

# **Review of the Washington State Visibility Protection State Implementation Plan**

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## **Final Report**

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Washington State Department of Ecology  
Air Quality Program

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## Executive Summary

Federal regulations and the Washington State Visibility Protection State Implementation Plan (Visibility SIP) require a formal assessment of the Visibility Protection Program to determine if the state has made reasonable progress toward the national visibility goal. This review presents Washington State's first Visibility SIP assessment. It is being made available to the public and the U.S. Environmental Protection Agency (USEPA) to meet the requirements of the federal Clean Air Act and the Visibility SIP.

The national visibility goal established by Congress in 1977 is the following:

*Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I Federal areas in which impairment results from man-made air pollution. (Section 169A(a)(1) of the federal Clean Air Act)*

Congress chose only to address the visibility in "mandatory Class I areas," which primarily are national parks and wilderness areas. Congress left it to individual states to decide if they wish to protect or improve visibility in other areas (such as the view of the Tacoma Narrows Bridge from Interstate 5 at the Nisqually Hill, views in the Columbia Gorge or views of Mt. Rainier from Seattle).

The federal strategy for visibility improvement called for a two-phased effort. Thus far, visibility program efforts nationwide have focused on large sources, referred to as Phase I sources, that have obvious negative impacts on visibility. Obvious impacts mean visual plumes extending from a large source to the area of visibility impairment.

Phase II, regional haze, is more complex. While scientific and technical limitations to understanding regional haze have long prevented the USEPA from proceeding with the development of a Phase II program to deal with regional haze, these have largely been overcome and the USEPA is in the process of developing regulations. Washington State looks forward to developing a regional haze program.

The Washington State Department of Ecology prepared the Visibility SIP in 1985. The SIP assessed visibility impairment, considered control and monitoring strategies, looked at the likelihood of achieving reasonable further progress, and set out long-term control strategies for protecting and improving visibility. Emphasis was directed toward management of smoke from silvicultural burning, mitigation of visibility impairing emissions from new sources coming into the state, and development of retrofit regulations (referred to as Best Available Retrofit Technology or BART) to address existing sources demonstrated to cause or contribute to visibility impairment in Class I areas. The plan was formally approved by the USEPA on May 4, 1987.



Both the Clean Air Act and the Visibility SIP itself required that the SIP be reviewed and, if necessary, revised on a regular schedule. While Ecology has thus far failed to keep that schedule, this first Visibility SIP review represents our effort to comply with requirements and reestablish a regular review schedule. The review is essentially a technical assessment of whether the current Visibility SIP has made reasonable progress and will continue to make reasonable progress toward the national goal. The review is the result of a team effort that included federal land management staff, state land management staff, and state air regulators.

Federal regulations require the review to assess seven specified areas. The findings and conclusions of the review with respect to these seven areas are as follows:

1. Reasonable progress toward the national goal has occurred because of smoke management efforts, review and control of new sources coming into the state, and emission reductions from other air quality programs.
2. The long term strategy to meet the national goal contained in the current Visibility SIP is adequate to prevent future impairment from Phase I sources, but inadequate to assure reasonable progress from regional haze impairment in mandatory Class I areas.
3. Visibility has become less impaired from Phase I sources but more impaired from regional haze. The overall result is only marginal improvement in visibility.
4. Revisions to the Visibility SIP are needed to assure reasonable progress on dealing with visibility impairment due to regional haze. Other needed revisions and updates to the Visibility SIP are identified in Section 9. In addition, Washington State looks forward to the development of federal regional haze regulations so it can begin developing its own regional haze program.
5. There has been no need up to this point to implement BART to address existing sources demonstrated to cause or contribute to visibility impairment in Class I areas.
6. No exemptions were granted to BART requirements under federal visibility protection regulations as BART determinations have not been required up to this point.
7. Federal land management agencies have not listed any integral vistas since plan approval. Consequently, BART has not been required to remedy existing impairment of any integral vista listed since plan approval.

# Introduction

## Purpose of the Review

Federal regulations and the Visibility Protection portion of Washington's State Implementation Plan (SIP) require a formal assessment of the Visibility Protection Program to determine if the state has made reasonable progress, and will continue to make reasonable progress towards the national visibility goal. The national visibility goal declared by Congress in 1977 is: "the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I federal areas in which impairment results from manmade pollution."

## Background

The Washington State Department of Ecology (Ecology) prepared a visibility SIP in March 1985 and the U.S. Environmental Protection Agency (USEPA) formally approved that plan on May 4, 1987. Federal law and the plan itself call for a formal review every three years from the date of adoption by the USEPA. This report is the product of Ecology's first review.

Federal strategy for visibility improvement called for a two phased effort. Phase I, which we are currently operating under, was designed to deal with visibility impairment in mandatory Class I areas resulting from stationary sources in the form of discernible plumes, called plume blight. Phase II will deal with impairment in mandatory Class I areas resulting from regional haze and urban plumes. At the time of the development of the current Visibility SIP there were many scientific and technical limitations to understanding regional haze and urban plumes. The USEPA forestalled development of Phase II until these limitations were overcome.

The scientific and technical limitations are largely overcome, and the USEPA, in consultation with state and other federal agencies, is currently addressing the development of regional haze regulations in concert with the effort to implement PM<sub>2.5</sub> regulations and revised ozone standards. Unfortunately, the time line for promulgation of regional haze regulations does not coincide with this Washington State Visibility SIP review and revision cycle. Draft regulations may be out by the time a revision resulting from this review is complete. This review has not had the benefit of specific guidance related to regional haze regulations. Ecology looks forward to the development of federal regional haze regulations, so that it can proceed with developing its own regional haze SIP.

Control strategies in the current Phase I Visibility SIP focus on three areas. Improved management of smoke plumes from prescribed burning of forest slash was the primary means to improve visibility in Washington State. Visibility requirements were added to the New Source Review (NSR) program as a means of mitigating the impact of visibility impairing emissions from new or modified major stationary sources. Although at the time of the original Visibility SIP no existing stationary sources had been identified as impairing visibility in any mandatory Class I area of the state, Ecology developed a regulation which governs the process for determining retrofit

requirements (Best Available Retrofit Technology or "BART") that can be applied to an existing stationary source to which significant visibility impairment in a mandatory Class I area is reasonably attributed.

Reasonable progress towards the national goal has resulted from improved smoke management and other state and local programs aimed at meeting the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants. Future impairments have been prevented in many cases through the NSR process. To date, no formal BART process has been conducted, although recent negotiations between the Centralia Power Plant and federal, state and local resource agencies have yielded a proposed solution to reduce emissions from the Centralia Power Plant which might otherwise have been a candidate for BART. This report describes how these programs have resulted in reasonable progress and discusses whether additional efforts (new or modified programs) will be required to continue to make reasonable progress.

## Scope and Process

For purposes of clarity, we are keeping the SIP review and the SIP revision processes separate. The first part, the SIP review, is essentially a technical assessment of whether the current Visibility SIP has made reasonable progress and will continue to make reasonable progress towards the national goal. This report describes that assessment and documents its conclusions. The second part concerns itself with actual revisions to the Visibility SIP if it is determined by the review that reasonable progress cannot be made through the current Visibility SIP and other ongoing air quality programs. Although the Visibility SIP review has documented many ways that have resulted in progress and will continue to result in progress, there are several ways the current Phase I Visibility SIP could be revised. Section 9 of this review report gives recommendations for revising the Visibility SIP. A work plan for developing and adopting these revisions will be completed later this year.

Much of the progress made under the current Phase I Visibility SIP may be overcome by impairment resulting from regional haze. Because of this Ecology looks forward to the development of federal regional haze programs, and is willing to work with the USEPA and the Federal Land Managers (The National Park Service and the U.S. Forest Service) in the development of a program which addresses regional haze in Washington State's mandatory Class I areas.

This review report is a result of formal consultation with state and federal land managers over the last eight months. The review team consisted of several staff from Ecology's Air Quality program and staff from the National Park Service, the U.S. Forest Service, and the Washington State Department of Natural Resources. Although the USEPA declined to formally serve on the review team, (doing so might be viewed as being in conflict with its role as final report reviewers) USEPA staff were made available to attend review team meetings and act as a resource for the review team. **Although these agencies were consulted in this process and contributed greatly to the effort, the views, opinions and conclusions contained within this review are solely those of the Washington State Department of Ecology, unless otherwise noted.**

## **1.0 Consultation with Federal Land Managers Regarding Impairment in Mandatory Class I Areas and Integral Vistas, and the Need to Provide Additional Protection to Visually Important Class II Areas**

Much has happened in terms of air quality since the Federal Land Managers (FLM) made their initial determinations of visibility impairment in 1979. As part of this SIP review process Ecology asked the FLM to review visibility impairment in all mandatory Class I areas and associated integral vistas to determine if impairment still existed and if they felt that the sources suspected as responsible for this impairment had changed since their initial determinations.

The original Visibility SIP lists several integral vistas which were proposed by the National Park Service (NPS). This list of vistas was never formally finalized by the NPS, but was adopted into the Visibility SIP by the state, (see discussion in Section 1.2). The U.S. Forest Service (USFS) did not identify any integral vistas at the time of the original Visibility SIP. As part of this SIP review process Ecology asked the FLM to comment on the need to provide visibility protection to these proposed integral vistas and if there are any additional vistas which the FLM would like to propose for adoption into the Visibility SIP.

In addition, several new wilderness, scenic and recreational areas have been created since the original list of mandatory Class I areas was promulgated. These areas are currently designated as Class II and do not directly receive the same level of visibility protection as mandatory Class I areas. As part of this SIP review process Ecology asked the FLM to assess these areas to determine their visual importance and the need for additional visibility protection. This assessment also included visually important Class II areas in adjacent states that may be impacted by activities in Washington State.

Ecology's letter requesting information from the FLM on the above issues can be found in Appendix A. The full text of the response letters from both FLM (National Park Service and U.S. Forest Service) can also be found in Appendix A.

**1.1 Impairment in Mandatory Class I Areas** - Below is a discussion of each FLM response and issues related to the question of visibility impairment.

National Park Service - The NPS stated, by reference to earlier letters to the USEPA and Ecology, that it considers all three mandatory Class I areas under its jurisdiction (Mt. Rainier NP, Olympic NP and North Cascades NP) and all Class II areas to be experiencing some level of visibility impairment from "uniform haze." The specific source and source categories identified as responsible for a portion of this impairment are the Centralia Power Plant, pulp and paper mills or lime kiln activities, other coal fired power plants, urban transportation and vegetative burning. These sources are identified as all being located in western Washington and Canada.

Through the data collected during the Pacific Northwest Regional Visibility Experiment Using Natural Tracers (PREVENT)<sup>1</sup> study, the NPS believes that visibility impairment in Mt. Rainier National Park and other mandatory Class I areas can be reasonably attributed to the Centralia Power Plant. It further concluded that it may be possible to attribute a portion of the haze to other nearby source areas or source types through the use of existing visibility studies and monitoring data. Ecology believes that these assertions are qualified given their use of terms such as "data suggest" and "may be possible." Ecology attempted to determine if any portion of the impairment could be reasonably attributed to these other suspected sources. At this time Ecology finds that impairment cannot be reasonably attributed to these other sources. Our findings are discussed as Section 6 of this report.

The NPS recognized that improvements to visibility have occurred due to restrictions on summertime vegetative burning, but it continues to be concerned about the effect of other contributing sources and the long term preservation of good visibility and the need for improvements at all times of the year.

It is Ecology's conclusion that some of the other contributing sources, such as mobile sources, are not required to be addressed under Phase I of visibility protection regulations and are therefore not a subject of any revision resulting from this review. Ecology anticipates that these sources will be addressed under forthcoming regional haze programs (Phase II visibility protection regulations).

Ecology considers that seasonal visibility protection (late spring through early fall) is an appropriate concept given Class I area visitation patterns and meteorology of the remaining time of the year. The Washington State Department of Natural Resources (WDNR), in consultation with Ecology, has already expanded the definition of the visibility protection period in its Smoke Management Plan, specifically to get better coverage of high visitation and fair weather days. With this expansion the visibility protection period curtails prescribed burning on weekends and Fridays from June 15 to September 30. Ecology agrees that further expansion of the protection period beyond the current protection period could be the subject of a future review and revision to the Visibility SIP if it is determined that no more reasonable progress can be made without another expansion to the protection period. It will not, however, be addressed at this review and revision cycle.

Ecology also believes that the concept of a visibility protection period may be appropriate for impairment resulting from other emission sources, not just emissions from prescribed burning. Priority should be given to developing control strategies that optimize the protection during this period over protection during other times of the year. It makes little sense to burden emission sources that are emitting predominately outside of this period. If an emission source is able to shift its emissions outside this period, much like that done with prescribed burning, then such efforts should be viewed as viable alternatives in mitigating the impact of emissions on visibility

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<sup>1</sup> Malm et al, "Pacific Northwest Visibility Experiment Using Natural Tracers (PREVENT), Final Report," February 1994.

and should be considered as making reasonable progress towards the visibility goal. Ecology believes this concept should be further developed and formally adopted into the Visibility SIP as a management goal.

U.S. Forest Service - At the time of the development of the original Visibility SIP the USFS did not identify any impairment in its five mandatory Class I wilderness areas. In its most recent letter the USFS stated that the data they reviewed suggest that visibility has improved since 1983 during the visibility protection period, primarily due to reductions in emissions from prescribed burning. Credit for this was given to the reduction of the use of fire west of the Cascades and the Smoke Management Plan curtailment of prescribed fire on Friday, Saturday and Sunday during the visibility protection period.

The USFS claims that its monitoring data suggest that visibility impairment from regional haze, rather than plume blight, still exists in all five mandatory Class I wilderness areas under its jurisdiction (Pasayten, Glacier Peak, Alpine Lakes, Mt. Adams and Goat Rocks wilderness areas). The USFS concluded that more extensive monitoring will be required to make this statement with absolute certainty.

Ecology agrees that regional haze and sources contributing to regional haze are an increasingly significant portion of the visibility problem. Again, regional haze and some source types which contribute to regional haze are not being addressed in this review and revision cycle, but will be the subject of upcoming regional haze programs.

**1.2 Integral Vistas** - Below is a discussion of each FLM response and other issues related to the question on integral vista protection and proposed additional integral vistas.

National Park Service - The list of integral vistas proposed by the NPS and listed in the current Visibility SIP as proposed integral vistas was never finalized or formally adopted by the NPS. The Secretary of the Department of Interior issued a decision in October of 1985 not to finalize the proposed list, (see attachment to NPS letter in Appendix A). The Secretary explained that formal publication of a list was unnecessary since the Clean Air Act already authorized Park Superintendents to work with states and private interests to resolve air quality issues related to the parks. The NPS most recent letter urges the State to develop processes to consider existing and potential impacts on the scenic resources of the national park system and protect them to the fullest extent possible. The NPS did not propose any additional integral vistas.

Washington's current Visibility SIP declares that until the NPS finalizes the list of integral vistas, the vistas in the proposed list will be provided protection consistent with visibility protection regulations. There was some discussion within the SIP review team that because the list was never finalized by the NPS, then formal protection of the vistas is not required.

Ecology has determined that continuing to protect the vistas in the proposed list (those listed in the current Visibility SIP) is consistent with the intent of the visibility protection regulations and the reasons given by the Department of Interior not to finalize the list. Ecology will continue to

provide protection to these vistas as it has since adoption of the current Visibility SIP. Ecology believes the current language in the Visibility SIP provides sufficient authority to provide protection to these vistas.

U.S. Forest Service - The USFS did not propose any integral vistas to be included in the original Visibility SIP and the Department of Agriculture later declined to officially list any integral vistas quoting reasons similar to those of the Department of Interior discussed above. Thus, the naming of integral vistas associated with the USFS mandatory Class I areas and incorporation into the Visibility SIP was left up to the state. Washington State did not identify any other integral vistas at that time. Thus, no official integral vistas are associated with any of the five USFS mandatory Class I area wilderness.

In its most recent letter, the USFS has proposed two new integral vistas and have requested they be considered for adoption into the Visibility SIP. These are Heliotrope Ridge, associated with Mt. Baker Wilderness area, and Portal Peak, associated with Glacier Peak Wilderness area. Adoption of these vistas into the Visibility SIP will be considered during the revision phase. Prior to formal adoption into the Visibility SIP, Ecology will request the USFS to provide verification that these vistas were identified in accordance with the selection criteria discussed in Appendix C of the current Visibility SIP.

Ecology notes that the proposed Heliotrope Ridge integral vista is associated with a non-Class I area (Mt. Baker Wilderness). Upon inquiry by Ecology, the USEPA has stated that current regulations allow for the adoption of vistas associated with non-Class I areas. The level of protection provided to a non-Class I area integral vista is at the discretion of the state and may be more stringent than what is required by federal regulation. Ecology believes providing protection to integral vistas should be uniform for all vistas to be consistent with the intent of the integral vista concept. However, it does seem inconsistent to provide a lesser degree of protection to the wilderness area with which the proposed integral vista is associated. During the revision phase, Ecology will further address this issue.

**1.3 Visually Important Class II Areas** - Below is a discussion of the FLM response and other issues related to the question of providing additional visibility protection to visually important Class II areas.

National Park Service - With regard to the protection of visibility in non-Class I areas under its jurisdiction the NPS stated that it will continue to comment on a case by case basis, rather than ask for additional programs or redesignation to Class I of any visually important Class II national park lands. For example, it is concerned about the possible impact to Coulee Dam National Recreation Area from a nearby proposed project and have stated its concerns as part of the Environmental Impact Statement process for that project. This is similar to its reasoning for not finalizing the list of integral vistas, intending rather to depend on other regulatory authority and processes for visibility protection in non-Class I areas and vistas. No specific requests for non-Class I area visibility protection were made. No visually important non-Class I areas in adjacent states were identified as being impacted by activities in Washington State.

U.S. Forest Service - The USFS concluded that most non-Class I wilderness areas receive a certain degree of protection from impairment caused by regional haze due to these areas proximity to existing mandatory Class I areas. Three exceptions were noted and the USFS has asked to work with Ecology to provide an extra degree of visibility protection for the Mt. Baker Wilderness area, the Mt. St. Helens National Volcanic Monument and the Columbia River Gorge National Scenic Area. These areas are currently designated as Class II. In the letter the USFS did not specifically state whether redesignation to Class I was its preferred option for addressing additional visibility protection. Options for providing additional protection to these areas, including redesignation to Class I, will be explored. A team of staff from the USFS, Ecology and the USEPA will be formed for this purpose.

The Columbia River Gorge National Scenic Area (CRGNSA) was specifically mentioned by the USFS as experiencing visibility impairment. Air quality monitoring is presently being conducted at two sites in the CRGNSA. The intent is to collect data for a period of time, analyze the data to ascertain the level of visibility impairment, and identify sources responsible for contributing to visibility impairment. This is a joint effort of Ecology, the USFS and the Oregon State Department of Environmental Quality. The data collection phase of this study is expected to be complete after the fall of 1997. Source attribution analysis will follow that phase, but no time line for this work has been agreed upon. Funding for the source attribution phase has not been granted, and remains a barrier to successful completion of this study.



## 2.0 Assessment and Documentation of Reasonable Progress

Assessment and documentation of reasonable progress can best be made through two avenues: the review and analysis of mandatory Class I area visibility monitoring data; and the review and analysis of visibility impairing pollutant emission data.

**2.1 Review of Monitoring Data** - Mandatory Class I area visibility data exist in various formats and locations. For this review, data representative of mandatory Class I areas were used. Ecology currently collects nephelometric data at five sites in western Washington in or near mandatory Class I areas. Other Ecology nephelometric sites have been discontinued but data from these sites were available for this review.

The FLM operate a network of IMPROVE (Interagency Monitoring of PROtected Visual Environments) sites which collect nephelometric, particulate and meteorologic data. Four IMPROVE sites are currently in operation, two near mandatory Class I areas and two in the Columbia River Gorge National Scenic Area (CRGNSA). For this review, data from the two mandatory Class I area IMPROVE sites and one of the CRGNSA IMPROVE sites were evaluated. The second IMPROVE site in the CRGNSA was established in October of 1996 and no validated data is yet available for review.

The specific objectives of reviewing this mandatory Class I area monitoring data were to answer the questions: "Can any changes and/or trends in mandatory Class I area visibility be identified through the monitoring data?" and "Do the trends indicate that we are making reasonable progress towards the visibility goal?" In addition to providing answers to these questions, the data has also given us other insights into the nature of visibility in western Washington mandatory Class I areas.

In addition, three local air pollution agencies have begun monitoring visibility in urban areas of western Washington (Bellingham, Seattle and Olympia). Data from these sites was not reviewed for this report for two reasons. First, the period of record for this data is too short and second, the data does not specifically apply to mandatory Class I areas. However, this data is part of an in-progress initiative to increase our understanding of the character of regional haze and visibility in western Washington, including urban visibility.

A grant was provided to Ecology from the USEPA to conduct the review and analysis of the mandatory Class I area data. The SIP Review team decided to contract out this work and a contractor was hired to review and analyze the monitoring data with the specific objectives discussed above and to also complete the following tasks:

- ◆ Make an assessment of the adequacy of the current monitoring network's ability to track progress towards visibility improvement. If appropriate, develop recommendations for enhancing the monitoring network. This is discussed in Section 3.
- ◆ Make a comparison of visibility monitoring data trends with emission data trends and suggest reasons for any inconsistencies.

In addition to analysis of nephelometric visibility the contractor was asked to analyze the IMPROVE aerosol chemistry data in order to complete the following task:

- ◆ Analyze the IMPROVE data and chemistry to develop mass and light extinction budgets of pollutant species that affect visibility in mandatory Class I areas of Washington State.

Information resulting from the completion of this task was not necessary to ascertain trends in visibility impairments in mandatory Class I areas. This data will be a useful tool in identifying other source categories that might be contributing to visibility impairment. Eventually this information will serve as part of the technical foundation for decisions regarding what other programs or control strategies, if any, are needed to continue to make reasonable progress towards the national visibility goal. In addition, this information will be useful in the development of regional haze programs (Phase II visibility protection programs).

The full text of the contractor report on nephelometric visibility can be found in Appendix B. Sections 2.1.1 and 2.1.2 summarize the findings of this report.

**2.1.1 Nephelometric Visibility Monitoring Data** - A review of nephelometric measurements of light scattering by aerosol particles at ten remote sites in Washington State was conducted by Dr. Halstead Harrison of the Department of Atmospheric Science at the University of Washington in Seattle. The sites are (see map in Section 3):

- ◆ Columbia River Gorge - near Wishram, IMPROVE.
- ◆ Tahoma Woods - near Ashford, IMPROVE.
- ◆ Snoqualmie-Mt. Baker - at Snoqualmie Pass, IMPROVE.
- ◆ Olympic Camp - near Carbon River entrance to Mt. Rainier NP, Ecology, (discontinued).
- ◆ Carbon River Ranch - near Carbon River entrance to Mt. Rainier NP, Ecology, (replaces Olympic Camp).
- ◆ Paradise - at Paradise Visitor Center, Mt. Rainier NP, Ecology.
- ◆ Newhalem - near Newhalem, Ecology, (discontinued).
- ◆ Marblemount - at Marblemount, Ecology, (replaces Newhalem).
- ◆ Hurricane Ridge - at Hurricane Ridge Lodge, Olympic NP, Ecology.
- ◆ South Mountain - near Shelton, Ecology.

A brief summary of Harrison's findings follows:

- ◆ Local variances minimize in summer, during afternoon hours, when the intercomparability between data from several sites and the two networks is greatest.

- ◆ With data selected for these low-variance times, the maximum Deciview indices at South Mountain declined significantly between 1985 and 1989 and less dramatically over the entire period, likely from reduced fires, (Figure 7b in Appendix B).
- ◆ No significant trends in the percentile measurements of summertime, afternoon, nephelometric visibility could be detected among the ten sites. Figure 7a - 7d of Appendix B shows percentile trends at four long-term Ecology nephelometer sites. Note that the appearance of a trend at the Carbon River sites (Figure 7d) is due to moving the site after it was discovered that significant local activity was causing adverse effects that were not representative of the regional air mass.
- ◆ The lack of a significant trend in nephelometric visibility is consistent with the overall trend in emissions of all western Washington visibility impairing pollutants combined, (see Section 2.2.3 for further discussion).
- ◆ About 36 percent of the nephelometric data variance at all sites can be attributed to coincident "regional haze," with Newhalem and Snoqualmie-Mt. Baker (Snoqualmie Pass) being untypical of the network.
- ◆ Dramatic qualitative differences are seen in the high-end statistics of data from the two nephelometer types used by the Ecology and IMPROVE networks. Ecology uses heated nephelometers while the IMPROVE network employs ambient nephelometers. Ambient nephelometers are sensitive to the effects of relative humidity on hygroscopic aerosols. *(Note: Problems with ambient nephelometers overestimating scattering have been noted by IMPROVE staff.)*

**2.1.2 IMPROVE Aerosol Chemistry** - A summary of Harrison's analysis of pollutant species contribution to fine mass and light extinction is presented below. The complete text of his findings and accompanying graphs is presented in Appendix B.

### **Fine Mass Budgets**

The pollutant species contribution to fine mass (PM<sub>2.5</sub>) at three IMPROVE sites (Columbia River Gorge, Mt. Rainier and Snoqualmie Pass) is presented in Figures 12a -12c of Appendix B. Organic carbon is the largest contributor at all three sites, accounting for 40 percent to 48 percent of the fine mass at these sites. Sulfate is the next largest contributor, accounting for 17 percent to 19 percent of the fine mass at the three sites. Light absorbing carbon (elemental carbon) is the third largest contributor at Mt. Rainier and Snoqualmie Pass, (11 percent of the fine mass), while nitrates are the third largest contributor at Columbia River Gorge (13 percent of fine mass).

### **Light Extinction Budgets**

Harrison presents the light extinction budgets using two different methods of calculation. Previous methodology developed for use in other parts of the country have ascribed a higher scattering efficiency to sulfates during periods of high relative humidity due to their hygroscopicity. This "standard method" assumes that the sulfate is almost completely in the form of ammonium sulfate, which is highly hygroscopic, compared to some of its brethren sulfates like ammonium bisulfate or sulfuric acid which are far less hygroscopic. The result of this is that the relative contribution to light extinction from sulfates usually more than doubles

that of its contribution to fine mass. Harrison presents the average light extinction budget using this methodology as Figure 11b of Appendix B. Note that using this method sulfates contribute 54.5 percent of the light extinction, followed by nitrates, rayleigh scattering, organic carbon, soil and extinction due to absorption.

Harrison developed his own method for calculating light extinction, which may more accurately describe what occurs in Washington State. Harrison's method assumes that the dominant form of sulfate is the less hygroscopic species of ammonium bisulfate and/or sulfuric acid. Figure 11a of Appendix B presents the light extinction budget calculated using Harrison's method. Note that organic carbon dominates the budget (29 percent), while sulfates account for 24 percent, less than half the contribution from sulfates calculated using the standard method.

Harrison further broke down the data into subsets of dirty days and clean days, (Table X in Appendix B). Although his method reduces the calculated contribution of sulfates to the average day from that of the "standard method," we note that on dirty days the sulfate component is dominant relative to other pollutant species. On dirty days sulfates account for 21 percent while organic carbon only accounts for four percent of the light extinction, (down from 29 percent organic carbon contribution to the average of all days).

More work to resolve the differences between the two methods should be done. The differences in the relative contribution of pollutant species is critical. Decisions about control strategy priorities often depend on the relative contribution of pollutant species and the source categories that emit these pollutants. If we were protecting the average day, Harrison's method would lead us to give roughly equal attention to sources of organic carbon and sulfate. The "standard method" would lead us to focus mostly on sources of sulfate, to protect the average day. If our priority were to reduce the number of dirty days, then our focus would be on sources of sulfate because it dominates the light extinction budget on dirty days, even when calculated using Harrison's method.

**2.1.3 Reasonable Progress Milestones** - To date, no quantifiable definition of what constitutes reasonable progress exists. Unlike the NAAQS, federal visibility regulations did not set an ambient pollutant standard for visibility. The forthcoming regional haze rule may include criteria for defining reasonable progress and methods for measuring reasonable progress. In the interim, Ecology has attempted to make an assessment of reasonable progress in the absence of federal guidance, through the examination of both monitoring and emission data as discussed in Sections 2.1.1 and 2.2.2 - 2.2.4. Below is a discussion of another possible quantifiable measure of reasonable progress using existing monitoring data.

Trying to judge whether the slope of a curve (trend) of the nephelometric data represents reasonable progress is not easy. Perhaps another method of tracking progress towards the national visibility goal would be to develop a set of quantifiable milestones. For instance, set an overall goal of reducing the number of significantly impaired hours within a visibility protection period of July 1 through Labor Day, and set milestone dates and goals to determine if reasonable progress towards the overall goal is being made. To illustrate this concept, the first milestone

might be to reduce the number of significantly impaired hours to five percent or less of the total hours by the year 2000, (in this case a significant impairment is a one hour average  $\geq$  to  $0.5 \times 10^{-4} \text{m}^{-1}$ , which is approximately equal to a visual range of 80 km). Figures 2.1.1 - 2.1.5 shows the nephelometric data from the Ecology network presented in a way to determine if this has occurred. At all the Ecology sites except Carbon River Ranch, this example milestone has been met. Additional milestones might be to further reduce the percentage of significantly impaired hours in subsequent defined intervals.

Ecology suggests that it is worthwhile to attempt to develop a set of quantifiable milestones for measuring reasonable progress towards the national visibility goal, while awaiting federal guidance on this subject. Ecology, in consultation with the FLM, will attempt to develop a set of milestones for use in future assessments of reasonable progress.

**2.2 Review of Emission Data** - Air quality control programs, both non-visibility and visibility specific programs, have been responsible for reducing emissions or preventing the increase of emissions which affect visibility. A review and analysis of available emission data was made. The objective of this analysis was to answer the questions:

- ◆ What are the trends in visibility impairing emissions since original Visibility SIP adoption?
- ◆ Do the trends indicate that we have made reasonable progress toward the national goal?
- ◆ What are projected future emission trends?
- ◆ Do the projected future emission trends indicate that we will continue to make reasonable progress towards the national goal?
- ◆ How do emission trends compare with monitoring data trends?

These are discussed below.

**2.2.1 Scope of the Emission Inventory** - The emissions inventory of actual emissions was calculated on an hourly basis over a five km grid system covering all of western Washington. Eastern Washington emissions were not inventoried due to time constraints. The inventory included emissions of sulfur dioxide ( $\text{SO}_2$ ), nitrogen oxides ( $\text{NO}_x$ ), and particulate matter ( $\text{PM}_{10}$  and  $\text{PM}_{2.5}$ ). The following source categories were inventoried: onroad vehicles, nonroad equipment and vehicles, agricultural windblown dust, prescribed burning, and point sources. Emissions were calculated for base years 1985 and 1994, and for a projection year of 2006.

It was agreed by the SIP review team that the focus would be on the visibility protection period of June through September. To that end, an emissions inventory representing a typical summer weekday was constructed.

**2.2.2 Presentation of the Emission Inventory Information** - This discussion is limited to the pollutants  $\text{NO}_x$ ,  $\text{SO}_2$ , and  $\text{PM}_{10/2.5}$ . Limitations of this approach will be discussed in Section 4 of this report. Details and documentation of emissions calculations may be found in Appendix C.

Trends in emissions vary among the visibility impairing pollutants and the source categories which emit them. Each pollutant is discussed below, along with accompanying graphs.

### **PM<sub>10/2.5</sub>**

The largest sources of PM<sub>10/2.5</sub> in the inventory are re-entrained road dust from automobiles and agricultural windblown dust (Figures 2.2.1 and 2.2.2). The equation for calculating road dust emissions is directly dependent on vehicle miles traveled (VMT). Increases/decreases in miles traveled will produce the same percentage change in emissions. Since 1985, VMT (and therefore emissions) have increased by about 54 percent. They are projected to grow another 26 percent by 2006.

Emissions from agricultural windblown dust were assumed to remain constant in the emissions inventory from 1985 to 2006. Average western Washington meteorological conditions were used to calculate emissions. Emissions are dependent on farming practices, meteorology, and the number of acres under cultivation.

Most of the smaller sources of particulate matter (onroad mobile tailpipe, prescribed burning, and point sources) show an overall decrease in emissions, with prescribed burning and point sources showing the largest decreases. Prescribed burning emissions from June to September decreased by 78 percent from 1985-87 to 1993-95. In eastern Washington, prescribed burning emissions during the same season decreased by 60 percent. Mobile nonroad sources show a slight increase in emissions. There is an overall increasing trend in both PM<sub>2.5</sub> and PM<sub>10</sub> from all western Washington sources combined (Figure 2.2.3).

### **Sulfur Dioxide**

While nonroad mobile and onroad mobile sources contribute to sulfur dioxide emissions, point sources dominate (Figure 2.2.4). Since 1985, large decreases and expected future decreases in sulfur dioxide emissions may be attributed to two major stationary sources, ASARCO in Tacoma and the Centralia Power Plant. Records from the late 1970s to 1984 show that ASARCO emitted between 55,000 and 87,000 tons of sulfur dioxide per year. The smelter was being shut down in 1985, and the emissions decreased to 12,000 tons. By 1986, emissions were 36 tons and were soon zero when completely shut down.

The Centralia Power Plant has emitted between 42,000 and 69,000 tons of SO<sub>2</sub> each year during the mid 1980s to 1995. Proposed future controls on the power plant could reduce SO<sub>2</sub> emissions to 10,000 tons per year by the year 2002. When emissions were projected to 2006, it was assumed that the proposed reductions were achieved.

The overall decrease in SO<sub>2</sub> emissions from 1985 to 1994 was 24 percent (Figure 2.2.3). From 1994 to 2006 a decrease of 53 percent is expected if the proposed controls on the Centralia power plant are in place, which translates to a decrease of 64 percent from 1985 to 2006 (assuming all other point sources remain constant). Even with the large decreases in SO<sub>2</sub> from these two sources, point sources will still account for about 75 percent of the SO<sub>2</sub> inventory. Changes in

fuels, processes or production at other major point sources will affect future SO<sub>2</sub> emissions and could alter the reductions estimated here.

### **Nitrogen Oxides**

Overall, there is really no trend in NO<sub>x</sub> emissions (Figure 2.2.3). Combined NO<sub>x</sub> emissions in western Washington increased from 1985 to 1994, but are projected to decrease by 2006 to slightly below 1985 levels. The Centralia power plant will be decreasing its emissions, but for onroad mobile sources, which dominate the inventory (65 percent), improvements in NO<sub>x</sub> emission rates have been and will continue to be largely offset by growth in miles traveled (Figure 2.2.5). Only minute changes are expected in nonroad mobile sources and the other point sources.

**2.2.3 Conclusions** - Review of all visibility impairing pollutants combined indicate no trend from 1985 to 1994 (Figure 2.2.6). This is consistent with the trends for nephelometric visibility data presented in Section 2.1.1 of this report. The projections for all visibility impairing pollutants combined indicate a moderate decrease in these emissions from 1994 to 2006 (also Figure 2.2.6).

The sources which dominate PM<sub>10/2.5</sub>, mobile onroad dust and agricultural dust, increase significantly or remain constant, respectively. The source which dominates the NO<sub>x</sub> inventory (mobile onroad) increases significantly. Without the influence of these source categories the decrease in combined emissions would be dramatic. Currently, the Phase I visibility regulations do not cover these types of sources. This highlights the need to address emissions from these sources in forthcoming regional haze programs if we expect to continue to make reasonable progress.

However, even though the emission inventory indicates that these sources dominate the inventory, it is unclear that their actual impact in mandatory Class I areas is significant. Recent studies<sup>1,2,3</sup> indicate that the nitrate component of light extinction ranges from nine percent to 13 percent (or even less using Harrison's method, see Section 2.1.2 and Appendix B) at rural and mandatory Class I area receptors in Washington State and the Pacific Northwest. What percentage of the nitrates collected at these receptors that can actually be attributed to mobile sources is not known.

These studies also indicate that dust (soil) contributes from one percent to seven percent of the light extinction at the same receptors, (or unknown, using Harrison's method). This dust contribution is not broken down into individual source category contribution to the total dust

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<sup>1</sup> "Pacific Northwest Regional Visibility Experiment Using Natural Tracers (PREVENT), Final Report," Malm et al, February 1994.

<sup>2</sup> "Protecting Visibility in National Parks and Wilderness Areas," National Research Council, National Academy Press, 1993.

<sup>3</sup> "Spatial and Seasonal Patterns and Long Term Variability of the Composition of the Haze in the United States: An Analysis of Data from the IMPROVE Network," Sisler et al, Cooperative Institute for Research in the Atmosphere, Colorado State University, July 1996.

component. How much of this dust component that can be ascribed to individual categories, such as mobile onroad dust and agricultural dust, is not known at this time.

This should be contrasted to the relative contribution of sulfates and organic carbon at these same receptors. Sulfates contribute from 33 percent to 53 percent (or 24 percent using Harrison's method) of the anthropogenic light extinction and organic carbon contributes from 17 percent to 28 percent (29 percent by Harrison's method). In addition, elemental carbon contributes another ten percent to 15 percent of the light extinction. This means that sulfates, organic carbon and elemental carbon combined contribute approximately 78 percent to the light extinction (less using Harrison's method). The combined dust and nitrate contribution is ten percent to 20 percent (less using Harrison's method). Priority should continue to be in reducing emissions of SO<sub>2</sub>, organic carbon and elemental carbon. A secondary priority should be given to control of dust and NO<sub>x</sub> emissions.

It is apparent that further study is needed to accurately apportion the contribution of the various source categories to the major pollutant components (sulfate, organic carbon, elemental carbon, nitrates and dust) found at these mandatory Class I area receptors.

**2.2.4 Reasonable Progress for Phase I Sources** - Phase I of visibility regulations required states to develop visibility protection SIP's that addressed a specific type of visibility impairment (plume blight) and sources that contributed to this impairment (point sources and prescribed burning). Washington's approved Phase I Visibility SIP developed long-term strategies which addressed emissions from point sources and prescribed burning. Therefore it is important to examine this subset of all visibility impairing emission sources to determine if reasonable progress has been made and will continue to be made under the Phase I Visibility SIP.

Emissions from all western Washington Phase I sources combined have decreased by approximately 28 percent from 1985 to 1994 and are projected to decrease another 30 percent by the year 2006 (Figure 2.2.7), for a combined 58 percent decrease from 1985 to 2006. The bulk of this decrease is attributable to reductions in SO<sub>2</sub>.

Continued progress in reducing emissions will be made under the current Phase I Visibility SIP, and is mostly due to the reduction in SO<sub>2</sub> from point sources, (attributable mostly to the projected reductions at the Centralia Power Plant). Reductions in PM<sub>10/2.5</sub> from prescribed burning and point sources is less dramatic, but clearly a contributor to overall Phase I source emission reductions. Reductions in NO<sub>x</sub> are also less dramatic than those for SO<sub>2</sub>, but clearly contribute to the overall decrease in Phase I source emissions. NO<sub>x</sub> decrease is almost wholly due to real and projected reductions at the Centralia Power Plant.



Fig. 2.1.1 PERCENT OF HOURS IMPAIRED  
JULY 1 - LABOR DAY, SOUTH MOUNTAIN

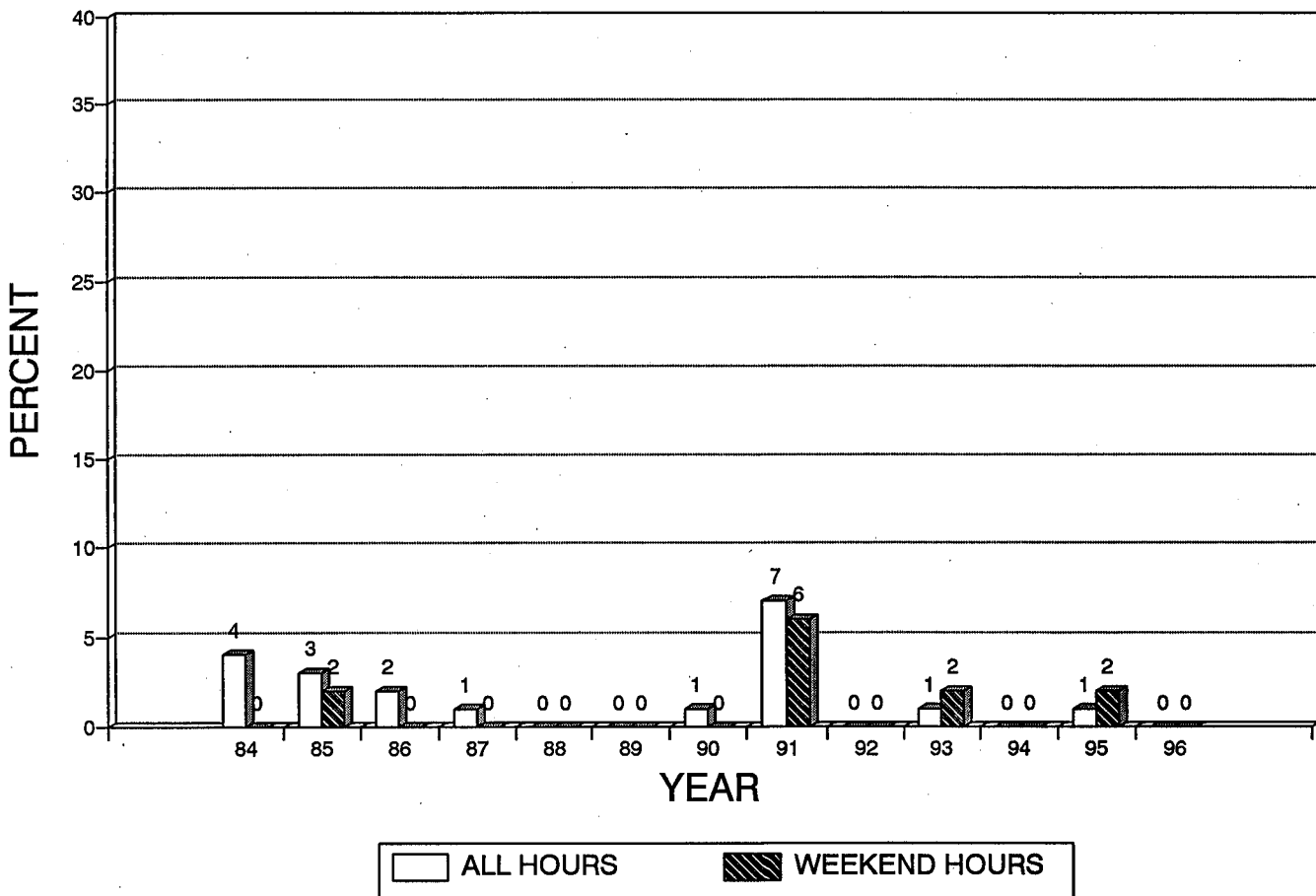


Fig. 2.1.2 PERCENT OF HOURS IMPAIRED  
JULY 1 - LABOR DAY, PARADISE

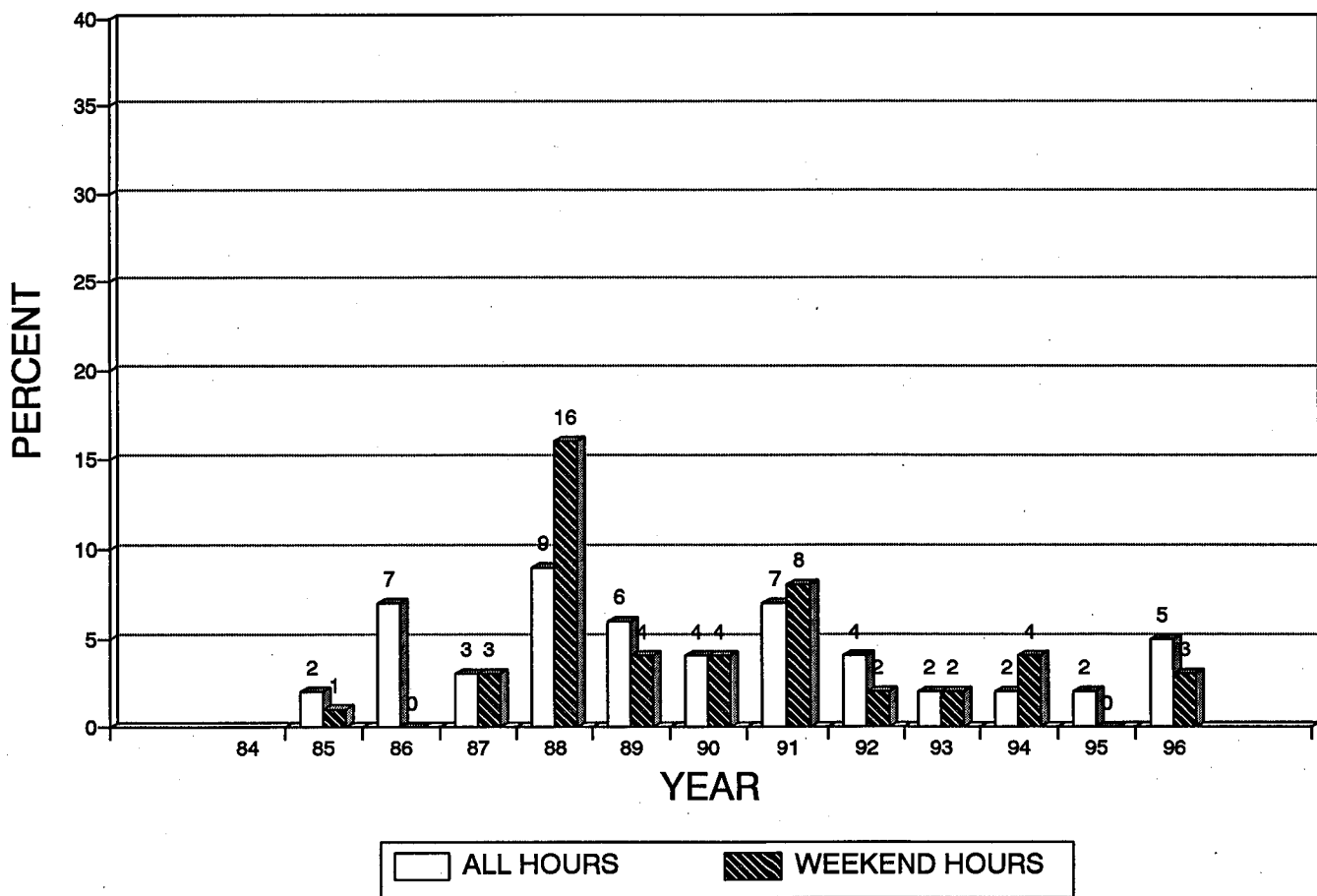


Fig 2.1.3 PERCENT OF HOURS IMPAIRED  
JULY 1 - LABOR DAY, MARBLEMOUNT

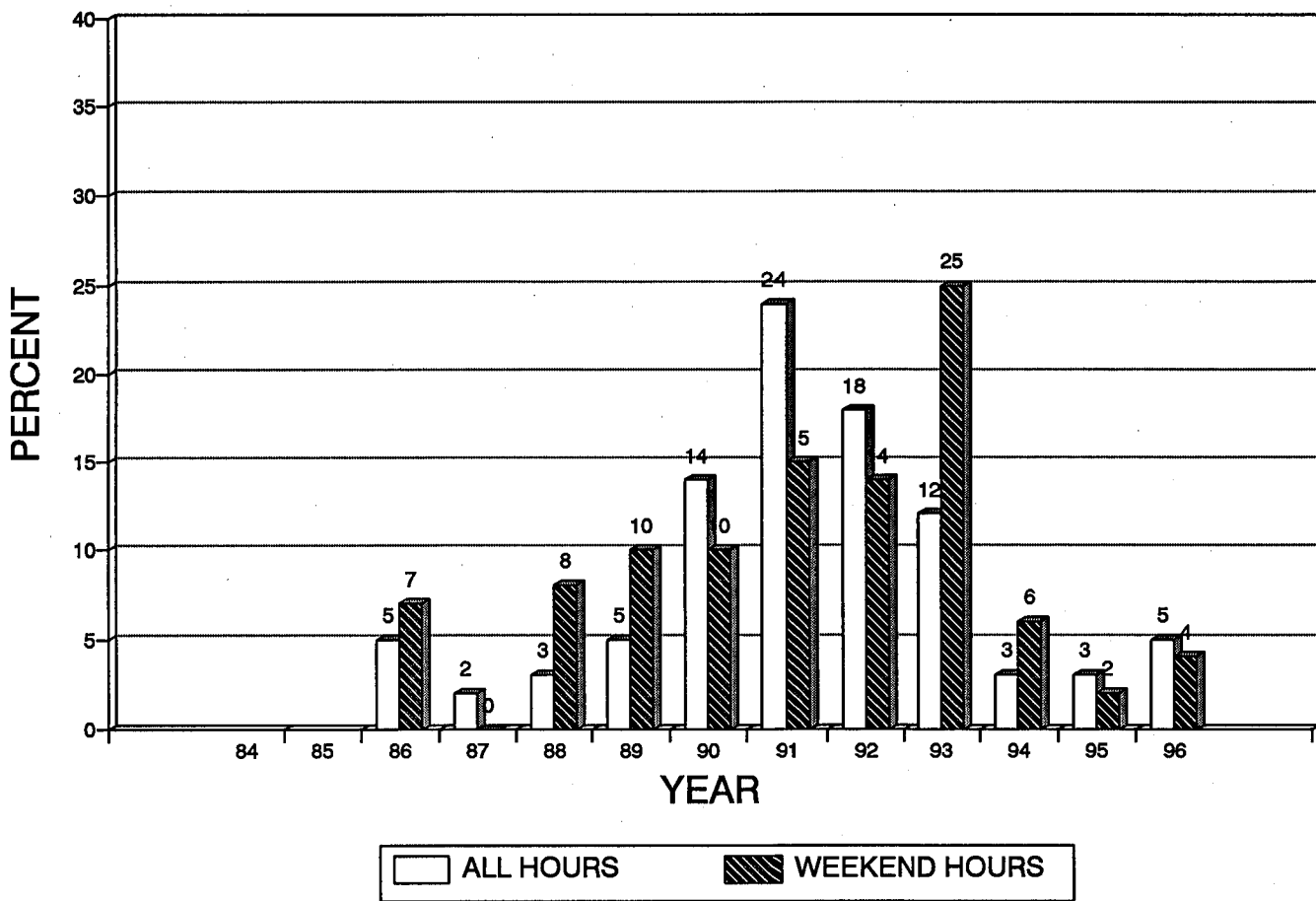


Fig. 2.1.4 PERCENT OF HOURS IMPAIRED  
JULY 1 - LABOR DAY, CARBON RIVER RANCH

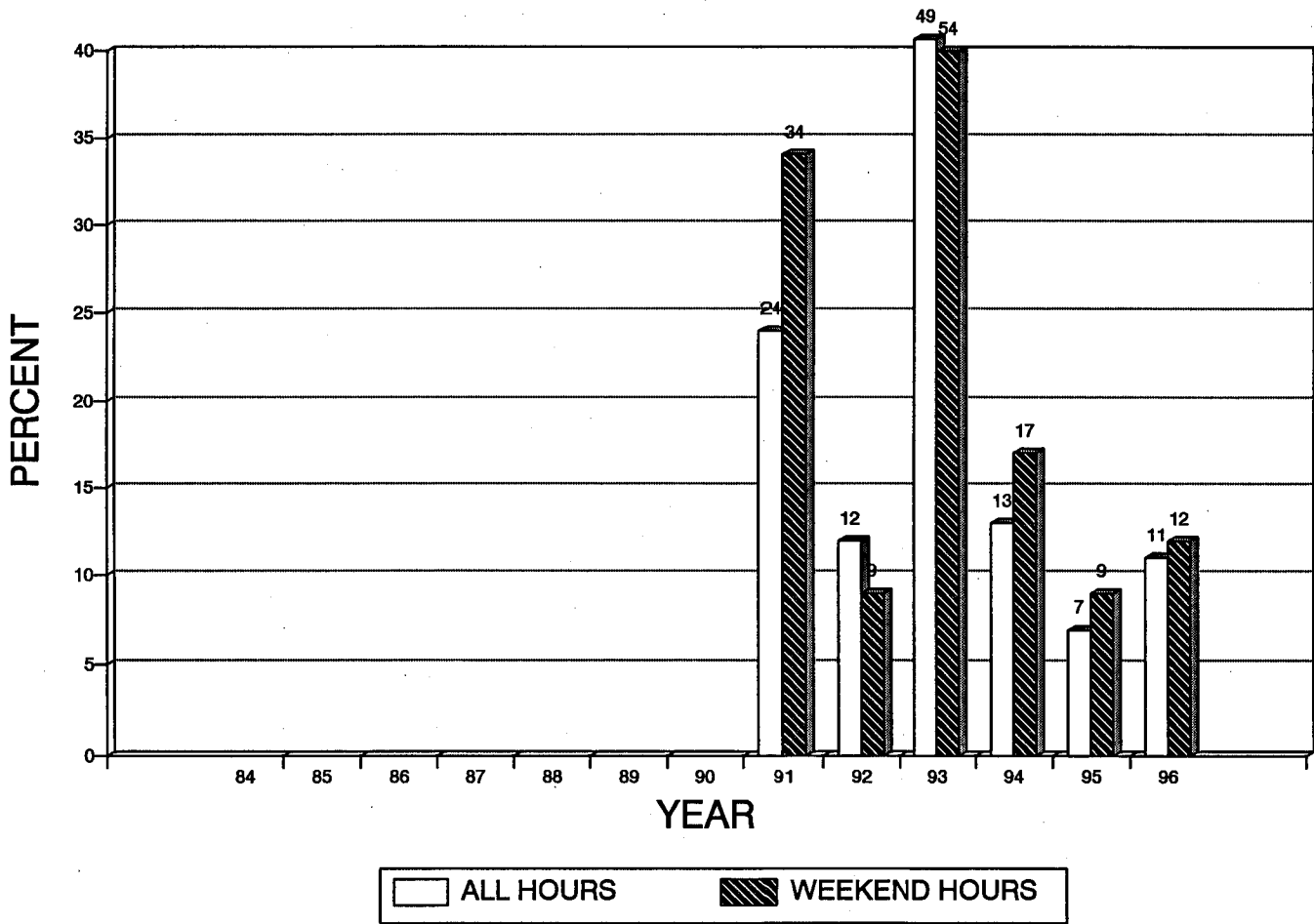
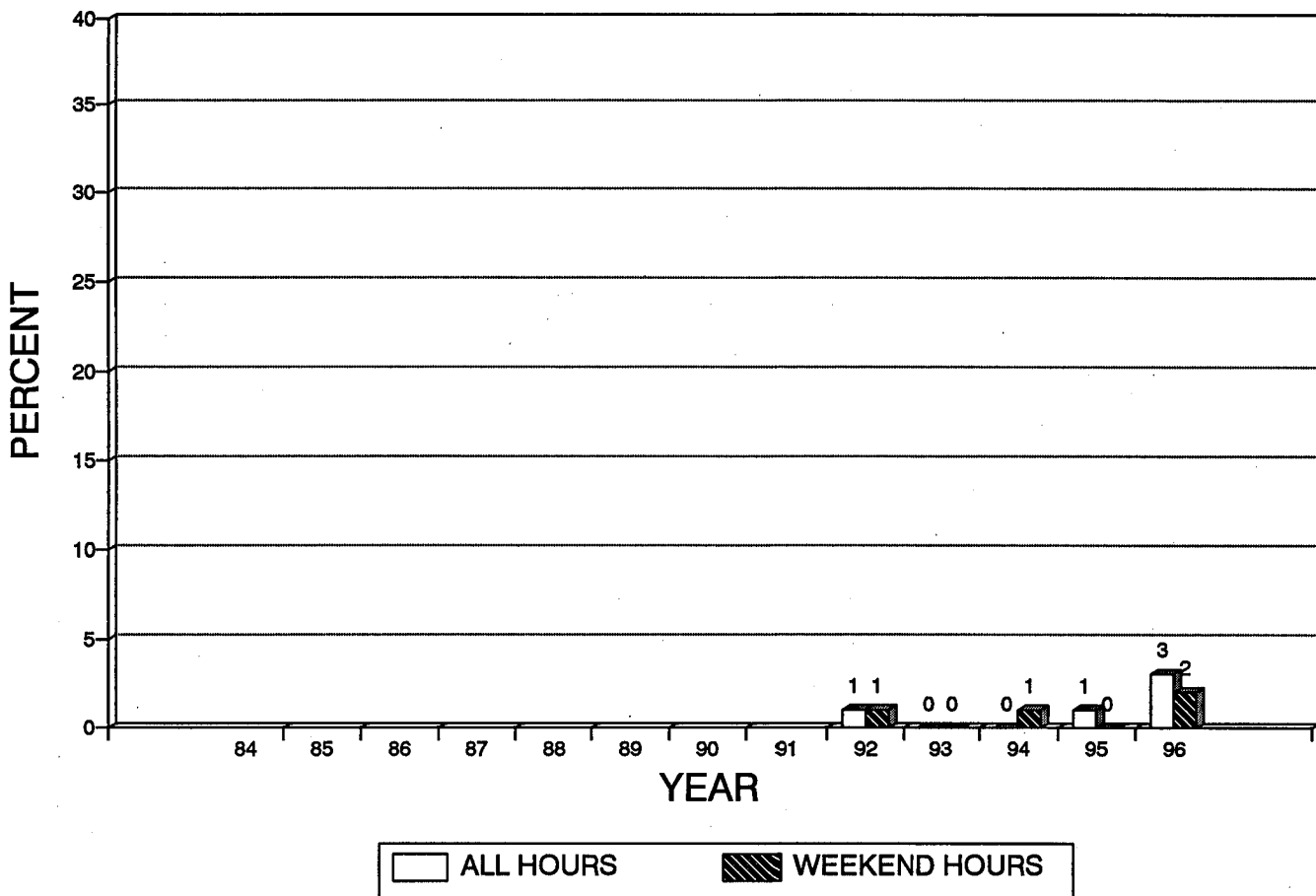
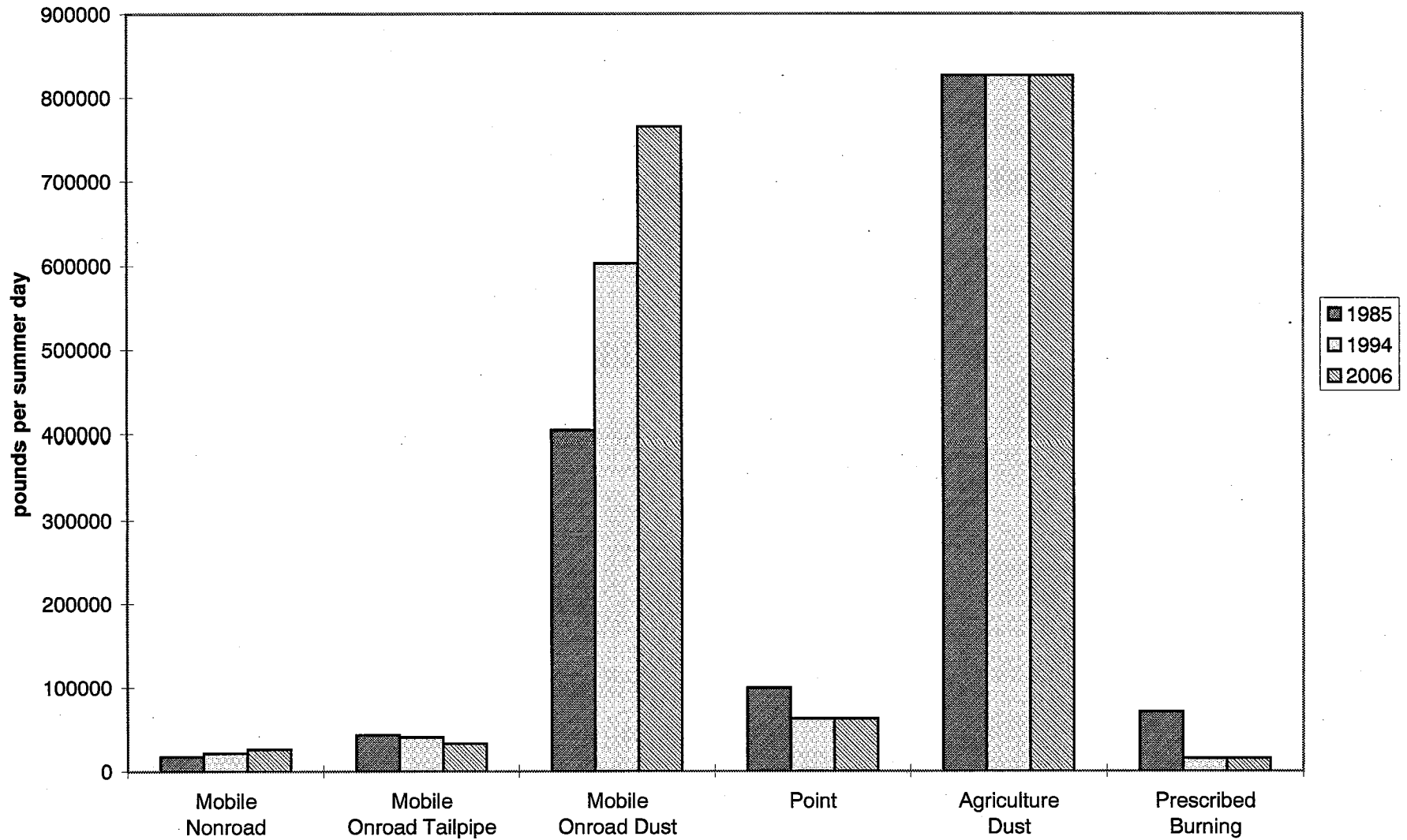


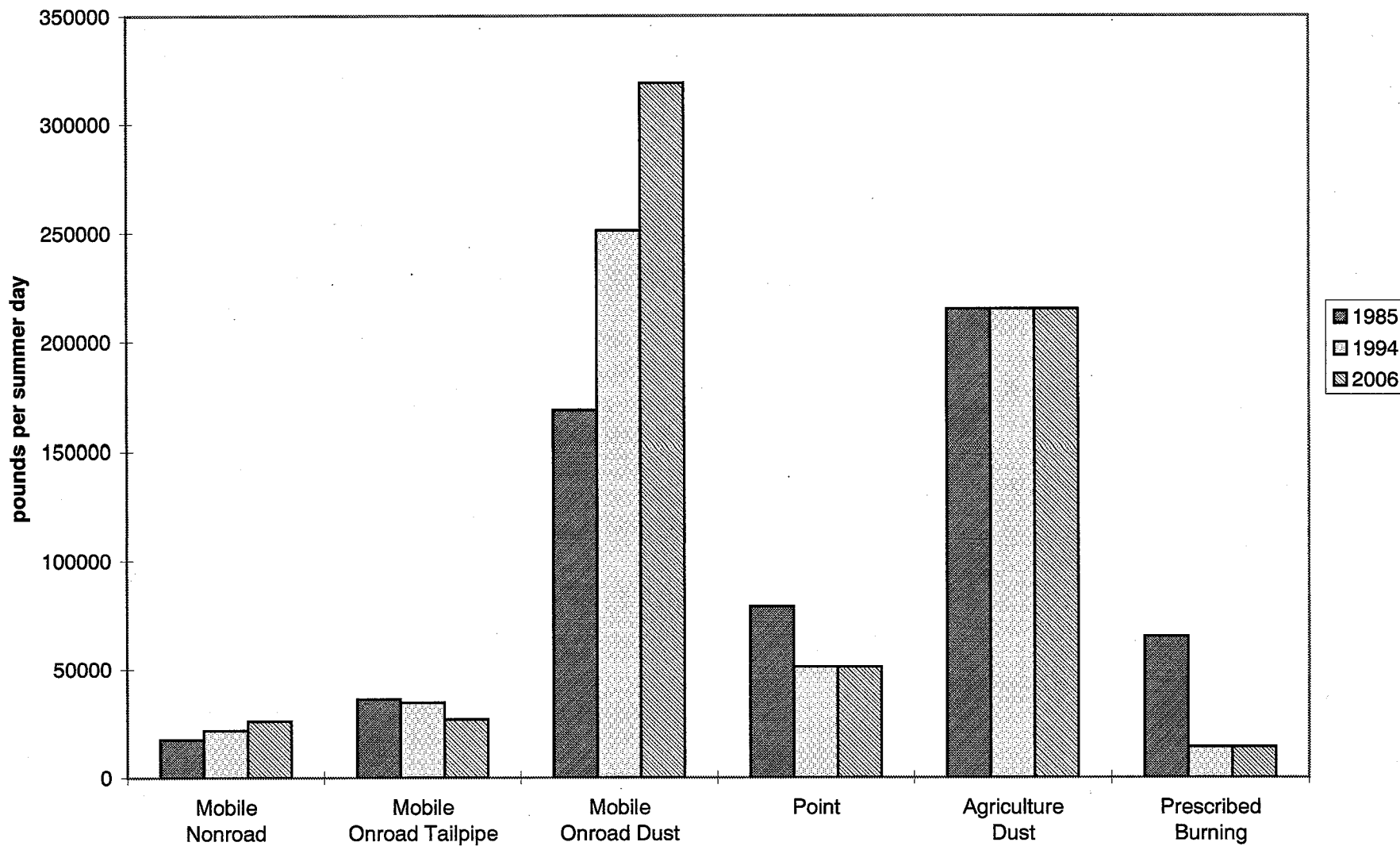
Fig. 2.1.5 PERCENT OF HOURS IMPAIRED  
JULY 1 - LABOR DAY, HURRICANE RIDGE



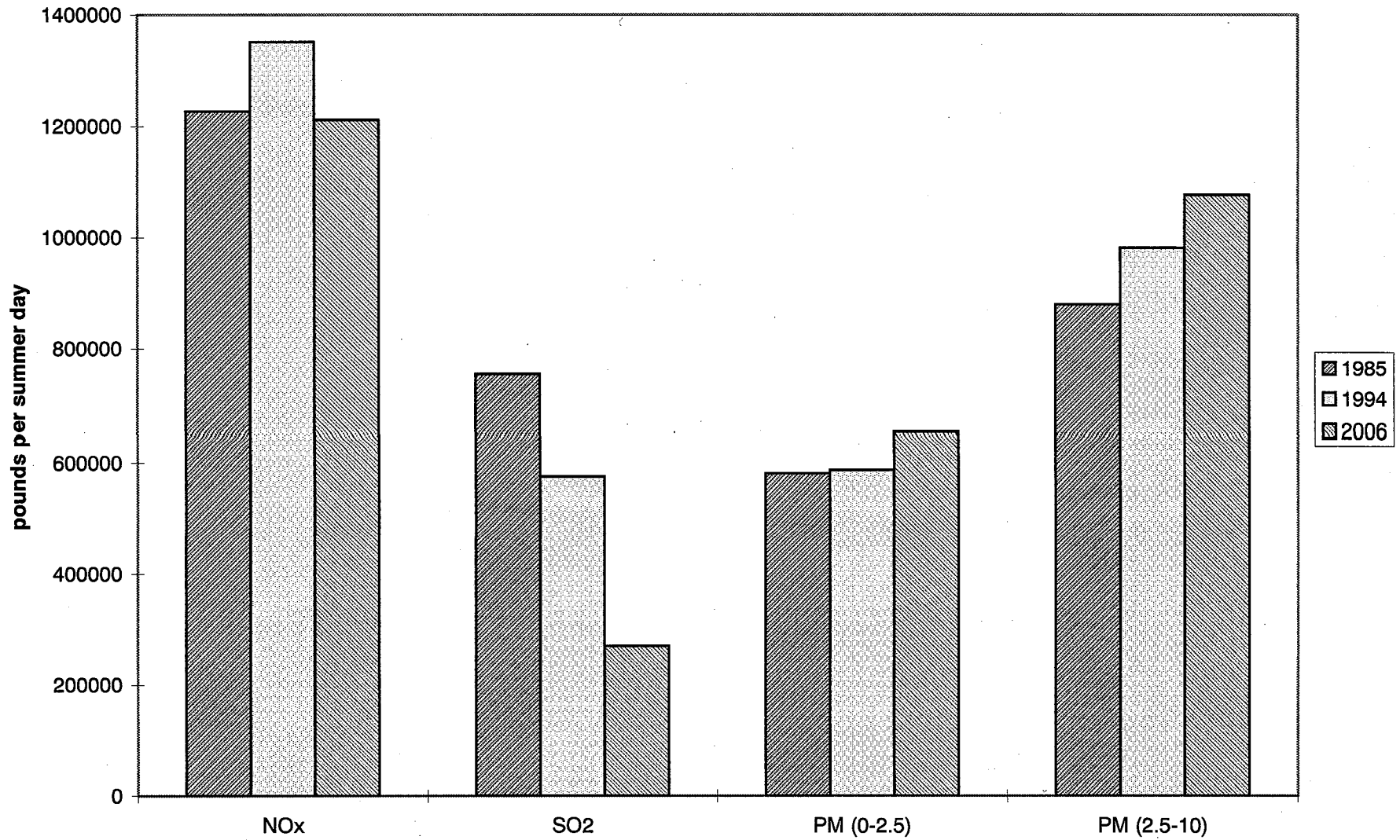
**Figure 2.2.1**  
**Western Washington PM10 Emissions**



**Figure 2.2.2**  
**Western Washington PM2.5 Emissions**

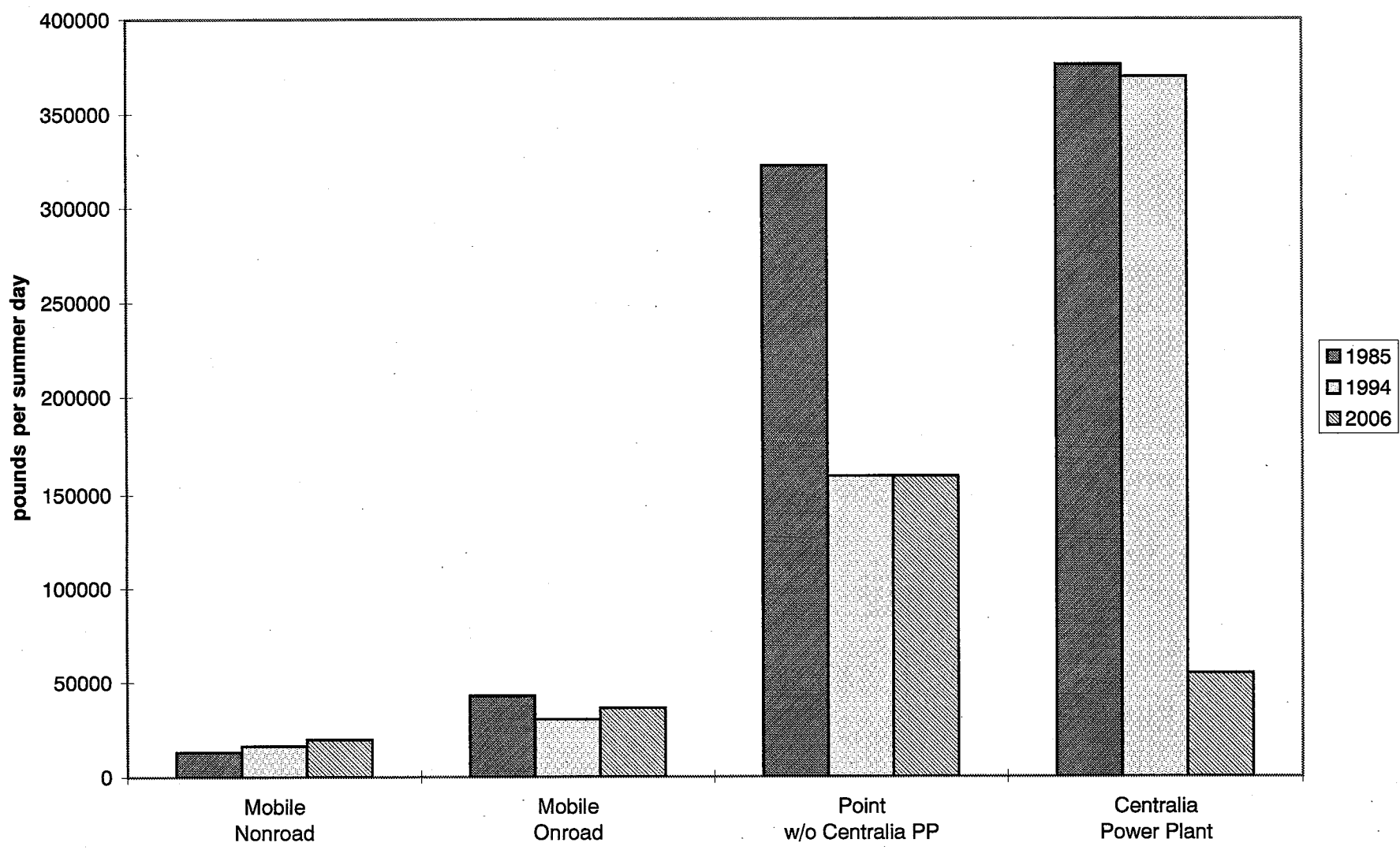


**Figure 2.2.3**  
**Western Washington Emissions Trends**

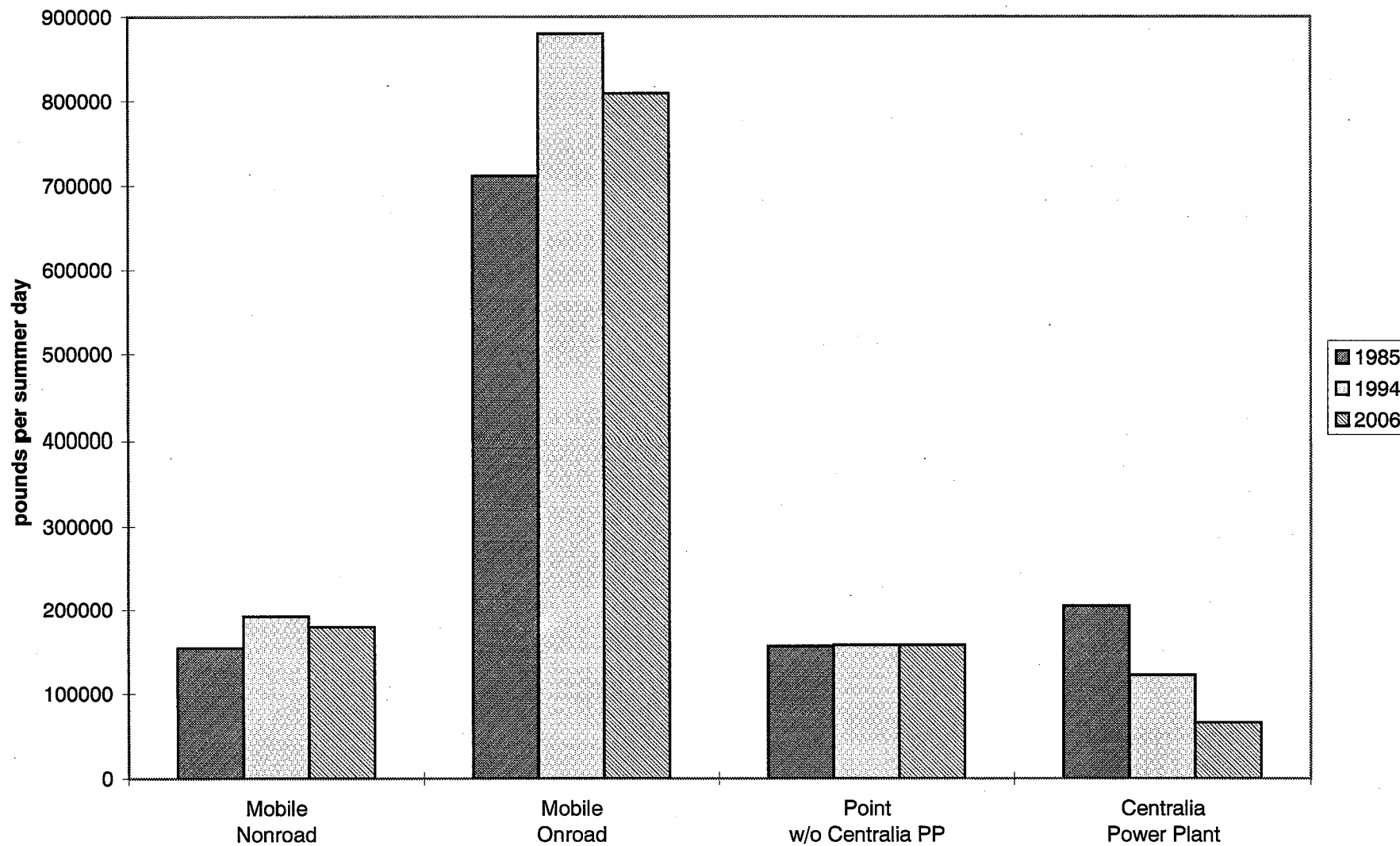




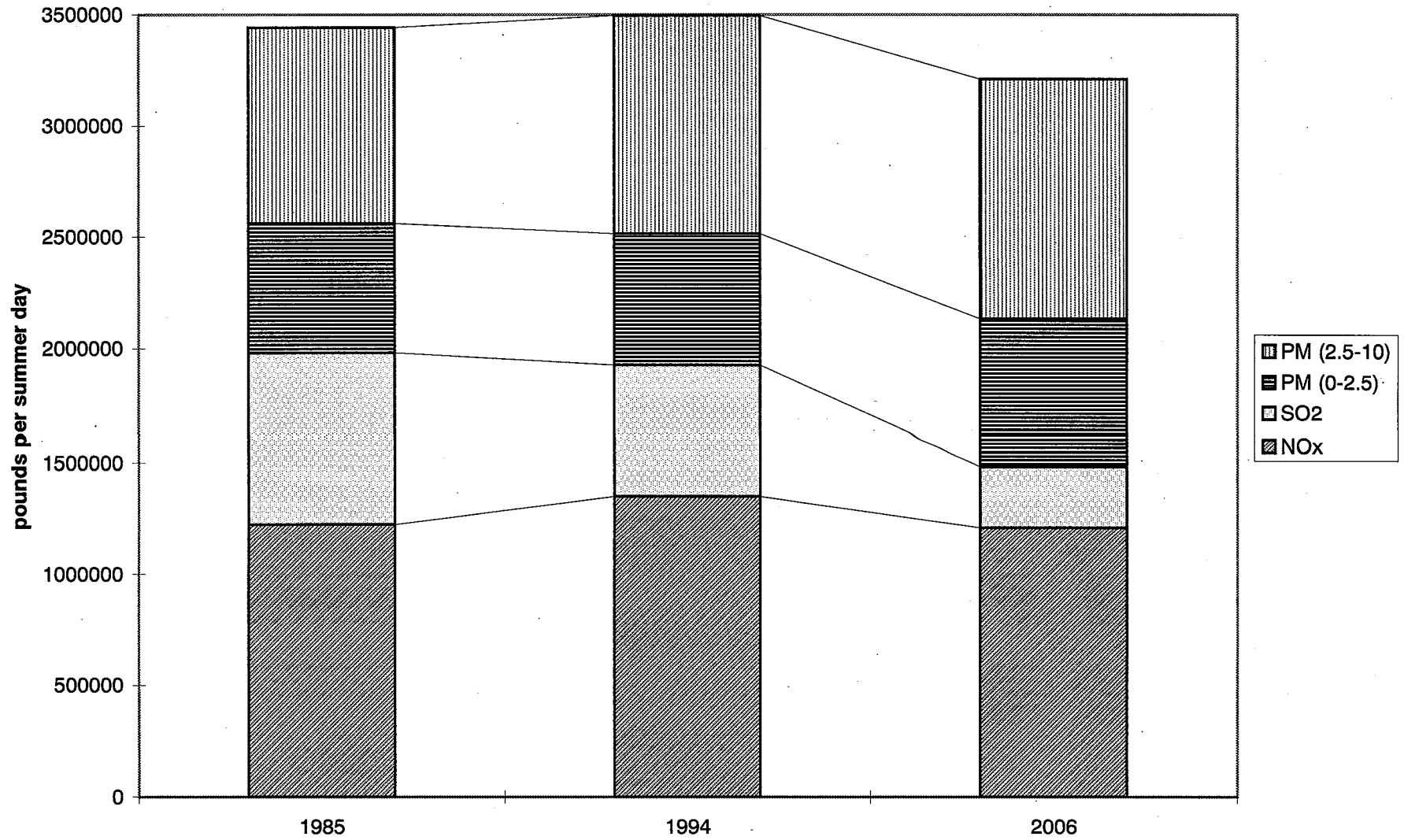
**Figure 2.2.4**  
**Western Washington SO2 Emissions**



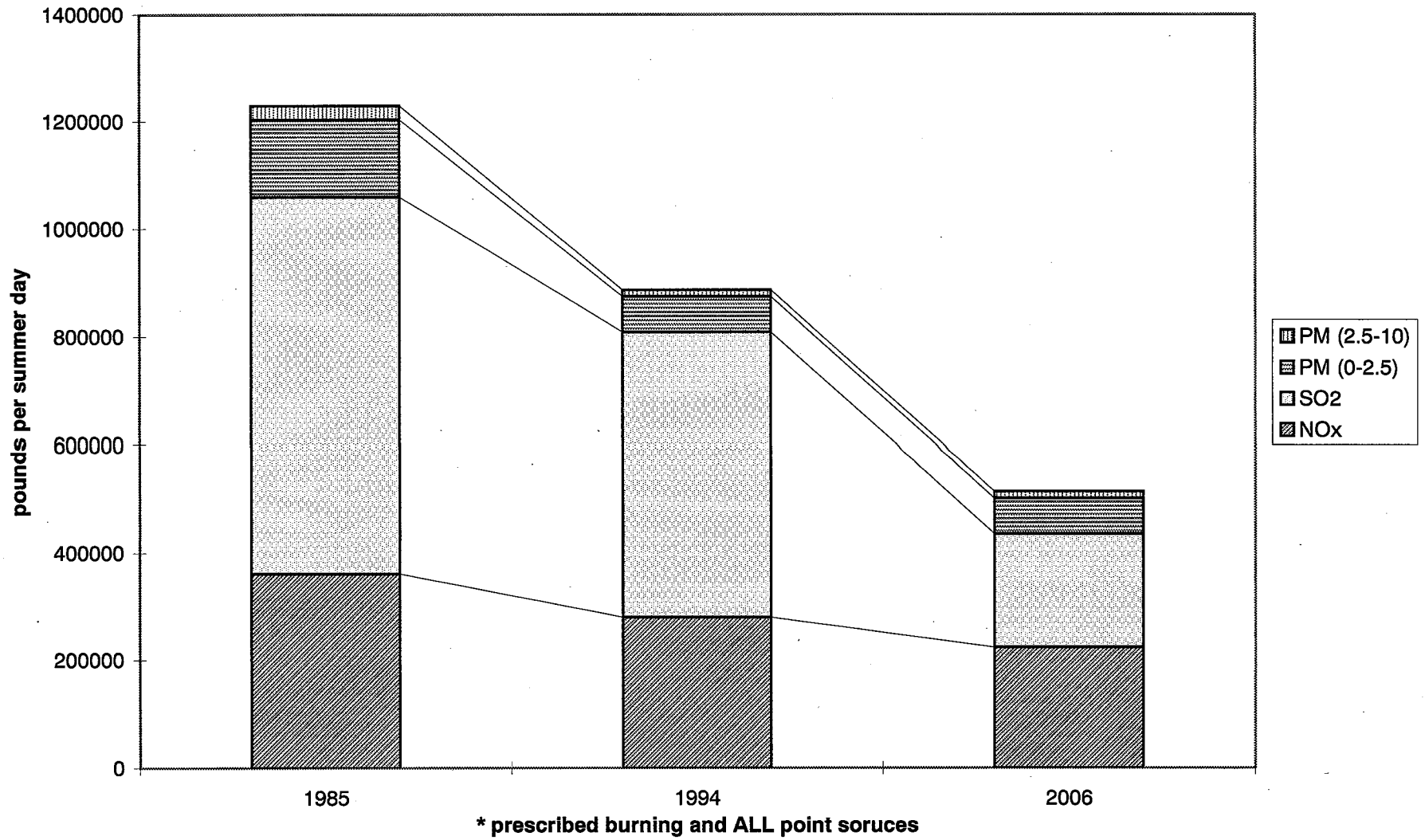
**Figure 2.2.5**  
**Western Washington Nox Emissions**



**Figure 2.2.6**  
**Western Washington Emissions Trends - All Pollutants**



**Figure 2.2.7**  
**Western Washington Emissions Trends - Phase 1 Sources\***



### 3.0 Assessment of the Adequacy of Existing Monitoring Programs

A long term visibility monitoring program is essential to: (1) evaluate and identify sources which cause or contribute to visibility impairment; and (2) assess the effectiveness of the visibility protection program's ability to make reasonable progress towards the national visibility goal. A successful long-term visibility monitoring program must address the needs of documenting visual air quality, tracking changes in visual air quality, and ascertaining a cause and effect relationship for any observed visibility impairment.

The original visibility SIP proposed a minimum monitoring strategy (Section VI, page 21 of the current Visibility SIP, presented here as Appendix D) which includes a network, (to be operated from June through September at each mandatory Class I area) of visual observations, photographic observations, nephelometric measurements, meteorological measurements, and fine particulate sampling and chemical analysis of the samples. The original Visibility SIP highlighted the need to fund and operate the network through a cooperative effort between Ecology and the FLM.

Difficulties in obtaining funding for visibility monitoring have hindered our ability to establish and operate the minimum network. Recent shifts in air quality management priorities have mitigated this problem somewhat, and Ecology in cooperation with the FLM are currently working to enhance the network. In addition, separate but related visibility monitoring initiatives have led to the establishment of an urban visibility monitoring network and an air-shed study of the Columbia River Gorge National Scenic Area (CRGNSA), a visually important non-Class I area.

**3.1 Class I Area Visibility Monitoring Network** - The current mandatory Class I area visibility monitoring network is listed below and shown on the map. Ecology sites consist of nephelometers only, (and photography at South Mountain). The IMPROVE sites operated by the FLM consist of: ambient nephelometer, IMPROVE PM<sub>2.5</sub> and PM<sub>10</sub>, light absorption, and various meteorological measurements. The PM<sub>2.5</sub> samples are later analyzed for chemical constituents of the aerosol.

Ecology sites are:

- ◆ Marblemount - North Cascades NP
- ◆ Carbon River Ranch - Mt. Rainier NP
- ◆ Paradise - Mt. Rainier NP
- ◆ Hurricane Ridge - Olympic NP
- ◆ South Mountain - Near Olympic NP

FLM IMPROVE sites are:

- ◆ Snoqualmie/Mt. Baker - Near Alpine Lakes Wilderness, USFS
- ◆ Tahoma Woods - Near Mt. Rainier NP, NPS

Ecology is currently implementing an enhancement of its network. The South Mountain and Marblemount sites will be upgraded to include IMPROVE PM<sub>2.5</sub> sampling and chemical analysis, and meteorology. A new site will be established in the Mt. St. Helens area and will include: nephelometry, IMPROVE PM<sub>2.5</sub> sampling and chemical analysis, and possible meteorologic measurements. Sites will probably be upgraded and established sometime this summer. Funding for the PM<sub>2.5</sub> chemical analysis is for one year only. Funding for long-term operation and aerosol chemistry analysis at existing and proposed sites remains an issue and should be resolved.

With the establishment of these new sites the geographic coverage of the state's mandatory Class I areas will be vastly improved. However, gaps still exist. At a minimum, a new site representative of the Glacier Peak Wilderness should be established and should include nephelometry, IMPROVE PM<sub>2.5</sub> sampling and chemical analysis, and meteorology.

It would also be useful, but of lesser priority, to add IMPROVE PM<sub>2.5</sub> sampling and chemical analysis, and meteorology to the Hurricane Ridge, Carbon River Ranch and Paradise sites.

Differences in nephelometric monitoring methodology between the Ecology and FLM networks needs to be resolved. It is very difficult to compare data from ambient nephelometers and heated (dry) nephelometers. Due to the value of the long-term record of state nephelometry sites, Ecology is reluctant to change methodology especially since ambient nephelometry has shown problems with significant overestimation of the scattering coefficient. FLM IMPROVE staff have noted these problems with ambient nephelometers and will be investigating them further.

As discussed in Section 2.1.2, the two methods for calculating light extinction budgets give significantly different results. This issue needs more study before it can be resolved.

Ecology concludes that the minimum requirements for a mandatory Class I area monitoring program will be met when the current network expansion is completed and an additional site is established near the Glacier Peak Wilderness. Such a network will satisfy the need to document visual air quality, track changes in visual air quality, and ascertain cause and effect relationships for any observed impairment.

**3.2 Non-Class I Area Visibility Monitoring** - Visibility monitoring in urban areas is being conducted by the Northwest Air Pollution Authority, the Puget Sound Air Pollution Control Agency and the Olympic Air Pollution Control Authority. Visibility monitoring in the CRGNSA is being conducted by Ecology, the USFS and the Oregon State Department of Environmental Quality.

Urban monitoring is being conducted to characterize visibility in the Bellingham, Seattle and Olympia areas. Monitoring in the Bellingham and Seattle area consists of nephelometry, IMPROVE PM<sub>2.5</sub> sampling and chemical analysis, meteorology and photography. Monitoring in

the Olympia area consists of nephelometry and photography. The urban visibility sites are identified on the map as:

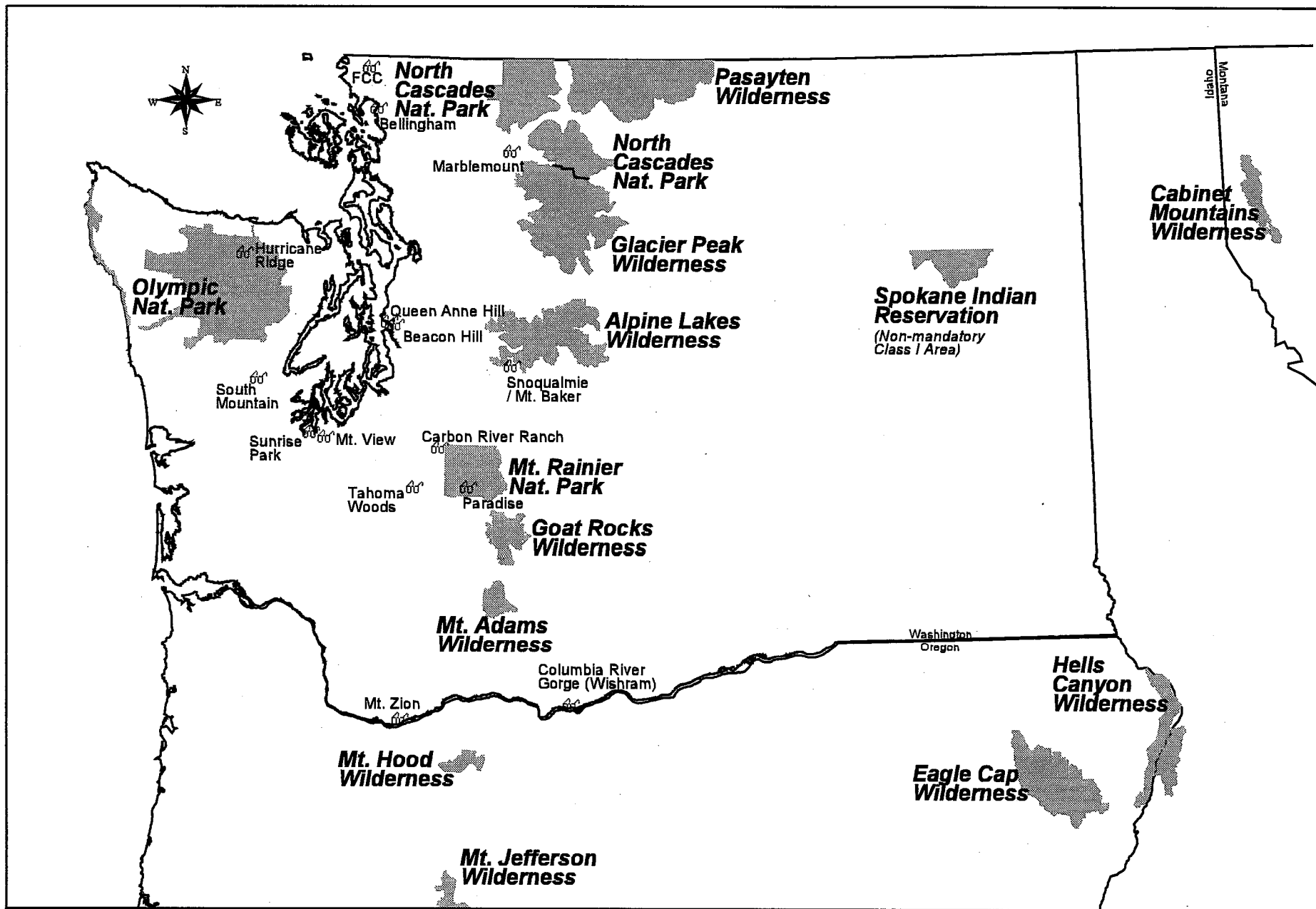
- ◆ FCC - PM<sub>2.5</sub>, nephelometer and meteorology.
- ◆ Bellingham - Photography.
- ◆ Queene Anne Hill - Photography.
- ◆ Beacon Hill - PM<sub>2.5</sub>, nephelometer and meteorology.
- ◆ Mt. View - Nephelometer.
- ◆ Sunrise Park - Photography.

The establishment of IMPROVE PM<sub>2.5</sub> sampling and chemical analysis in the Olympia area would be very valuable. Long-term monitoring at these urban sites is encouraged.

Visibility monitoring in the CRGNSA is described at the end of Section 1.3 of this report. CRGNSA sites are identified on the map as:

- ◆ Mt. Zion - PM<sub>2.5</sub>, nephelometer and meteorology.
- ◆ Columbia River Gorge (Wishram) - PM<sub>2.5</sub>, nephelometer, meteorology and photography.

Support for the long-term operation of the CRGNSA sites is encouraged. Funding for additional phases of this study needs to be obtained.



## Mandatory Class I Areas And Visibility Monitoring Sites





#### **4.0 Assessment of the Adequacy of Existing Emission Inventory of Sources Which Can Impact Visibility in Mandatory Class I Areas**

The original Visibility SIP focused mostly on prescribed burning as the source of Phase I visibility impairment in mandatory Class I areas. The Visibility SIP also provided strategies to deal with the impact from future and existing major stationary sources. These were requirements of Phase I visibility protection SIPs.

Available emission source inventories constructed for different NAAQS non-attainment areas and inventories resulting from other air quality initiatives and projects provide useful information on emission trends. However, an understanding of the cumulative impacts of non-regulated and non-inventoried emissions may be needed to develop the technical foundation for any decisions regarding future visibility protection strategies beyond that required by the current Phase I Visibility SIP. Development of a realistic, efficient and equitable regional haze program (Phase II visibility protection programs) is certainly dependent in part on the completeness and accuracy of the emission inventory.

The objective of this section is to assess the adequacy of the emission inventory by identifying gaps and problems in the available inventory (described in Section 2.2). Suggestions for options or strategies for improving the inventory will be made.

In addition, the ability to accurately model impacts from sources which impair visibility, both in an individual and cumulative sense, is also a key to the development of a realistic, efficient and equitable visibility protection program. Many problems exist with currently available models. Strategies and options to improve models and model utility will be discussed below.

**4.1 Adequacy of the Emission Inventory** - The task in this SIP review was to assess reasonable progress. This meant focusing on emissions trends rather than total quantification of emissions. In judging the adequacy of the emissions inventory, three major areas of the inventory development process must be considered: 1) omissions, 2) emissions estimates, and 3) spatial/temporal allocation. Each of these are discussed below.

##### **Omissions**

Many source categories were not inventoried, and in most cases it was because previous inventory efforts had shown them to be of little consequence. For example, space heating and residential outdoor burning are not significant contributors to regional inventories during the visibility protection period of June to September.

Time and methodology constraints did not allow the inventorying of several sources which in total do have some significance during the visibility protection period. These sources mainly affect the NO<sub>x</sub> and PM inventories. For NO<sub>x</sub>, those sources include locomotives, air craft, commercial ships, small industrial fuel use, and natural emissions from the soil. Soil emissions should not alter emissions trends. NO<sub>x</sub> emissions from the other sources accounted for only 11 percent and four percent of the Seattle-Tacoma and Portland-Vancouver ozone maintenance plan

inventories, respectively. The maintenance plans projected very modest increases in these sources in the future, increases that are unlikely to change emissions trends.

For  $PM_{10/2.5}$ , sources omitted include fugitive dust from unpaved roads and nonroad mobile operations such as construction site operations. These emissions will be dependent on population and meteorology. The State Office of Financial Management's population estimates for western Washington show population increases from 1985 to 1994, and from 1994 to 2006 to be 813,000 and 816,000, respectively. These numbers are within one percent of each other. Unless there are severe differences in meteorology, they can be expected to have little effect on emissions trends.

Two pollutants were not inventoried, gaseous volatile organic compounds (VOC) and ammonia. Ecology does not generally require the reporting of ammonia emissions, and time constraints did not allow the compilation of a complete VOC inventory for all inventory years. It should be noted that Ecology is preparing for ozone modeling in a separate project. A complete VOC inventory is being compiled for this purpose and will soon be available for the benefit of both ozone and visibility modeling.

As stated earlier, due to time constraints, the emissions inventory was limited to western Washington. It is noted here, however, that four major stationary sources of PM and  $SO_2$  in eastern Washington are located within 60 km of mandatory Class I wilderness areas. Two are near the Alpine Lakes Wilderness; the third is located near the Goat Rocks Wilderness, and the fourth is near the Mount Adams Wilderness.

While not specifically an omission, the pollutants inventoried were not converted to the specific products that decrease visibility. If further work is to be done, the inventory pollutants would need to be converted to "visibility" pollutants, i.e.  $SO_2$  to sulfates;  $NO_x$  and ammonia to nitrates; and PM to organics, elemental carbon and dust. This would help further interpret the effect that emission increases/decreases have on actual visibility.

### **Emissions Estimates**

Deficiencies can occur both in estimating activity levels and in emission rates associated with the activities. The two largest particulate sources are both dust sources, and dust sources are difficult to accurately estimate.

Recent and on-going studies are addressing the equations used to estimate emissions from re-entrained road dust, particularly questioning the role of silt loading and humidity. The emission inventory documentation (Appendix C) includes a brief comparison of road dust emissions estimates calculated using the USEPA guidance and those calculated using a recent study done in Spokane. Windblown dust from agricultural fields is currently being studied in eastern Washington. It is anticipated that a better understanding of both of these emissions sources will be forthcoming.

## **Spatial/Temporal**

Emissions must be allocated in the area of concern both spatially and temporally, although without modeling, the effect of the allocations on pollutant concentrations in areas of interest cannot be determined. Detailed discussions of methods chosen for allocations for each category may be found in the inventory detail (Appendix C). In general, because of the variation in emissions from the different source categories both spatially and temporally, assumptions about the variations are made using surrogate data and/or reasonable assumptions about the nature of the given activities. This means that the accuracy of the inventory lessens when emissions are examined in either areas or time periods that are different from the area/time that the emissions estimates were originally based.

**4.1.1 Conclusions About the Adequacy of the Emission Inventory** - As stated above, the task in this SIP review was to assess reasonable progress. This meant focusing on emissions trends rather than total quantification of emissions. While the absolute pounds per day figures could be increased or decreased because of the omissions and/or methodologies employed, the general upward/downward trends in emissions are less subject to change.

Emissions inventories can always be improved. Literature searches, special studies, dispersion modeling and ambient sampling are on-going, and help refine emissions estimates. The inventory was compiled using methods acceptable for SIP inventories, and using as consistent and up-to-date information as was available in the time allowed. In fact, it had the advantage of being built on a detailed inventory compiled for a photochemical modeling project. The results of that project are not complete, but when they are, refinements will be made to both inventories. This will be beneficial to any future visibility emission inventory work.

Ecology concludes that the emission inventory presented in this report was useful and adequate to describe trends in emissions which can impair visibility. It further concludes that refinements to the inventory will enhance our ability to describe trends and model impacts, especially impacts resulting from regional haze.

**4.2 Visibility Modeling** - Though the original Visibility SIP addressed impairment due to specific impacts from Phase I sources, a comprehensive analysis of the combined effects from all sources is required to fully characterize visibility impairment. Efforts were made during the SIP review process to begin a simplified computer simulation of accumulated impacts for western Washington sources on Class I areas. This task was simplified to better address the current SIP protection level and to remain within time constraints. During the development of this simulation, a number of deficiencies with the modeling system were identified which prevented completion of the modeling for this report. The following describes progress to date and proposed methods to address these problems.

## **Meteorology**

Due to the size of the modeling domain, accurate meteorological (wind speed, direction, temperature, etc..) information is required to describe the transport mechanism during an

investigation period. This is further complicated by the complex terrain features surrounding the impact zones. Mountains, waterways, and significant land use differences greatly affect localized wind flows and dispersion characteristics. For the SIP review simulations, observational data from the National Weather Service and specialized computed data from the USEPA were used in generating meteorology fields. Subsequent analysis of the fields showed a lack of detail in describing local effects. In some cases, meteorological fields were generated that were non-realistic and would be unusable for modeling simulation. Efforts are continuing to improve this data set.

In addition, Ecology is a part of recent and on-going efforts by a northwest consortium of researchers and governmental agencies working with a research meteorological modeling system that has proved to generate consistently high quality meteorological fields for Washington and adjacent areas. This tool is being proposed to address the requirements needed by a regional visibility modeling system. Conditional on successful funding, a project using this meteorological tool would create a specific set of meteorological parameters at sufficient resolution to properly characterize localized effects of the terrain and other influences.

### **The Model**

Modeling efforts to date have utilized Cal-series products developed by Earth Tech, Inc.. This system of modeling utilities and processors are designed to perform simulations of airborne dispersion and compute impacts from a number of point and non-point source categories. At this time, the model system has a number of limitations and is going through continued evaluation and development phases. As such, maintaining current and matching versions of tools along with subsequent documentation have been difficult. This difficulty has resulted in relatively simple tasks taking longer than expected.

A number of improvements to the Cal-series model system have been proposed by the USEPA that would greatly affect continued visibility modeling efforts. These proposals include: improvement of the chemical mechanism in Calpuff to account for aqueous phase sulfate formation; establishing a linkage between the MM5 meteorological model to Calmet; improvement in Calmet for valley flows and soil moisture; and establishing a one-way linkage between Calpuff and Calgrid. As before, these efforts are dependent on successful funding.

### **Emission Inventory For Modeling**

As described in the previous section, the development of an adequate emission inventory for visibility analysis can be quite complex. Because degradation can result from the reaction of two or more primary emissions, it is highly critical to accurately describe sources as well as to adjust for spatial and temporal changes. Needed improvements to emissions inventories specific to modeling include better characterization of emission location, daily and seasonal cycles, and a comprehensive description of industrial complexes. This work is ongoing.

## **5.0 Assessment of the Ability of Existing Programs to Make Reasonable Progress and the Need to Develop Additional Measures**

The current Visibility SIP identifies five factors for consideration of a long term strategy for insuring reasonable progress in preventing and protecting visibility impairment to mandatory Class I areas. Those factors are as follows:

- ◆ Emission reductions resulting from ongoing air pollution control programs including emission limitations and schedules for compliance.
- ◆ Measures to mitigate the impacts of construction activities.
- ◆ Source retirement and replacement schedules.
- ◆ Smoke management techniques for agricultural and forestry management.
- ◆ Strategy coordination with existing land management plans and goals.

A review of those factors, both from the perspective of their past successes and from their potential to continue reducing/preventing emissions contributing to visibility impairment, follows.

### **5.1 Emission Reductions Resulting from Ongoing Air Pollution Control Programs**

**Including Emission Limitations and Schedules for Compliance** - The current Visibility SIP discusses urban air quality problems, especially areas designated as nonattainment of National Ambient Air Quality Standards (NAAQS) for total suspended particulate (TSP), and talks about plans to bring these areas into compliance. Monitoring programs indicate that these areas have been brought into compliance with the standards.

The USEPA is in the process of revising particulate matter standards and is likely to adopt standards that control ultrafine particulate known as PM<sub>2.5</sub>. These ultrafine particles have an even more direct impact on visibility than the previously regulated PM<sub>10</sub> and their regulation will likely have an even larger beneficial impact on visibility than past programs. The specific standard is unknown at this time but is likely to be known during the time period of a visibility SIP revision as recommended by this review.

Nonattainment of ozone NAAQS was not discussed in the current Phase I Visibility SIP and the connection between ozone and visibility impairment is not well understood. Ozone nonattainment areas were identified similarly to PM<sub>10</sub> nonattainment areas and plans were developed and implemented to reduce the ozone levels. Current information indicates that these areas are now in attainment of the existing standard and will remain in attainment for the next several years. Again, however, the USEPA is considering revising the ozone NAAQS so more reductions may be required in the future.

“New Source Review” and “Prevention of Significant Deterioration” are state run programs that also protect and improve visibility in Washington State. Whenever an existing source is modified, or a new source is proposed, visibility impacts must be considered and shown not to

cause a significant reduction in visibility in any mandatory Class I area within 100 kilometers. This process includes consultation with FLMs who look specifically at visibility and other air quality related impacts.

Ecology's scheduled review of Reasonably Available Control Technology (RACT) is another program that will likely have beneficial impacts on visibility improvement and protection. This program requires Ecology to develop RACT-based emission levels for categories and individual sources. The RACT process results in issuance of regulations limiting the emissions for source categories, and regulatory orders for individual sources that go through the RACT process. Washington State's RACT program is the only program in the nation that considers visibility as an air quality element in developing RACT for a source.

Similarly, Best Available Control Technology (BACT) limits are placed on new sources to insure their emissions are controlled at the lowest possible level, even if there is no indication they would impact visibility in a mandatory Class I area. Major new sources in PM<sub>10</sub> nonattainment areas are required to use Lowest Available Emission Rates (LAER) which are the most stringent emission controls. Air Operating Permits are issued to sources to insure they control their emissions at the levels specified in regulatory orders and regulations, thereby safeguarding against future increases in emissions that could impact visibility.

Since the Visibility SIP was written, the Centralia Power Plant has been the subject of discussions between the FLM and federal, state and local air regulators regarding the need to reduce sulfur emissions in order to improve visibility at Mt. Rainier National Park. A collaborative decision making process was initiated which resulted in a declaration, signed by all participating parties, that identified a target solution of 90 percent removal of sulfur dioxide emissions by installing sulfur dioxide scrubbers and low nitrogen oxide burners in the boilers by the end of 2002. It is Ecology's belief that this alternative process, when put in the form of an enforceable order, will yield results that comply with the Federal Clean Air Act and the Washington State Visibility SIP.

In addition to these programs already in place, there are a variety of proposed programs that will have beneficial impacts on visibility. The most significant of these programs is likely to be the regional haze program being developed by the USEPA, in consultation with other federal and state agencies, as part of their integrated strategy to control particulate matter, ozone and regional haze. The USEPA will present a proposed program in mid-1997 with the expectation that it will provide criteria for determining whether or not reasonable progress in improving visibility is being made, or whether additional efforts will be required.

Other programs under development or being implemented by the USEPA that will provide benefits for visibility, especially in improvements from urban based regional haze, include development of clean fuel regulations, low emitting vehicle development, heavy duty engine emission standards for trucks and buses, retrofit requirements for urban buses and new standards for diesel locomotives.

There are also local programs that will contribute to the protection from, and reduction of, visibility impairment in many parts of the state, including mandatory Class I areas. Prohibitions against backyard burning, control of fugitive dust from construction sites and control of point sources in their jurisdiction are good examples.

**5.2 Measures to Mitigate the Impacts of Construction Activities** - The current Visibility SIP stated that construction activities had not been determined to contribute to any impairment in mandatory Class I areas. No evidence has come to light to contradict that statement; however, as noted previously, control of fugitive dust from construction sites has been undertaken by local air agencies, generally as part of particulate NAAQS attainment efforts or state nuisance abatement requirements.

**5.3 Source Retirement and Replacement Schedules** - These factors were not included as part of the management strategies under the current Visibility SIP because, "Currently no stationary air pollution source has been identified by the FLM or the state as contributing to impairment." The SIP went on to say, "If such sources are identified in the future, then source retirement/replacement will be considered in a BART review." Should a BART analysis be required of any source in the future, retirement/replacement schedules will be considered.

**5.4 Smoke Management Techniques for Agricultural and Forestry Management** - This factor received the most attention in the current Visibility SIP because it was the most visible issue at the time the Visibility SIP was prepared. Development and implementation of visibility protection considerations in the Smoke Management Plan (SMP) were completed by the Washington State Department of Natural Resources in consultation with Ecology and the FLM. The SMP has been updated since then to further enhance visibility protection through setting emission reduction goals and expanding the visibility protection period. The plan is frequently identified as a model for smoke management nationally and, as noted in letters from the FLM, has been successful in significantly reducing visibility impacts in mandatory Class I areas from silvicultural activities during the visibility protection period.

Discussion of utilization of forestry slash residue is also required by the SIP. Ecology feels it is most appropriate to include this discussion as a sub-section under the heading of Smoke Management long-term control strategies rather than as a separate heading as identified in the current Visibility SIP, (see discussion in Section 8.6-(K)). A discussion of utilization follows in Section 5.4.1.

Agricultural burning has not been identified as a significant contributor to visibility impairment in mandatory Class I areas since it mostly occurs in the eastern side of the state. Recent actions have been taken to reduce emissions from agricultural burning for health based reasons.

**5.4.1 Forestry Slash Residue Utilization** - The current Visibility SIP requires a discussion of incentives such as tax credits and low cost loans to promote utilization and legal aid to change or modify blocking legislation. Although these specific barriers to utilization are no longer pertinent, a discussion of utilization in general follows.

State and private landowners have not needed incentives, tax credits or low cost loans to take advantage of pulp markets in recent years in eastern or western Washington. Cogeneration plants now make electricity from wood waste fuel in Spokane, Everett and north of Colville in competition with cheap hydropower from the Columbia River.

On the other hand, a stable supply of small size wood products such as utility logs, pulp, or hog fuel at a fixed cost is needed to stimulate private sector investments that can better utilize dense dry true fir stands on federal lands in eastern Washington. The FLM have not been able to make the needed long term supply commitments. This may be changing once watershed analysis and forest plans are completed under new guidelines protecting fish and wildlife habitat and other values on an ecosystem scale. Once FLM alternatives based on the final EISs for the Columbia Basin are available from the NEPA process, timber sale, thinning, and utilization contracts may be greatly facilitated.

The FLM have not been able to take advantage of good pulp markets which fluctuate so greatly from year to year with international economies. Pulp mills find the cheapest source each year, which may not be the local forest or in the United States. Federal forest multiple use management has been further complicated by the Northwest Forest Plan, watershed analysis, wildlife habitat conservation, and ecosystem planning. This has made it difficult for the FLM to take advantage of the highly volatile pulp market on short notice.

The FLMs face more constraints than other landowners in utilizing the buildup of fuels and restoring forest health in eastern Washington. Huge amounts of biomass need to be removed from federal lands in eastern Washington to reduce the growing threat of catastrophic wildfire (which can seriously impact visibility). A big increase in thinning, utilization, and other appropriate management practices, including prescribed fire, is needed on federal lands. One goal is to replace low vigor overstocked stands with more fire tolerant stands resulting in fewer catastrophic fires.

Catastrophic wildfires produce emissions that occur during summer and early fall, when high pressure systems and prevailing wind patterns are more likely to result in visibility impacts to mandatory Class I areas. Increases in utilization on federal lands over many years can help to reduce the size and intensity of wildfire and potential smoke impacts to mandatory Class I areas.

Even with more utilization we can expect to see some future increases in prescribed burning on these lands for many years. It is not clear whether these increases are likely to exceed the 50 percent emission reduction from silvicultural forest burning by 2001 required under RCW 70.94.665. However, most burning of piled logging slash in eastern Washington is now accomplished outside of the primary visibility protection season, when prevailing winds from west to east and turbulent weather patterns disperse smoke away from all mandatory Class I areas.

If further roadblocks to utilization are identified on federal lands in eastern Washington following modification of existing forest management plans to reflect the Basin-wide values,



then they may need to be addressed at the next Visibility SIP review. At the present time no other significant roadblocks have been identified except perhaps the low cost of hydroelectric power in this region of the country which may discourage cogeneration as a form of utilization.

**5.5 Strategy Coordination with Existing Land Management Plans and Goals** - The current Visibility SIP gives strong support to federal land management goals under Congressional mandates such as the Organic Act, the Wilderness Act, the National Environmental Policy Act, the Endangered Species Act, and the National Forest Management Act. The state continues to coordinate with federal agencies and support their efforts to manage and protect our national parks and wilderness areas.

Federal Land Managers have acknowledged that years of fire suppression, single species reforestation and other management practices have resulted in increasingly unhealthy forests in our parks and wilderness areas. They have asked the USEPA, state and local land management and air regulators to work with them to develop methods and policies to reintroduce fire into their forest ecosystems in an attempt to improve forest health, while at the same time, minimizing impacts to visibility and assuring maintenance of national health based air quality standards.

Ecology should continue to work closely with the FLMs and incorporate appropriate policy decisions into the revised Visibility SIP when appropriate.

**5.6 Conclusions** - Taken all together, the previously identified, ongoing emissions reduction programs will undoubtedly have a beneficial impact on visibility. When criteria for judging "reasonable progress" has been developed by the USEPA and better emissions inventories and modeling technologies are completed, it may be possible to quantify these levels of protection or improvement. At this time, it can only be stated that it appears reasonable to assume emission reductions due to ongoing air pollution control programs will result in improvements to visibility.

## 6.0 Assessment of the Need to Remedy Any Identified Impairment from Existing Sources

The current Visibility SIP, approved May 7, 1987, identifies three mandatory Class I areas as suffering from visibility impairment. The certification of visibility impairment is found in the November 10, 1982 letter from the NPS and included in the current Visibility SIP as Appendix D. Those three areas are Mount Rainier, Olympic and North Cascades national parks.

Consultation with FLMs in 1996 resulted in a reaffirmation from the NPS that the three national parks previously mentioned still suffer from visibility impairment. Further, the USFS has responded that visibility impairment exists in all five mandatory Class I wilderness areas in Washington State. Those five mandatory Class I wilderness areas are Alpine Lakes, Glacier Peak, Goat Rocks, Mount Adams and Pasayten. The FLM letters are discussed in Section 1 of this report and are included as Appendix A of this report.

Visibility improvement has been acknowledged by the FLMs but limited to improvements resulting primarily from management and reductions in summertime vegetative burning in western Washington. Both the NPS and the USFS specified regional haze as the current source of visibility impairment in their mandatory Class I areas. The NPS additionally reaffirmed its determination that a portion of the visibility impairment at Mount Rainier can be reasonably attributed to emissions from the Centralia Power Plant in Lewis County. The NPS further concluded that studies and monitoring data suggest it may be possible to "reasonably attribute" a portion of the current regional haze to nearby source areas or source types under Phase I of the visibility protection program.

Monitoring data and published reports single out sulfur emissions as the single most significant source of visibility impairment. Analysis of data from the IMPROVE network concludes that 86 percent of the average annual light extinction in the Cascade Mountain region is due to aerosols and that the largest contributors to aerosol extinction are sulfates<sup>1</sup>. Reductions in natural sulfur emissions from Mt. St. Helens and elimination of sulfur emissions resulting from the closure of ASARCO copper smelter in Tacoma have left the Centralia Power Plant as the largest remaining SO<sub>2</sub> source in Washington.

Other sources of SO<sub>2</sub> in the Washington Point Source Air Emissions Inventory of facilities that emit over 250 tons per year of a pollutant that contribute to visibility impairment include aluminum smelters, oil refineries and pulp mills. Collectively, these sources emit only a fraction of the amount of SO<sub>2</sub> currently emitted by the Centralia Power Plant. Geographically, the largest collection of these smaller sources can be found in the Anacortes/Ferndale area.

The IMPROVE data indicates that organic carbon is the second largest annual contributor to aerosol light extinction in the Cascade Mountain region. Organic carbon is contributed by a

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<sup>1</sup> "Spatial and Seasonal Patterns and Long Term Variability of the Composition of the Haze in the United States: An Analysis of the Data from the IMPROVE Network," Sisler et al, Cooperative Institute for Research in the Atmosphere, Colorado State University, July 1996.

variety of sources including wood combustion and agricultural and silvicultural burning but is not generally associated with Phase I type point sources.

Another monitored and inventoried visibility impairing pollutant that is identified in reports is nitrate. Nitrate is formed from oxides of nitrogen (NO<sub>x</sub>), which are predominately emitted from mobile onroad and nonroad sources as opposed to Phase I type point sources. These mobile sources emit more than three times as much NO<sub>x</sub> as all the major point sources combined. The Centralia Power Plant is the single largest major point source of NO<sub>x</sub> in the inventory.

In an October 16, 1995 letter the NPS asked Ecology to review and, if appropriate, confirm a finding of reasonable attribution with respect to the Centralia Power Plant's impact on visibility in Mount Rainier National Park; or, as an option, participate in discussions with the owners of the Centralia Power Plant to see if all parties could agree on control strategies that would result in additional SO<sub>2</sub> reductions that would settle all concerns raised about the Centralia Power Plant's emissions.

Federal, state and local air officials and federal land managers chose to enter into a negotiation process with the owners of the Centralia Power Plant as a process that could yield results that would settle the NPS concerns and comply with the Federal Clean Air Act and the Washington Visibility SIP.

Tentative results of that negotiation process are acceptable to all participants in the process. Subject to considerations by the Washington State Legislature and actions by the Southwest Air Pollution Control Authority, including a formal public comment process, the target solution will result in removal of 90 percent of the sulfur dioxide emissions from the Centralia Power Plant by installing sulfur dioxide scrubbers and low nitrogen oxide burners in the boilers by the end of 2002. Ecology expects implementation of the target solution to result in levels of control that demonstrate reasonable progress towards remedying existing visibility impairment and are equal or better than the levels of control that would be required by WAC 173-400-151. Further, Ecology anticipates that issuance of an enforceable order reflecting the agreed upon emission limits would satisfy NPS concerns and if approved by EPA as a SIP revision, would comply with the Federal Clean Air Act and the Washington Visibility SIP. Alternatively, in the event the target solution is not incorporated into an enforceable order by November 30, 1997, Ecology will explore alternative measures for the Centralia Power Plant that will address the visibility impairment in Mt. Rainier National Park.

The question of whether visibility impairment at Mt. Rainier, Olympic and North Cascades National Parks can be attributed to remaining Phase I sources, after emission reductions from the Centralia Power Plant are achieved, is extremely complex. It is not even known whether these remaining sources will continue to cause impairment that will be perceptible in a mandatory Class I area. It is likely that at a minimum a regional modeling assessment would need to be conducted to ascertain whether these remaining sources may be causing or contributing to perceptible impairment in mandatory Class I areas.

The Clean Air Act and federal visibility regulations limit application of the Best Available Retrofit Technology requirements to sources by the type of facility, potential to emit 250 tons per year of visibility impairing pollutants and the year they came into operation. Washington State regulations related to this issue are silent on type of facility or the year they came into operation and consider only sources whose actual emissions are over 250 tons per year. It will be recommended elsewhere in this review that these differences between state and federal regulations be considered and possibly eliminated through rule revisions (see Section 7.1).

For purposes of this review, state regulations were used since they seem more encompassing. The first threshold question is: "Can any of the 250 ton sources in the Point Source Air Emissions Inventory be reasonably anticipated to cause or contribute to impairment at any of the eight mandatory Class I areas?" Based on the criteria set forth above, sources which may be reasonably anticipated to cause or contribute to visibility impairment are listed in Table 6.1. Lacking a state or federal definition of "contribute," and given the spatial distribution of mandatory Class I areas and the variable meteorology impacting them, it is essentially impossible to eliminate any sources from consideration as contributors.

The second question is: "Is the visibility impairment 'reasonably attributable' to the emissions from any of these sources?" Reasonably attributable is defined in federal regulations and the Visibility SIP as "attributable by visual observation or any other technique the State deems appropriate."

There is no record of visual observations of any of the identified sources in Table 6.1 as impacting visibility at any of the national parks suffering from impairment. The NPS has identified general source categories as contributing to visibility impairment from regional haze and the Centralia Power Plant as a source of emissions to which visibility impairment at Mt. Rainier and other mandatory Class I areas can be attributed. The state has investigated and attempted to use regional modeling and chemical speciation and source apportionment analysis as possible techniques for reasonable attribution of emissions from Phase I sources. At this time, the state agrees with the NPS conclusion that some Phase I type sources are contributing to regional haze. The state has also determined there is insufficient basis for reasonably attributing existing visibility impairment to any individual source with the possible exception of the Centralia Power Plant.

The state has also determined that, if legally enforceable limits, based on the signed, negotiated target solution are placed on the Centralia Power plant and made a part of the Visibility SIP approved by the USEPA, the state expects to conclude that the emission reductions will result in reasonable progress towards improving visibility in Mt. Rainier National Park and other mandatory Class I areas.

It is expected that during the Visibility SIP revision phase recommended by this review, and future Visibility SIP reviews, the status of SO<sub>2</sub> reductions from the Centralia Power Plant and its contribution to visibility impairment in Mt. Rainier National Park and other mandatory Class I areas will be evaluated. Additionally, if the target solution is not implemented or is found to be unsatisfactory to assure reasonable progress in visibility improvement, the state will revisit the question of "reasonable attribution."

Table 6.1 Sources with Actual emissions greater than or equal to 250 tons per year of visibility impairing pollutants

AGENCY	NAME	CITY	TSP_TPY	PM10_TPY	SO2_TPY	NOX_TPY
PSAPCA	HOLNAM, INC., IDEAL DIVISION	SEATTLE		93	805	2360
PSAPCA	WA, UNIV OF, POWER PLANT & HOSPITAL	SEATTLE		3	19	397
PSAPCA	ASH GROVE CEMENT COMPANY (E MARG,)	SEATTLE		74	109	837
PSAPCA	NAVSHIPYD PUGET SOUND	BREMERTON		32	90	292
PSAPCA	PUGET POWER (FREDERICKSON)	TACOMA		48	0	508
ECY-INDST	PT TOWNSEND PAPER	PORT TOWNSEND	397	327	1030	596
ECY-INDST	SIMPSON TACOMA KRAFT	TACOMA	302	236	1178	714
ECY-INDST	KAISER ALUMINUM AND	TACOMA	463	120	1368	6
NWAPA	TEXACO INC	ANACORTES	368	244	3638	1545
NWAPA	SHELL OIL	ANACORTES	881	323	2694	1608
NWAPA	TOSCO NW COMPANY	FERNDALE	110	78	2686	807
NWAPA	ARCO CHERRY PT REF.	FERNDALE	144	144	1880	2079
OAPCA	DAISHOWA AMERICA	PORT ANGELES	126	104	1003	278
ECY-INDST	INTALCO ALUMINUM	FERNDALE	607	335	3788	52
SWAPCA	PACIFIC POWER	CENTRALIA	3241	2789	67435	22269
ECY-INDST	JAMES RIVER II	CAMAS	389	235	238	1576
ECY-INDST	VANALCO, INC	VANCOUVER	890	460	2677	76
ECY-INDST	LONGVIEW FIBRE	LONGVIEW	632	582	1061	3344
ECY-INDST	WEYERHAEUSER CO	LONGVIEW	625	569	1366	3434
ECY-INDST	REYNOLDS METALS	LONGVIEW	1297	500	56	22
BCCAA	UNOCAL DIV. BUS., AG. PRODUCTS	KENNEWICK	110	27	0	1631
ECY-NUCWST	U.S. DEPT OF ENERGY	RICHLAND	26	19	691	342
ECY-INDST	ALUM CO OF AMERICA	WENATCHEE	429	227	3804	0
ECY-INDST	COLUMBIA ALUMINUM	GOLDENDALE	375	340	389	63
ECY-INDST	KAISER ALUM & CHEM	MEAD	819	185	4757	135
ECY-INDST	BOISE CASCADE	WALLULA	264	248	2031	922

NOTE: From 1994 point source air emissions inventory

## 7.0 Review and Assessment of Current Visibility SIP and Rules for Completeness

Specific parts of the Washington State regulations and the Visibility SIP are deficient, incomplete or different from that required by federal regulations for Phase I visibility SIPs. A review of the current Visibility SIP and Ecology regulations which relate to visibility was conducted by the SIP review team in consultation with the USEPA. The review team reached the following conclusions and recommendations.

**7.1 Retrofit Requirements for Visibility Protection** - Appendix A of the Visibility SIP (Proposed Best Available Retrofit Technology) is WAC 173-403-051, which deals with best available retrofit technology (BART). Chapter 173-403 WAC has since been repealed and portions readopted into Chapter 173-400 WAC. The section dealing with BART is WAC 173-400-151, (adopted in 1991). The Team agrees that:

- ◆ The definition of significant impairment is consistent with the federal regulation.
- ◆ The rule includes the following steps:
  1. FLM certifies visibility impairment.
  2. Ecology identifies sources that are reasonably attributable to the impairment.
  3. Ecology makes a BART determination.
  4. The pollution source can apply to the USEPA for exemption based on the belief that their contribution is not significant.
- ◆ The word “significant” should be removed from WAC 173-400-151(2) and (3) to be consistent with the federal rule. Federal Court decisions since the current rule language was adopted have clarified that visibility impairment does not have to be significant to trigger a reasonable attribution determination. However, if the owner/operator of a source (that is reasonably attributable for the impairment and for which a BART determination has been made) applies for an exemption from BART it must show that the visibility impairment attributed to that source is not significant. The issue of significance of the impairment only comes into play when a source owner/operator applies for an exemption under WAC 173-400-151(4), which is pursuant to 40 CFR 51.303.
- ◆ Provisions in WAC 173-400-151(4) are consistent with the federal regulation and satisfy the requirement to include FLM consultation and concurrence with the USEPA in any source exemption decision.
- ◆ The definition of “existing stationary facility” in WAC 171-400-030(26) is not consistent with the federal version (40 CFR 51.301(e)). The federal version has an exclusionary clause for sources already in operation prior to August 7, 1962, or that came into existence after August 7, 1977, (apparently sources which came into existence after August 7, 1977 would be evaluated for potential to impair visibility through the NSR program). Many of our large sources would be excluded under the federal definition because they predate 1962.

Further evaluation of why the exclusionary clause was omitted from the WAC needs to be made. If it is determined that it was an oversight or is no longer applicable then the definition for "existing stationary facility" in WAC 171-400-030(26) should be revised to be consistent with the federal definition.

- ◆ WAC 171-400-151 uses the term "source" rather than "existing stationary facility" and had WAC 171-400-151 not further qualified that the source must emit more than 250 tons per year it could be construed as applying to all sources. This was clearly not the intention of the BART regulation. The term "source" in WAC 171-400-151 needs to be replaced with the term "existing stationary facility."

Some of the above proposed changes, if appropriate, will require rule amendments. It may be possible to combine these amendments with other amendments that are being done on Chapter 173-400 WAC. After the amendments have been made, this section will be submitted to the USEPA for comment, approval and adoption into the Visibility SIP.

**7.2 New Source Review** - The new source review (NSR) citation that appears in the 1985 Visibility State Implementation Plan makes reference to Chapter 173-403 WAC. As noted above, that WAC has since been repealed and portions readopted into Chapter 173-400 WAC. Such is the case with new source review which was adopted into WAC 173-400-110, 112, and 113. Subsections WAC 173-400-112(9) and 113(6) deal with visibility protection for major new source review in attainment and non-attainment areas. These subsections will be submitted to the USEPA for review and comment. Based on the USEPA comment, these sections will be submitted for adoption into the Visibility SIP. Further discussions with the USEPA will determine if additional delegation of the PSD program to Ecology is desired or warranted.

NSR for PSD permitting is covered in WAC 173-400-141. The criteria for visibility impact analysis incorporated in the Federal PSD program (40 CFR 52.21) and its supporting guidance is incorporated into state regulations by reference. An analysis of visibility impacts using the better of the VISCREEN or PLUVUE plume visibility prediction models is a routine portion of each major source permit application review and analysis.

**7.3 Interstate Coordination** - It is recognized that pollution knows no political boundaries and that pollutants can cross those boundaries and impair visibility in mandatory Class I areas of states adjacent to Washington. On May 4, 1987, the USEPA approved Washington's Visibility SIP conditional on Washington developing interstate visibility protection measures at the time of the next periodic review. These measures are to provide a level of protection to Oregon's mandatory Class I areas which is comparable to protection of Washington's mandatory Class I areas as provided by the Oregon Visibility SIP. Development of additional visibility protection measures will be contingent upon Oregon demonstrating that sources in Washington impair visibility in its mandatory Class I areas.

Ecology will also seek contacts in Idaho and Montana to review the ability of Washington's Visibility SIP to protect mandatory Class I areas of these states. Development of additional visibility protection measures for Washington's Visibility SIP will be contingent upon Idaho and/or Montana demonstrating that sources within Washington impair visibility in their mandatory Class I areas.

Through the NSR program, Ecology currently notifies affected land managers in adjacent states of proposals for new or modified stationary sources that may potentially affect visibility in mandatory Class I areas of those adjacent states. Washington's BART regulation currently addresses impairment from existing sources in mandatory Class I areas of adjacent states. Existing provisions in the NSR and BART regulations are consistent with the condition to provide protection to mandatory Class I areas of adjacent states from emissions from new, modified and existing major point sources. Ecology believes no new regulations are needed with respect to major point sources' impacts on mandatory Class I areas of adjacent states.

The Smoke Management Plan (SMP), administered by the Washington State Department of Natural Resources (WDNR) has no specific language addressing visibility impacts to mandatory Class I areas of adjacent states from prescribed burning (although the SMP does have specific language which disallows any burn that would knowingly violate another state's air quality standards). Because the SMP calls for curtailment (as opposed to plume trajectory management) of any burning on Friday, Saturday and Sunday between June 15 and September 30, it is expected that the same benefits will occur for mandatory Class I areas of adjacent states. In practice, the WDNR disallows any burn that would send a plume into a mandatory Class I area of an adjacent state. Therefore, Ecology envisions that formalizing these protection measures by developing specific language addressing mandatory Class I areas of adjacent states as a revision to the SMP and subsequent adoption into the Visibility SIP would satisfy the need to protect visibility in mandatory Class I areas of adjacent states from emissions resulting from prescribed burning. This will be explored further during discussions with representatives of the adjacent states and is contingent upon these states demonstrating that prescribed burning in Washington State is impairing visibility in their mandatory Class I areas.

Regional haze and non-point sources (such as mobile, the cumulative impact of small point sources, and area sources) which contribute to regional haze are not being addressed in this review and revision cycle and will not be considered for inclusion in interstate coordination programs at this time.



## **8.0 Current Visibility SIP Will Be Brought Up to Date Administratively**

The objective of this section is to identify administrative and “housekeeping” revisions necessary to bring the original Visibility SIP up to date, but will not make substantive changes in the visibility protection program as it is currently administered. Listed below are changes necessary to make the original Visibility SIP a current and useful document. These are suggested changes and revisions not addressed elsewhere in this report. Some of these revisions and updates may really be of a more substantive nature than one would be led to expect under this heading. Likewise, possible revisions identified elsewhere in this report may not be substantive.

It was difficult to delineate a difference between a substantial and minor revision to the SIP. At any rate, revisions to the Visibility SIP, small or large, will be made only in accordance with formal SIP revision process requirements.

**8.1 Background Section** - A background section should be added to the Visibility SIP. This section should discuss issues up to the present.

**8.2 Update Mandatory Class I Area Acreage** - Per the FLM letters in Appendix A, acreage for current mandatory Class I areas should be updated.

**8.3 Incorrect or Outdated WAC and CFR References** - Many of the Washington Administrative Codes (WACs) and Code of Federal Regulations (CFRs) referenced throughout the original Visibility SIP are incorrect due to repeal, readoption, or revision to various regulations. For instance, WAC 173-403 has been replaced and renumbered as 173-400. 40 CFR 51.24 (redesignation to Class I) is now 52.21(g).

**8.4 Map of Class I Areas** - Map should be updated to include the Spokane Reservation which was redesignated to a non-mandatory Class I area on April 12, 1991.

**8.5 Adopt Current Smoke Management Plan (SMP) into the Visibility SIP** - The Washington State Smoke Management Plan has been revised twice since the original 1985 revision addressing visibility protection. In 1993 the SMP was revised to enhance visibility protection through setting emission reduction goals and expanding the visibility protection period. This was done specifically to meet “reasonable progress” goals of state and federal visibility protection regulations. Then in 1996, the SMP was revised to recognize the need to conduct forest health burning in eastern Washington while maintaining the enhanced protection of visibility of the 1993 revision.

The revised SMP has not yet been adopted into the Visibility SIP. The revised SMP should be submitted for adoption into the Visibility SIP.

**8.6 Visibility SIP Review Report Requirements** - The Washington Visibility SIP has specific language about what will be assessed in the SIP review. These requirements are based on the federal requirements found in 40 CFR 51.306(c)(1) - (7). In addition, the Visibility SIP lists an additional five review requirements that are not part of the federal requirements of 40 CFR

51.306(c). Understanding what the original Visibility SIP authors intended by these additions has been challenging, but in three of the cases it seems to be due to a misreading of the CFR. In addition, one federal requirement, 40 CFR 51.306(c)(6), impact of exemptions granted under 40 CFR 51.303, is not included in the current Visibility SIP. These anomalies will be explained below.

Listed below are the Visibility SIP review requirements as found in Washington's Visibility SIP. After each the equivalent CFR is identified, and where the requirement is not from 40 CFR 51.306(c)(1) - (7), a discussion follows.

Washington SIP Review Report Requirements (from "Revision to the Washington State Implementation Plan, Washington State's Visibility Protection Program," March 1985, Section VIII. F., Review and Revision Procedures, pg. 26 - 27).

The SIP review report will include an assessment of:

- A. The progress achieved in remedying existing visibility impairment in any Class I area. *40 CFR 51.306(c)(1).*
- B. The ability of the long-term strategy to prevent future visibility impairment in any Class I area. *40 CFR 51.306(c)(2).*
- C. Any change in visibility since the last report; in the case of the first report, any changes since plan approval. *40 CFR 51.306(c)(3).*
- D. Additional measures which may be needed to assure reasonable further progress toward remedying existing and preventing future impairment. *40 CFR 51.306(c)(4).*
- E. Progress in implementing BART, if BART determinations have been made. *40 CFR 51.306(c)(5).*
- F. The need for BART to remedy existing visibility impairment of any integral vista listed in the plan since the last report, or in the case of the first report, since plan approval. *40 CFR 51.306(c)(7).*
- G. Review of additional proposed integral vistas, if any, and adoption into the SIP of those meeting selection criteria. *40 CFR 51.304. This is not a review report requirement as found in 40 CFR 51.306(c). Requirements for review and adoption of any proposed integral vistas should have been included and discussed in Section III. C. (pages 4 -6) of the original Visibility SIP. This should be removed from Section VIII. F. and an expanded discussion added to Section III. C. of the original Visibility SIP.*

- H. Review of projected impacts to visibility in any Class I area [or] any proposed new major stationary source or modification. 40 CFR 51.306(d)..

*and*

- I. Review of impacts any new major stationary source or major modification may have on visibility in any Class I area. 40 CFR 51.306(d). (H.) and (I.) are puzzling for two reasons. First they both seem to be saying the same thing. Second, the review of impacts from new or modified sources is already conducted under the New Source Review (NSR) program on an ongoing basis. The requirement to add visibility protection to the NSR program is discussed in 40 CFR 51.306(d), and is not an element of the periodic Visibility SIP review requirements defined under 40 CFR 51.306(c) which, incidentally, directly precedes it. It is our theory that the original Visibility SIP authors may have mistakenly construed 40 51.306(d) to be an eighth SIP review report requirement, when in fact it really addresses the requirement for states to revise their NSR programs to include evaluation of visibility impacts. The NSR program has been revised to address visibility impacts..

*Visibility SIP review requirements (H.) and (I.) should be removed from the SIP.*

- J. Progress in decreasing impacts from prescribed forestry burning, including rescheduling, utilization and emission reduction programs. No federal equivalent. (J.) should really be discussed as part of SIP report requirements (A.) and (B.) along with the discussions of emission trends and projections of other sources. The original Visibility SIP authors probably listed this separately due to the significance of this source at that time. However, Ecology intends to evaluate the trends and projections of all sources impacting visibility, now and at future reviews. We see no reason to give this source a separate evaluation requirement.

*Visibility SIP review requirement (J.) should be removed from the SIP with the understanding that prescribed fire emissions will be considered under (A.) and (B.) along with emissions from other sources..*

- K. Discussion of incentives such as tax credits and low cost loans to promote utilization, and legal aid to change or modify blocking legislation. No federal equivalent. At the time of the original Visibility SIP one barrier to increased utilization of forest slash was a lack of a profitable market for use of chipped slash as hog fuel. Tax credits, low cost loans and revised legislation was seen as a means to promote these types of markets. Although barriers to utilization still exist, these barriers are of a nature that cannot be changed by tax credits, low cost loans and legal aid to change blocking legislation. Ecology recommends that (K.) be revised to require an overall assessment of utilization and barriers to utilization rather than be limited to just the specific issues addressed in the current version. Also, the discussion of utilization should be moved to the section on long-term control strategies for smoke management, (see Section 5.4.1).

Missing Requirement 40 CFR 51.306(c)(6). The impact of any exemption granted under 40 CFR 51.303, (BART regulations). *No Washington State equivalent. To date no BART determinations have been made, thus no exemptions have been applied for or granted. Therefore omission of this requirement has not effected the visibility protection program in Washington State. Nonetheless, language consistent with 40 51.306(c)(6) should be added to the Visibility SIP.*

## **9.0 Recommendation on the Need to Revise the Current Visibility SIP and Summary of Recommended Action Items**

Reasonable progress toward the national goal has occurred because of smoke management efforts, review and control of new sources coming into the state, and emission reductions due to other air quality programs.

The long term strategy to meet the national goal contained in the current Visibility SIP is adequate to prevent future impairment from Phase I sources, but inadequate to assure reasonable progress from regional haze impairment in mandatory Class I areas.

Revisions to the Visibility SIP are needed to assure reasonable progress on dealing with visibility impairment due to regional haze. Washington State looks forward to the development of federal regional haze regulations so it can begin developing its own program.

Other revisions or updates to the Visibility SIP and action items related to visibility protection that this review identified are:

1. Further develop the concept of a visibility protection period and adopt into the Visibility SIP as a management goal (see Section 1.1).
2. Review and evaluate and, if appropriate, adopt into the Visibility SIP the new integral vistas proposed by the FLM (see Section 1.2).
3. In consultation with the FLM, further explore the need for and, if appropriate, possible options for providing additional visibility protection to the Class II areas identified by the FLM (see section 1.3).
4. Continue to work on resolving differences in methodology for apportioning light extinction values to different pollutant species (see Section 2.1.2).
5. Attempt to develop a set of quantifiable milestones for measuring reasonable progress towards the national visibility goal (see Section 2.1.3).
6. Continue to refine methods to accurately apportion the contribution of various emission source categories to pollutant species which cause regional haze (see Section 2.2.3).
7. Complete the current expansion of the mandatory Class I area visibility monitoring network including the addition of one site near the Glacier Peak Wilderness (see Section 3.1).
8. Continue to work on resolving differences in nephelometric monitoring methodology (see Section 3.1).

9. Continue to refine the emission inventory of pollutants which contribute to regional haze in support of regional haze modeling (see Section 4.1 and 4.1.1).
10. Continue to refine modeling and model utility, as appropriate, to increase our understanding of regional haze impacts in mandatory Class I areas (see Section 4.2).
11. When the proposed emission limits for the Centralia Power Plant become part of an enforceable order, adopt these emission limits into the Visibility SIP. If an enforceable order is not issued by November 30, 1997, alternative measures will be explored (see Section 6).
12. Further evaluate the WAC 173-400-151 (BART Regulation) and, if appropriate, make revisions as recommended and adopt into the Visibility SIP (See Section 7.1).
13. Further evaluate WAC 173-400-110, 112 and 113 (NSR regulation) and, if appropriate, make revisions as recommended and adopt into the Visibility SIP (see Section 7.2).
14. In consultation with the FLM, adjacent states and the Washington State Department of Natural Resources, develop, if appropriate, an interstate coordination program for visibility protection (see Section 7.3).
15. Make the recommended updates, corrections and revisions as discussed in Section 8, including adopting the current Smoke Management Plan into the Visibility SIP (see Section 8.5) and making corrections to the Visibility SIP Review reporting requirements (see Section 8.6).

A Visibility SIP revision team will be formed consisting of staff from Ecology, the FLM, the USEPA, and state land management agencies. Members of the public, local government, and stake holder organizations will be invited to serve on an advisory committee to the Visibility SIP revision team. The Visibility SIP revision team will develop a work plan for developing and implementing the revision.