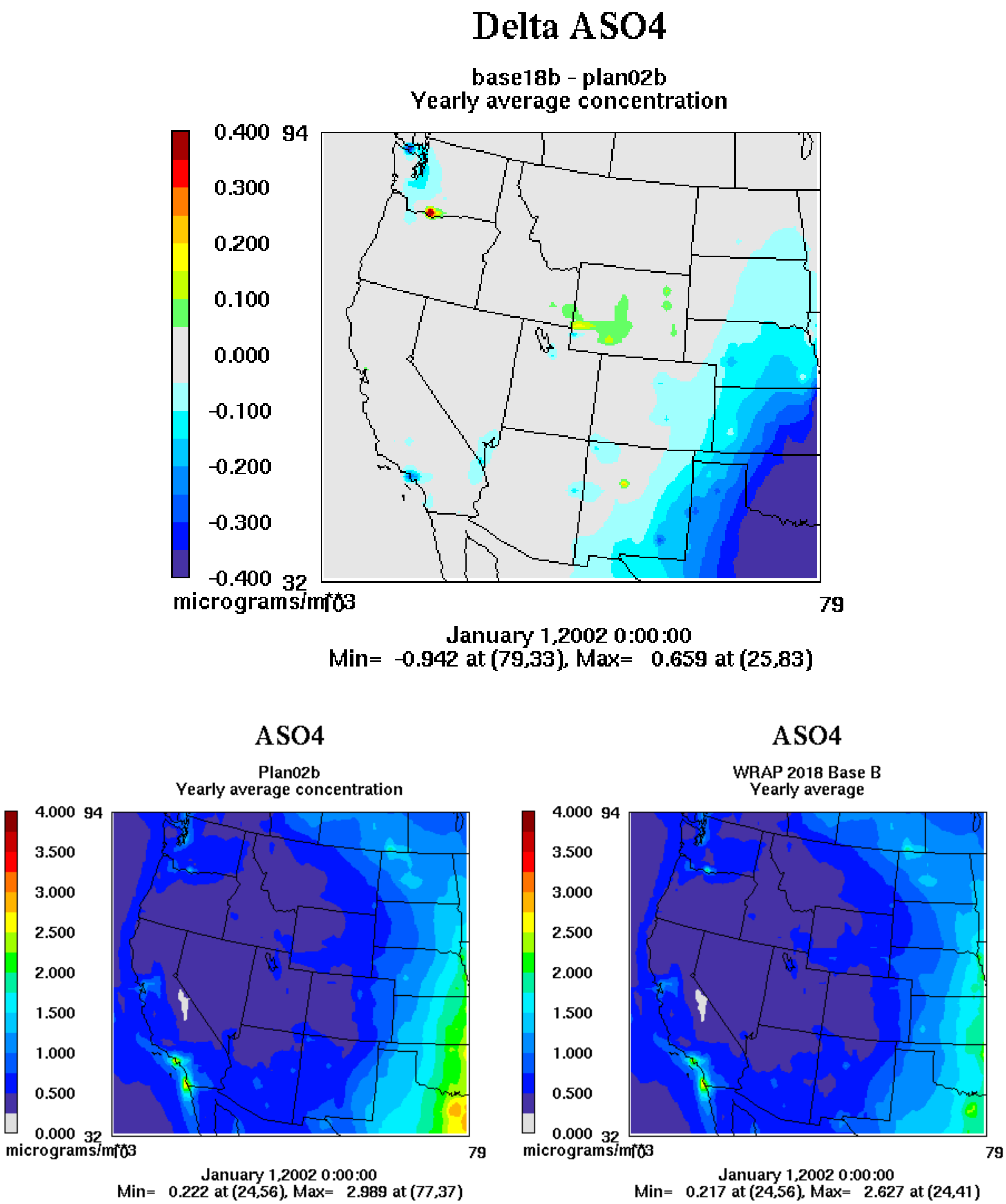

Figure 1. Annual average aerosol sulfate (ASO4) concentration comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b – Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

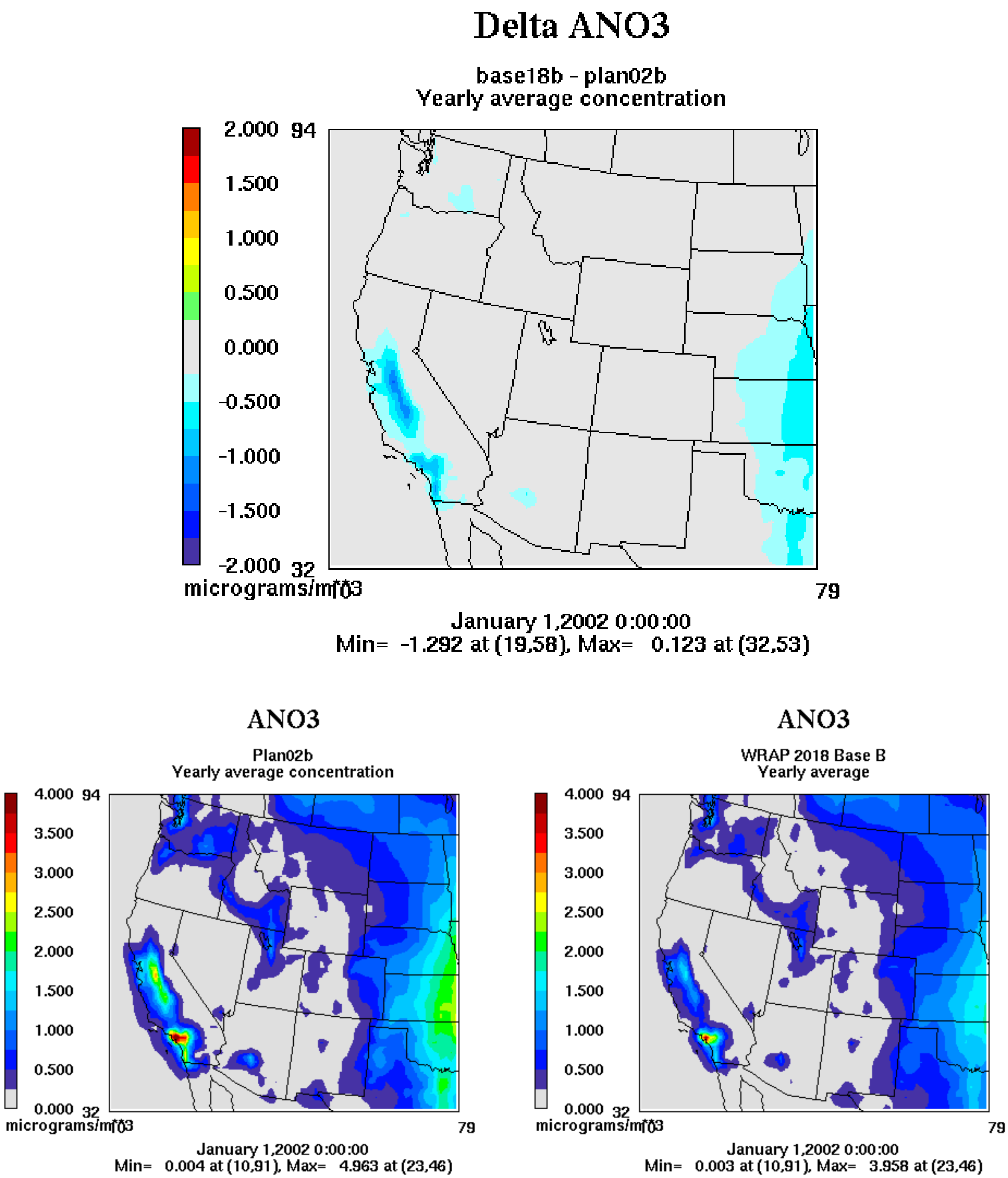

Figure 2. Annual average aerosol nitrate (ANO3) concentration comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b – Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

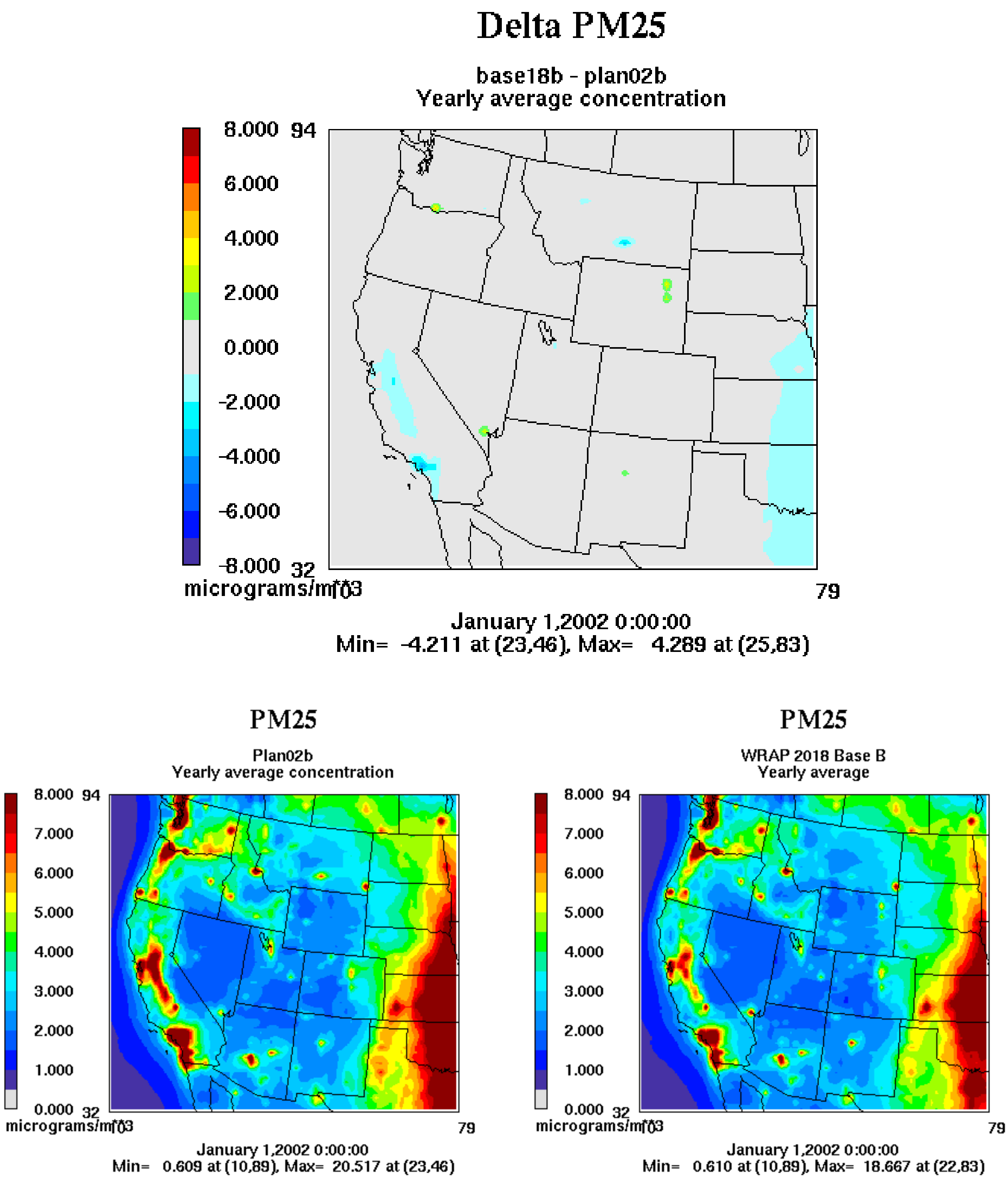

Figure 3. Annual average $PM_{2.5}$ concentration comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b – Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

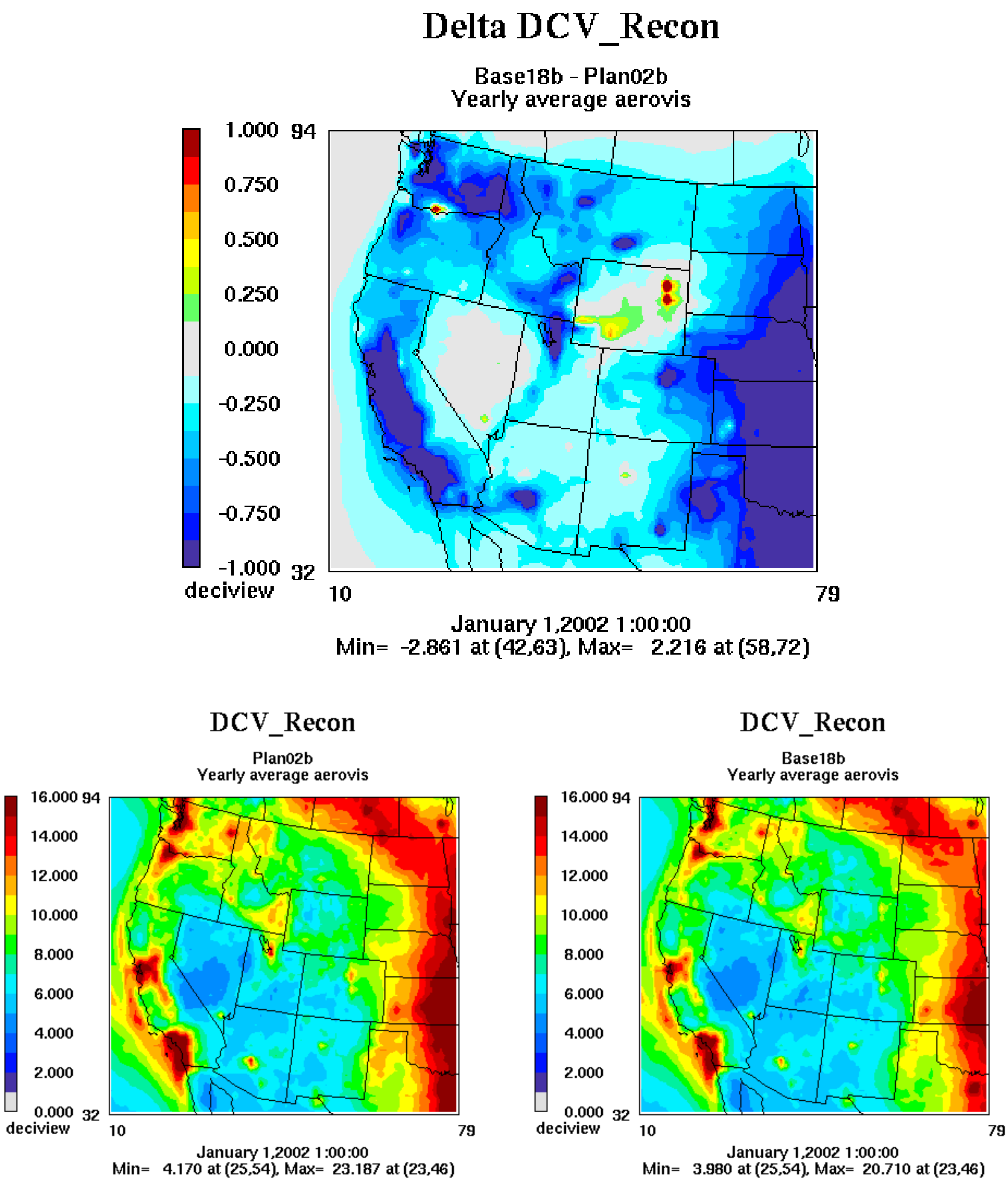

Figure 4. Annual average deciview comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b – Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

Visibility Projections

The Regional Haze Rule (RHR) goals include achieving natural visibility conditions at 156 Federally mandated Class I areas by 2064. In more specific terms, that RHR goal is defined as (1) visibility improvement toward natural conditions for the 20% of days that have the worst visibility (termed "20% worst," or W20%, visibility days) and (2) no worsening in visibility for the 20% of days that have the best visibility ("20% best," or B20%, visibility days). One component of the states' demonstration to EPA that they are making reasonable progress toward this 2064 goal is the comparison of modeled visibility projections for the first milestone year of 2018 with what is termed a uniform rate of progress (URP) goal. As explained in detail below, the 2018 URP goal is obtained by constructing a "linear glide path" (in deciviews) that has at one end the observed visibility conditions during the mandated five-year (2000-2004) baseline period and at the other end natural visibility conditions in 2064; the visibility value that occurs on the glide path at year 2018 is the URP goal.

Preliminary WRAP 2018 visibility projections have been made using the Plan02c and Base18b CMAQ 36-km modeling results, following EPA guidance that recommends applying the modeling results in a relative sense to project future-year visibility conditions (U.S. EPA, 2001, 2003a, 2006**).** Projections are made using relative response factors (RRFs), which are defined as the ratio of the future-year modeling results to the current-year modeling results. The calculated RRFs are applied to the baseline observed visibility conditions to project future-year observed visibility. These projections can then be used to assess the effectiveness of the simulated emission control strategies that were included in the future-year modeling. The major features of EPA's recommended visibility projections are as follows (U.S. EPA, 2003a,b, 2006):

- Monitoring data should be used to define current air quality.
- Monitored concentrations of PM_{10} are divided into six major components; the first five are assumed to be $PM_{2.5}$ and the sixth is $PM_{2.5-10}$.
    - SO_4 (sulfate)
    - NO_3 (particulate nitrate)
    - OC (organic carbon)
    - EC (elemental carbon)
    - OF (other fine particulate or soil)
    - CM (coarse matter).
- Models are used in a relative sense to develop RRFs between future and current predicted concentrations of each component.
- Component-specific RRFs are multiplied by current monitored values to estimate future component concentrations.
- Estimates of future component concentrations are consolidated to provide an estimate of future air quality.

- Future estimated air quality is compared with the goal for regional haze to see whether the simulated control strategy would result in the goal being met.
- It is acceptable to assume that all measured sulfate is in the form of ammonium sulfate [$(NH_4)_2SO_4$] and all particulate nitrate is in the form of ammonium nitrate [NH_4NO_3].

To facilitate tracking the progress toward visibility goals, two important visibility parameters are required for each Class I area:

- *Baseline Conditions:* "Baseline Conditions" represent visibility for the B20% and W20% days for the initial five-year baseline period of the regional haze program. Baseline Conditions are calculated using monitoring data collected during the 2000-2004 five-year period and are the starting point in 2004 for the uniform rate of progress (URP) glide path to Natural Conditions in 2064 (U.S. EPA, 2003a).
- *Natural Conditions:* "Natural Conditions," the RHR goal for 2064 for the Federally mandated Class I areas, represent estimates of natural visibility conditions for the B20% and W20% days at a given Class I area.

<u>Baseline Conditions</u>

Baseline Conditions for Class I areas are calculated using fine and coarse PM concentrations measured at Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors (Malm et al., 2000). Each Class I area in the WRAP domain has an associated IMPROVE PM monitor. The IMPROVE monitors do not measure visibility directly, but instead measure speciated fine particulate ($PM_{2.5}$) and total $PM_{2.5}$ and PM_{10} mass concentrations from which visibility is calculated using the IMPROVE aerosol extinction equation, discussed later.

Visibility conditions are estimated starting with the IMPROVE 24-h average PM mass measurements related to six PM components of light extinction:

- Sulfate [$(NH_4)_2SO_4$]
- Particulate nitrate [(NH_4NO_3]
- Organic matter [OMC]
- Light-absorbing carbon [LAC] or elemental carbon [EC]
- Soil
- Coarse matter [CM]

The IMPROVE monitors do not directly measure some of these species, so assumptions are made as to how the IMPROVE measurements can be adjusted and combined to obtain these six components. For example, sulfate and particulate nitrate are assumed to be completely neutralized by ammonium and only the fine mode ($PM_{2.5}$) is speciated to obtain sulfate and nitrate measurements (that is, any coarse-mode sulfate and nitrate in the real atmosphere may be present in the IMPROVE CM measurement). Concentrations for the above six components of light extinction in the IMPROVE aerosol extinction equation are obtained from the IMPROVE measured species using the formulas shown in Table 1.

Table 1. Definition of IMPROVE components from measured species.

IMPROVE Component	Calculation of Component from IMPROVE Measured Species
Sulfate	1.375 x (3 x S)
Nitrate	1.29 x NO_3^-
OMC	1.4 x OC
LAC	EC
Soil	(2.2 x Al) + (2.49 x Si) + (1.63 x Ca) + (2.42 x Fe) + (1.94 x Ti)
CM	MT – MF

where

- S is elemental sulfur as determined from proton-induced x-ray emissions (PIXE) analysis of the IMPROVE Module A. To estimate the mass of the sulfate ion ($SO_4^{=}$), S is multiplied by 3 to account for the presence of oxygen. If S is missing then the sulfate (SO_4) measured by ion chromatography analysis of Module B is used to replace (3 x S). For the IMPROVE aerosol extinction calculation, sulfate is assumed to be completely neutralized by ammonium (1.375 x SO_4).
- NO_3^- is the particulate nitrate measured by ion chromatography analysis of Module B. For the IMPROVE aerosol extinction calculation, it is assumed to be completely neutralized by ammonium (1.29 x NO_3).
- The IMPROVE organic carbon (OC) measurements are multiplied by 1.4 to obtain organic matter (OMC), which adjusts the OC mass for other elements assumed to be associated with OC.
- Elemental carbon (EC) is also referred to as light-absorbing carbon (LAC).
- Soil is determined as a sum of the masses of those elements (measured by PIXE) predominantly associated with soil (Al, Si, Ca, Fe, K, and Ti), adjusted to account for oxygen associated with the common oxide forms. Because K is also a product of the combustion of vegetation, it is represented in the formula by 0.6 x Fe and is not shown explicitly.
- MT and MF are total PM_{10} and $PM_{2.5}$ mass, respectively.

Associated with each PM species is an extinction efficiency that converts concentrations (in $\mu g/m^3$) to light extinction (in inverse megameters, Mm^{-1}), as listed below. Sulfate and nitrate are hygroscopic, so relative humidity (RH) adjustment factors, f(RH), are used to increase the particles' extinction efficiency with increasing RH; this accounts for the particles' taking on water and having greater light scattering. Note that some organic matter (OMC) compounds may also have hygroscopic properties, but the IMPROVE aerosol extinction equation assumes OMC is nonhygroscopic.

$$\beta_{Sulfate} = 3 \text{ x } f(RH) \text{ x } [sulfate]$$
$$\beta_{Nitrate} = 3 \text{ x } f(RH) \text{ x } [nitrate]$$
$$\beta_{OM} = 4 \text{ x } [OMC]$$
$$\beta_{EC} = 10 \text{ x } [EC]$$
$$\beta_{Soil} = 1 \text{ x } [soil]$$
$$\beta_{CM} = 0.6 \text{ x } [CM]$$

The total light extinction (β_{ext}) is assumed to be the sum of the light extinctions due to the six PM species listed above plus Rayleigh (blue sky) background extinction (β_{Ray}), which is assumed to be 10 Mm^{-1}. This is reflected in the IMPROVE extinction equation:

$$\beta_{ext} = \beta_{Ray} + b_{Sulfate} + \beta_{Nitrate} + \beta_{EC} + \beta_{OMC} + \beta_{Soil} + \beta_{CM}$$

The total light extinction (β_{ext}) in Mm^{-1} is related to visual range (VR) in kilometers using the following relationship:

$$VR = 3912 / \beta_{ext}$$

The RHR requires that visibility be expressed in terms of a haze index (HI) in units of deciview (dv), which is calculated as follows:

$$HI = 10 \ln(\beta_{ext}/10)$$

The equations above, with measurements from the associated IMPROVE monitor, are used to estimate the daily average visibility at each Class I area for each IMPROVE monitored day. For each year from the 2000-2004 baseline period, these daily average visibility values are then ranked from highest to lowest. The "worst days" visibility for each of the five years in the baseline period is defined as the average visibility across the 20% worst-visibility days (highest deciview values); similarly, the "best days" visibility is defined as the average visibility across the 20% best-visibility days (lowest deciview values) for each year. The Baseline Conditions for the best and worst days are defined as the five-year average of the B20% visibility days and of the W20% visibility days, respectively, across the five-year baseline period.

The set of equations given above for relating measured PM species to visibility (light extinction) are referred to as the "Old IMPROVE" equation. The IMPROVE Steering Committee has developed a "New IMPROVE" equation that they believe better represents the fit between measured PM species concentrations and visibility impairment. Although conceptually similar to the Old IMPROVE equation, the New IMPROVE equation includes updates to many of the parameters and the addition of extinctions due to NO_2 absorption and sea salt. 2018 visibility projections and comparisons with the URP glide path goals were performed using both the New and Old IMPROVE equations. The reader is referred elsewhere for details on the New IMPROVE extinction equation (e.g., EPA, 2006a,b).

Mapping Model Results to IMPROVE Measurements

As noted above, future-year visibility at Class I areas is projected by using modeling results in a relative sense to scale current observed visibility for the B20% and W20% visibility days. This scaling is done using RRFs, the ratios of future-year modeling results to current-year results. Each of the six components of light extinction in the IMPROVE reconstructed mass extinction equation is scaled separately. Because the modeled species do not exactly match up with the IMPROVE measured PM species, assumptions must be made to map the modeled PM species to the IMPROVE measured species for the purpose of projecting visibility improvements. For example, in the model's chemistry (which explicitly simulates ammonium), sulfate may or may not be fully neutralized; the IMPROVE extinction equation, on the other hand, assumes that observed sulfate is fully neutralized by ammonium. For the CMAQ v4.5 model (September 2005 release) used in the WRAP RMC modeling, the mapping of modeled species to IMPROVE measured PM species is listed in Table 2.

Table 2. Mapping of CMAQ v4.5 modeled species concentrations to IMPROVE measured components.

IMPROVE Component	CMAQ V4.3 Species
Sulfate	1.375 x (ASO4J + ASO4I)
Nitrate	1.29 x (ANO3J + ANO3I)
OMC	AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI
LAC	AECJ + AECI
Soil	A25J + A25I
CM	ACORS + ASEAS + ASOIL

Projecting Visibility Changes Using Modeling Results

RRFs calculated from modeling results can be used to project future-year visibility. For the urrent modeling efforts, RRFs are the ratio of the 2018 modeling results to the 2002 modeling results, and are specific to each Class I area and each PM species. RRFs are applied to the Baseline Condition observed PM species levels to project future-year PM levels, which are then used with the IMPROVE extinction equation listed above to assess visibility. The following six steps are used to project future-year visibility for the B20% and W20% visibility days (the discussion below is for W20% days but also applies to B20% days):

1. For each Class I area and each monitored day, daily visibility is ranked using IMPROVE data and IMPROVE extinction equation for each year from the five-year baseline period (2000-2004) to identify the W20% visibility days for each year.

2. Use an air quality model to simulate a base-year period (ideally 2000-2004, but in reality just 2002) and a future year (e.g., 2018), then apply the resulting information to develop

Class-I-area-specific RRFs for each of the six components of light extinction in the IMPROVE aerosol extinction equation.

3. Multiply the RRFs by the measured 24-h PM data for each day from the W20% days for each year from the five-year baseline period to obtain projected future-year (2018) 24-h PM concentrations for the W20% days.
4. Compute the future-year daily extinction using the IMPROVE aerosol extinction equation and the projected PM concentrations for each of the W20% days in the five-year baseline from Step 3.
5. For each of the W20% days within each year of the five-year baseline, convert the future-year daily extinction to units of deciview and average the daily deciview values within each of the five years separately to obtain five years of average deciview visibility for the W20% days.
6. Average the five years of average deciview visibility to obtain the future-year visibility Haze Index estimate that is compared with the 2018 progress goal.

In calculating the RRFs, EPA draft guidance (U.S. EPA, 2001, 2006a) recommends selecting modeled PM species concentrations "near" the monitor by taking a spatial average of PM concentrations across a grid-cell-resolution–dependent NX by NY array of cells centered on the grid containing the monitor. For the WRAP 36-km CMAQ modeling, the model estimates for just the grid cell containing the monitor are used (i.e., NX=NY=1).

For the preliminary 2018 visibility projections, results are presented only for "Method 1," which is the recommended approach in EPA's draft modeling guidance documents (U.S. EPA, 2001, 2006a). In the Method 1 Average RRF Approach, an average RRF for the W20% days from 2002 (Modeled Worst Days) is obtained for the Plan02c and the Base18b CMAQ simulations by averaging the PM concentration components across the Modeled Worst Days and then calculating the (future year):(base year) ratio of the average PM concentrations. For example, if $SO4_{i,j}$ is the measured sulfate concentrations at Class I area j for the i=1,…,N 20% worst visibility days in 2002, then the RRF for sulfate on the W20% days would be obtained as:

$$RRF_j(SO4) = \frac{\frac{1}{N}\sum_{i=1}^{N} SO4_{ij}(2018)}{\frac{1}{N}\sum_{i=1}^{N} SO4_{ij}(2002)} = \frac{\sum_{i=1}^{N} SO4_{ij}(2018)}{\sum_{i=1}^{N} SO4_{ij}(2002)}$$

For each Class I area and each of the W20% days, the average RRF for each PM component would be applied to concentrations for the W20% days from the 2000-2004 baseline period to estimate future-year PM concentrations for each of the W20% days. Extinction and HI would then be calculated to obtain the projected future-year visibility conditions using the procedures given previously.

Glide Path to Natural Conditions

The presumptive visibility target for 2018 is the URP goal that is obtained by constructing a linear glide path from the current Baseline Conditions to Natural Conditions in 2064 (both expressed in deciviews). For instance, Figure 5 displays an example visibility glide path for the Grand Canyon National Park (GRCA) Class I area. EPA's default Natural Conditions value for the W20% days (U.S. EPA, 2003b), shown as the green line, is the 2064 visibility goal at GRCA of 6.95 dv. The blue diamonds at the left of the plot are the annual average current conditions, based on IMPROVE observations for the W20% days as obtained from the Visibility Information Exchange Web System (VIEWS) web site (http://vista.cira.colostate.edu/views/). These annual average visibility values for the 20% worst days allow an assessment of trends and the year-to-year variation in visibility. The Baseline Conditions are the average of the W20% visibility from 2000-2004, which is the starting point for the glide path in 2004 (12.04 dv for GRCA). A linear URP from the Baseline Conditions in 2004 to Natural Conditions in 2064 (sloping pink line with triangles) is assumed, and the value on the glide path at 2018 is the presumptive URP visibility target that the modeled 2018 projections are compared against to judge progress. In this example, the visibility progress goal in 2018 would be 10.85 dv. Meeting this would require a 1.19 dv reduction in visibility by 2018 to meet that milestone year's visibility progress target at the Grand Canyon National Park.

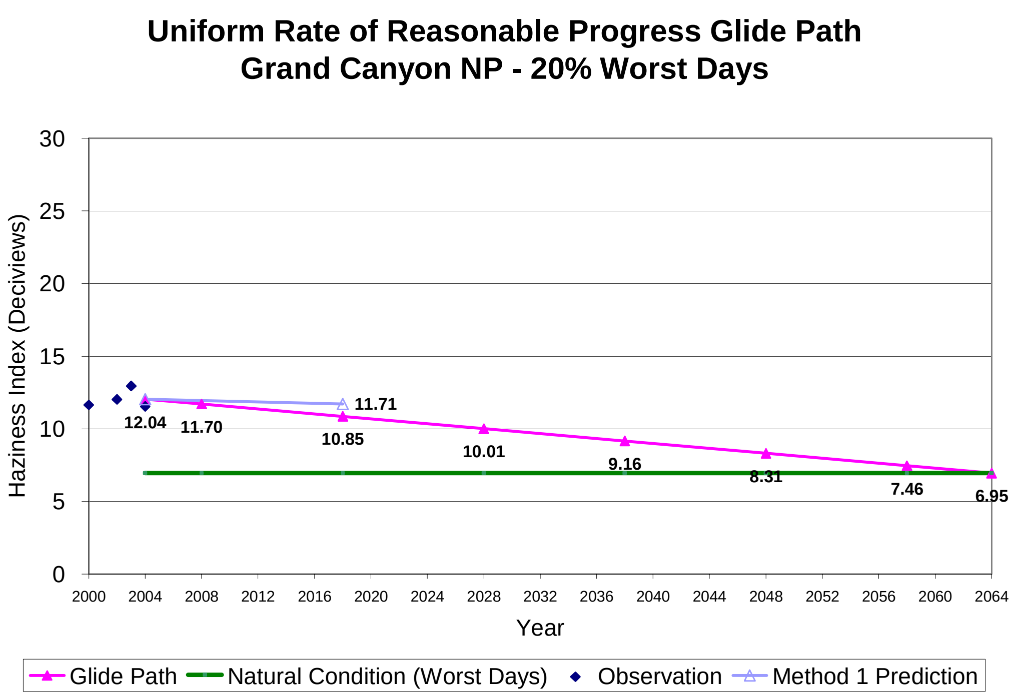

Figure 5. Example of URP glide path using IMPROVE data from the Grand Canyon National Park for the W20% days and comparison with Base18b visibility projections.

Preliminary Visibility Projection Results

For all of the WRAP Class I areas, the RMC performed preliminary 2018 visibility projections and compared them to the 2018 URP goals using the Plan02c and Base18b CMAQ modeling results and the Old and New IMPROVE equations. As an example, Figure 5 above compares the Base18b visibility projections with the URP goal based on the glide path for GRCA and the Old IMPROVE equation. To achieve the 2018 URP goal, the modeled 2018 visibility projection would have to show a 1.19 dv (=12.04-10.85) reduction. However, the modeled 2018 visibility projection shows only a 0.33 dv (=12.04-11.71) reduction by 2018, which indicates that the emission controls simulated in case Base18b would not achieve the modeled URP goal; the 2018 visibility projection achieves only 28% of the goal (28% = 100 x 0.33/1.19). Figure 6 displays the 2018 visibility projections for all WRAP Class I areas, using both the Old and New IMPROVE equations, expressed as a percentage of achieving the URP goal, with values of 100% or greater achieving the goal. Using the procedures outlined above, none of the WRAP Class I areas are projected to achieve their URP goals. There are various reasons for this, such as the presence of W20% days that are dominated by emissions from sources that are not controllable, such as wildfires, dust, and/or international transport. Additional analysis of these results and alternative projection techniques are currently under study.

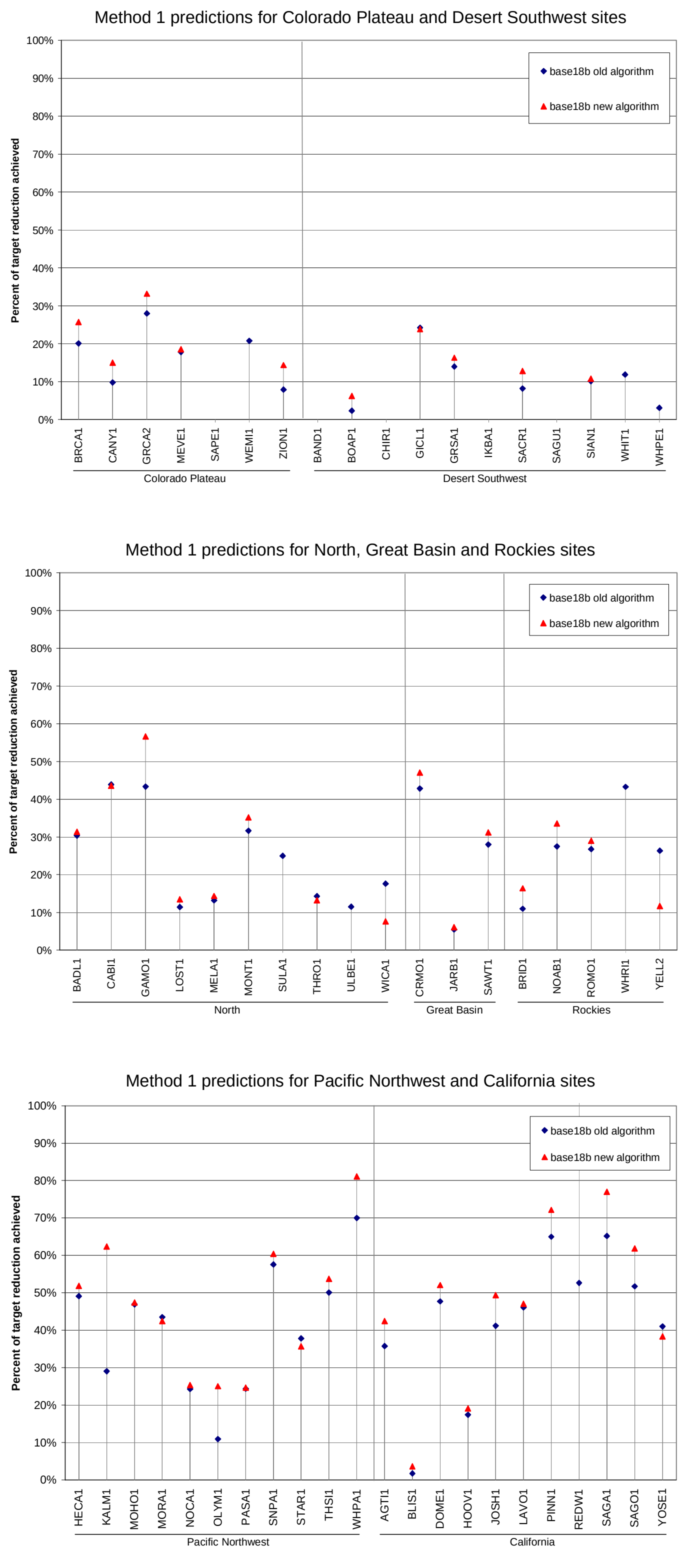

Figure 6. 2018 visibility projections at WRAP Class I areas expressed as a percent of achieving the 2018 URP goal using the Old and New IMPROVE equation and the WRAP Base18c CMAQ 36-km modeling results.

PM Source Apportionment

Impairment of visibility in Class I areas is caused by a combination of local air pollutants and regional pollutants that are transported long distances. To develop effective visibility improvement strategies, the WRAP member states and tribes need to know the relative contributions of local and transported pollutants, and which emissions sources are significant contributors to visibility impairment at a given Class I area.

A variety of modeling and data analysis methods can be used to perform source apportionment of the PM observed at a given receptor site. Model sensitivity simulations have been used in which a "base case" model simulation is performed and then a particular source is "zeroed out" of the emissions. The importance of that source is assessed by evaluating the change in pollutants at the receptor site, calculated as pollutant concentration in the sensitivity case minus that in the base case. This approach is known as a "brute force" sensitivity because a separate model run is required for each sensitivity.

An alternative approach is to implement a mass-tracking algorithm in the air quality model to explicitly track for a given emissions source the chemical transformations, transport, and removal of the PM that was formed from that source. Mass tracking methods have been implemented in both the CMAQ and CAMx air quality models. Initial work completed by the RMC during 2004 used the CMAQ Tagged Species Source Apportionment (TSSA) method. Unfortunately, there were problems with mass conservation in the version of CMAQ used in that study, and these affected the TSSA results. A similar algorithm has been implemented in CAMx, the PM Source Apportionment Technology (PSAT). Comparisons of TSSA and PSAT showed that the results were qualitatively similar, that is, the relative ranking of the most significant source contributors were similar for the two methods. However, the total mass contributions differed. With separate funding from EPA, UCR has implemented a version of TSSA in the new CMAQ release (v4.5) that corrects the mass conservation error, but given the uncertainty of the availability of this update, the CAMx/PSAT source apportionment method was used for the WRAP modeling analysis.

The main objective of applying CAMx/PSAT is to evaluate the regional haze air quality for typical 2002 (Plan02c) and future-year 2018 (Base18b) conditions. These results are used

- to assess the contributions of different geographic source regions (e.g., states) and source categories to current (2002) and future (2018) visibility impairment at Class I areas, to obtain improved understanding of (1) the causes of the impairment and (2) which states are included in the area of influence (AOI) of a given Class I area; and

- to identify the source regions and emissions categories that, if controlled, would produce the greatest visibility improvements at a Class I area.

CAMx/PSAT

The PM Source Apportionment Technology performs source apportionment based on user-defined source groups. A source group is the combination of a geographic source region and an emissions source category. Examples of source regions include states, nonattainment areas, and counties. Examples of source categories include mobile sources, biogenic sources, and elevated point sources; PSAT can even focus on individual sources. The user defines a geographic source region map to specify the source regions of interest. He or she then inputs each source category as separate, gridded low-level emissions and/or elevated-point-source emissions. The model then determines each source group by overlaying the source categories on the source region map. For further information, please refer to the white paper on the features and capabilities of PSAT (http://pah.cert.ucr.edu/aqm/308/reports/PSAT_White_Paper_111405_final_draft1.pdf), with additional details available in the CAMx user's guide (ENVIRON, 2005; http://www.camx.com).

PM source apportionment modeling was performed for aerosol sulfate (SO_4) and aerosol nitrate (NO_3) and their related species (e.g., SO_2, NO, NO_2, HNO_3, NH_3, and NH_4). The PSAT simulations include 9 tracers, 18 source regions, and 6 source groups. The computational cost for each of these species differs because additional tracers must be used to track chemical conversions of precursors to the secondary PM species SO_4, NO_3, NH_4, and secondary organic aerosols (SOA). Table 3 summarizes the computer run time required for each species. The practical implication of this table for WRAP is that it is much more expensive to perform PSAT simulations for NO_3 and especially for SOA than it is to perform simulations for other species.

Table 3. Benchmarks for PSAT computational costs for each PM species. Run time is for one day (01/02/2002) on the WRAP 36-km domain.

Species	No. of Species Tracers	RAM Memory	Disk Storage per Day	Run Time with 1 CPU
SO_4	2	1.6 GB	1.1 GB	4.7 h/day
NO_3	7	1.7 GB	2.6 GB	13.2 h/day
SO_4 and NO_3 combined	9	1.9 GB	3.3 GB	16.8 h/day
SOA	14	6.8 GB	Not tested	Not tested
Primary PM species	6	1.5 GB	3.0 GB	10.8 h/day

Two annual 36-km CAMx/PSAT model simulations were performed: one with the Plan02c typical-year baseline case and the other with the Base18b future-year case. It is expected that the states and tribes will use these results to assess the sources that contribute to visibility impairment at each Class I Area, and to guide the choice of emission control strategies. The RMC web site includes a full set of source apportionment spatial plots and receptor bar plots for both Plan02b and Base18b. These graphical displays of the PSAT results, as well as additional analyses of these results are available on the TSS under http://vista.cira.colostate.edu/tss/Tools/ResultsSA.aspx

CAMx/PSAT 2002 and 2018 Setup

PSAT source apportionment simulations for 2002 and 2018 were performed using CAMx v4.30. Table 4 lists overall specifications for the 2002 PSAT simulations. The domain setup was identical to the standard WRAP CMAQ modeling domain. The CAMx/PSAT run-time options are shown in Table 5. The CAMx/PSAT computational cost for one simulation day with source tracking for sulfate (SO_4) and nitrate (NO_3) is approximately 14.5 CPU hours with an AMD Opteron CPU. The source regions used in the PSAT simulations are shown in Figure 7 and Table 4. The six emissions source groups are described in Table 6. The development of these emissions data are described in more detail below.

The annual PSAT run was divided into four seasons for modeling. The initial conditions for the first season (January 1 to March 31, 2002) came from a CENRAP annual simulation. For the other three seasons, we allowed 15 model spin-up days prior to the beginning of each season. Based on the chosen set of source regions and groups, with nine tracers, and with a minimum requirement of 87,000 point sources and a horizontal domain of 148 by 112 grid cells with 19 vertical layers, the run-time memory requirement is 1.9 GB. Total disk storage per day is approximately 3.3 GB. Although the RMC's computation nodes are equipped with dual Opteron CPUs with 2 GB of RAM and 1 GB of swap space, the high run-time memory requirements prevented running PSAT simulations using the OpenMP shared memory multiprocessing capability implemented in CAMx.

Table 4. WRAP 2002 CAMx/PSAT specifications.

WRAP PSAT Specs	Description
Model	CAMx v4.30
OS/compiler	Linux, pgf90 v.6.0-5
CPU type	AMD Opteron with 2 GB of RAM
Source region	18 source regions; see Figure 4.1 and Table 4.4
Emissions source groups	Plan02b, 6 source groups; see Table 4.5
Initial conditions	From CENRAP (camx.v4.30.cenrap36.omp.2001365.inst.2)
Boundary conditions	3-h BC from GEOS-Chem v2

Table 5. WRAP CAMx/PSAT run-time options.

WRAP PSAT specs	Description
Advection solver	PPM
Chemistry parameters	CAMx4.3.chemparam.4_CF
Chemistry solver	CMC
Plume-in-grid	Not used

WRAP PSAT specs	Description
Probing tool	PSAT
Dry/wet deposition	TRUE (turned on)
Staggered winds	TRUE (turned on)

Table 6. WRAP CAMx/PSAT source regions cross-reference table.

Source Region ID	Source Region Description[1]	Source Region ID	Source Region Description[1]
1	Arizona (AZ)	10	South Dakota (SD)
2	California (CA)	11	Utah (UT)
3	Colorado (CO)	12	Washington (WA)
4	Idaho (ID)	13	Wyoming (WY)
5	Montana (MT)	14	Pacific off-shore & Sea of Cortez (OF)
6	Nevada (NV)	15	CENRAP states (CE)
7	New Mexico (NM)	16	Eastern U.S., Gulf of Mexico, & Atlantic Ocean (EA)
8	North Dakota (ND)	17	Mexico (MX)
9	Oregon (OR)	18	Canada (CN)

[1]The abbreviations in parentheses are used to identify source regions in PSAT receptor bar plots.

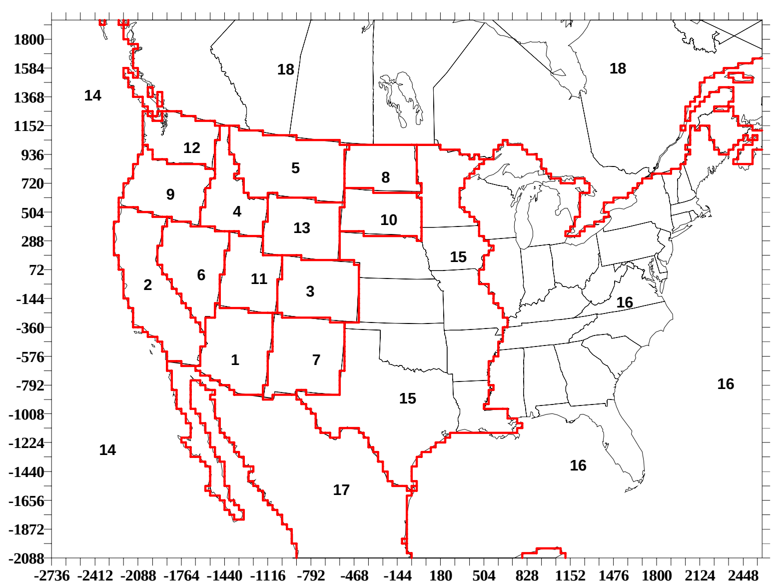

Figure 7. WRAP CAMx/PSAT source region map. Table 6 defines the source region IDs.

Table 7. WRAP CAMx/PSAT emissions source groups.

Emissions Source Groups	Low-level Sources	Elevated Sources
1	Low-level point sources (including stationary off-shore)	Elevated point sources (including stationary off-shore)
2	Anthropogenic wildfires (WRAP only)	Anthropogenic wild fires (WRAP only)
3	Total mobile (on-road, off-road, including planes, trains, ships in/near port, off-shore shipping)	
4	Natural emissions (natural fire, WRAP only, biogenics)	Natural emissions (natural fire, WRAP only, biogenics)
5	Non-WRAP wildfires (elevated fire sources in other RPOs)	Non-WRAP wild fires (elevated fire sources in other RPOs)
6	Everything else (area sources, all dust, fugitive ammonia, non-elevated fire sources in other RPOs)	

PSAT Results

The source apportionment algorithms implemented in CAMx generate output files in the same format as the standard modeled species concentrations files. This typically consists of a two-dimensional, gridded dataset of hourly-average surface concentrations for each source group tracer that gives the contribution of the tracer to all the surface grid cells in the model domain for each hour of the simulation. Three-dimensional instantaneous concentrations are also output for the last two hours of the simulation, which are used to restart the model. Although there are options to output hourly 3-D average tracer concentrations, the model is usually configures to output only the model's surface layer concentrations because of the vast disk storage space needed for the 3-D file output for all the source group contributions.

The source apportionment model results are typically presented in two ways :

- *Spatial plots* showing the area of influence of a source group's PM species contributions throughout the model domain, either at a given hourly-average point in time or averaged over some time interval (e.g., monthly average).
- *Receptor bar plots* showing the rank order of source groupings that contribute to PM species at any given receptor site. These plots also can be at a particular point in time or averaged over selected time intervals—for example, the average source contributions for the 20% worst visibility days.

If the 3-D tracer output files are saved, it is also possible to prepare animations of PM species plumes from each of the source groups. However, these plots are less useful than the others for quantitative analysis, are expensive to produce, and require saving 3-D hourly output, which is disk-space intensive. The primary products of the WRAP PSAT modeling were receptor bar plots showing the emission source groups that contribute the most to the model grid cells containing each IMPROVE monitoring site and other receptor sites identified by WRAP.

Model Sensitivity Simulations

A variety of sensitivity simulations were conducted by the RMC as part of their modeling efforts to support the WRAP in addressing the Regional Haze Rule requirements. These sensitivity simulations are described below.

2002 Clean Case

There are many natural sources of ambient $PM_{2.5}$, both direct emissions of primary $PM_{2.5}$ (such as windblown dust) and emissions of gaseous species that undergo photochemical transformation or condensation to form secondary $PM_{2.5}$. Natural sources of $PM_{2.5}$ are of concern because they represent sources that cannot be controlled. Estimates of natural haze levels have been developed by EPA for visibility planning purposes and are described in *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (U.S. EPA, 2003a). These are the natural haze levels to be used in glide path calculations, such as those we performed as part of the visibility projections for 2018. However, the natural haze levels developed by EPA for glide path calculations were based on ambient data analysis, not on visibility modeling. This question thus arises: Would modeled levels of natural haze be consistent with the values estimated by EPA for visibility planning? If the natural haze levels calculated by the model were substantially higher than the levels used for planning purposes, this would make it more difficult for modeling studies to demonstrate progress in attaining visibility goals, because the model would predict haze levels that exceeded EPA's natural haze levels even if all anthropogenic sources of $PM_{2.5}$ were removed from the modeling. The RMC explored this issue by conducting a CMAQ sensitivity "clean conditions" simulation

There are many uncertainties and unknowns regarding natural emissions. There have been only limited studies of natural emissions conditions. It is known that there are very large uncertainties in the categories of natural emissions included in the WRAP emissions inventories, and that some categories of natural emissions are not included at all. Also, it is difficult to know what truly natural emissions would have been like in the absence of human modifications of the environment. For example, wildfire emissions are a large source of natural emissions in our modeling, but how much larger might that source be in the absence of fire suppression efforts? For all of these reasons, it was decided to describe this sensitivity simulation as a "clean conditions" scenario rather than a "natural conditions" scenario. In this simulation, all anthropogenic emissions were removed from the inventory and only those emissions that were defined as biogenic in the 2002 base case (Base02) were included. Thus, this model simulation does not represent true natural conditions. It indicates instead the lowest haze levels that could be achieved in the model if all anthropogenic emissions were zeroed out.

Emission Inventories

The emissions for the clean 2002 sensitivity case were derived from case Base02a. Because it was a sensitivity analysis to test the impacts of natural emissions sources on visibility, it is referred to it as scenario Base02nt, where "nt" refers to natural. The following emissions categories in Base02nt were included:

- *Biogenics:* Generated in case Base02a by BEIS3.12 using SMOKE.

- *WRAP Ammonia:* The Base02a ammonia emissions for the WRAP region were developed with a GIS by ENVIRON. The five emissions category modeled included three anthropogenic sources (domestic animals, livestock, and fertilizer application) and two natural sources (soils and wildlife). Only the two natural sources in scenario Base02nt were used.

- *CENRAP and MRPO Ammonia:* To create ammonia inventory files for only natural sources, we used a list of SCCs representing natural sources to extract the emissions records of these sources from the monthly inventory files that were used in Base02a. it was found that there were no natural ammonia sources in the MRPO monthly inventory files.

- *Natural Area Sources:* The Base02a area-source inventory files included natural sources, such as wildfires and wild animals. These records were extracted from the stationary-area-source inventories. Note that the WRAP area-source files did not include any natural sources.

- *Natural Fires:* Of the five fire categories modeled in Base02a (wildfires, wildland fire use, non-Federal rangeland prescribed fires, prescribed fires [which were split into natural and anthropogenic prescribed for this purpose of this sensitivity], and agricultural fires), only the categories that represent natural fires (wildfires, wildland fire use, and natural prescribed fires) were included.

- *Windblown Dust:* We used the windblown dust inventory that ENVIRON and the RMC developed for use in case Base02a. Additional details on this dust inventory are available at http://www.cert.ucr.edu/aqm/308/wb_dust2002/wb_dust_ii_36k.shtml.

The biogenic and windblown dust emissions from the Base02a SMOKE outputs that are stored at the RMC were used directly. For the fire (including both point and area fires), natural area, and ammonia emissions, these data were reprocessed specifically for scenario Base02nt using the same ancillary data (temporal, chemical, and spatial allocation data) used in case Base02a. QA plots and documentation for scenario Base02nt are posted on the RMC web site at http://pah.cert.ucr.edu/aqm/308/qa_Base02nt36.shtml.

Modeling Results

Figure 8 shows the model-reconstructed light extinction in the clean emissions model simulation. Because the natural fire emissions in the WRAP states were a major component of the clean emissions, the largest visibility impairment is in the regions with natural fire emissions. Contributions to light extinction from natural sources were small in regions without large fire emissions, as evidenced in the eastern U.S., where the extinction was only slightly larger (about 2 Mm^{-1}) than perfectly clean Rayleigh conditions of 10 Mm^{-1}.

Although there are large uncertainties in the natural emissions, and it is known that there are missing types of natural emissions, the components of the natural inventory used in this sensitivity simulation did contribute to relatively large visibility impairment in regions where there were large wildfires. Extinction coefficients as large as 90 Mm^{-1} were simulated in the southern Oregon and northern California regions; this was most likely a result of the large Biscuit fire in Oregon, plus contributions from smaller fires and other natural emissions. These visibility impairment levels exceed the natural visibility levels specified in the EPA regional haze natural visibility guidance document. It will thus be more difficult for the modeling to demonstrate attainment of progress goals in areas of the country subject to wildfires because of their large contribution to visibility impairment that is not controllable. In other regions of the country for which the inventories lacked large natural fire emissions, the modeled clean visibility was only slightly greater than clean Rayleigh conditions. Note the model results may be overly optimistic in these regions because we lack a complete, accurate natural emissions inventory.

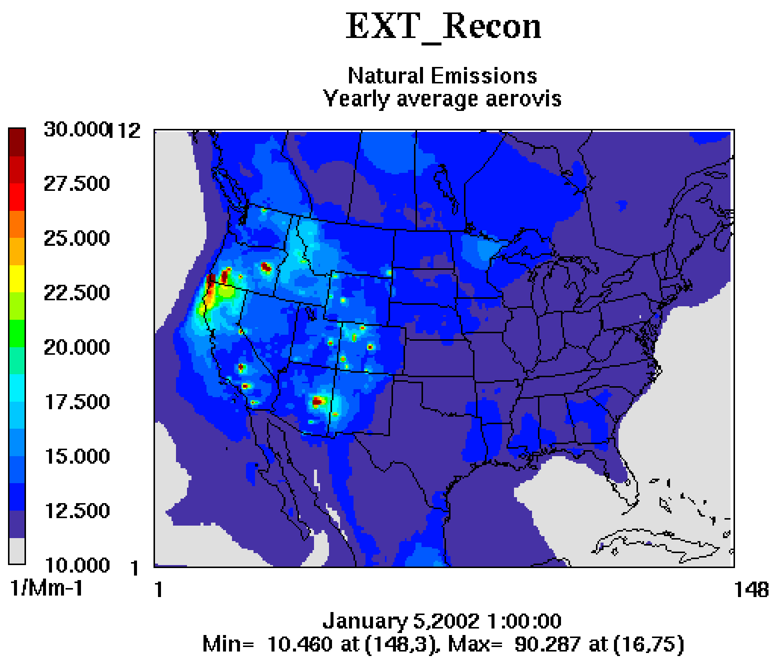

Figure 8. Annual average model-reconstructed "clean conditions" visibility as extinction coefficient.

These results are all very tentative because of the large uncertainties in natural emissions. Considerable effort would be needed to more fully investigate natural conditions in future modeling studies. It will always be difficult to determine and quantify "clean conditions" based on observations because of the pervasive influence of anthropogenic emissions.

Also as part of this sensitivity analysis, the contributors to organic carbon aerosols (OC) for the clean conditions scenario wer4e evaluated. The CMAQ model represents explicitly three classes of organic carbon aerosols:

- *AORGPA:* Primary anthropogenic OC resulting from direct organic mass emissions, such as primary organic aerosol (POA).
- *AORGA:* Secondary anthropogenic OC resulting from aromatic VOCs, such as xylene, toluene, and cresols.

- *AORGB:* Secondary biogenic OC resulting from biogenic VOCs, such as terpenes.

Because it was not cost effective to carry out CAMx/PSAT simulations with OC, the explicit OC results for the clean conditions case were analyzed, and then compared those results to the Base02b case in an attempt to infer the relative contributions of biogenic and anthropogenic VOCs to OC. These results are difficult to interpret for at least two reasons:

- Because of the simplified approach used by CMAQ and the Carbon Bond Mechanism version 4 (CB4) to represent these species, it is not possible to accurately classify all emissions into the CMAQ model as either biogenic or anthropogenic based simply on the species name. Thus, some biogenic OC might be included with AORGA, and some anthropogenic OC might be included in AORB.

- Some fire emissions are classified as anthropogenic, but these emissions might include species such as terpenes that are typically considered biogenic. Using the analysis approach in which all terpenes are assumed biogenic then incorrectly causes some anthropogenic emissions to be labeled biogenic when we use the simplified approach of analyzing OC in terms of AORGPA, AORGA and AORGB.

In spite of these difficulties, however, the results should classify the majority of the emissions correctly as either biogenic or anthropogenic.

For each of the above three components of OC, plots of the annual average mass in the Base02b case were prepared, and then the controllable mass was estimated as the difference between the Base02b case the Base02nt clean emissions scenario. Figure 9 shows the annual average mass of OC contributed from AORGPA in case Base02b (top) and the portion of that mass attributed to controllable emissions (bottom). Comparing these two plots indicates that in the western U.S. there is considerable AORGPA mass that is not controllable. It is likely that much of this mass is from fires, since uncontrollable AORGPA mass is present at the site of large fires in southern Oregon and north of Tucson, AZ.

Figure 10 shows the annual average mass of secondary OC contributed from AORGA in the Base02b case (top) and the portion of that mass attributed to controllable emissions (bottom). These plots indicate that virtually all of the AORGA mass is controllable, since the bottom plot is almost identical to the top plot.

Figure 11 shows the annual average mass of OC contributed from AORGPA in the Base02b case (top) and the portion of that mass attributed to controllable emissions (bottom). These plots indicate that although most of the AORGB mass is not controllable, a significant amount of mass is controllable. It is likely that the controllable AORGB mass results from VOC oxidation chemistry and the larger amount of biogenic mass that is oxidized and subsequently condenses to form OC in the Base02b case. These results indicate that controlling O_3 precursor emissions is effective at reducing a small but significant fraction of the biogenic OC.

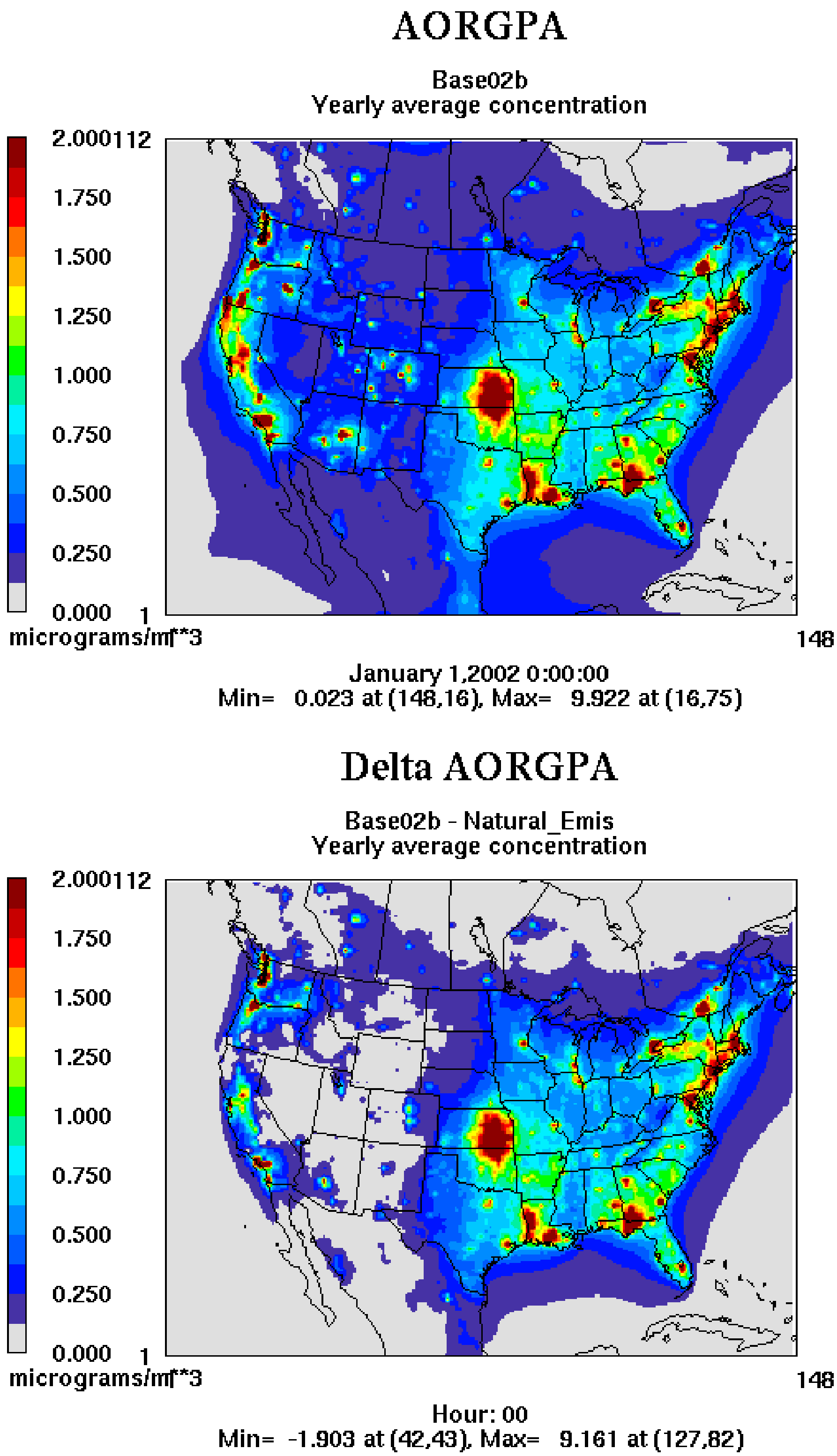

Figure 9. Annual average modeled primary anthropogenic OC (AORGPA) in Base02b (top) and the portion that is "controllable" primary anthropogenic OC (bottom).

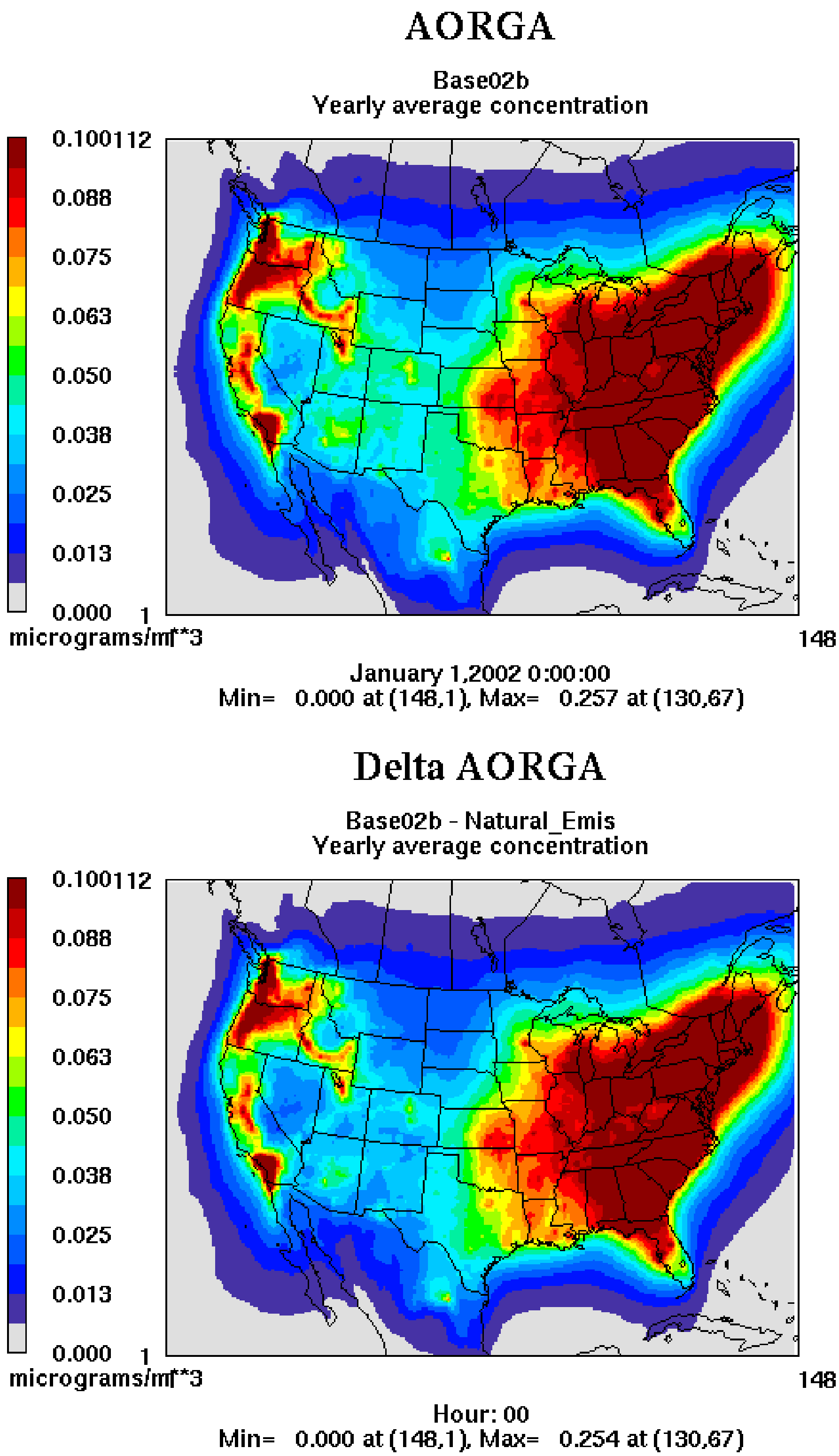

Figure 10. Annual average modeled secondary anthropogenic OC (AORGA) in Base02b (top) and the portion that is "controllable" secondary anthropogenic OC (bottom).

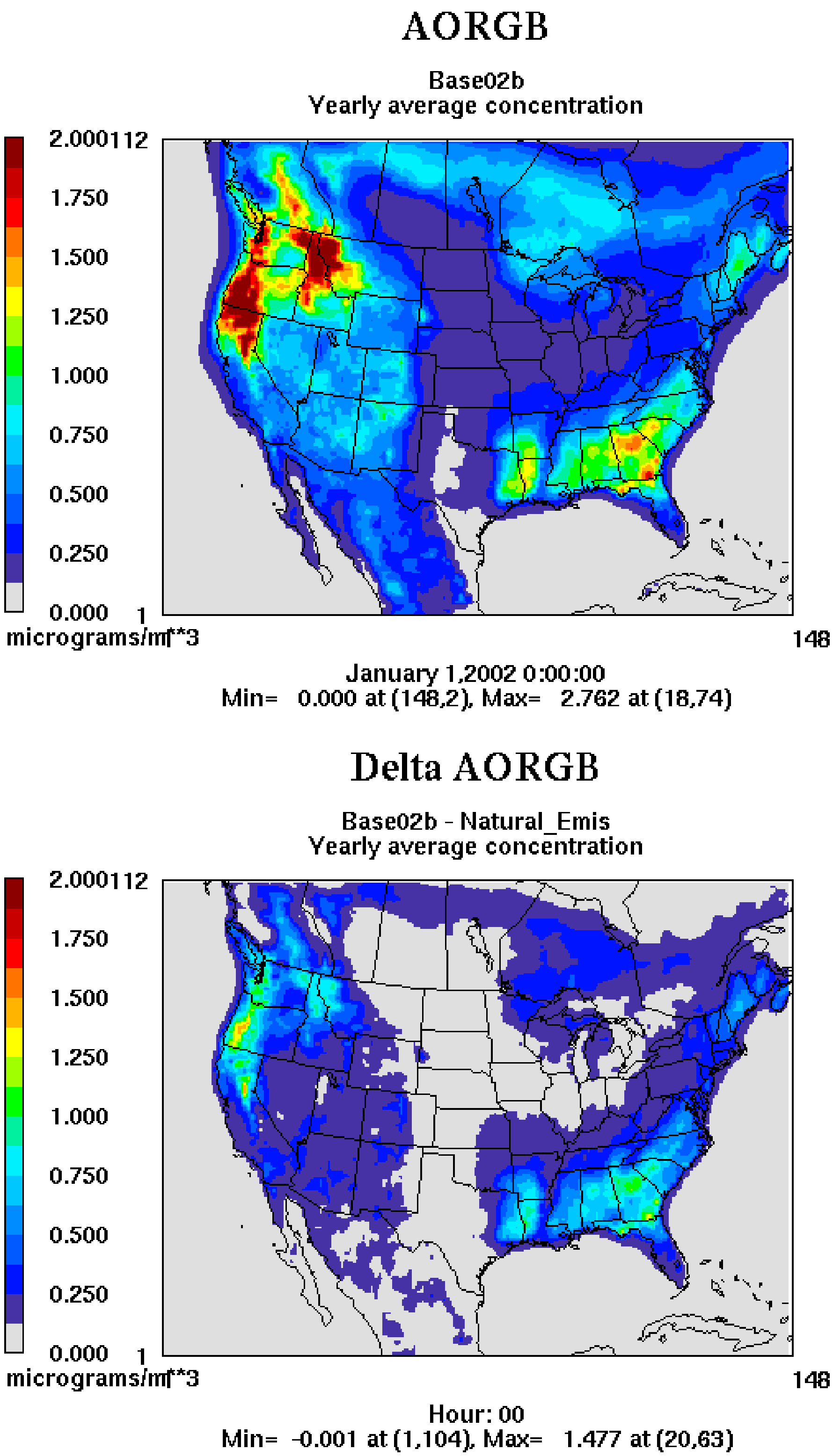

Figure 11. Annual average modeled primary biogenic OC (AORGB) in Base02b (top) and the portion that is "controllable" primary biogenic OC (bottom).

It might be difficult for the WRAP states and tribes to use these results quantitatively in developing emissions control strategies for visibility SIPs and TIPs. However, the results do provide some insight into the relative contributions of biogenic and anthropogenic OC as well as the amount of each that is controllable in the model simulations.

Finally, it is noted that there are uncertainties in the modeled emissions of anthropogenic VOCs, and larger uncertainties in the modeled emissions of biogenic VOCs. It is not possible to evaluate the model performance individually for biogenic and anthropogenic OC because the OC measurements do not distinguish between those two forms. Instead, only comparisons of total modeled OC to total measured OC can be made. Therefore, even when the model achieves good performance for total OC, it is possible that the model may be overpredicting one component of total OC and underpredicting the other. The inability to evaluate model performance for each component of OC increases the uncertainty of the results described here and illustrated in Figures 9 through 11, so caution should be used when drawing conclusions about the sources of OC based on these results.

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APPENDIX F

Federal Land Management Agency Letters and California's Response

Appendix F
California Regional Haze Plan Response to Comments

January 14, 2009 comment letter from the United States Department of the Interior National Parks Service (DOI-NPS) letter

1. **Comment: Elaborate within the body of the Plan narrative the rationale for groupings of Class 1 Areas chosen and how the geographic source regions were defined.**

   Response: Chapter 2, section 2.3 introduces the four sub-regions. As explained in this section, the primary reason for looking at Class 1 Areas data by sub-region is that the main “drivers” of haze on worst days are the same one or two species for each site in the sub-region. Sources for the driving species are the same in each sub-region. This results from the position of the monitors in the landscape and the prevalent weather patterns to which they are exposed. In addition, California has long-established air basins that reflect these relationships between sources and receptors. For the purpose of analyzing visibility, the four sub-regional groupings are closely related to combinations of the air basin descriptions.

2. **Comment: Similar to the nitrate portion assessment for reasonable progress, include assessments for sulfate and organic aerosols.**

   Response: The Plan includes Tables 6-3 and 6-4, which specify the modeled visibility progress for sulfate and organic carbon due to California’s strategy for all of the Class 1 Areas.

3. **Comment: In Chapter 2, the Class 1 Areas could be grouped in a different manner and this should be further explored with examining strategies for reasonable progress.**

   Response: As stated in Chapter 2, the Class 1 Areas were grouped due to the main drivers of haze on the worst days. In addition, the sub-regional groupings of Class 1 Areas introduced in Chapter 2 correlate with meteorological patterns, regulatory jurisdictions, and also with their federal and State non-attainment status. California determined that these groupings were appropriate for examining strategies for reasonable progress. Independent evaluation of each Class 1 Area, or looking at different groupings, would not result in a different control strategy than what currently exists as described in the Plan.

4. **Comment: Include summarized emission changes by regions which affect the geographic sub-regions of Class 1 Areas noted in Chapter 2.**

Response: Appendix I contains summarized baseline emission inventories for each sub-region, which highlight the key source categories affecting each site in the sub-region. The baseline emission inventories are adequate for examining the sources currently contributing to Class 1 Areas on a sub-regional basis. California constantly updates growth and control factors and will evaluate changes to the inventory in the mid-course review.

5. **Comment: In 4.3, the description of the new source review program could be expanded to show which districts require "offsets" and which have a more traditional new source review program.**

Response: Figure 4-4 illustrates the current extent of federal non-attainment in California for ozone and particulate matter based on the 1997 federal standards. Relatively few Class 1 Areas in California are actually in attainment areas with "traditional" prevention of significant deterioration (PSD) requirements associated with new source review. All air districts in the federal non-attainment areas require offsets through their new source permit programs although, the offset ratios will vary depending on the severity of the ozone problem. Most of the Class 1 Areas in California are within or immediately downwind of federal non-attainment areas and benefit when these offsets are applied. Even when areas attain federal standards, they keep existing offset rules in their maintenance plans to prevent backsliding to their former non-attainment status.

Figure 4-4 does not include new non-attainment areas for the recent ozone and PM standards since the designations were not finalized prior to approval of the Plan by the California Air Resources Board (ARB.) However, due to these stricter standards ARB anticipates that the total number of air districts that already require offsets, or will soon require them for new major sources, will be 25 of the 35 districts Statewide.

6. **Comment: It would be good to mention the NSR/PSD requirement for FLM consultation on major new permits in section 4.3.**

Response: As explained in section 4.4, U.S. EPA is currently reviewing the PSD/NSR programs of all of California's 35 air districts. While ARB does not administer the program, we agree that the

NSR/PSD requirement for FLM consultation on major new permits is an important mechanism to ensure continued visibility protection.

7. **Comment: A table or map of districts or areas that are likely to be undergoing control strategy development for attainment of ambient standards, if implementation occurs within the timeframe for regional haze, would support the conclusion in Section 4.4 that programs underway are reasonable for visibility protection purposes.**

Response: Existing controls reducing emissions already apply throughout California in non-attainment areas, as depicted in Figures 4-4 through 4-6, in order to attain federal and State standards. As discussed in response to comment 5, upcoming federal non-attainment designations mean additional controls will be developed prior to 2018 to reduce haze precursors to attain new ozone 8-hour and PM2.5 standards. This comprehensive response to reducing ozone and PM throughout the State, in every air district, means that haze pollutants will be reduced to improve visibility. As further noted in the response to comment 5, designations for the revised PM2.5 and 8-hour ozone standards were not finalized at the time the Plan was released. However, U.S. EPA's recommended PM2.5 non-attainment areas can be found at:

www.epa.gov/pmdesignations

and ARB staff recommendations for 8-hour ozone non-attainment areas can be found at:

www.arb.ca.gov/desig/8-houroz/8-houroz.htm.

8. **Comment: Nevada has a significant impact on several California Class 1 Areas, so the SIP should note that those areas rely on Nevada sufficiently addressing their contribution in order to achieve reasonable progress.**

Response: California does not characterize Nevada's impacts on total light extinction at California's Class 1 Areas as significant. ARB examined the SOx and NOx tracer studies which show that concentrations of nitrates and sulfates attributable to Nevada sources are generally less than 10 percent of the total concentrations of nitrates and sulfates in each of the California sub-regions. However, when these concentrations are converted to percent contribution to total light extinction for the worst days annual average, their impact drops to barely 1 percent of total light extinction.

California's Reasonable Progress Goals are based on measures in effect through 2004 but with implementation dates in the future. While California recognizes that Nevada controls for specific BART sources have recently been finalized, the information was not available for regional modeling to quantify the beneficial impact in 2018 prior to release of this Regional Haze Plan. Therefore, California will evaluate the benefits to be achieved by the Nevada controls in the mid-course review.

9. Comment: The Bay Area Air Quality Management District (BAAQMD) asserts that additional control of NOx from the CO boilers by SCR is not feasible due to the high concentration of sulfur in the stream. Please compare SO2 in CO boiler exhaust to those of a typical coal-fired boiler with SCR or provide statement from SCR vender supporting BAAQMD assertion.

<u>Response:</u> Prior to the Board hearing, BAAQMD submitted a comment letter clarifying that existing NOx and PM controls for all the BART-eligible units feeding into the Main Stack, as verified by the current permit conditions, meet the BART requirement and further controls were not cost-effective to improve visibility. The current NSCR does protect visibility by removing NOx in a manner that is cost-effective and energy efficient. This clarification is reflected in Table 5.4 of the Plan, as approved by the Board. While further control of NOx from the CO boilers at the facility may occur in the future, under California's more stringent State requirements for protecting public health, the existing level of NOx control meets the national BART requirement.

In addition, it should be noted that the operating conditions (input/output gas concentrations, temperature, and pressure) through each step of the linked process stream at the Valero refinery are not comparable to the configuration and functional operation of a coal-fired boiler. The CO boilers at the Valero refinery are configured as control equipment to collect and combust waste gases containing high levels of sulfur and carbon monoxide (CO) from a Fluid Catalytic Cracker Unit (FCCU) and a Fluid Coking Unit (coker), which produces more sulfur than the FCCU. Heat from the CO boilers is used to produce steam for other refinery processes, thereby reducing energy consumption. The coker, FCCU, and the CO boilers' functional and structural configuration are unique to this refinery.

10. **Comment: DOI would like cost information on the SO2 control for the main stack as requested in a previous email.**

Response: The BAAQMD calculations in Appendix D for the total annual cost for installation and operation of the scrubbers used the same principal parameters recommended in the OAQPS Control Cost Manual. The $80 million annualized cost is based on 15 years at 10 percent which is the rate suggested by the Manual.

11. **Comment: BAAQMD should provide additional justification for the 25 ppm limit and the vendor guarantee that it cites as limiting SO2 removal to 25 ppm. DOI determined that a similar refinery process unit had a 20 ppm annual SO2 limit.**

Response: The consent decree specifies that scrubbers meet an SO2 emission limit attributable to the Benicia Fluid Coker of no greater than 25 ppmvd, measured as a 365-day rolling average and 50 ppmvd, measured as a 7-day rolling average, both at 0% O2. These emission limits are the same as U.S. EPA's limits in Section 60.104a (b)(3) of the Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007. The facility referenced by DOI achieved the limit for FCCU exhaust only. At Valero, both coker and FCCU exhaust are run through the CO boilers. Pressure, temperature, and siting constraints control where the scrubbers can be placed which presents a different situation to be evaluated once the system is installed and tested. The 25 ppm limit for the Main Stack is appropriate for a retrofit situation, especially given the unique configuration of the Valero facility.

12. **Comment: BAAQMD commented that additional reduction of all the remaining SO_2 from the main stack scrubber would result in an imperceptible improvement at the Class 1 Area. Please note that reductions do not have to be perceptible to represent BART.**

Response: It is understood that a one deciview (dv) change is "perceptible" to the human eye and that one source "contributes to" but does not "cause" visibility impairment if less than a one deciview change is attributable to that source, even though the change is "imperceptible." The Regional Haze Rule specifies that the cost of controls must be considered in light of several factors, one of which is visibility improvement. The marginal improvement in visibility, if there were an additional 7% reduction in SO_2, is estimated at 0.03dv. Taking into account cost, technical feasibility, and the relative additional visibility improvement in this particular situation, further controls were not considered cost-effective for regional haze purposes.

13. **Comment: BAAQMD stated that the combined NOx emissions from the three Turbine/Boiler sets are about 341 tpy. However, our calculations estimate that the current potential emissions are 503 tpy.**

Response: The combined NOx emissions per year are 341 tons under normal practice, i.e. reported actual emissions versus potential to emit under permit. As required, modeling was based upon the 24-hour maximum actual emissions during the baseline years, which would be equivalent to 503 tons per year if the units were permitted to operate at that daily rate continuously for the entire year. Each set operates intermittently in practice.

14. **Comment: BAAQMD should provide a justification on their conclusion that $5000 to $7000/ton for NOx reductions by adding SCR to three boiler-turbine sets was above reasonable cost-effectiveness levels for regional haze.**

Response: BAAQMD based their cost-effectiveness analysis on the change between SCR control level and current actual emissions for the three turbine/boiler sets controlled for NOx by water injection. BAAQMD reasoned that the real visibility improvement would be improvement measured from actual conditions, rather than from theoretical potential emissions. Section 3 of Appendix D explains why NSCR and low NOx burners were not feasible for retrofit at these three turbine/boiler sets. On balance, the cost per ton for achievable SCR levels for these three turbine/boiler sets was not deemed cost effective for the amount of improvement in visibility (0.03 dv per unit). The determination that SCR for the three boiler-turbine sets is not cost-effective for the relative improvement in visibility does not preclude future retrofit or replacement to BACT levels, if necessary to attain federal standards for public health protection.

15. **Comment: BAAQMD should provide cost supporting that lowering the limit to 5 ppmv@15% O2 would have a higher cost per ton and be less cost-effective.**

Response: The level of control achieved by new turbines that burn natural gas is 3-5 ppmv. The turbine/boiler sets evaluated run on refinery fuel gas, not commercial utility natural gas. The boilers are not standard duct burners, but old stand-alone boilers with their own air supply. The District considers 10 ppmv a feasible level of control if SCR were applied as retrofit to these unique older units. Lowering NOx limits to 5 ppmv would require more catalyst and ammonia, increasing cost.

The BART determination reports that the current units have the potential to operate at a rule limit of 55 ppmv @ 15% O_2 and at an actual rate of 40 ppmv @ 15% O_2. If it were technically feasible to lower the limits with SCR to 5 ppmv @ 15% O_2, and if that is actually equivalent to an additional 12.5 per cent of the 0.091 dv reduction in the visibility improvement modeled for the turbine/boiler sets alone, then the incremental additional visibility improvement is estimated at 0.011 dv for all three turbine/boiler sets (or 0.0038 dv per unit.) On balance, these mathematically calculated increments are still not cost-effective per deciview for the additional 55 tons per year of NOx reduced.

16. **Comment: CARB modeled a hypothetical reduction of 268 tpy NOx at the turbines to 73 tpy. However, DOI estimates the reduction would be 430 tpy.**

Response: CalPuff modeling for BART determinations specifies using the 24-hour maximum emissions for the three year modeling period, 2000-2002 in this case. Therefore, ARB modeled a change of about 440 tons per year for replacing the three turbine/boiler sets with SCR control level of 10 ppmv @ 15% O_2 from their actual operating levels of 40 ppmv @ 15% O_2. The BAAQMD reference to a "hypothetical reduction of 268 tons of NOx" in the discussion on p. D-9 of their BART determination refers to the actual annual emissions that would be reduced in practice, since the turbine-boiler sets do not operate continuously at the modeled rate.

17. **Comment: BAAQMD states that a 0.091 deciview reduction is insignificant. However, visibility improvements do not have to be perceptible to represent BART and the amount of emission reduction and the corresponding visibility improvement may have been understated.**

Response: Please see responses to comments 12 through 16. We agree that visibility improvements do not have to be perceptible to the human eye (less than one deciview) to represent BART. BAAQMD determined that on balance with the other factors spelled out in the Regional Haze Rule and considered in the BART determination, the incremental modeled visibility improvement resulting from installation of SCR for the three turbine/boiler sets is not cost-effective. ARB concurs, especially considering the significant visibility improvement that can be achieved by controlling SOx.

18. Comment: The modeling and results reported do not include final BART determinations or other actions taken after the WRAP modeling.

Response: Currently, regional modeling results including BART determinations are unavailable. California will evaluate the updated results of new modeling that includes BART determinations during the mid-course review.

19. Comment: If new modeling is not completed by the time California submits their SIP, the goals will need to be revised based on the final model runs no later than the mid-term review.

Response: If new modeling results become available, California plans to evaluate the results in our mid-course review.

<u>January 21, 2009 comment letter from the United States Department of the Agriculture Forest Service (DOA) letter</u>

1. **Comment: DOA would like to emphasize their support and the importance of continued investigation of wildfire emissions in the natural conditions target.**

   <u>Response</u>: ARB agrees that an improved understanding of the link between wildfires and natural condition targets is needed. As stated in the Regional Haze Plan, we plan to evaluate this in our Plan updates.

2. **Comment: DOA would like to see the plan commit to more specific interstate coordination in smoke management.**

   <u>Response</u>: In Chapter 8, section 8.4, of the Plan, ARB discusses the two existing vehicles for moving forward the discussion of interstate coordination in smoke management at both the technical (Interagency Air and Smoke Council) and the policy (Air and Land Managers) level. Currently, impacts to populated areas on either side of the state borders are considered when ARB makes the daily burn/no burn day assessments calls for each California air basin. In the Lake Tahoe Basin, shared by California and Nevada, further coordination is handled either by the local air districts or by the burners themselves. For federal prescribed burns in national forests that extend over the California/ Nevada and California/Oregon border, the federal land managers consider impacts when preparing their burn plans and prescriptions. Although not stated in the Plan, ARB's Prescribed Fire Incident Reporting System (PFIRS) coordinator is in contact with the coordinator for the WRAP's Fire Emissions Tracking System (FETS). Additional initiatives for interstate coordination can best be developed through IASC and the ALM. Progress can be reported in the mid-course review.

3. **Comment: DOA suggests that the plan acknowledge the point source contribution of nitrates from Nevada to the Desolation, Mokelumne, and Hoover Wilderness Areas on the 20% worst days.**

   <u>Response</u>: Please refer to the response to DOI's comment 8. In Chapter 4 of the Plan, current out-of-state influences were evaluated for all source categories at Class 1 Areas on worst days. Despite modeling which shows elevated nitrate concentrations attributable to Nevada point sources on a few days each year, the actual contribution to total light extinction is less than one percent of the annual worst days average. Future impacts from Nevada could be more or less of the nitrate light extinction share, depending on the reductions of

California mobile source nitrates in comparison with anticipated BART reductions from Nevada point sources. As noted in response to DOI's comments 18 and 19, the modeled impact of these future reductions will be evaluated during the mid-course review.

United States Department of the Interior
NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

January 14, 2009

N3615 (2350)

Lynn Terry, Deputy Executive Officer
California Air Resources Board
1001 I Street
P.O. Box 2815
Sacramento, California 95812-2815

Dear Ms. Terry:

On May 5, 2008, the State of California sent to us a draft implementation plan describing your proposal to improve air quality regional haze impacts at mandatory Class I areas across your region. We provided informal comments to the Air Resources Board staff on May 21, 2008. After evaluating our draft comments and reviewing internal priorities, your agency delayed final SIP action to incorporate, among other items, a full Best Available Retrofit Technology assessment.

On November 13, 2008, we received a revised draft implementation plan for review. Many of the issues we raised in our preliminary comments had been addressed, but we have some follow-up comments. We appreciate the opportunity to work closely with the State through the initial evaluation, development, and, now, subsequent review of this plan. Cooperative efforts such as these ensure that, together, we will continue to make progress toward the Clean Air Act's goal of natural visibility conditions at all of our most pristine National Parks and Wilderness Areas for future generations.

This letter acknowledges that the U.S. Department of the Interior, U.S. Fish and Wildlife Service (FWS), and National Park Service (NPS) have received and conducted a substantive review of your revised proposed Regional Haze Rule implementation plan in fulfillment of your requirements under the federal regulations 40 CFR 51.308(i)(2). Please note, however, that only the U.S. Environmental Protection Agency (EPA) can make a final determination regarding the document's completeness and, therefore, ability to receive federal approval from EPA.

As outlined in a letter to each State dated August 1, 2006, our review focused on eight basic content areas. The content areas reflect priorities for the Federal Land Manager agencies, and we have enclosed comments associated with these priorities. We look forward to your response, as per section 40 CFR 51.308(i)(3). For further information, please contact Bruce Polkowsky (NPS Air Resources Division) at (303) 987-6944, or Tim Allen of the FWS Branch of Air Quality at (303) 914-3802.

Again, we appreciate the opportunity to work closely with the State of California and compliment you on your hard work and dedication to significant improvement in our nation's air quality values and visibility.

Sincerely,

John Bunyak
for Christine L. Shaver
Chief, Air Resources Division
National Park Service

Sincerely,

Sandra V. Silva
Sandra V. Silva
Branch of Air Quality
U.S. Fish & Wildlife Service

Enclosure

cc:
Christine M. Suarez-Murias
Air Pollution Specialist
California Air Resources Board
1001 I Street
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General Comments on California's Draft Regional Haze State Implementation Plan

California has done an excellent job in compiling a draft State Implementation Plan (SIP) that examines the current visibility conditions at its mandatory Federal Class I (Class I) areas. Appendix B is well thought out and communicates the causes of current visibility conditions, as well as projected natural conditions, in a clear, understandable manner. This effort creates a good foundation for this and future SIP efforts.

Long-Term Strategy and Resulting Reasonable Progress Goals

In our preliminary comments we noted that California's decision to adopt ongoing air quality control programs plus some non-quantified future programs as the basis for a Long-Term Strategy for regional haze addresses key statutory and regulatory requirements. However, the conclusion that no additional control measures for visibility improvement are "reasonable" needed better support based on the statutory and regulatory factors. We are pleased to find that the assessment of the statuary factors was added to the revised draft. Given the large number of Class I areas in California we understand the reason for conducting the reasonable progress assessment based on groups of Class I areas and the geographic areas associated with transport of visibility impairing pollutants for each grouping. While Appendix B establishes the basic causes of visibility impairment for each of the Class I Areas, we would encourage some elaboration within the body of the SIP narrative on the rationale for groupings of Class I areas chosen and how the geographic source regions where defined. Addressing the selection of geographic areas, and therefore all major sources of emissions within those areas, ensures that the State reviewed the statutory factors for possible reasonable progress measures for impacts that could result at any Class I area in the group.

We do support the inclusion of a review of the nitrate portion of "reasonable progress" and suggest that similar assessments for sulfate and organic aerosols be provided, especially for those Class I areas where those pollutants cause the majority of current impairment.

We appreciate the State linking its new source review requirements to the protection of the clearest days at the Class I areas under the regional haze rule in the revised SIP. We feel it is important to note that current new source review programs will be used to assure that no Class I area sees degradation from expansion or growth of a single new source or regional development.

Best Available Retrofit Technology (BART)

The BART chapter was significantly improved from the initial draft. We agree with California's conclusion that only one source, the Valero refinery, is subject to full BART review. We appreciate the additional information provided by the Bay Area Air Quality Management District (BAAQMD) at our request. At this time we have a few outstanding issues regarding the BART determination that we are requesting the

BAAQMD or State address prior to submitting the plan to EPA. The specific items are stated in the specific comments on Chapter 5 below.

Specific Comments

Chapter 2

Chapter 2 does an excellent job summarizing visibility conditions at the Class I areas. We particularly compliment the approach of setting geographic sub-regions. As noted, we agree that a few of the Class I areas could be grouped in a slightly different manner, and this should be further explored with examining strategies for reasonable progress.

Chapter 3

Chapter 3 summarizes current emissions and emissions projections for 2018. While overall emissions trend downward there are exceptions (sulfur dioxide for point sources) which are not very well explained. We request the State to summarize emissions changes by the regions which affect the geographic sub-regions of Class I areas noted in Chapter 2. This would help the reader understand what is likely to influence the visibility conditions in 2018 and whether there is any rationale to explore additional strategies beyond the WRAP modeled case for a given Class I area or sub-region.

Chapter 4

Chapter 4 does an excellent job presenting California's history of aggressive control of air pollution. In 4.3, the description of the new source review program could be expanded to show which districts require "offsets" and which districts have a more traditional new source review program. It would be good to mention the NSR / PSD requirement for FLM consultation on major new permits in this section as well. This would address the general comment above, regarding a link between new source review and the regional haze rule strategy.

Section 4.3 mentions that the largest source for sulfur oxides is located in a district that will likely be designated PM2.5 nonattainment, resulting in likely examination of control measures. A table or map of districts or areas that are likely to be undergoing control strategy develop for attainment of ambient standards, if implementation occurs within the time frame of the regional haze SIP, would support the conclusion in Section 4.4 that programs underway are "reasonable" for haze protection purposes. Again, listing or mapping those affected areas in a way that related to effects on the sub regions of Class I areas would be helpful.

Section 4.5 reviews the cost factor for assessing reasonable progress. We appreciate the SIP noting that California is a significant contributor to worst day impairment at Class I areas in Nevada, Arizona or Oregon and the revised discussion regarding the adequacy of the State Plan for addressing that contribution. Conversely, the sources in the State of Nevada has a significant impact on several California Class I areas, so your SIP should note that those areas rely on Nevada sufficiently addressing their contribution in order to achieve reasonable progress. This is particularly true regarding nitrate impacts on the worst twenty percent days.

Chapter 5

We generally agree with the SIP conclusion that most sources meet BART requirements through current conditions or limited impact on visibility. For the Valero refinery, the one source found subject to BART, we request the following items be addressed prior to submission of the SIP to EPA.

Main Stack

- The Bay Area Air Quality Management District (BAAQMD) states that additional control of NO_x from the CO boilers by SCR is not feasible because the stream contains a high concentration of sulfur at the point where the SCR will be installed. Considering that SCR is commonly used on boilers burning eastern high-sulfur coals, please compare the SO_2 concentrations in the CO boiler exhaust to that of a typical coal-fired boiler with SCR. (Or provide a statement from the SCR vendor supporting the BAAQMD assertion.)

- The costs for SO_2 control of the main stack were provided by Valero. The capital cost for the scrubbers is estimated to be $413 million, and the annual operating costs will be $7 million, for a total annual cost of $80 million. In a previous e-mail we attached a sample Excel workbook (based upon the OAQPS Control Cost Manual) and requested that the pertinent information on the first "Given/Assume" page be supplied. We again ask that this information be provided to us.

- Our initial reaction to the SO_2 scrubbing proposal was that 93% control seemed low for an amine scrubber. Our review of the RACT/BACT/LAER Clearinghouse (RBLC) found that all but one similar refinery process had limits of at least 25 ppm, as proposed by BAAQMD. However, the PSD permit issued by TX to Marathon Ashland petroleum (RBLC ID #TX-0532) contains a 20 ppm annual SO_2 limit for the Fluidized Catalytic Cracking Unit. If Valero were to achieve the same 20 ppm limit as Marathon-Ashland, then this largest source of SO_2 emissions would be reduced by an additional 20% or 83 tpy. BAAQMD should also provide additional justification for the 25 ppm limit and the vendor guarantee that it cites as limiting SO_2 removal to 25 ppm.

- BAAQMD states, "An additional reduction of all of the remaining SO_2 (7% more) would result in an imperceptible improvement at the Class I area." Please note that reductions do not have to be perceptible to represent BART.

Turbine/Boiler Sets

- BAAQMD states at the combined NO_x emissions of the remaining three sets are about 341 tpy. However, our calculations estimate that the current potential emissions are 503 tpy.

- The District determined that the cost/ton for controlling from 40 ppmv to 10 ppmv @ 15% O2 was $5,000 to $7,000/ton, and that this cost was above reasonable cost-effectiveness levels for regional haze. BAAQMD should provide a clear explanation of its cost-effectiveness calculations and justify its conclusions.

- Regarding application of SCR to the turbine/boiler sets, BAAQMD states, "If the limit were lowered to 5 ppmv @ 15% O2, it is expected that the cost/ton would be even higher and therefore even less cost-effective." It is more likely that, if a given control technology is more fully utilized, the cost/ton will decrease. BAAQMD should provide cost data to support its assertion.

- CARB modeled a hypothetical reduction of 268 tpy NO_x at the turbines to 73 tpy NO_x, which is equivalent to a 10 ppmv NO_x concentration achievable by SCR. However, our calculations estimate that the reduction would be 430 tpy.

- The modeling result for the hypothetical reduction was 0.091 deciview, which BAAQMD says is an insignificant improvement. However, visibility improvements do not have to be perceptible to represent BART, and the amount of emission reduction and the corresponding improvement in visibility may have been understated.

Chapter 6

Chapter 6 presents the source apportionment and modeling results. These results reflect the work of the WRAP regional modeling center. We note that Section 6.3.4 addresses any issues related to neighboring States contributing to impairment at California Class I areas.

The modeling and results reported do not include final BART determinations, or other actions taken after the WRAP modeling.

Chapter 7

Table 7-2 establishes the reasonable progress goals for the worst and best days in 2018 based on WRAP modeling which does not include all measures. If new modeling is not completed by the time California submits the SIP to EPA, then the established goals will need to be revised based on final model runs. This should be completed as soon as possible, but in no case later than the mid-term review. This revised modeling could also incorporate any additional measure beyond BART that may be quantified or may result from analysis of strategies needed to reach uniform rate of progress as noted above. While we understand, given California's aggressive record of pollution control and recent approval of a program to address climate change, there are not likely to be large changes from the current reasonable progress projections for most Class I areas, there may be significant additional progress made in one or two Class I areas.

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File Code: 2580-2
Date: January 21, 2009

Lynn Terry
Deputy Executive Officer
California Air Resources Board
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Dear Ms. Terry:

On November 12, 2008, the State of California submitted a draft implementation plan describing your proposal to improve air quality regional haze impacts at mandatory Class I areas across the state. We have appreciated the opportunity to work closely with the state of California through the initial evaluation, development, and now, subsequent review of the plan. Cooperative efforts such as these ensure that, together, we will continue to make progress toward the Clean Air Act's goal of natural visibility conditions at our Class I Wilderness Areas.

This letter acknowledges that the U.S. Department of Agriculture, U.S. Forest Service has received and conducted a substantive review of your proposed Regional Haze Plan in fulfillment of the requirements under federal regulations 40 CFR 51.308(i)(2). Please note, however, that only the U.S. Environmental Protection Agency (EPA) can make a final determination about the document's completeness, and therefore, only the EPA has the ability to approve the document. The Forest Service's participation in the State of California's administrative process does not waive any legal defenses or sovereignty rights it may have under the laws of the United States, including the Clean Air Act and its implementing regulations.

As outlined in a letter to you dated October 18, 2006, our review focused on eight basic content areas. The content areas reflect priorities for the U.S. Forest Service, and we have attached a few minor comments to this letter associated with these priorities. We look forward to your response required by 40 CFR 51.308(i)(3). For further information please contact Trent Procter at 559-784-1500, x1114 or Scott Copeland at (307) 332-9737.

Again, we appreciate the opportunity to work closely with the State of California. We particularly want to compliment your extremely talented and dedicated staff for their technical analyses and collaboration. We feel very confident that the final plan presents strategies that will protect these very special Class I Wilderness Areas.

Sincerely,

/s/ Richard J. Cook (for)
RANDY MOORE
Regional Forester

Enclosure

Attachment

1. **We would like to emphasize our support and the importance of continued investigation of wildfire emissions in the natural conditions target.** The plan (Section 9.4) suggests that the magnitude of wildfire emissions is not appropriately considered as a part of the natural conditions goal. We agree that long term wildfire tracking will provide a solid foundation for improving the estimate of these emissions in the natural conditions estimate. We are committed to working with California and our Federal Land Manager partners in this effort.
2. **We would like to see the plan commit to more specific interstate coordination in smoke management.** We understand that the Western Regional Air Partnership (WRAP) provides a mechanism for coordination in a general way, but we are interested in seeing a commitment to participate and assist in facilitating some of the informal land management and air pollution control district working groups that are currently struggling with effective coordination near the border with Oregon and Nevada. Occasionally, conflicting forecasts and separate tracking systems between states are posing a challenge to efficient smoke management. Consider the development of an Oregon / California integrated smoke management area.
3. **We also suggest that the plan acknowledge point source contribution of NO_3 from Nevada to the Desolation, Mokelumne, and Hoover Wilderness Areas on the worst 20% visibility days.** This appears to be a winter phenomenon and is displayed in the WRAP TSS data.

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APPENDIX G

Web links

Web links containing information used in the California Regional Haze Plan

General Western Regional Air Partnership (WRAP)
http://www.wrapair.org/

Air Quality Data: Visibility Information Exchange Web System (VIEWS)
http://vista.cira.colostate.edu/views/

Air Quality Data: Interagency Monitoring of Protected Visual Environments (IMPROVE)
http://vista.cira.colostate.edu/improve/Default.htm

Data Analysis and Technical Support: Technical Support System (TSS)
http://vista.cira.colostate.edu/tss/

Emission Inventory Information: WRAP Emissions Data Management System
http://www.wrapedms.org

Carl Moyer Program
http://www.arb.ca.gov/msprog/moyer/moyer.htm

Climate Change Program
http://www.arb.ca.gov/cc/cc.htm

Diesel Risk Reduction Plan
http://www.arb.ca.gov/diesel/documents/rrpapp.htm

District Rules Database
http://www.arb.ca.gov/drdb/drdb.htm

Goods Movement Program
http://www.arb.ca.gov/html/gmpr.htm

New Source Review Permitting Programs
http://www.arb.ca.gov/nsr/nsr.htm

Senate Bill 656 Implementation
http://www.arb.ca.gov/pm/pmmeasures/pmmeasures.htm#sb656

Smoke Management Program
http://www.arb.ca.gov/smp/smp.htm

State Strategy for California's 2007 State Implementation Plan
http://www.arb.ca.gov/planning/sip/2007sip/2007sip.htm

Vehicle Retirement Program
http://www.arb.ca.gov/msprog/avrp/avrp.htm

APPENDIX H

ARB BART Regulation Comment Letter

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Air Resources Board

Terry Tamminen
Agency Secretary

Alan C. Lloyd, Ph.D.
Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

July 2, 2004

Mr. Michael O. Leavitt
Administrator
United States Environmental Protection Agency
c/o OAR Docket
Mailcode: B102
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

RE: Docket ID No. OAR-2002-0076
Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations

Dear Administrator Leavitt:

The California Air Resources Board (ARB) appreciates the opportunity to review and comment on the United States Environmental Protection Agency (U. S. EPA) Proposed Rule for Regional Haze Regulations and Guidelines for Best Available Retrofit (BART) Determinations. We commend U. S. EPA on harmonizing the regional haze and PM2.5 State Implementation Plan (SIP) submittal schedules. California's strategy for meeting the health-based National Ambient Air Quality Standards will be a key component in reducing regional haze in our Class 1 areas. The common regional haze and PM2.5 SIP submittal date of January 31, 2008 allows an improved and coordinated planning process for these closely linked programs.

We also appreciate the additional flexibility provided in the revised BART Guidelines. Maintaining flexibility in measures to achieve reasonable progress goals allows states to develop appropriate strategies according to the contributions to regional haze at each Class 1 area. The proposed rule and Guidelines support state discretion in the process for determining BART-eligible sources, evaluating whether BART is required, and determining which BART controls will be most effective in each of the respective source categories.

Many California air districts have already adopted and implemented rules requiring best available retrofit control technology (BARCT) as part of planning requirements for meeting both the federal and California health-based air quality standards. California is prepared to demonstrate that specific air district BARCT rules meet the BART-level requirements of the regional haze rule on a source category basis. This ensures that sources will have installed BART equipment and practices by the required deadline of the regional haze rule.

Given the large number of BART-eligible sources in California, this rule-based approach provides a more efficient process, while still ensuring that the regional haze rule BART control requirements are met. It will enable the ARB and the air districts to focus more effectively on air district rules or Title V permits that must be upgraded to BART level. ARB believes that this rule-based alternative approach meets the intent of 40 CFR 51.308(e) and the BART Guidelines, and achieves the same results as a case-by-case BART determination.

Thank you for this opportunity to comment on the proposal. If you have further questions, you may contact Lynn Terry, Deputy Executive Officer at (916) 322-2739.

Sincerely,

Signed by LMT for

Catherine Witherspoon
Executive Officer

cc: Ms. Deborah Jordan, Director
Air Division (AIR-1)
U.S. EPA, Region IX
75 Hawthorne Street
San Francisco, California 94105

Mr. Patrick Cummins
Western Governors Association
1515 Cleveland Place, Suite 200
Denver, Colorado 80202-5114

Lynn Terry
Deputy Executive Officer

APPENDIX I

Sub-Regional Emissions Inventory

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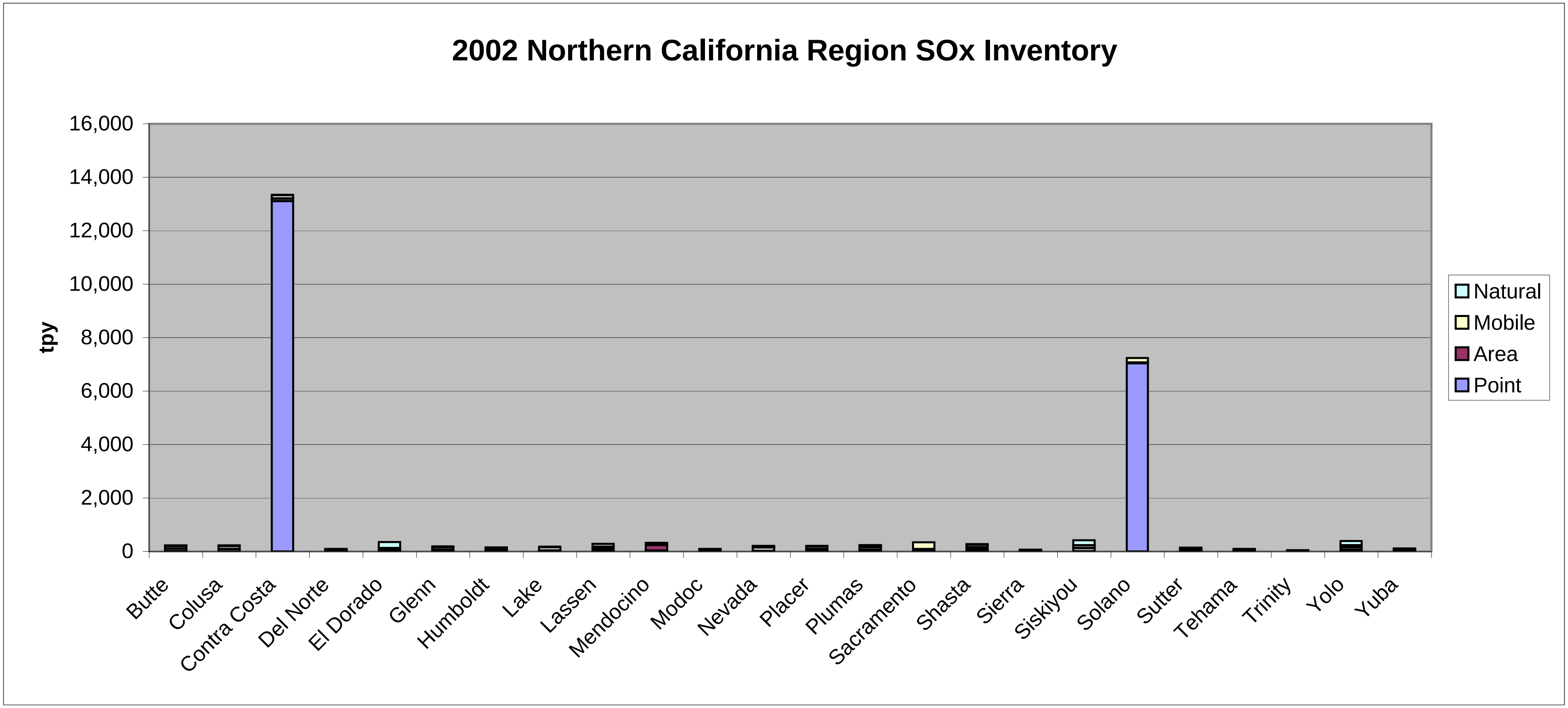
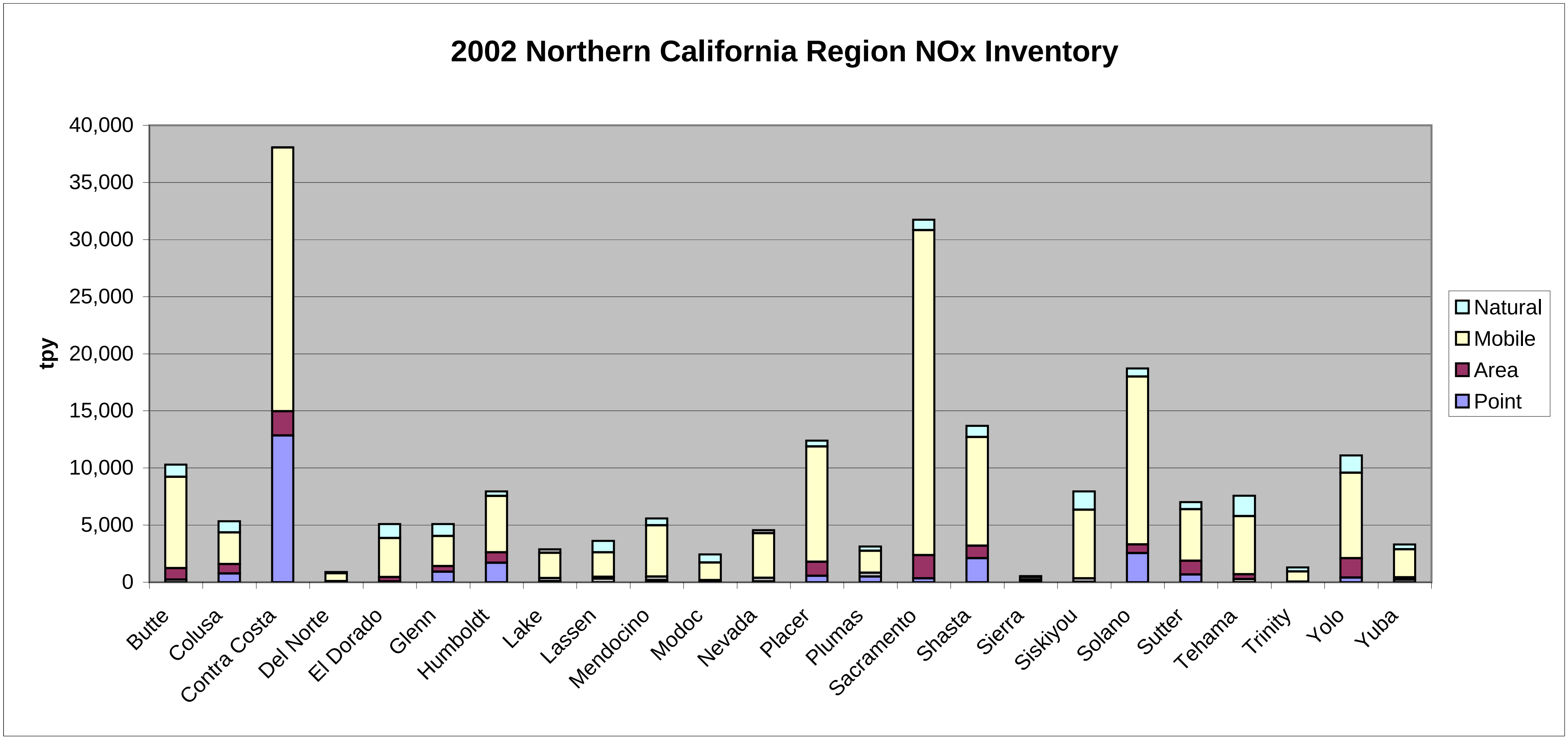
Sulfur Oxides-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	5	83	13,103	48	11	56	49	30	45	28	0	7	10	66	22	65	52	0	7,042	33	16	0	61	12
Area	100	121	94	28	77	94	59	132	68	208	29	149	86	98	61	89	14	123	23	66	23	10	90	51
Mobile	98	23	138	1	32	31	15	9	61	16	48	25	97	48	259	98	4	101	168	40	53	4	73	48
Natural	21	1	4	16	230	6	32	10	114	76	17	31	14	27	1	23	1	193	6	0	2	33	168	1
County Total	224	228	13,339	94	351	187	156	181	288	328	95	212	206	239	342	275	71	417	7,239	139	94	47	392	112



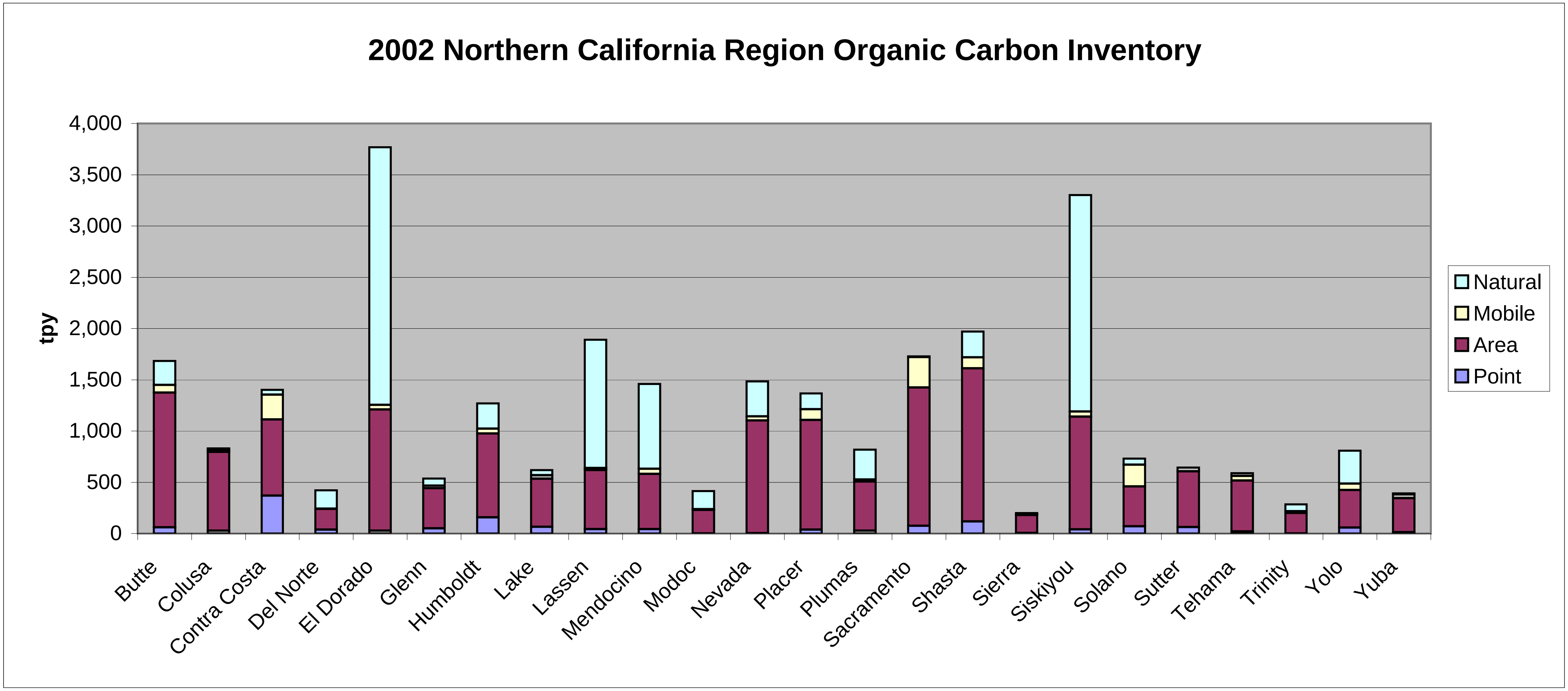
Nox-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	220	751	12,846	22	61	916	1,700	95	311	173	100	63	568	483	339	2,106	182	31	2,536	674	266	1	407	222
Area	1,006	841	2,125	64	385	500	911	257	155	328	81	315	1,209	335	2,022	1,096	45	299	768	1,195	427	51	1,686	201
Mobile	8,005	2,774	23,097	693	3,429	2,630	4,929	2,207	2,143	4,481	1,536	3,902	10,109	1,926	28,459	9,515	210	6,012	14,696	4,529	5,099	888	7,479	2,459
Natural	1,063	979	16	124	1,209	1,043	405	319	1,013	609	728	278	515	372	913	977	98	1,603	711	621	1,776	352	1,534	433
Total	10,294	5,344	38,084	903	5,084	5,087	7,945	2,879	3,622	5,591	2,445	4,558	12,401	3,116	31,732	13,694	535	7,945	18,711	7,019	7,567	1,292	11,107	3,315



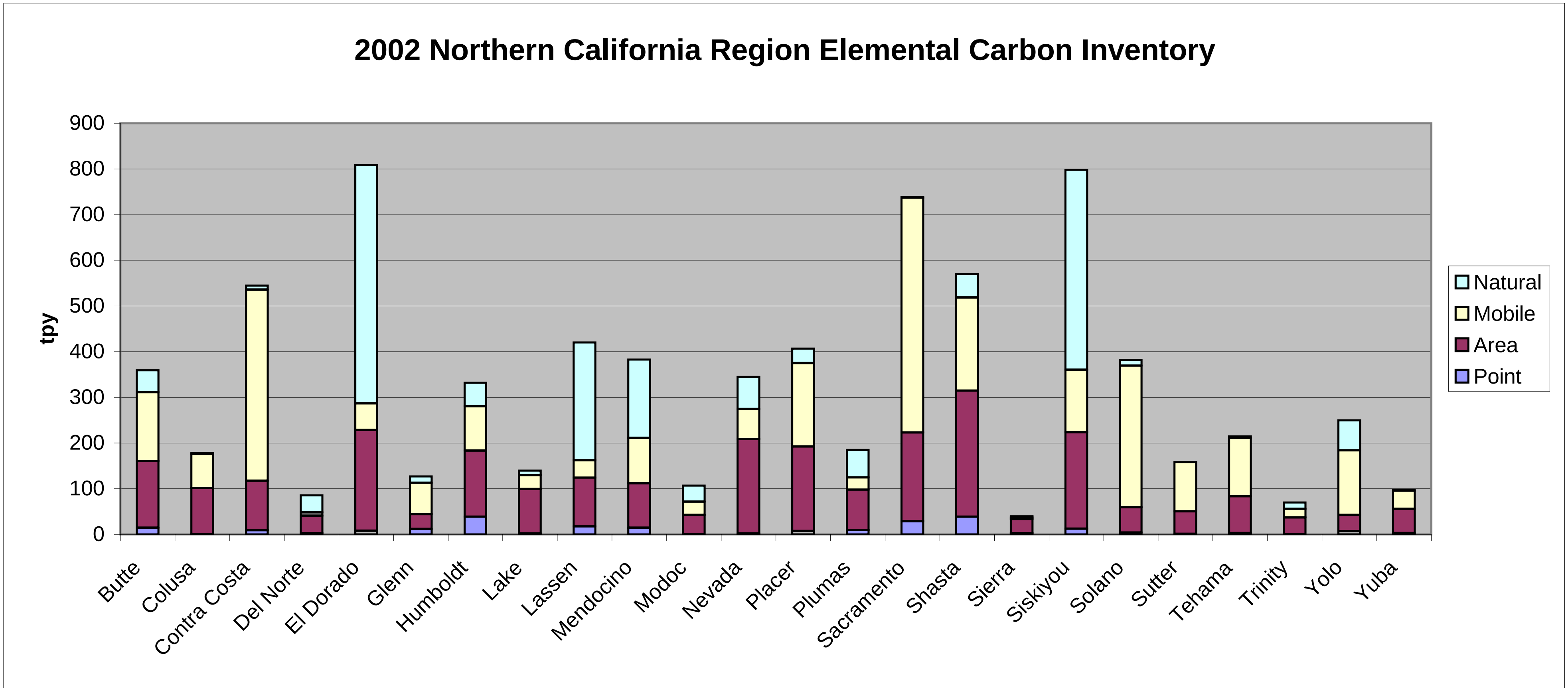
Organic Carbon-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	61	28	370	37	29	50	156	64	43	43	0	3	38	28	74	117	6	41	70	63	19	0	58	13
Area	1,313	767	743	201	1,180	393	818	470	576	538	229	1,099	1,070	478	1,350	1,493	174	1,099	389	543	499	200	365	331
Mobile	77	21	242	4	47	23	47	34	19	49	8	41	103	19	296	108	7	49	211	37	43	16	64	36
Natural	234	13	47	179	2,513	71	248	51	1,254	830	178	340	154	292	9	252	12	2,112	62	0	27	68	321	11
Total	1,684	830	1,401	422	3,768	536	1,270	619	1,891	1,460	415	1,483	1,365	817	1,729	1,970	200	3,301	732	643	588	284	808	392



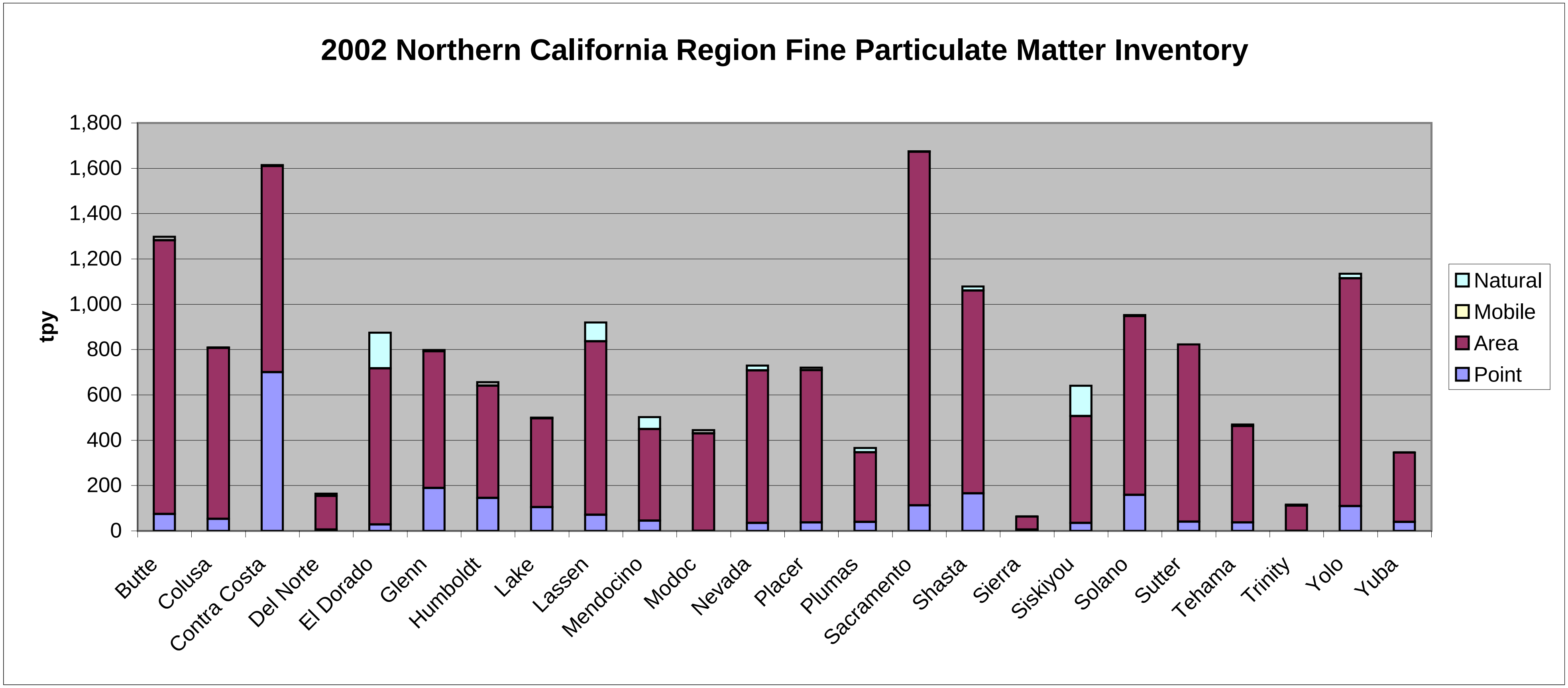
Elemental Carbon-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	14	1	9	2	8	12	39	2	17	14	0	2	7	9	28	38	2	12	4	1	3	0	7	3
Area	146	101	108	39	221	33	144	98	107	97	43	207	185	88	194	276	32	211	55	49	81	37	36	53
Mobile	151	74	418	7	58	68	97	30	38	99	29	66	183	27	514	204	3	137	310	108	128	19	141	40
Natural	48	2	9	37	522	14	51	10	258	172	35	71	32	60	1	51	2	438	12	0	3	14	66	2
Total	359	178	545	85	809	127	332	140	420	383	107	345	407	185	738	570	39	798	382	158	215	70	250	98



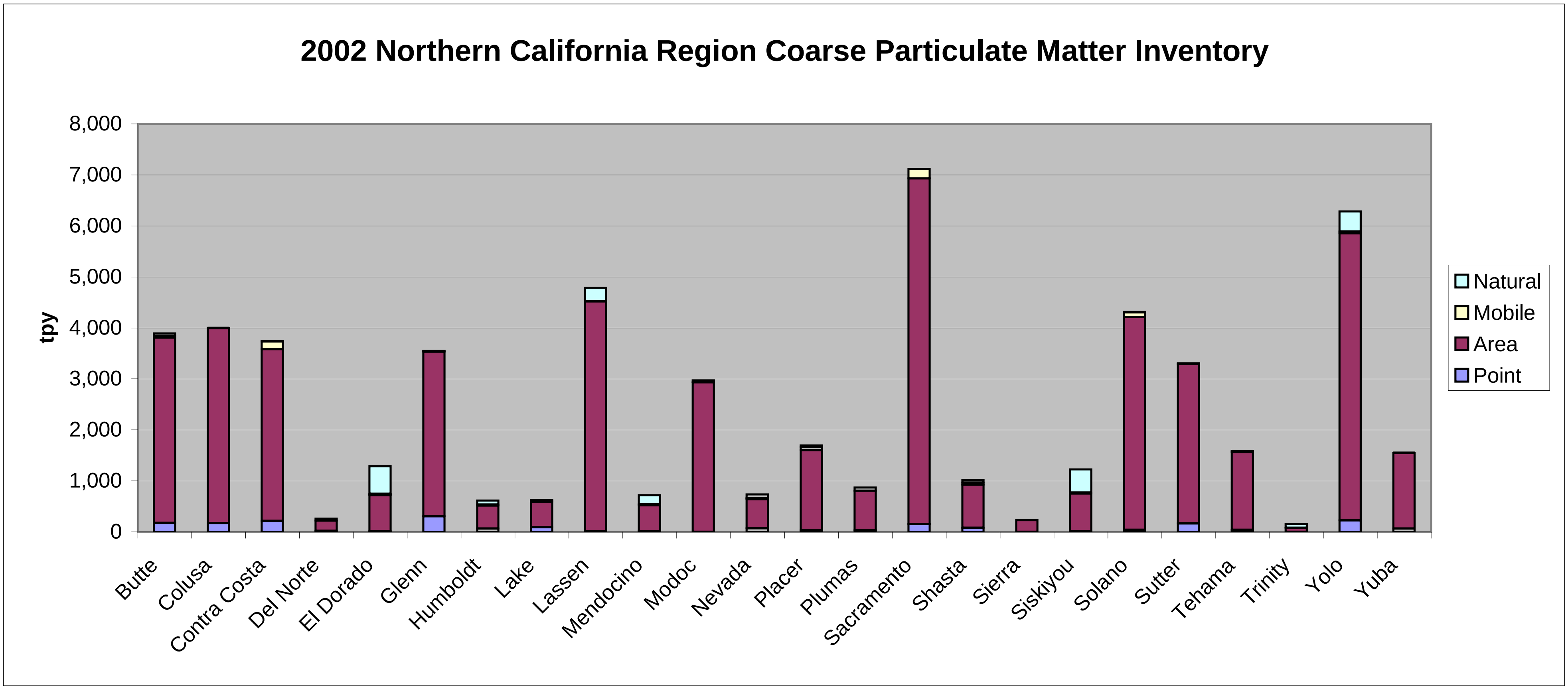
Fine Particulate Matter-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	75	53	700	6	28	189	145	105	71	45	0	35	37	39	113	165	6	35	159	40	38	0	109	40
Area	1,208	755	910	148	690	604	495	391	766	404	429	673	672	308	1,560	895	57	472	789	783	425	111	1,005	306
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural	15	2	4	11	157	6	16	4	83	53	15	22	11	18	2	18	1	134	5	0	7	4	21	1
Total	1,298	809	1,614	165	874	799	657	500	920	502	445	729	720	366	1,675	1,079	64	640	953	823	470	116	1,135	347



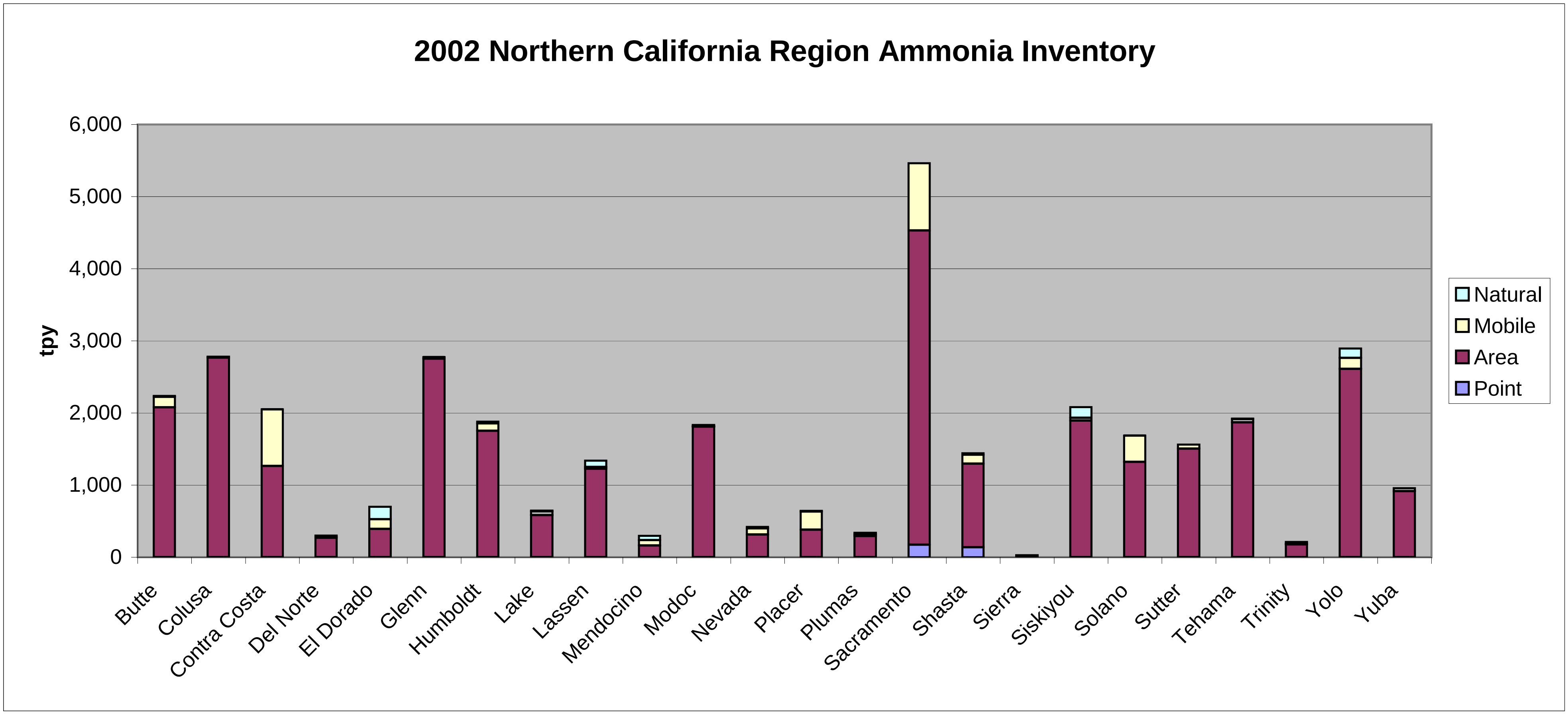
Coarse Particulate Matter-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	173	168	217	22	12	304	66	88	14	14	0	72	31	30	153	80	1	10	42	165	42	0	226	65
Area	3,634	3,823	3,367	197	710	3,228	450	504	4,503	508	2,933	566	1,571	774	6,776	844	229	739	4,171	3,125	1,523	75	5,627	1,480
Mobile	35	8	150	2	21	8	22	9	5	19	2	21	59	3	185	41	0	23	89	18	22	4	37	8
Natural	50	2	10	39	541	15	76	23	266	178	39	73	33	63	1	53	2	454	13	0	4	77	394	2
Total	3,892	4,001	3,744	259	1,285	3,554	614	624	4,788	720	2,974	733	1,695	870	7,116	1,018	233	1,225	4,314	3,307	1,590	156	6,284	1,556



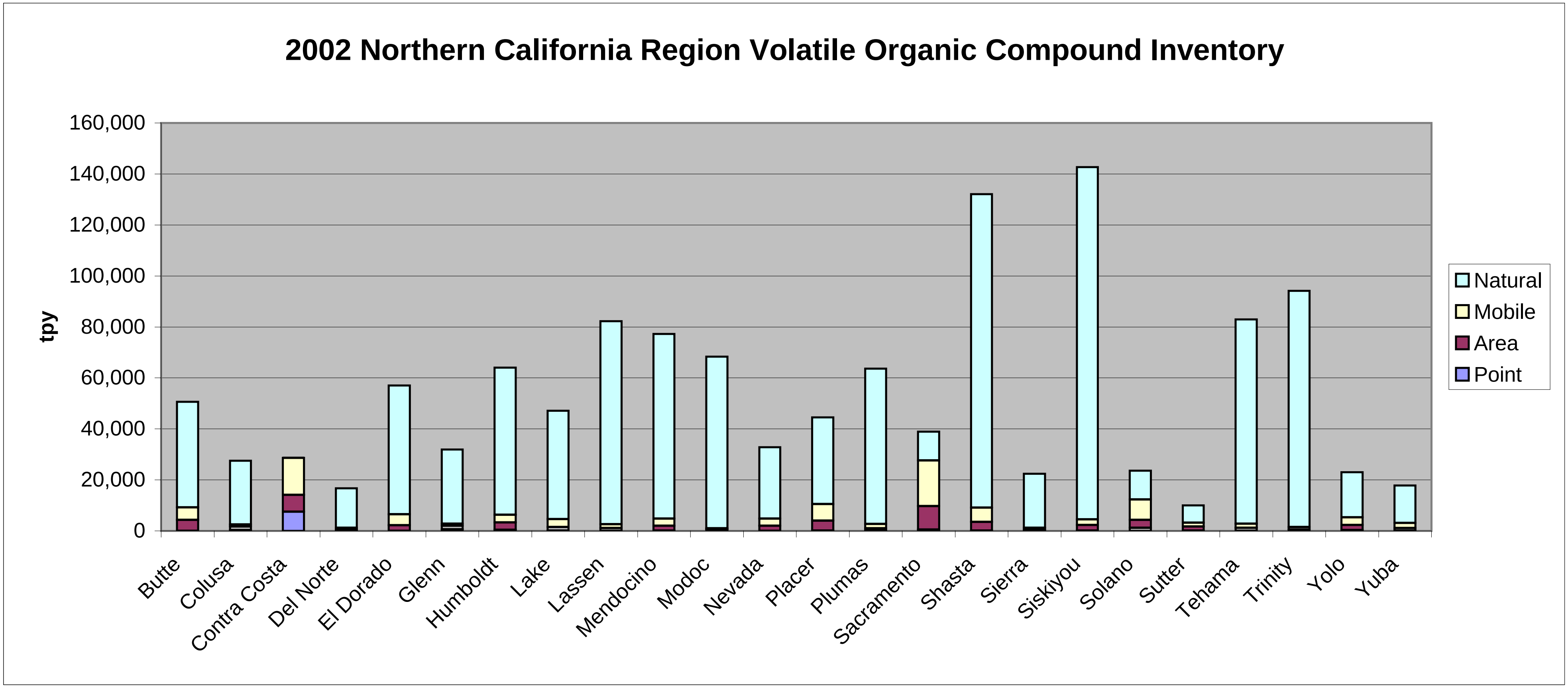
Ammonia-Northern California Region

County	Butte	Colusa	Contra C	Del Nor	El Dorad	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	174	137	0	0	0	0	0	0	0	0
Area	2,077	2,766	1,266	270	391	2,751	1,752	583	1,226	161	1,810	316	381	294	4,357	1,159	21	1,892	1,321	1,504	1,870	177	2,612	914
Mobile	145	15	782	18	134	22	102	55	26	76	7	82	251	24	931	126	7	39	364	59	47	11	152	43
Natural	17	2	4	13	176	6	25	8	90	59	15	24	11	21	1	19	1	149	5	0	4	25	128	1
Total	2,238	2,782	2,052	300	701	2,779	1,880	646	1,341	296	1,832	422	643	339	5,463	1,440	29	2,080	1,690	1,563	1,921	213	2,893	957



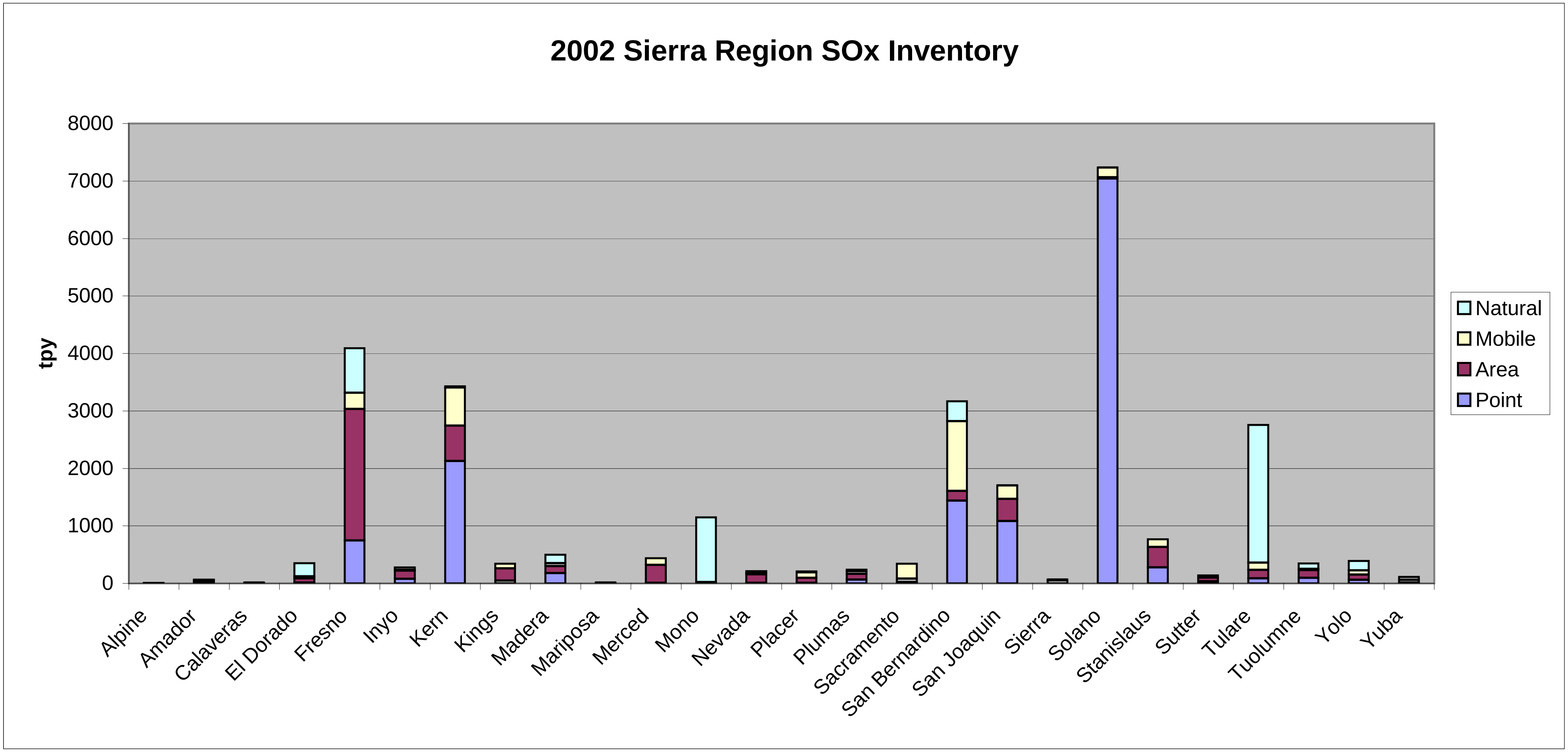
Volatile Organic Compounds-Northern California Region

County	Butte	Colusa	Contra Costa	Del Norte	El Dorado	Glenn	Humboldt	Lake	Lassen	Mendocino	Modoc	Nevada	Placer	Plumas	Sacramento	Shasta	Sierra	Siskiyou	Solano	Sutter	Tehama	Trinity	Yolo	Yuba
Point	23	257	7,534	53	16	554	407	110	19	70	0	23	111	73	492	103	12	78	1,222	50	45	0	291	65
Area	4,283	1,472	6,563	590	2,186	1,433	2,886	1,399	1,102	1,928	627	1,999	3,939	889	9,255	3,379	267	2,251	3,097	1,601	1,116	510	1,966	1,044
Mobile	4,868	783	14,546	513	4,274	840	3,012	3,061	1,440	2,763	398	2,752	6,450	1,751	17,836	5,636	971	2,195	7,967	1,592	1,665	949	3,051	1,999
Natural	41,431	25,018	35	15,586	50,608	29,053	57,743	42,593	79,673	72,519	67,274	28,003	33,995	60,878	11,301	122,926	21,122	138,184	11,302	6,751	80,136	92,653	17,749	14,682
Total	50,605	27,530	28,678	16,743	57,084	31,881	64,049	47,163	82,234	77,280	68,298	32,777	44,495	63,591	38,885	132,045	22,371	142,708	23,589	9,995	82,962	94,112	23,057	17,790



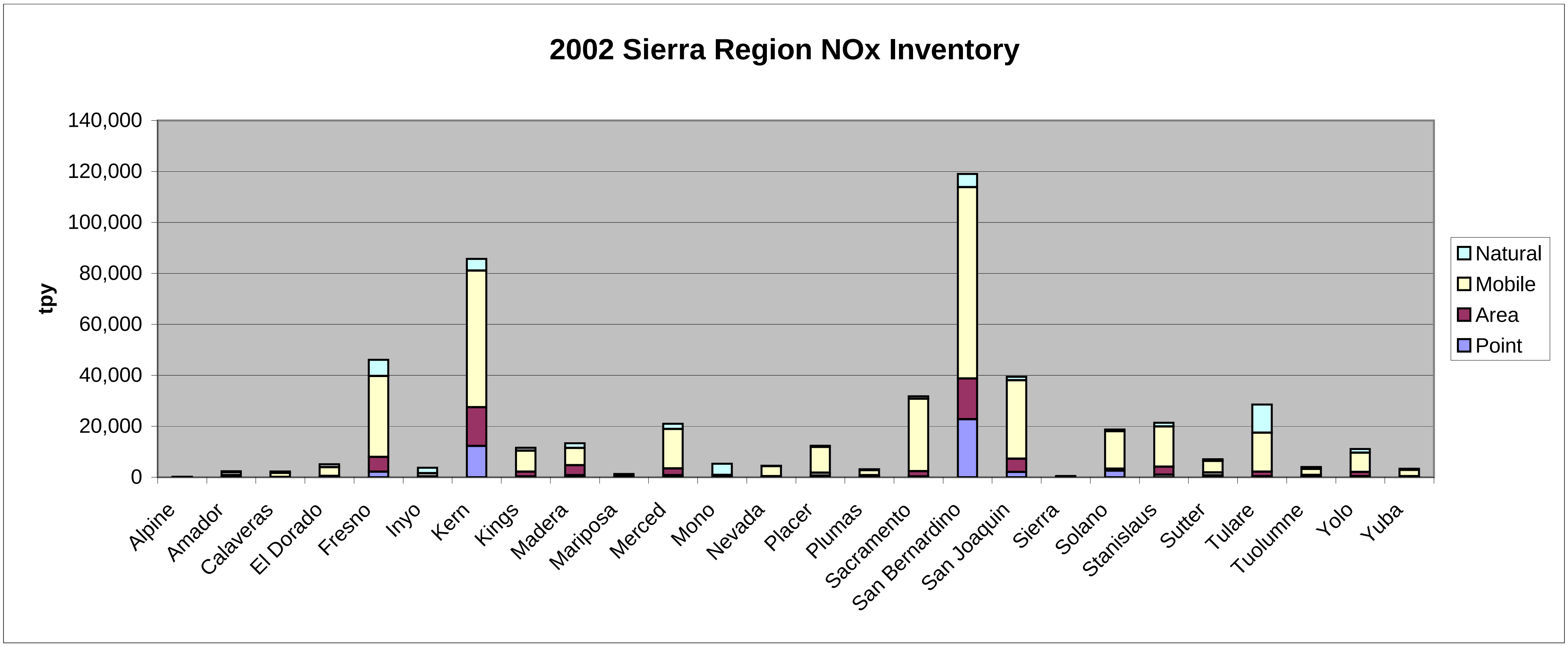
Sulfur Dioxide-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	29	0	11	744	76	2126	47	176	0	11	6	7	10	66	22	1437	1084	52	7042	277	33	88	96	61	12
Area	7	17	13	77	2288	146	618	214	125	13	312	11	149	86	98	61	170	383	14	23	356	66	147	136	90	51
Mobile	1	7	5	32	285	13	663	82	52	1	114	3	25	97	48	259	1215	236	4	168	134	40	126	21	73	48
Natural	3	12	1	230	773	44	20	1	147	3	2	1129	31	14	27	1	344	4	1	6	0	0	2394	96	168	1
Total	11	65	18	351	4090	279	3427	344	499	17	439	1149	212	206	239	342	3166	1708	71	7239	768	139	2755	348	392	112



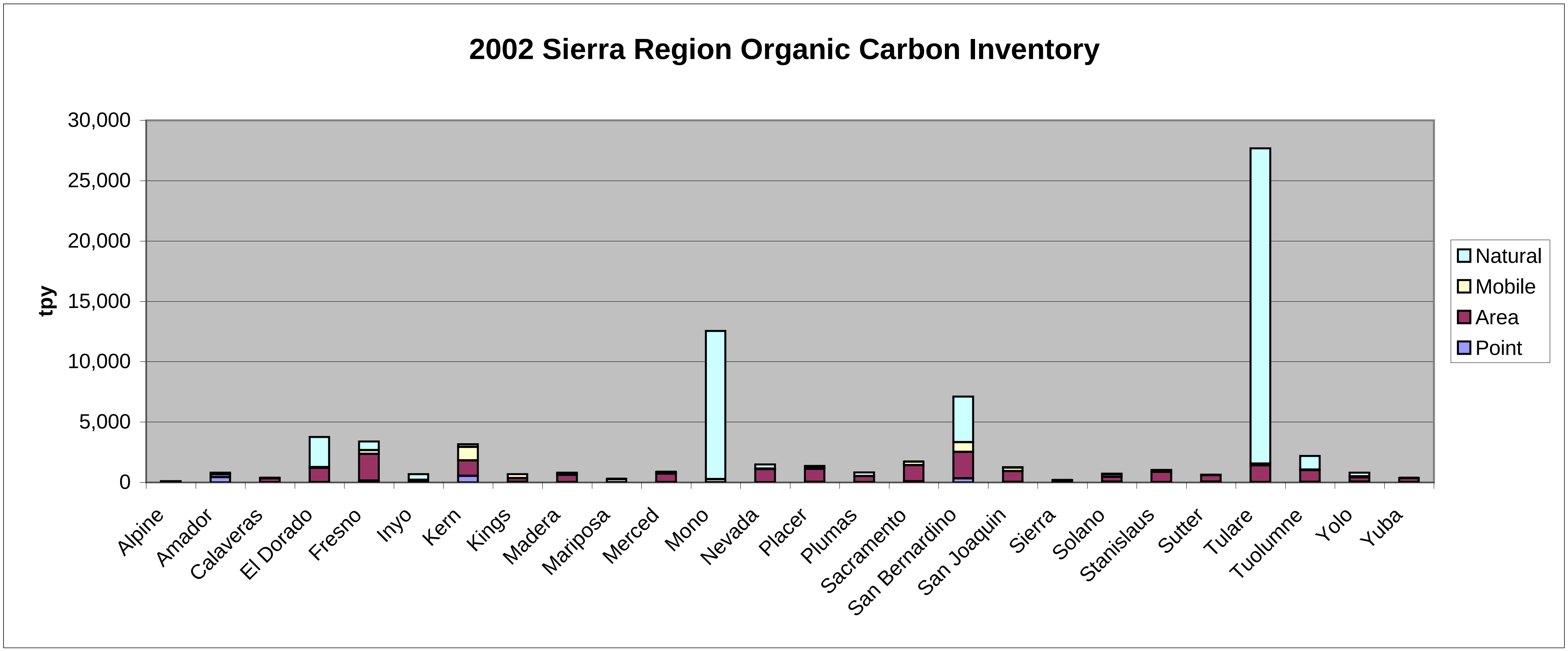
Nox-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	299	0	61	2,159	211	12,262	316	822	0	809	1	63	568	483	339	22,769	2,030	182	2,536	951	674	372	344	407	222
Area	25	529	101	385	5,825	84	15,161	1,806	3,918	74	2,658	52	315	1,209	335	2,022	15,971	5,180	45	768	3,121	1,195	1,823	550	1,686	201
Mobile	138	1,164	1,548	3,429	31,703	1,301	53,609	8,221	6,725	594	15,455	842	3,902	10,109	1,926	28,459	75,108	30,813	210	14,696	15,783	4,529	15,234	2,299	7,479	2,459
Natural	75	330	572	1,209	6,420	2,098	4,674	1,268	1,909	622	2,018	4,410	278	515	372	913	5,208	1,356	98	711	1,471	621	11,122	860	1,534	433
Total	238	2,322	2,222	5,084	46,107	3,693	85,705	11,612	13,373	1,289	20,940	5,304	4,558	12,401	3,116	31,732	119,055	39,379	535	18,711	21,325	7,019	28,552	4,054	11,107	3,315



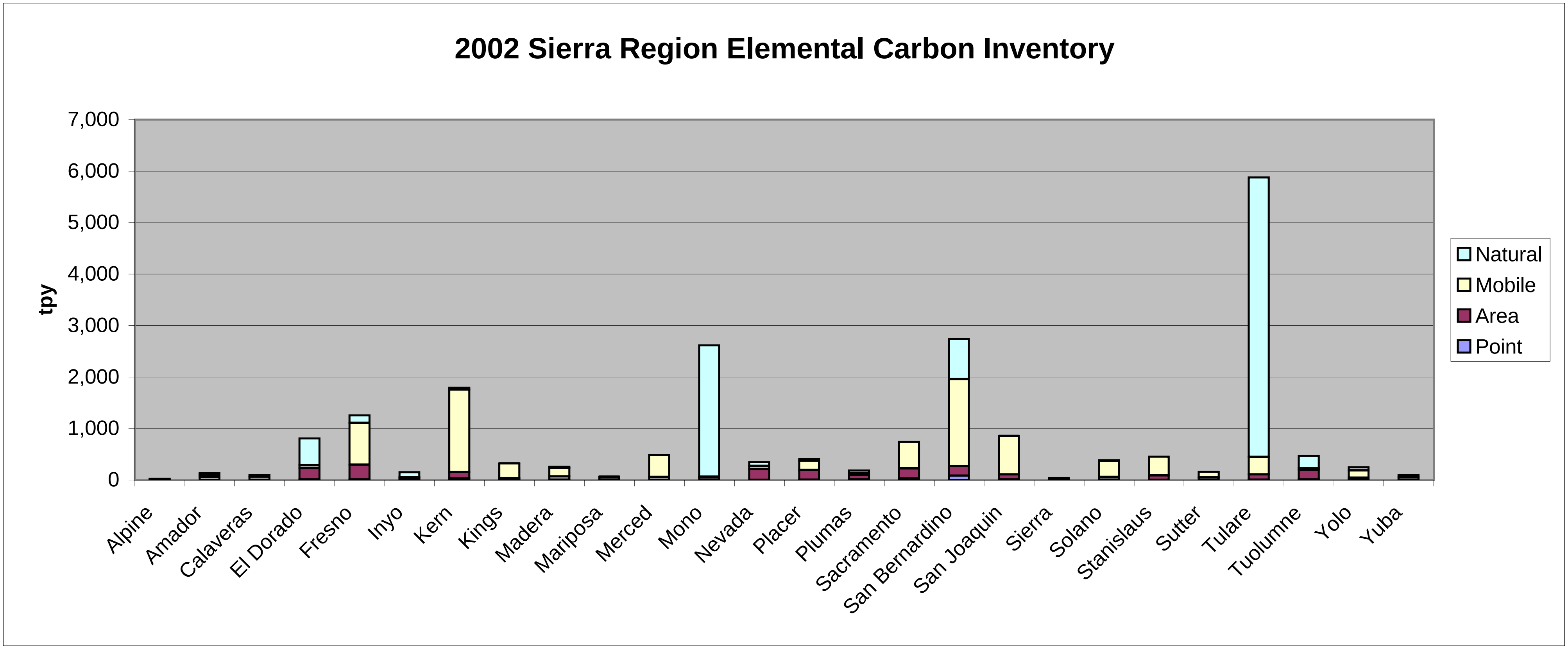
Organic Carbon-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	434	0	29	135	10	530	39	24	0	20	0	3	38	28	74	324	44	6	70	30	63	30	36	58	13
Area	67	230	340	1,180	2,218	177	1,280	313	599	261	696	267	1,099	1,070	478	1,350	2,206	884	174	389	838	543	1,379	979	365	331
Mobile	1	13	40	47	323	10	1,136	331	74	20	148	7	41	103	19	296	805	298	7	211	155	37	135	34	64	36
Natural	32	127	8	2,513	707	480	216	9	111	32	23	12,279	340	154	292	9	3,768	46	12	62	8	0	26,138	1,154	321	11
Total	99	803	389	3,768	3,384	677	3,162	692	808	314	886	12,554	1,483	1,365	817	1,729	7,104	1,271	200	732	1,032	643	27,682	2,201	808	392



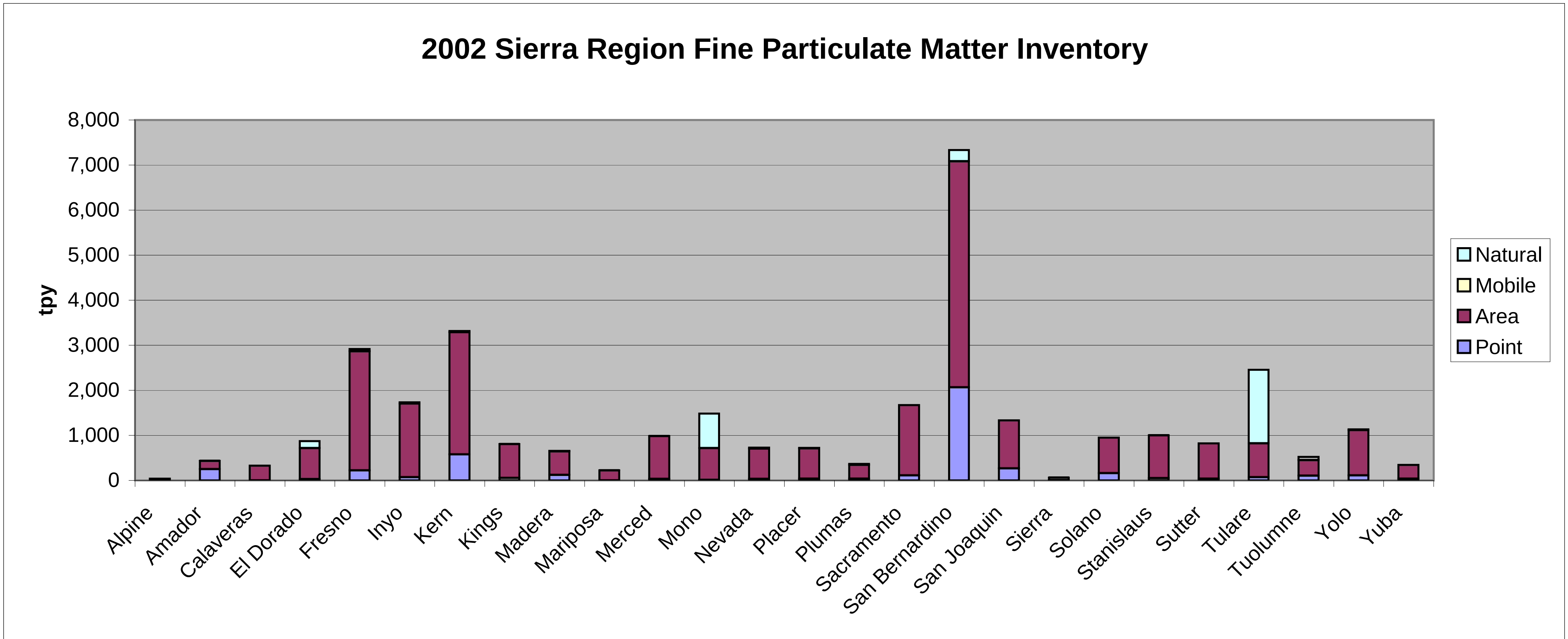
Elemental Carbon-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	53	0	8	12	3	30	7	4	0	0	0	2	7	9	28	85	9	2	4	2	1	4	11	7	3
Area	13	40	64	221	284	29	123	29	64	50	58	47	207	185	88	194	184	100	32	55	88	49	102	190	36	53
Mobile	3	14	27	58	811	22	1,601	286	166	11	423	16	66	183	27	514	1,689	745	3	310	364	108	343	27	141	40
Natural	7	26	1	522	146	99	37	1	22	6	3	2,551	71	32	60	1	777	9	2	12	0	0	5,430	239	66	2
Total	23	132	92	809	1,253	153	1,792	323	256	67	485	2,615	345	407	185	738	2,736	862	39	382	454	158	5,879	467	250	98



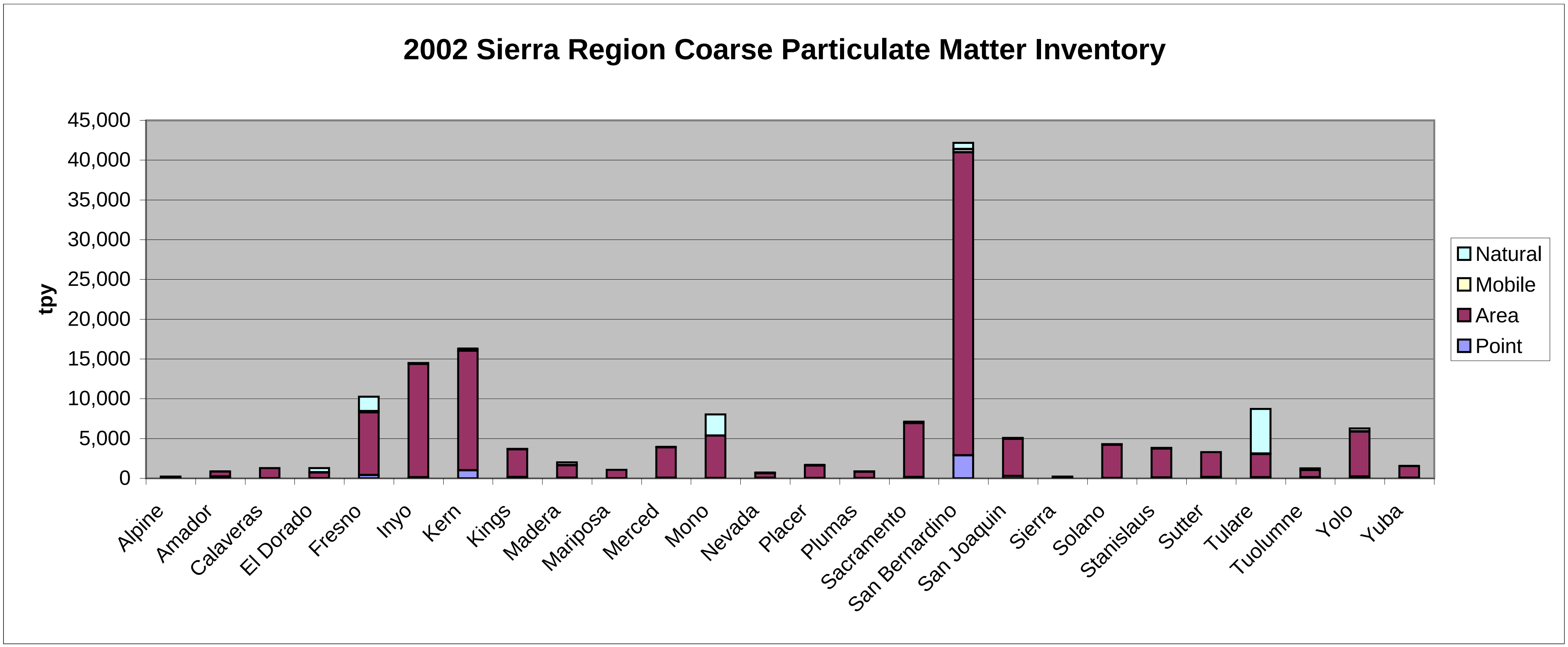
Fine Particulate Matter-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	252	0	28	224	70	577	55	124	3	32	10	35	37	39	113	2,068	266	6	159	51	40	74	103	109	40
Area	38	180	325	690	2,644	1,633	2,711	752	522	220	950	706	673	672	308	1,560	5,015	1,064	57	789	951	783	749	349	1,005	306
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural	2	9	2	157	47	32	31	2	9	4	4	766	22	11	18	2	248	4	1	5	3	0	1,633	73	21	1
Total	40	441	327	874	2,915	1,735	3,319	810	655	227	987	1,482	729	720	366	1,675	7,331	1,335	64	953	1,005	823	2,456	525	1,135	347



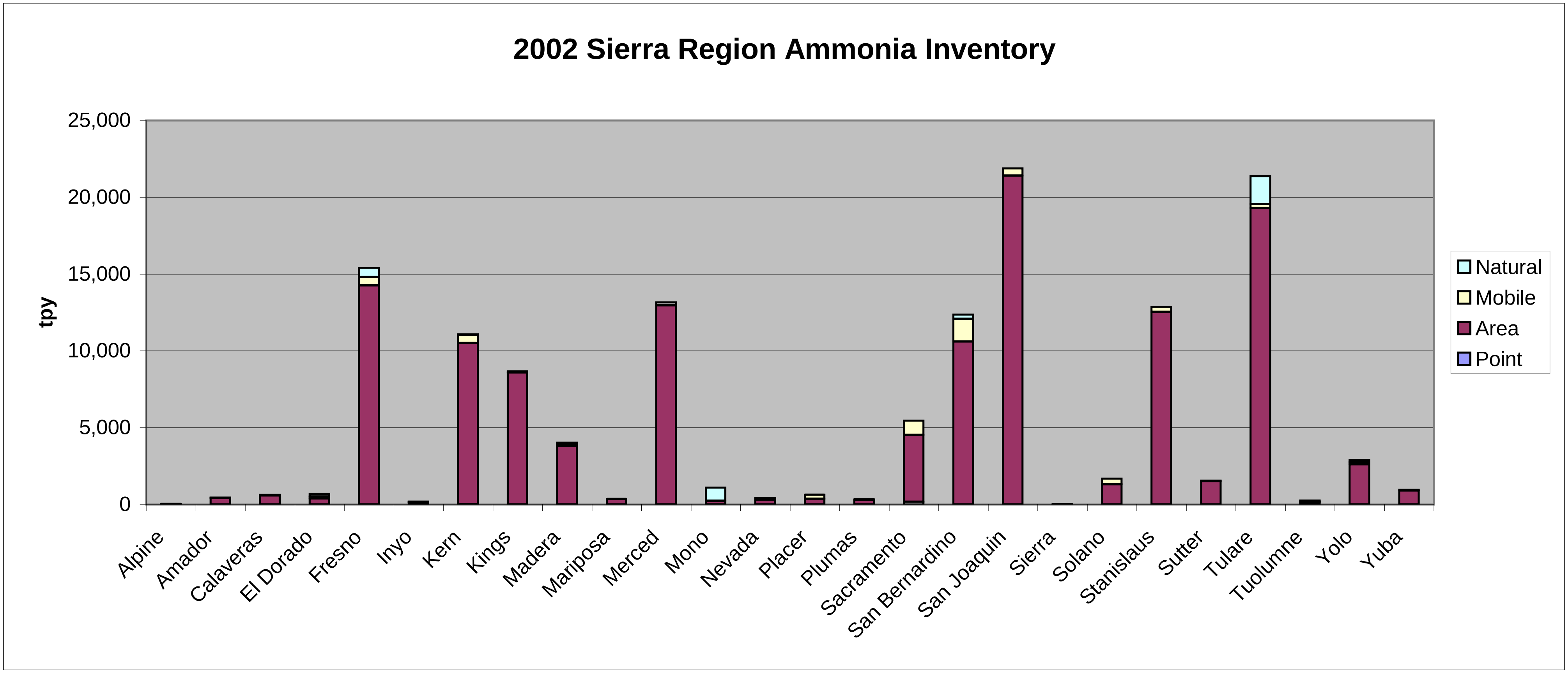
Coarse Particulate Matter-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	233	0	12	404	124	995	161	48	7	68	23	72	31	30	153	2,877	271	1	42	88	165	138	111	226	65
Area	216	604	1,274	710	7,880	14,263	15,027	3,488	1,593	1,046	3,814	5,350	566	1,571	774	6,776	38,094	4,693	229	4,171	3,651	3,125	2,903	913	5,627	1,480
Mobile	0	6	7	21	164	7	255	40	34	4	83	5	21	59	3	185	406	123	0	89	83	18	66	8	37	8
Natural	7	27	1	541	1,818	103	43	1	345	6	4	2,656	73	33	63	1	807	9	2	13	1	0	5,633	225	394	2
Total	223	871	1,282	1,285	10,266	14,497	16,321	3,690	2,020	1,063	3,969	8,033	733	1,695	870	7,116	42,184	5,097	233	4,314	3,823	3,307	8,739	1,257	6,284	1,556



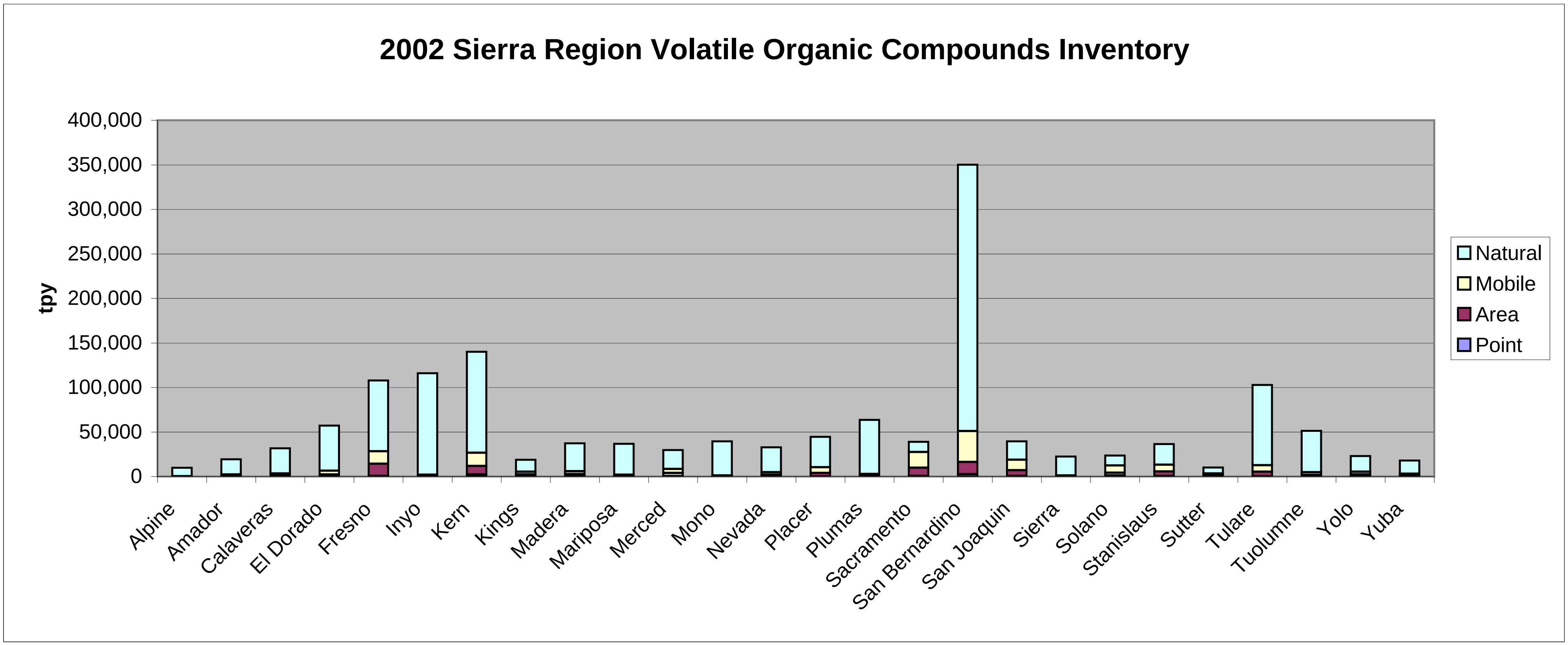
Ammonia-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	174	0	0	0	0	0	0	0	0	0	0
Area	38	416	591	391	14,259	136	10,492	8,585	3,816	361	12,959	228	316	381	294	4,357	10,602	21,410	21	1,321	12,546	1,504	19,291	131	2,612	914
Mobile	1	34	41	134	561	27	543	90	105	16	198	11	82	251	24	931	1,490	474	7	364	326	59	261	59	152	43
Natural	2	9	1	176	592	35	24	1	113	3	3	864	24	11	21	1	270	4	1	5	2	0	1,833	74	128	1
Total	41	459	634	701	15,412	197	11,077	8,677	4,034	380	13,160	1,103	422	643	339	5,463	12,361	21,887	29	1,690	12,873	1,563	21,385	264	2,893	957



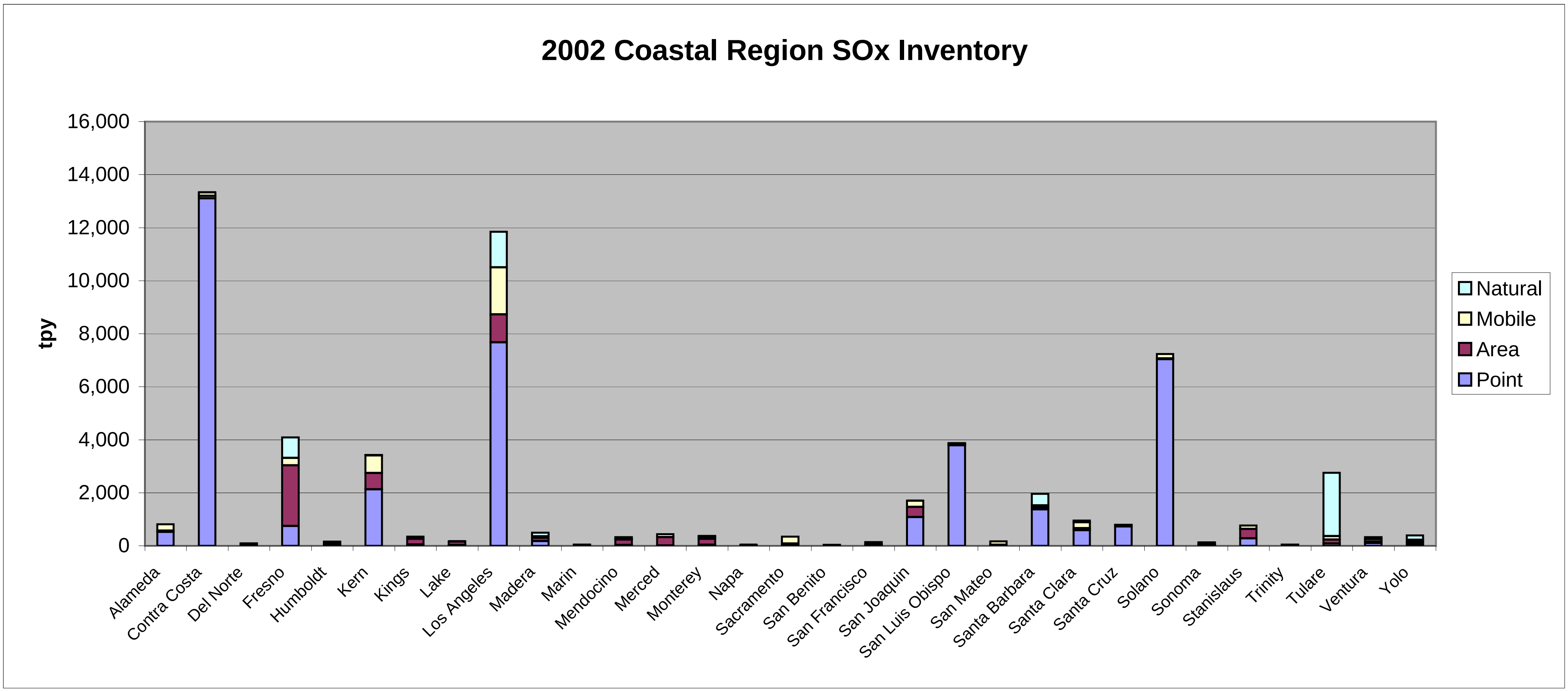
Volatile Organic Compounds-Sierra Region

County	Alpine	Amador	Calaveras	El Dorado	Fresno	Inyo	Kern	Kings	Madera	Mariposa	Merced	Mono	Nevada	Placer	Plumas	Sacramento	San Bernardino	San Joaquin	Sierra	Solano	Stanislaus	Sutter	Tulare	Tuolumne	Yolo	Yuba
Point	0	316	0	16	498	0	2,278	232	87	0	222	8	23	111	73	492	2,469	624	12	1,222	465	50	402	9	291	65
Area	98	822	820	2,186	13,759	733	9,427	1,942	2,518	549	3,566	536	1,999	3,939	889	9,255	13,789	6,338	267	3,097	5,092	1,601	4,989	1,558	1,966	1,044
Mobile	152	1,208	2,552	4,274	13,931	1,231	14,770	3,149	3,160	1,444	4,524	494	2,752	6,450	1,751	17,836	34,807	11,668	971	7,967	7,558	1,592	7,351	3,267	3,051	1,999
Natural	9,529	17,032	28,271	50,608	79,780	#####	######	13,582	31,562	34,564	21,427	38,388	28,003	33,995	60,878	11,301	299,007	20,878	21,122	11,302	23,274	6,751	90,128	46,439	17,749	14,682
Total	9,780	19,379	31,642	57,084	107,968	#####	######	18,906	37,328	36,557	29,739	39,425	32,777	44,495	63,591	38,885	350,072	39,508	22,371	23,589	36,389	9,995	102,870	51,273	23,057	17,790



Sulfur Dioxide-Coastal Region

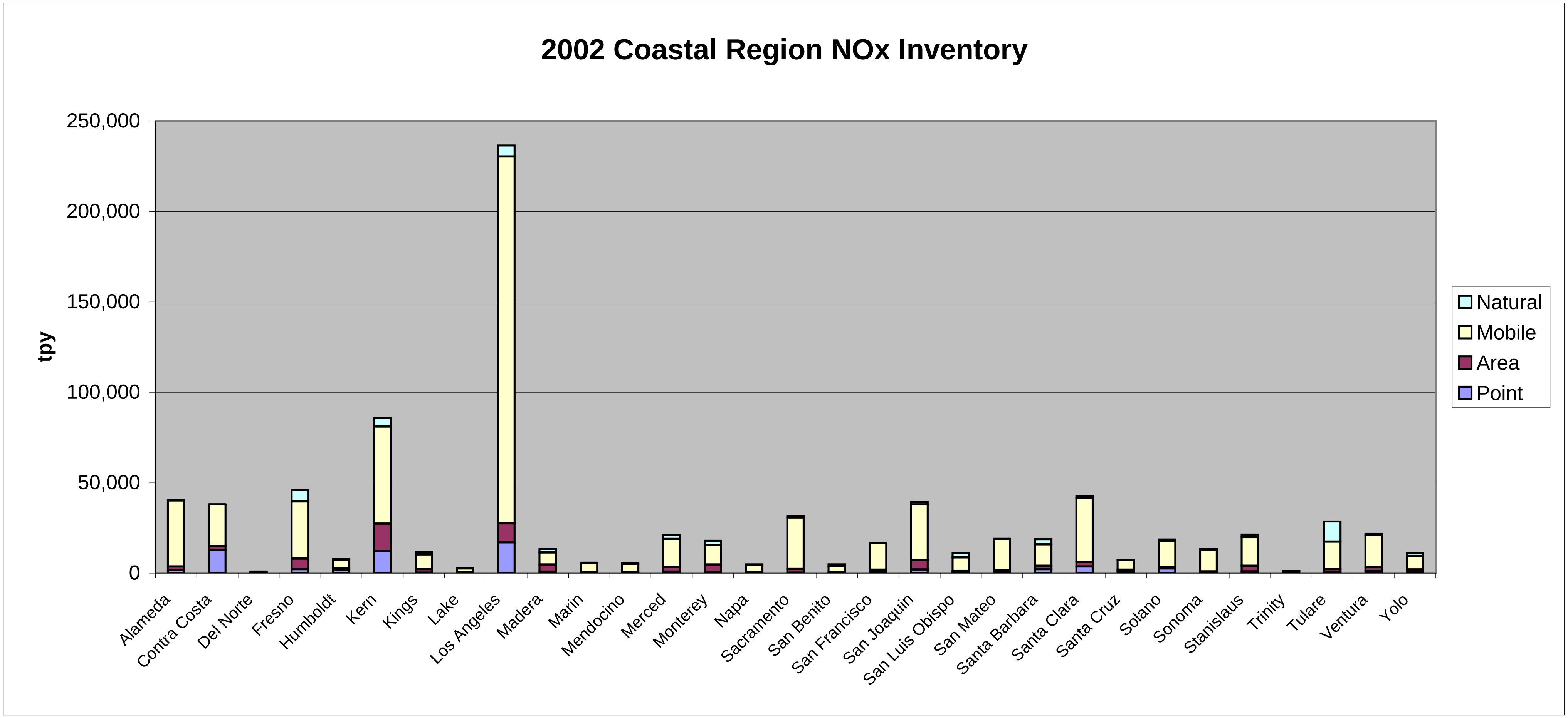
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	526	13,103	48	744	49	2,126	47	30	7,674	176	3	28	11	38	4	22	1	24	1,084	3,786	11	1,373	590	725	7,042	19	277	0	88	100	61
Area	47	94	28	2,288	59	618	214	132	1,050	125	16	208	312	220	7	61	12	41	383	24	28	84	76	50	23	47	356	10	147	61	90
Mobile	243	138	1	285	15	663	82	9	1,779	52	25	16	114	76	22	259	19	72	236	43	131	67	217	21	168	60	134	4	126	92	73
Natural	1	4	16	773	32	20	1	10	1,344	147	0	76	2	37	12	1	2	0	4	18	0	432	66	0	6	2	0	33	2,394	76	168
Total	816	13,339	94	4,090	156	3,427	344	181	11,848	499	44	328	439	371	45	342	35	137	1,708	3,871	170	1,956	949	796	7,239	129	768	47	2,755	328	392



Nox-Coastal Region

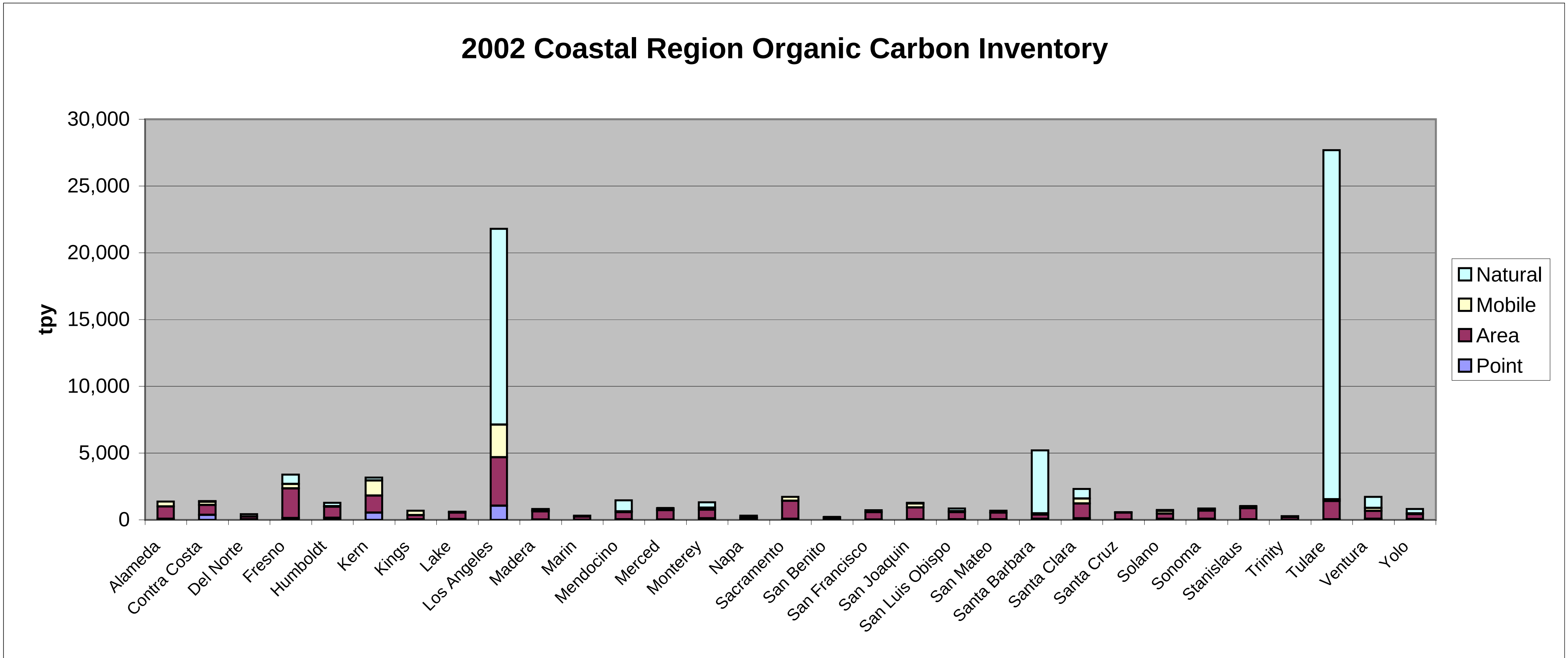
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa
Point	1,645	12,846	22	2,159	1,700	12,262	316	95	17,008	822	71	173	809	708	113
Area	2,039	2,125	64	5,825	911	15,161	1,806	257	10,521	3,918	481	328	2,658	4,008	240
Mobile	36,509	23,097	693	31,703	4,929	53,609	8,221	2,207	202,861	6,725	5,139	4,481	15,455	11,013	4,144
Natural	400	16	124	6,420	405	4,674	1,268	319	6,155	1,909	224	609	2,018	2,278	440
Total	40,594	38,084	903	46,107	7,945	85,705	11,612	2,879	236,545	13,373	5,914	5,591	20,940	18,007	4,937

County	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	339	42	651	2,030	573	332	2,198	3,618	888	2,536	193	951	1	372	1,179	407
Area	2,022	304	1,236	5,180	664	1,143	1,904	2,663	978	768	768	3,121	51	1,823	2,081	1,686
Mobile	28,459	3,427	15,052	30,813	7,484	17,464	11,902	35,331	5,371	14,696	12,123	15,783	888	15,234	17,694	7,479
Natural	913	1,142	20	1,356	2,307	91	2,758	900	83	711	445	1,471	352	11,122	821	1,534
Total	31,732	4,914	16,959	39,379	11,028	19,030	18,762	42,511	7,320	18,711	13,528	21,325	1,292	28,552	21,776	11,107



Organic Carbon-Coastal Region

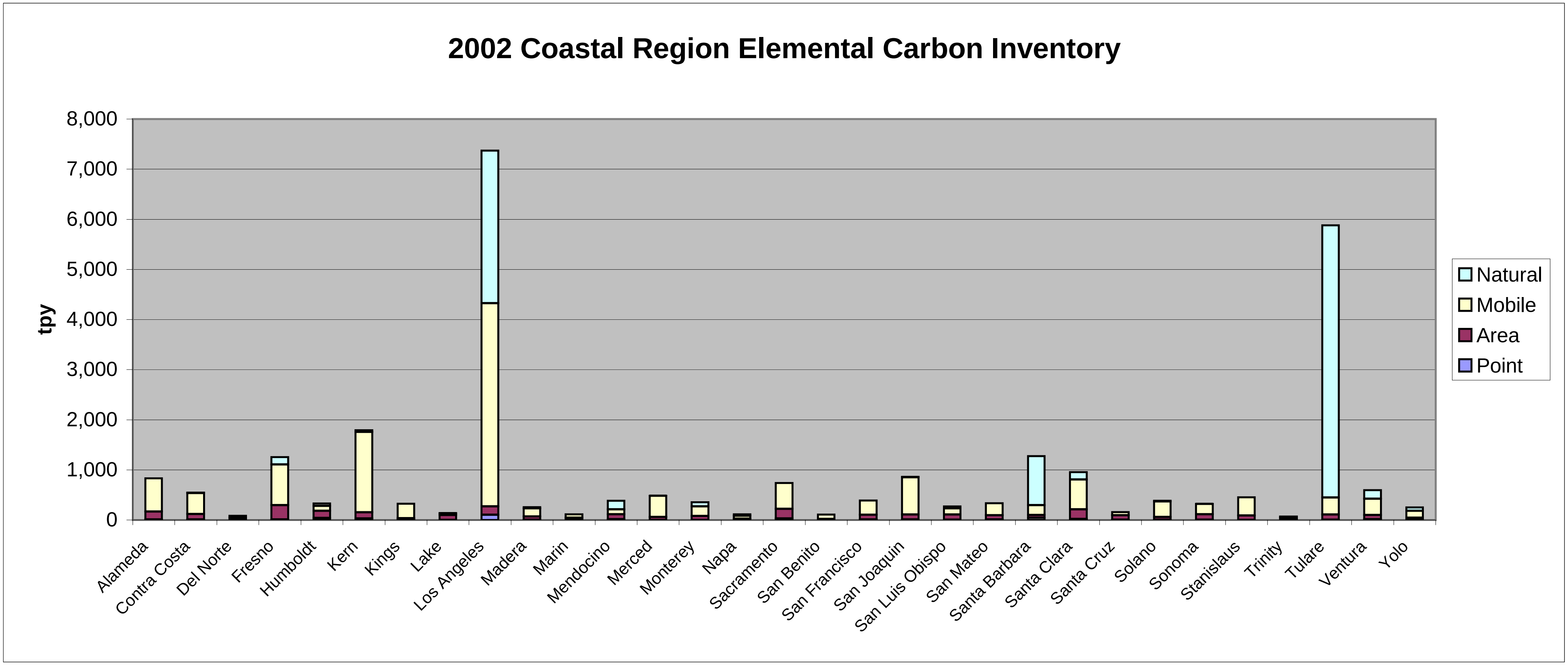
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	65	370	37	135	156	530	39	64	1,051	24	7	43	20	119	11	74	4	26	44	46	33	69	103	10	70	76	30	0	30	82	58
Area	941	743	201	2,218	818	1,280	313	470	3,637	599	238	538	696	643	131	1,350	169	548	884	532	503	314	1,127	523	389	617	838	200	1,379	588	365
Mobile	358	242	4	323	47	1,136	331	34	2,449	74	71	49	148	143	45	296	30	150	298	80	156	102	370	48	211	127	155	16	135	228	64
Natural	7	47	179	707	248	216	9	51	14,666	111	3	830	23	405	135	9	25	0	46	202	2	4,722	720	0	62	24	8	68	26,138	830	321
Total	1,371	1,401	422	3,384	1,270	3,162	692	619	21,803	808	320	1,460	886	1,310	321	1,729	229	724	1,271	859	693	5,206	2,320	582	732	844	1,032	284	27,682	1,727	808



Elemental Carbon-Coastal Region

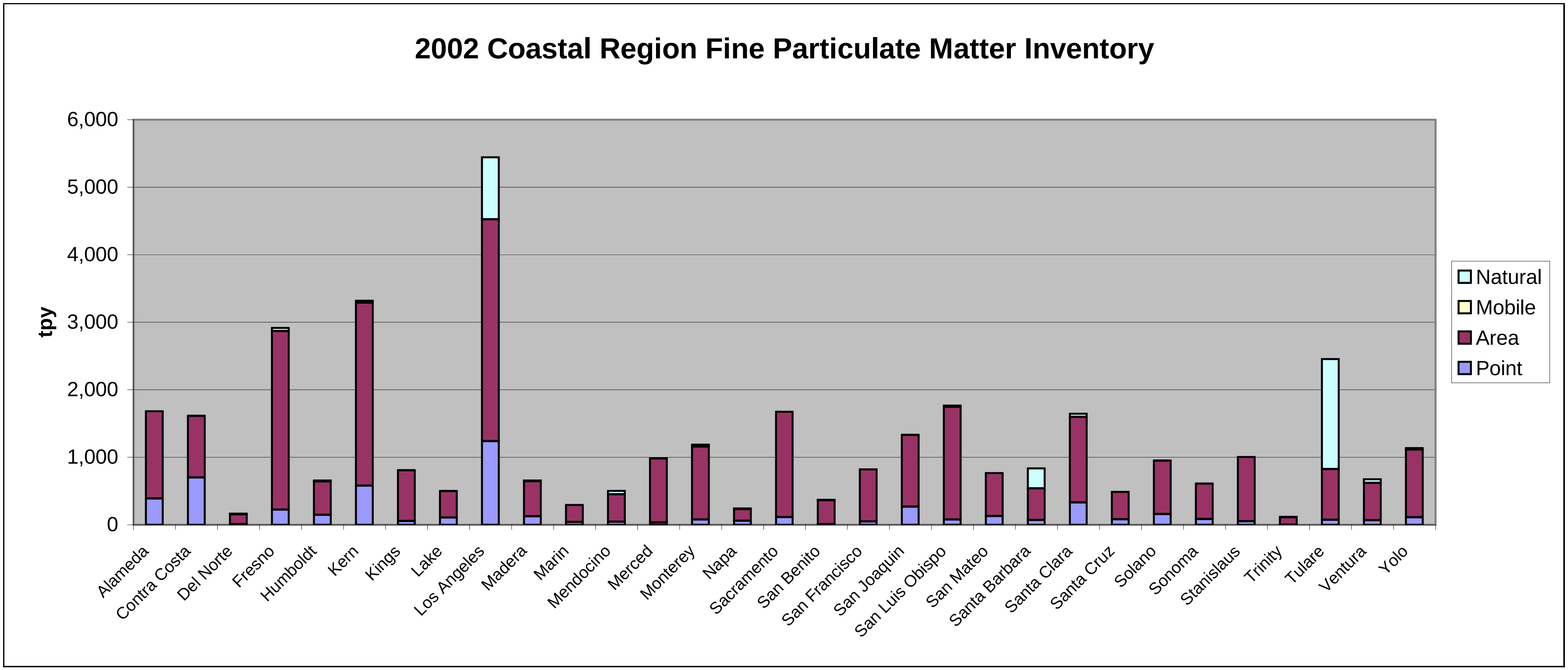
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa
Point	11	9	2	12	39	30	7	2	104	4	1	14	0	1	2
Area	159	108	39	284	144	123	29	98	167	64	42	97	58	75	23
Mobile	662	418	7	811	97	1,601	286	30	4,053	166	70	99	423	197	60
Natural	1	9	37	146	51	37	1	10	3,045	22	0	172	3	82	28
Total	832	545	85	1,253	332	1,792	323	140	7,369	256	114	383	485	354	113

County	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	28	0	10	9	3	9	42	18	4	4	3	2	0	4	13	7
Area	194	18	92	100	103	84	57	191	88	55	108	88	37	102	83	36
Mobile	514	88	287	745	124	242	194	596	64	310	208	364	19	343	327	141
Natural	1	3	0	9	39	0	980	149	0	12	4	0	14	5,430	171	66
Total	738	110	389	862	270	335	1,273	954	156	382	324	454	70	5,879	594	250



Fine Particulate Matter-Coastal Region

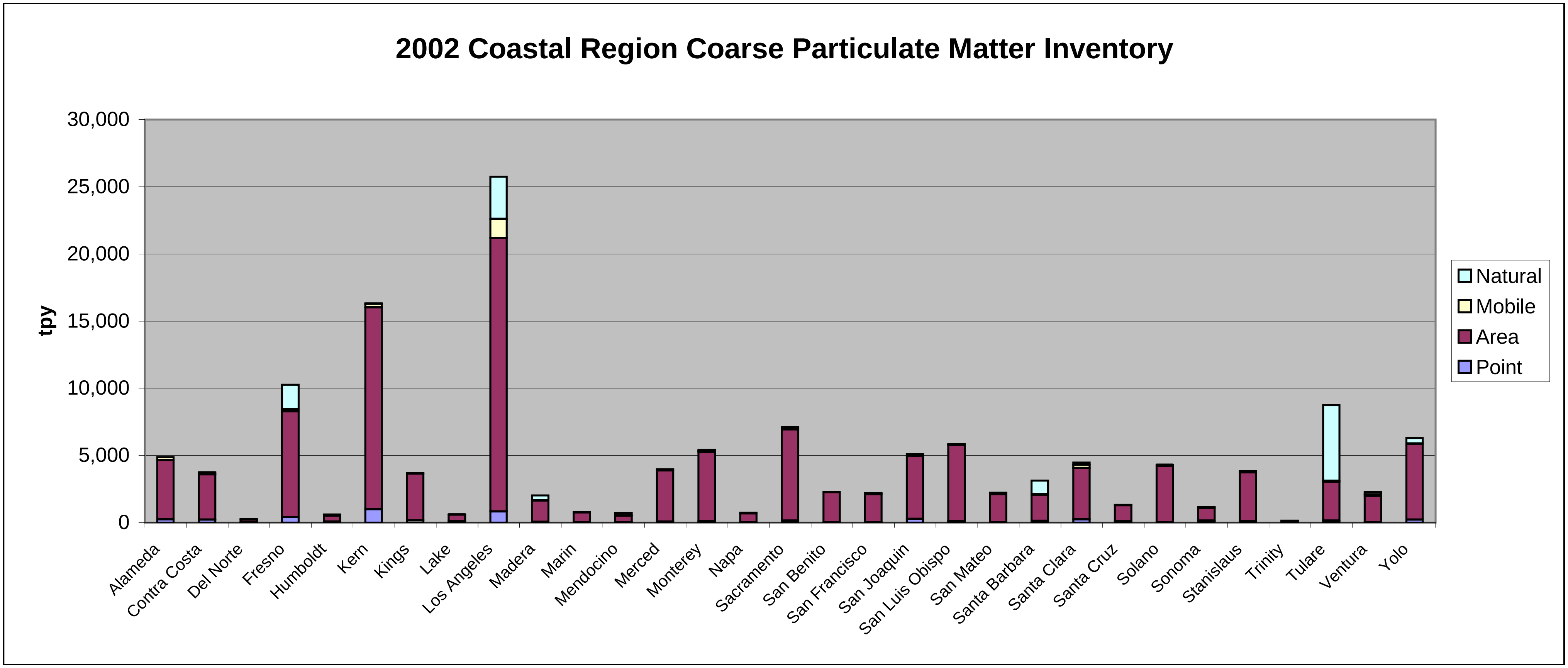
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	388	700	6	224	145	577	55	105	1,238	124	39	45	32	77	60	113	9	47	266	78	130	71	328	81	159	83	51	0	74	66	109
Area	1,292	910	148	2,644	495	2,711	752	391	3,284	522	253	404	950	1,079	171	1,560	354	775	1,064	1,669	635	467	1,268	408	789	525	951	111	749	555	1,005
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural	1	4	11	47	16	31	2	4	920	9	1	53	4	32	9	2	6	0	4	19	1	298	47	0	5	3	3	4	1,633	54	21
Total	1,682	1,614	165	2,915	657	3,319	810	500	5,442	655	293	502	987	1,188	240	1,675	369	822	1,335	1,766	766	836	1,643	489	953	610	1,005	116	2,456	675	1,135



Coarse Particulate Matter-Coastal Region

County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa	Sacramento
Point	237	217	22	404	66	995	161	88	824	48	10	14	68	94	19	153
Area	4,409	3,367	197	7,880	450	15,027	3,488	504	20,367	1,593	748	508	3,814	5,169	661	6,776
Mobile	233	150	2	164	22	255	40	9	1,407	34	36	19	83	76	24	185
Natural	1	10	39	1,818	76	43	1	23	3,162	345	0	178	4	87	29	1
Total	4,879	3,744	259	10,266	614	16,321	3,690	624	25,759	2,020	794	720	3,969	5,426	733	7,116

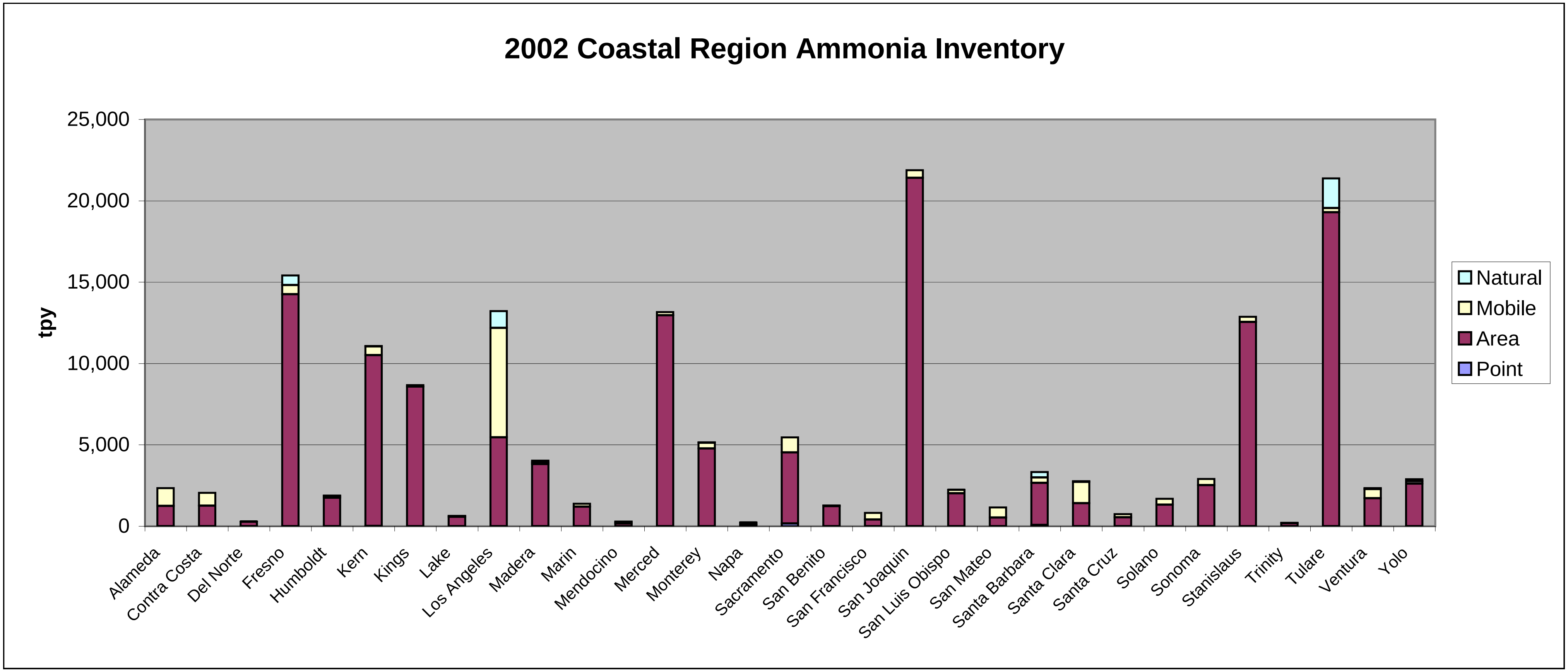
County	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	14	35	271	113	40	130	244	91	42	156	88	0	138	28	226
Area	2,252	2,080	4,693	5,659	2,074	1,919	3,821	1,192	4,171	936	3,651	75	2,903	1,966	5,627
Mobile	18	80	123	41	114	61	248	36	89	71	83	4	66	109	37
Natural	4	0	9	41	0	1,016	154	0	13	5	1	77	5,633	178	394
Total	2,288	2,194	5,097	5,854	2,228	3,126	4,467	1,319	4,314	1,168	3,823	156	8,739	2,280	6,284



Ammonia-Coastal Region

County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa
Point	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0
Area	1,254	1,266	270	14,259	1,752	10,492	8,585	583	5,456	3,816	1,194	161	12,959	4,780	106
Mobile	1,087	782	18	561	102	543	90	55	6,731	105	195	76	198	350	123
Natural	1	4	13	592	25	24	1	8	1,031	113	1	59	3	32	10
Total	2,342	2,052	300	15,412	1,880	11,077	8,677	646	13,218	4,034	1,391	296	13,160	5,162	239

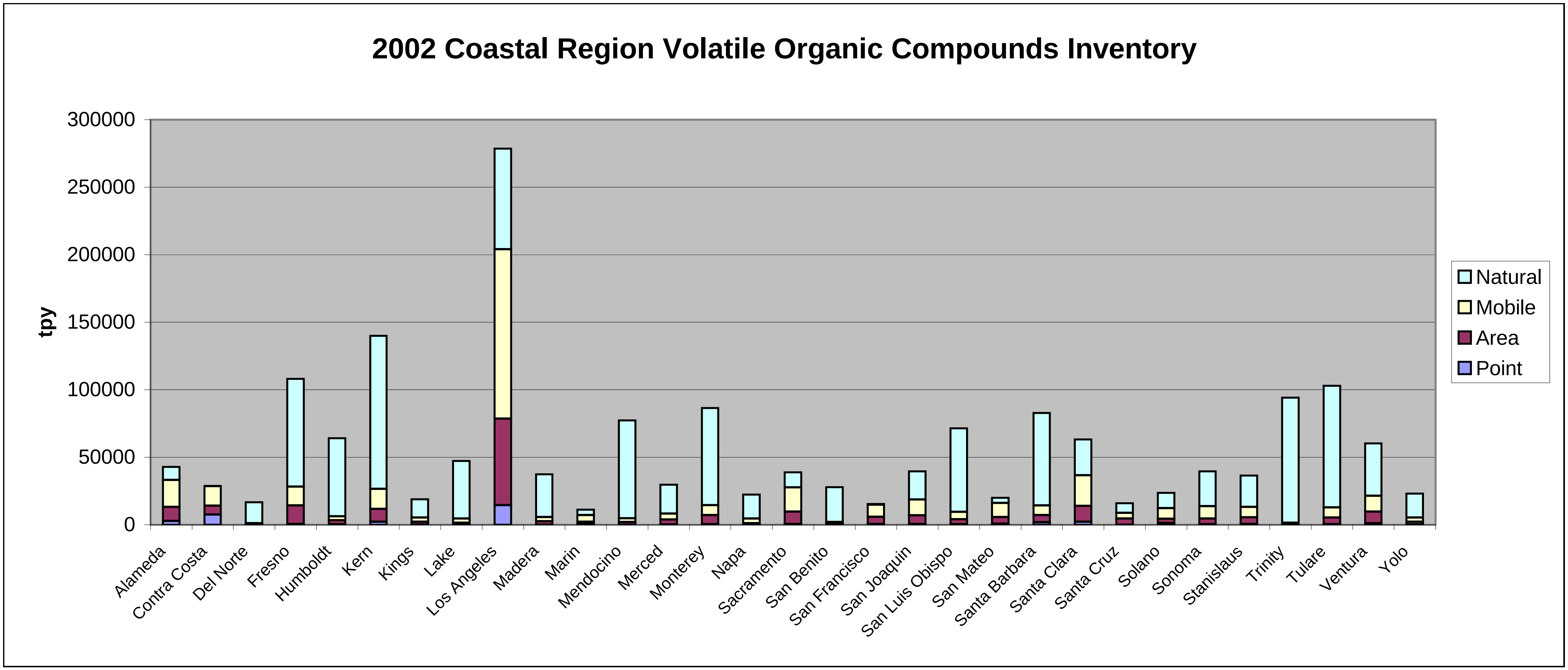
County	Sacramento	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	174	0	0	0	0	0	78	0	0	0	0	0	0	0	0	0
Area	4,357	1,228	406	21,410	2,017	539	2,592	1,411	551	1,321	2,532	12,546	177	19,291	1,718	2,612
Mobile	931	49	411	474	214	623	327	1,308	198	364	368	326	11	261	565	152
Natural	1	4	0	4	17	0	333	51	0	5	2	2	25	1,833	59	128
Total	5,463	1,280	817	21,887	2,248	1,162	3,330	2,770	749	1,690	2,902	12,873	213	21,385	2,343	2,893



Volatile Organic Compounds-Coastal Region

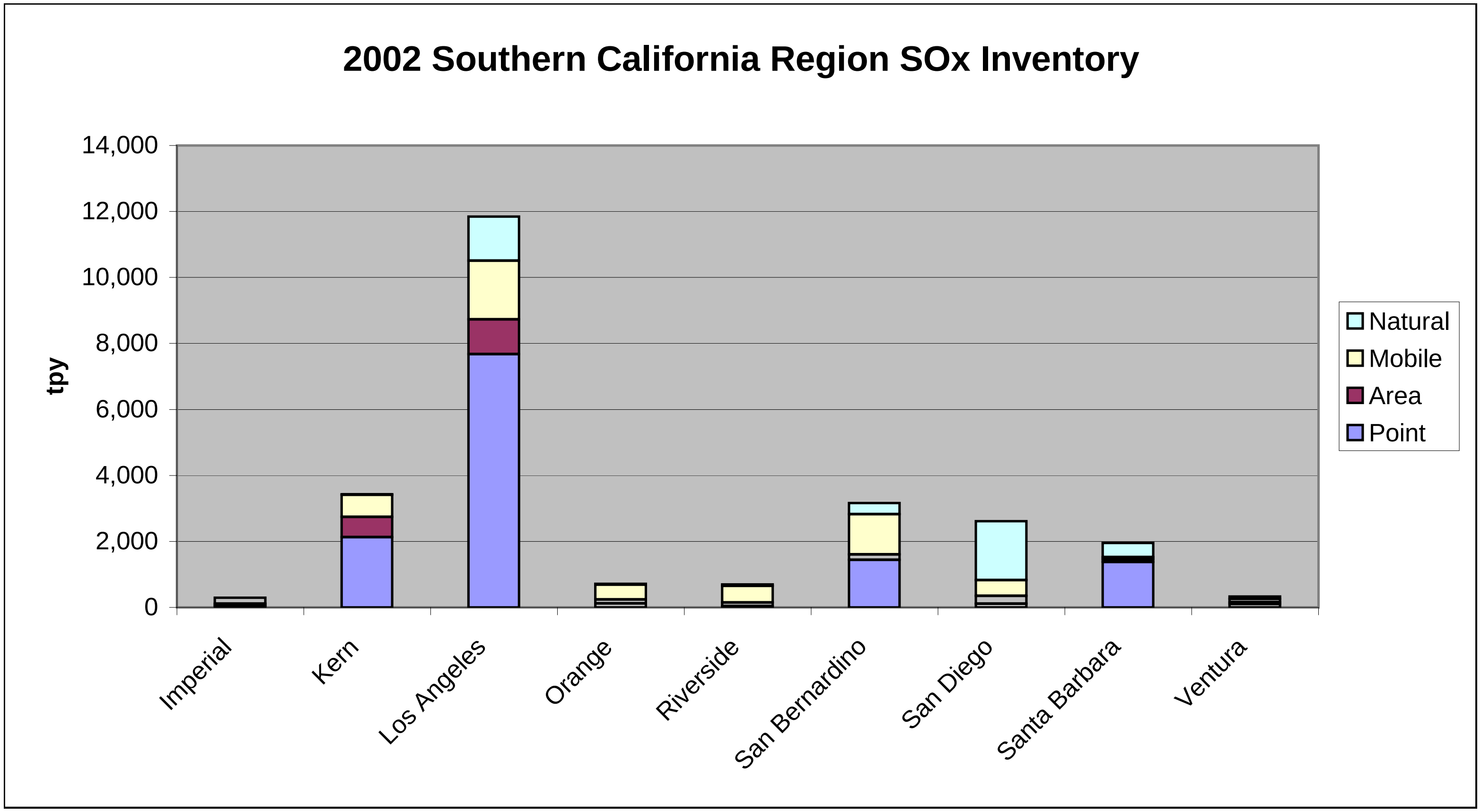
County	Alameda	Contra Costa	Del Norte	Fresno	Humboldt	Kern	Kings	Lake	Los Angeles	Madera	Marin	Mendocino	Merced	Monterey	Napa	Sacramento
Point	2826	7534	53	498	407	2278	232	110	14550	87	613	70	222	291	106	492
Area	10292	6563	590	13759	2886	9427	1942	1399	64048	2518	1637	1928	3566	6808	1075	9255
Mobile	20122	14546	513	13931	3012	14770	3149	3061	125470	3160	4886	2763	4524	7410	3357	17836
Natural	9638	35	15586	79780	57743	113538	13582	42593	74564	31562	4015	72519	21427	71864	17825	11301
Total	42878	28678	16743	107968	64049	140013	18906	47163	278632	37328	11151	77280	29739	86372	22363	38885

County	San Benito	San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara	Santa Cruz	Solano	Sonoma	Stanislaus	Trinity	Tulare	Ventura	Yolo
Point	87	511	624	309	736	1898	2120	20	1222	395	465	0	402	1121	291
Area	843	5309	6338	3806	4934	5313	11787	4512	3097	4212	5092	510	4989	8654	1966
Mobile	1011	9009	11668	5402	10513	7154	22789	4199	7967	9078	7558	949	7351	11686	3051
Natural	25885	601	20878	61902	3768	68488	26574	7227	11302	25951	23274	92653	90128	38847	17749
Total	27825	15431	39508	71419	19951	82854	63270	15958	23589	39636	36389	94112	102870	60308	23057



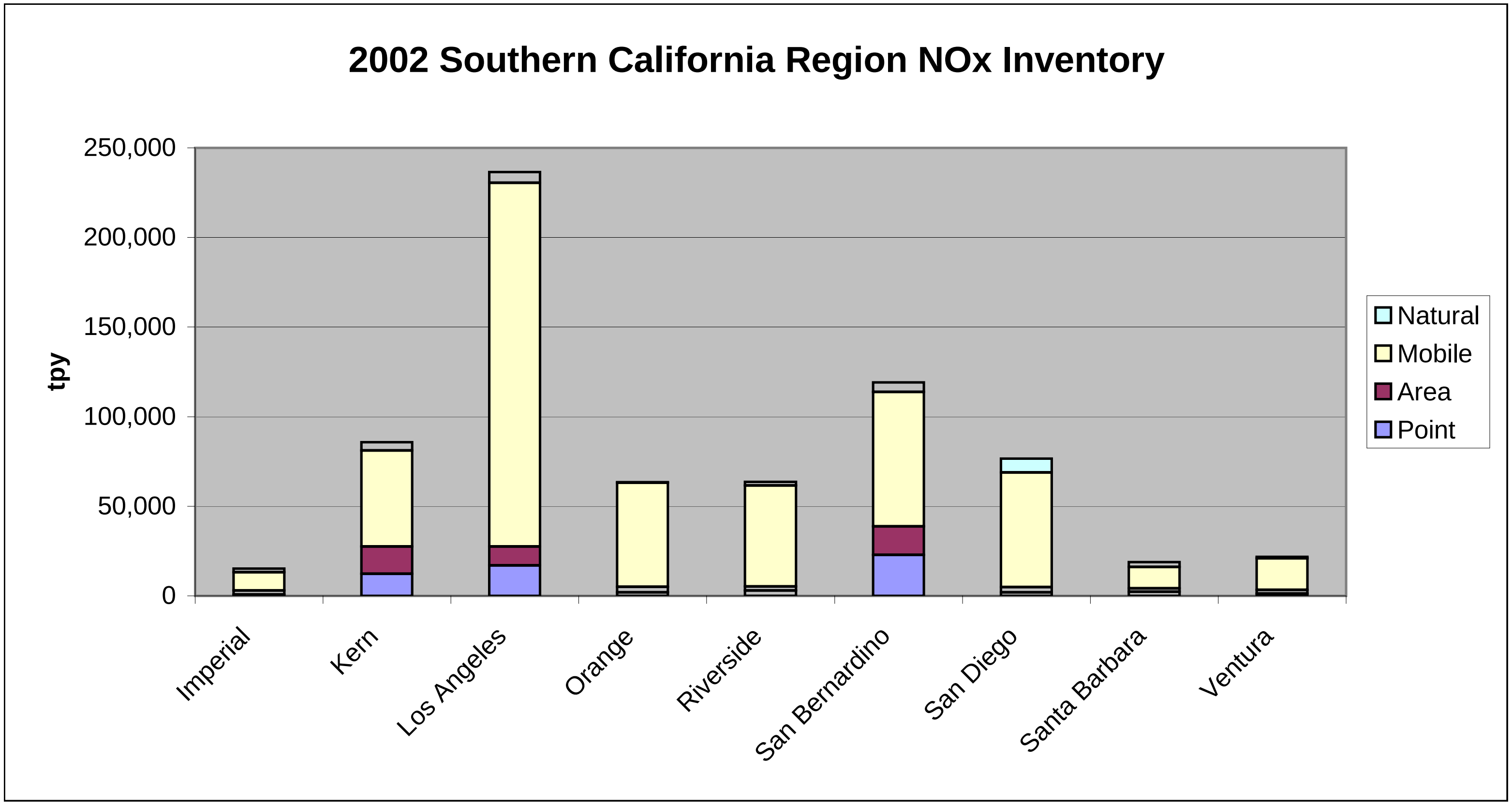
Sulfur Dioxide-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	44	2,126	7,674	123	34	1,437	107	1,373	100
Area	65	618	1,050	116	112	170	237	84	61
Mobile	189	663	1,779	448	508	1,215	484	67	92
Natural	0	20	1,344	27	43	344	1,781	432	76
Total	298	3,427	11,848	714	698	3,166	2,609	1,956	328



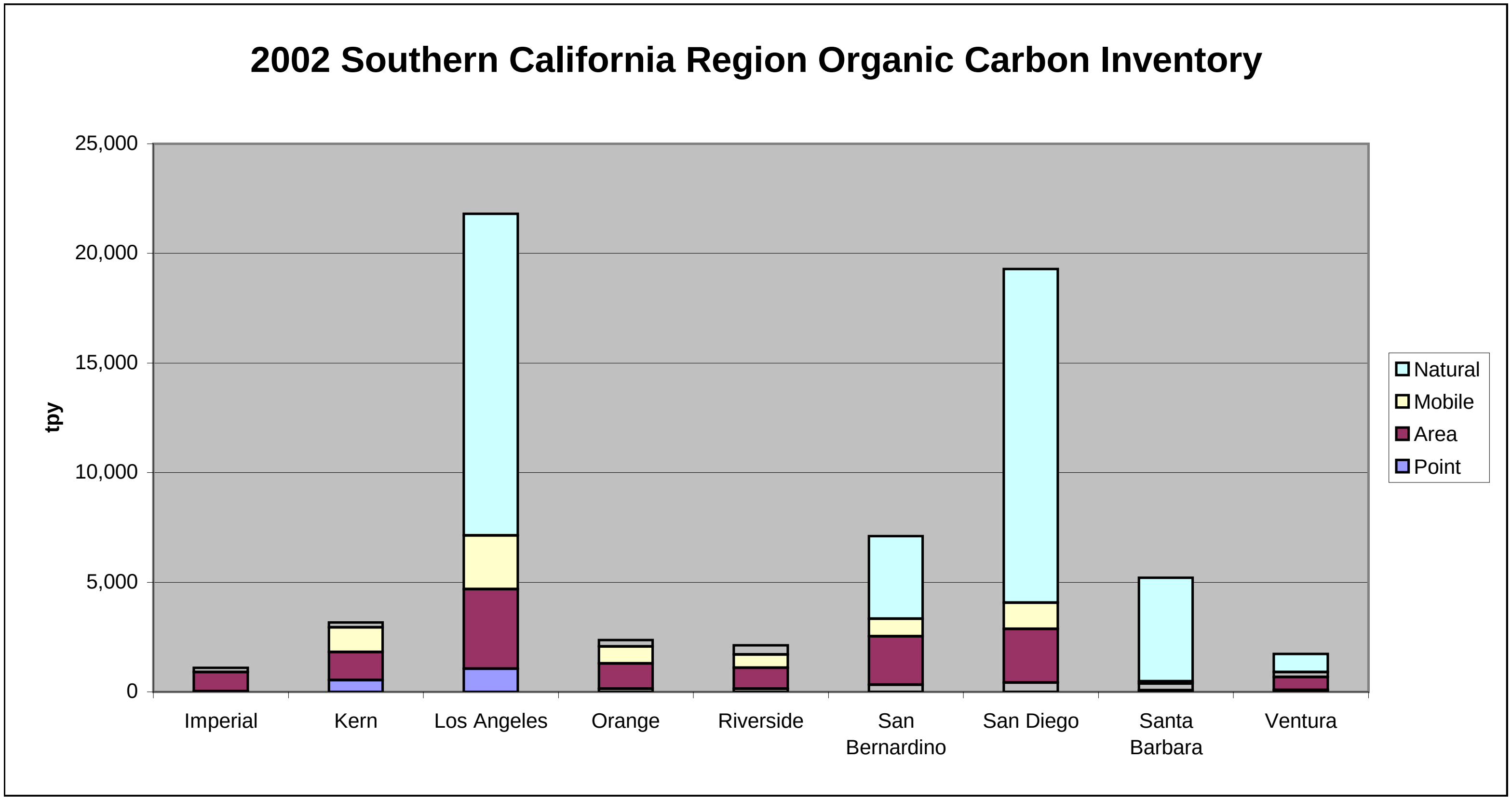
NOx-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	762	12,262	17,008	1,896	2,867	22,769	1,832	2,198	1,179
Area	2,128	15,161	10,521	3,192	2,364	15,971	3,094	1,904	2,081
Mobile	10,258	53,609	202,861	58,096	56,241	75,108	63,888	11,902	17,694
Natural	2,004	4,674	6,155	347	2,204	5,208	7,790	2,758	821
Total	15,152	85,705	236,545	63,532	63,676	119,055	76,604	18,762	21,776



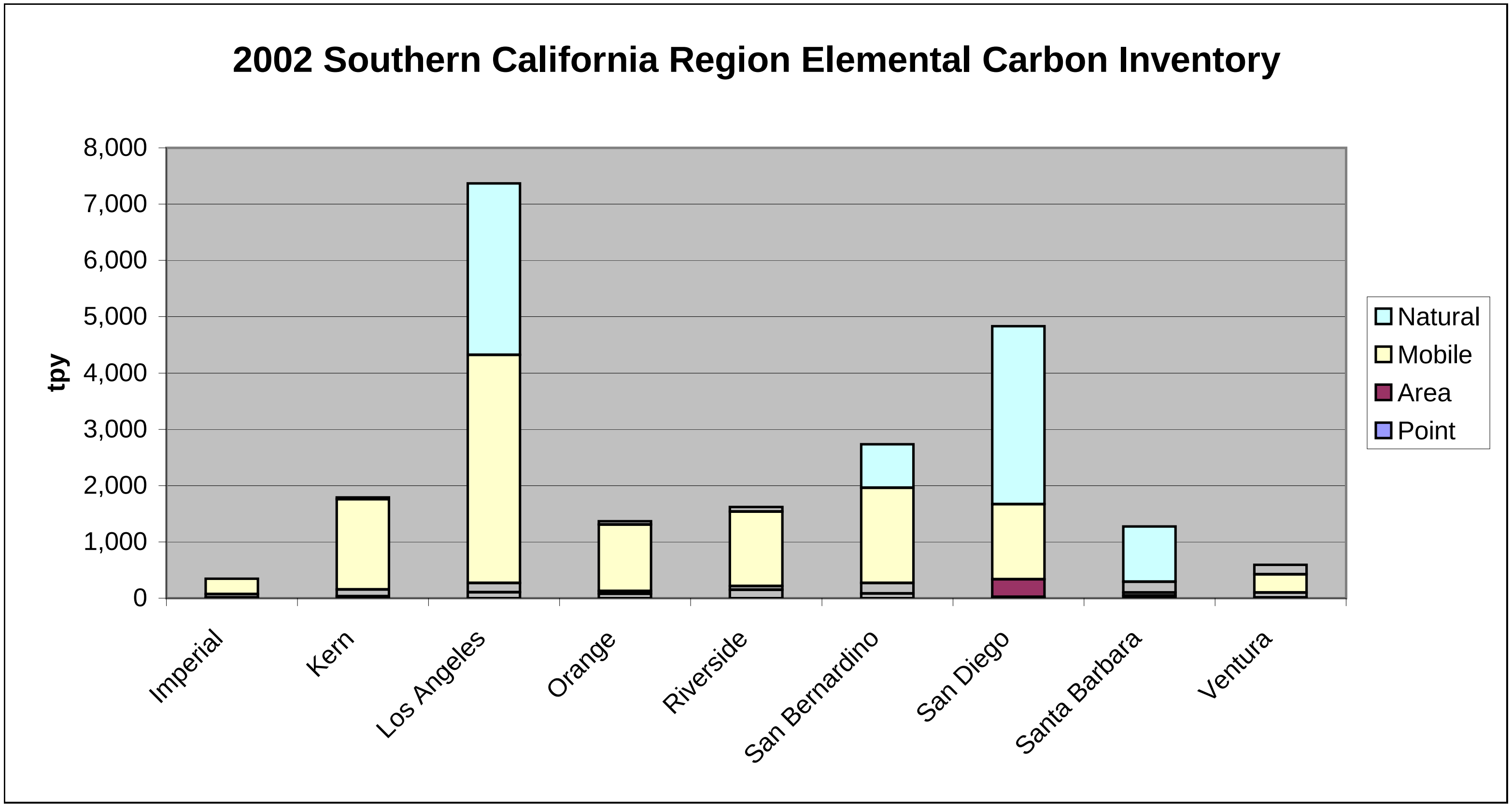
Organic Carbon-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	25	530	1,051	147	144	324	427	69	82
Area	880	1,280	3,637	1,141	948	2,206	2,436	314	588
Mobile	195	1,136	2,449	775	617	805	1,204	102	228
Natural	2	216	14,666	295	420	3,768	15,222	4,722	830
Total	1,102	3,162	21,803	2,359	2,129	7,104	19,289	5,206	1,727



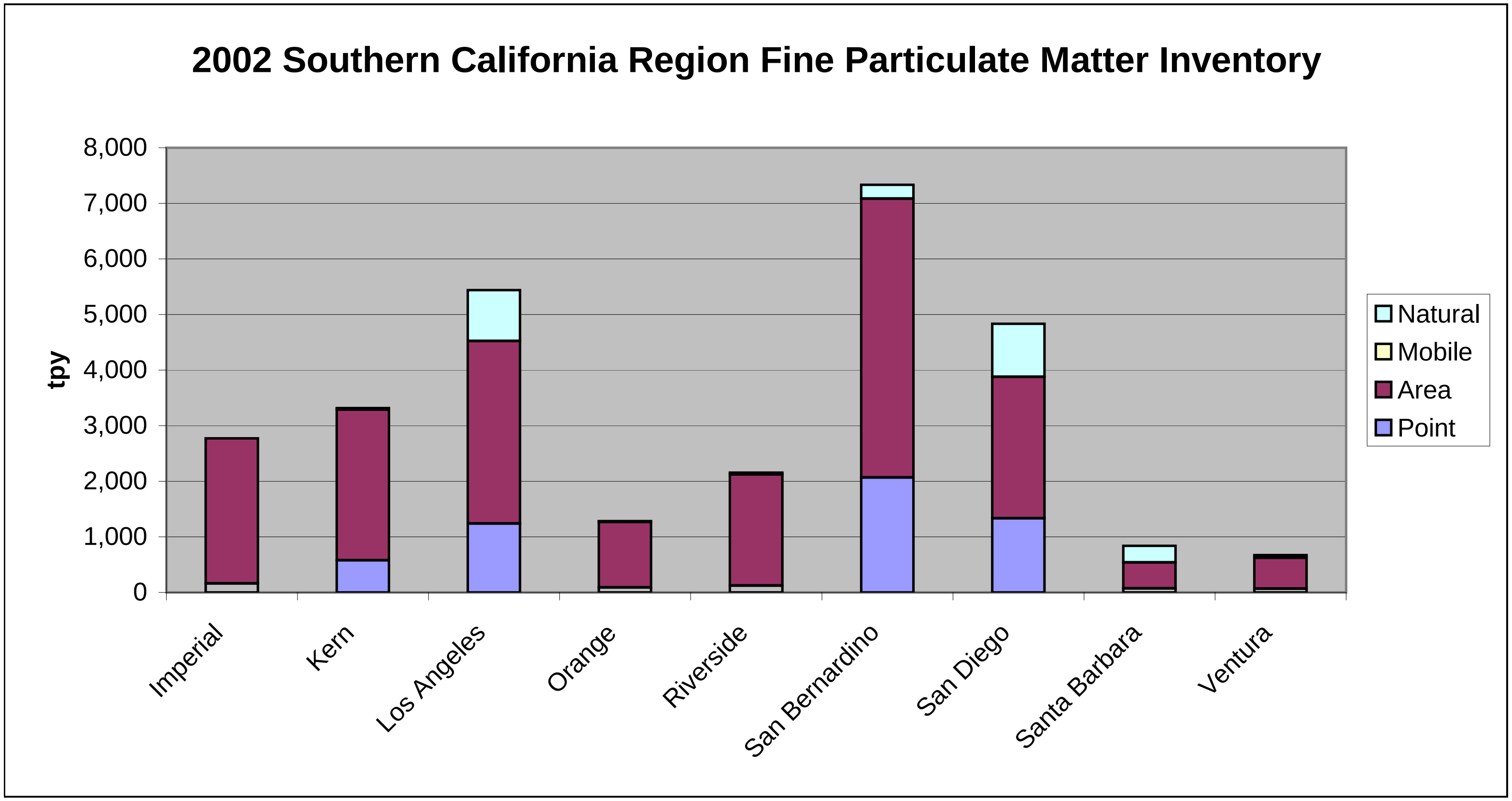
Elemental Carbon-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	13	30	104	77	148	85	19	42	13
Area	58	123	167	50	65	184	313	57	83
Mobile	275	1,601	4,053	1,179	1,325	1,689	1,339	194	327
Natural	0	37	3,045	61	85	777	3,160	980	171
Total	347	1,792	7,369	1,367	1,622	2,736	4,832	1,273	594



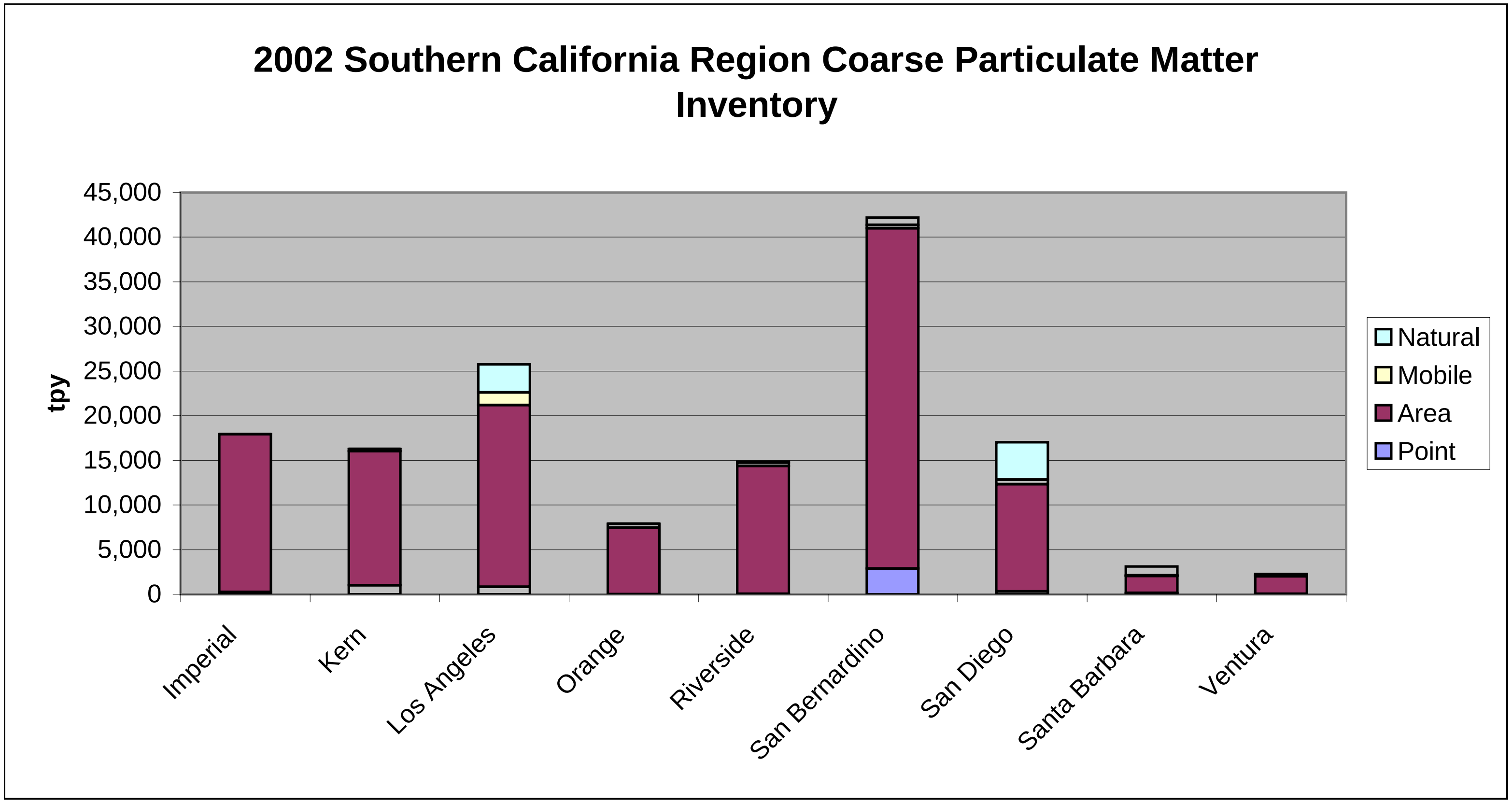
Fine Particulate Matter-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	162	577	1,238	91	122	2,068	1,336	71	66
Area	2,612	2,711	3,284	1,174	2,001	5,015	2,540	467	555
Mobile	0	0	0	0	0	0	0	0	0
Natural	0	31	920	19	32	248	956	298	54
Total	2,774	3,319	5,442	1,284	2,154	7,331	4,831	836	675



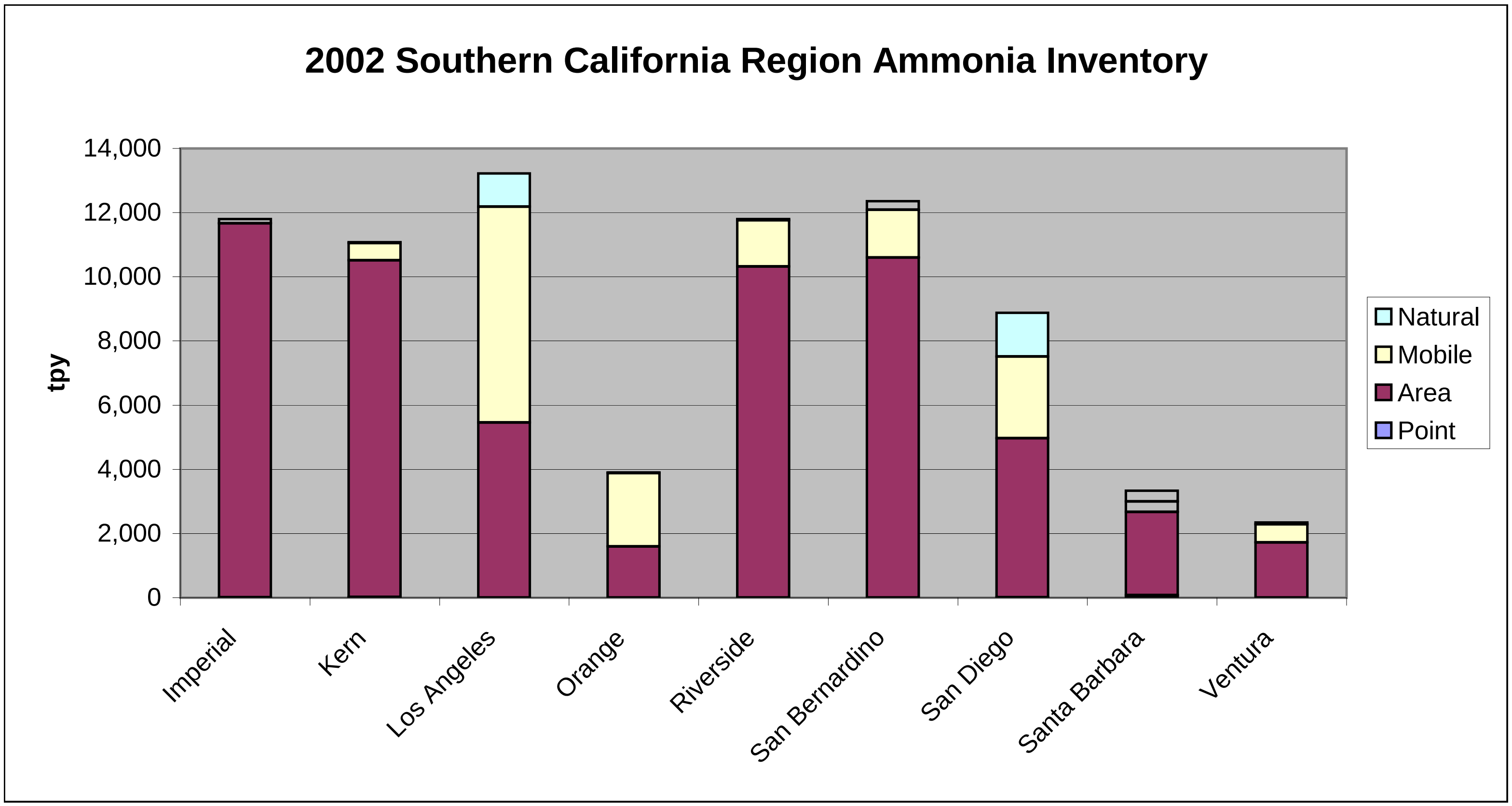
Coarse Particulate Matter-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	235	995	824	15	42	2,877	302	130	28
Area	17,684	15,027	20,367	7,431	14,312	38,094	12,020	1,919	1,966
Mobile	44	255	1,407	430	384	406	508	61	109
Natural	0	43	3,162	63	101	807	4,189	1,016	178
Total	17,963	16,321	25,759	7,939	14,839	42,184	17,020	3,126	2,280



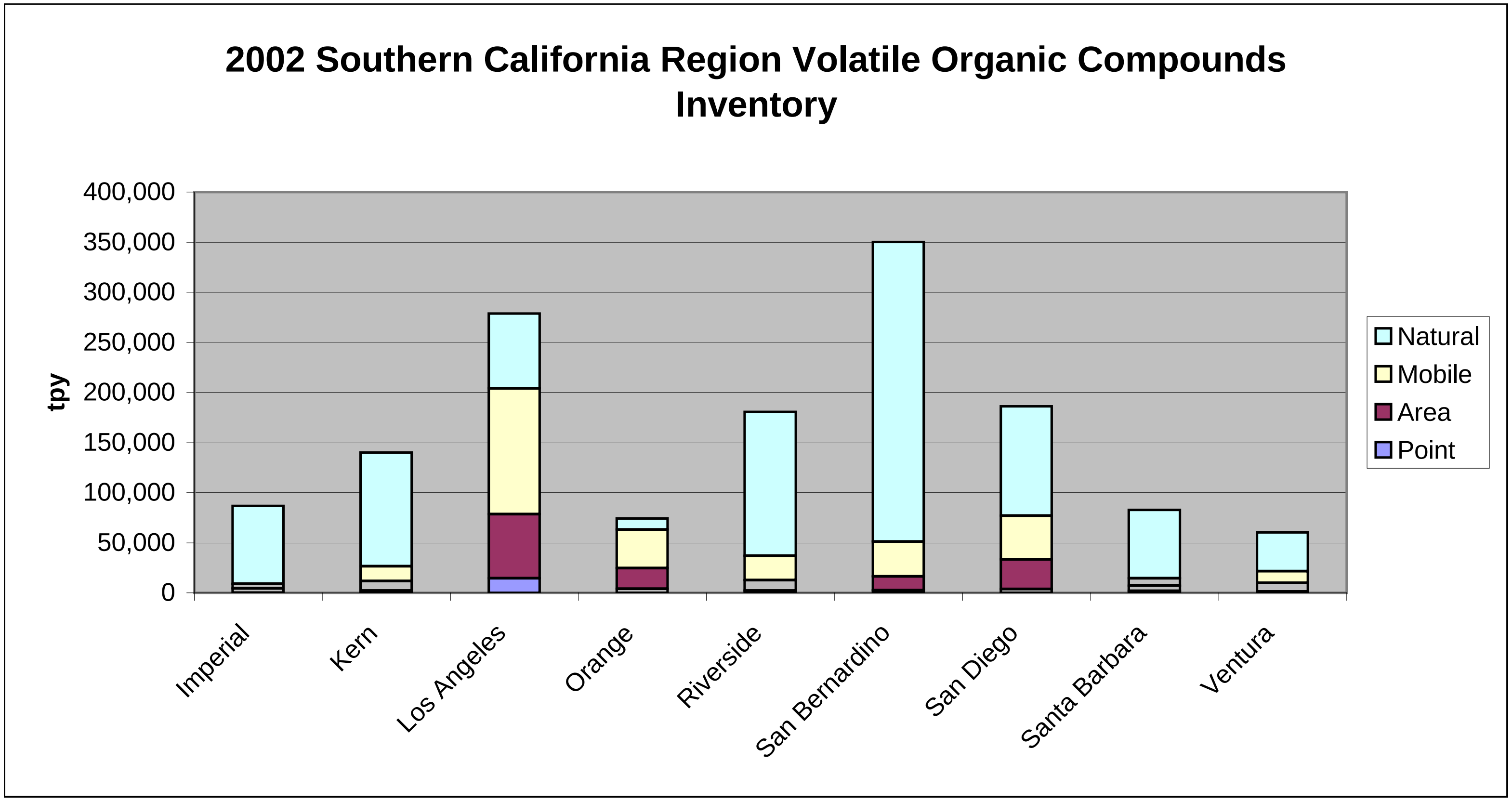
Ammonia-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	14	18	0	0	0	0	12	78	0
Area	11,652	10,492	5,456	1,599	10,319	10,602	4,952	2,592	1,718
Mobile	131	543	6,731	2,285	1,445	1,490	2,548	327	565
Natural	0	24	1,031	21	36	270	1,365	333	59
Total	11,797	11,077	13,218	3,905	11,800	12,361	8,877	3,330	2,343



Volatile Organic Compounds-Southern California Region

County	Imperial	Kern	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura
Point	117	2,278	14,550	3,846	2,261	2,469	3,605	1,898	1,121
Area	4,079	9,427	64,048	20,851	10,445	13,789	29,606	5,313	8,654
Mobile	4,629	14,770	125,470	38,336	24,071	34,807	43,752	7,154	11,686
Natural	78,052	113,538	74,564	11,267	143,762	299,007	109,095	68,488	38,847
Total	86,877	140,013	278,632	74,300	180,539	350,072	186,059	82,854	60,308



APPENDIX J

Regional Haze Plan Check List

CITATION	REQUIREMENT	LOCATION IN PLAN
Clean Air Act 110(a)(2)(D)(II)	SIP contains adequate provisions not to interfere with measure included in any other State to protect visibility.	Section 8.2
51.308(d)(1)	RPGs for each Class I area that provide for an improvement in visibility on worst days and no degradation in visibility for the best days.	Table 7.2
51.308(d)(1)(i)(A)	Consider the costs of compliance, time necessary for compliance, energy and non-air quality environmental impacts of compliance, and remaining useful life of affected sources, and demonstrate how these factors were taken into consideration in selecting the RPG.	Documented in Sections 4.6 and 4.7 of the 2018 Progress Strategy Chapter.
51.308(d)(1)(i)(B)	Analyze and determine the uniform rate of progress needed to attain natural conditions by 2064.	Documented in Section 7.3 and Appendix B.
51.308(d)(1)(i)(B)	In establishing the RPG for each Class I area, consider the emission reductions measure needed to achieve the uniform rate of progress.	Appendix B
51.308(d)(1)(ii)	If RPG is higher than uniform rate of progress, demonstrate based on the four factors that attaining natural conditions by 2064 is unreasonable and assess when the area would reach natural conditions based on the RPG.	Table 7.2
51.308(d)(1)(iv)	When developing the RPG, consult with other States which may reasonably be anticipated to cause or contribute to visibility impairment in the Class 1 Area.	Section 8.2
51.308(d)(2)	Determine baseline and natural visibility conditions for best and worst days at all Class 1 Areas. Determine the difference between baseline and natural visibility for best and worst days.	Table 2-1

CITATION	REQUIREMENT	LOCATION IN PLAN
51.308(d)(3)	Submit a long-term strategy that addresses visibility impairment for each Class I area, inside and outside the State, which may be affected by the State's emissions and include enforceable emissions limitations, compliance schedules, and other measures as necessary to achieve the RPGs.	Chapter 4
51.308(d)(3)(i)	Consult with other states regarding inter-state transport of emissions and their impact on Class I Areas in or out of state.	Section 8.2
51.308(d)(3)(ii)	Demonstrate that the long-term strategy includes all measures necessary to reduce its share of the emission reductions needed to meet the RPG for an out-of-state Class 1 Area.	Section 8.2
51.308(d)(3)(iii)	Document the technical basis, including modeling, monitoring and emissions information, on which it is relying to determine its apportionment of emission reduction obligations necessary for achieving reasonable progress in each Class I area it affects. The State may meet this requirement by relying on technical analysis developed by the regional planning organization.	Section 1.1
51.308(d)(3)(iii)	Identify the baseline emissions inventory on which its strategies are based.	Section 3.3
51.308(d)(3)(iv)	Identify all anthropogenic sources considered in developing the long-term strategy.	Appendix B
51.308(d)(3)(v)(A)	In developing the long-term strategy, consider emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment.	Chapter 4

CITATION	REQUIREMENT	LOCATION IN PLAN
51.308(d)(3)(v)(B)	In developing the long-term strategy, consider measures to mitigate construction activity impacts.	Section 4.5
51.308(d)(3)(v)(C)	In developing the long-term strategy, consider emission emissions limitations and schedules for compliance to achieve the RPG.	Chapter 4
51.308(d)(3)(v)(D)	In developing the long-term strategy, consider source retirement and replacement schedules.	Section 4.5
51.308(d)(3)(v)(E)	In developing the long-term strategy, consider smoke management techniques for agriculture and forest management purposes.	Section 4.5
51.308(d)(3)(v)(F)	In developing the long-term strategy, consider enforceability of emissions limitations and control measures.	Chapter 4
51.308(d)(3)(v)(G)	In developing the long-term strategy, consider the change in visibility due to changes in point, area, and mobile sources.	Chapter 4 and Appendix B
51.308(d)(4)	Submit a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment representative of all Class I areas within the State. The requirement can be met through participation in IMPROVE.	Section 9.2
51.308(d)(4)(i)	If needed, establish additional monitoring sites to assess whether RPGs are being achieved.	Section 9.2
51.308(d)(4)(ii)	Include procedures by which monitoring data and other information are used to determine the contribution of emissions from within the State to regional haze visibility impairment at Class I Areas both within and outside the State.	Section 9.2
51.308(d)(4)(iv)	Provide for reporting all visibility monitoring data annually to the Administrator.	Section 9.2

CITATION	REQUIREMENT	LOCATION IN PLAN
51.308(d)(4)(v)	Include baseline and future emission inventories for visibility impairment pollutants and a commitment to update the inventory periodically.	Chapter 3 and Sections 9.3 and 9.4
51.308(d)(4)(vi)	Include reporting, recordkeeping, and other measures, necessary to assess and report on visibility.	Section 9.2
51.308(e)	Include emission limitations representing BART and schedules for compliance with BART for each BART-eligible source that contributes to visibility impairment at a Class 1 Area.	Section 5.9 and Table 5-4
51.308(e)(1)	Include a list of all BART-eligible sources, BART determination for any source that contributes to visibility impairment, and documentation for these analyses.	Table 5-2 and Appendix D
51.308(e)(1)(iv)	Sources subject to BART must install and operate BART as expeditiously as practicable, but no later than 5 years after SIP approval.	Section 5.9
51.308(e)(1)(v)	Sources subject to BART must maintain the control equipment required and ensure it is properly operated and maintained.	Appendix D
51.308(i)(2)	Provide the FLMs with an opportunity for consultation at least 60 days prior to holding any public hearing.	Section 8.3
51.308(i)(3)	Describe how the FLM comments will be addressed.	Section 8.3
51.308(i)(4)	Provide procedures for continuing consultation between the State and the FLMs.	Section 8.4

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