6.0 STATE AND CLASS I AREA SUMMARIES

As described in Section 2.0, each state is required to submit progress reports at interim points between submittals of Regional Haze Rule (RHR) State Implementation Plans (SIPs), which assess progress towards visibility improvement goals in each state's mandatory Federal Class I areas (CIAs). Data summaries for each CIA in each Western Regional Air Partnership (WRAP) state, which address Regional Haze Rule (RHR) requirements for visibility measurements and emissions inventories are provided in this section. These summaries are intended to provide individual states with the technical information they need to determine if current RHR implementation plan elements and strategies are sufficient to meet all established reasonable progress goals, as defined in their respective initial RHR implementation plans.

6.14 WASHINGTON

The goal of the RHR is to ensure that visibility on the 20% most impaired, or worst, days continues to improve at each Federal Class I area (CIA), and that visibility on the 20% least impaired, or best, days does not get worse, as measured at representative Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites. Washington has 8 mandatory Federal CIAs, which are depicted in Figure 6.14-1 and listed in Table 6.14-1, along with the associated IMPROVE monitor locations.

This section addresses differences between the 2000-2004 baseline and 2005-2009 period, for both monitored data and emission inventory estimates. Monitored data are presented for the 20% most impaired, or worst, days and for the 20% least impaired, or best, days, as per Regional Haze Rule (RHR) requirements. Annual average trend statistics for the 2000-2009 10-year period are also presented here to support assessments of changes in each monitored species that contributes to visibility impairment. Some of the highlights regarding these comparisons are listed below, and more detailed state specific information is provided in monitoring and emissions sub-sections that follow.

- For the best days, the 5-year average deciview metric decreased at all Washington Federal CIA IMPROVE sites except the WHPA1 site.
  - The increase on best days at the WHPA1 site was small (0.1 dv), and due to an increase in average ammonium sulfate, which was partially offset by a decrease in ammonium nitrate. This was not consistent emissions inventory comparisons which showed decreases in state-wide emissions of SO_2, and decreases in annual averages of SO_2 from EGU sources.
- For the worst days, the 5-year average deciview metric decreased at all sites.
  - For the worst days, all sites measured lower 5-year averages of ammonium nitrate, and all sites measured either decreasing or insignificant annual average trends in ammonium sulfate and ammonium nitrate. This was consistent with emission inventory comparison results that showed net decreases in NO_X and SO_2 emissions, mostly due to reductions from point and mobile sources.
  - All sites except WHPA1 showed decreasing trends in elemental carbon. Emissions inventory comparisons showed decreasing off-road mobile sources of elemental carbon, but increasing on-road sources. Other on-road species (e.g. oxides of nitrogen, SO_2, and volatile organic carbon) decreased, so inventory increases in elemental carbon may be due to methodology differences.

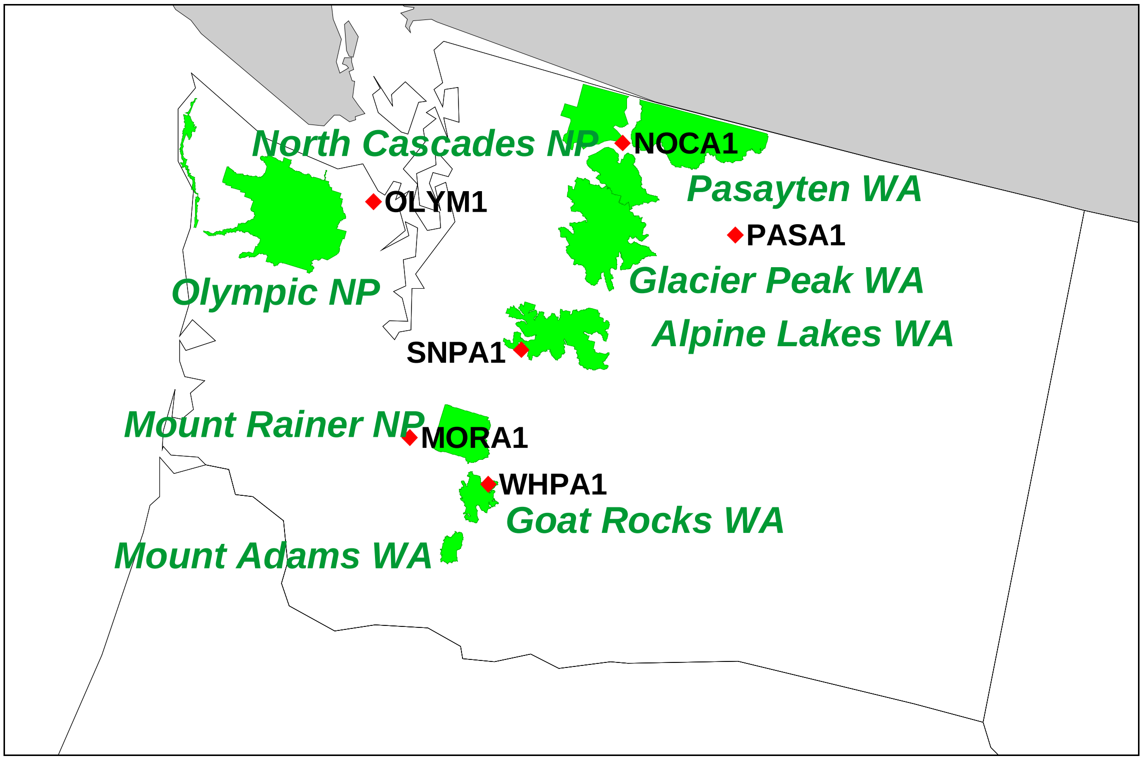

Figure 6.14-1. Map Depicting Federal CIAs and Representative IMPROVE Monitors in Washington.

Table 6.14-1
Washington CIAs and Representative IMPROVE Monitors

Class I Area	Representative IMPROVE Site	Latitude	Longitude	Elevation (m)
Mount Rainer NP	MORA1	46.76	-122.12	439
North Cascades NP Glacier Peak WA	NOCA1	48.73	-121.06	568
Olympic NP	OLYM1	48.01	-122.97	599
Pasayten WA	PASA1	48.39	-119.93	1627
Alpine Lakes WA	SNPA1	47.42	-121.43	1049
Goat Rocks WA Mount Adams WA	WHPA1	46.62	-121.39	1827

6.14.1 Monitoring Data

This section addresses RHR regulatory requirements for monitored data as measured by IMPROVE monitors representing Federal CIAs in Washington. These summaries are supported by regional data presented in Section 4.0 and by more detailed site specific tables and charts in Appendix N.

As described in Section 3.1, regional haze progress in Federal CIAs is tracked using calculations based on speciated aerosol mass as collected by IMPROVE monitors. The RHR calls for tracking haze in units of deciviews (dv), where the deciview metric was designed to be linearly associated with human perception of visibility. In a pristine atmosphere, the deciview metric is near zero, and a one deciview change is approximately equivalent to a 10% change in cumulative species extinction. To better understand visibility conditions, summaries here include both the deciview metric, and the apportionment of haze into extinction due to the various measured species in units of inverse megameters (Mm^{-1}).

6.14.1.1 Current Conditions

This section addresses the regulatory question, ***what are the current visibility conditions for the most impaired and least impaired days (40 CFR 51.308 (g)(3)(i))?*** RHR guidance specifies that 5-year averages be calculated over successive 5-year periods, i.e. 2000-2004, 2005-2009, 2010-2014, etc.[1] Current visibility conditions are represented here as the most recent successive 5-year average period available, or the 2005-2009 period average, although the most recent IMPROVE monitoring data currently available includes 2010 data.

Tables 6.14-2 and 6.14-3 present the calculated deciview values for current conditions at each site, along with the percent contribution to extinction from each aerosol species for the 20% most impaired, or worst, and 20% least impaired, or best, days for each of the Federal CIA IMPROVE monitors in Washington. Figure 6.14-2 presents 5-year average extinction for the current progress period for both the 20% most impaired and 20% least impaired days. Note that the percentages in the tables consider only the aerosol species which contribute to extinction, while the charts also show Rayleigh, or scattering due to background gases in the atmosphere.

Specific observations for the current visibility conditions on the 20% most impaired days are as follows:

- The largest contributors to aerosol extinction at Washington sites were ammonium sulfate and particulate organic mass.
- The highest aerosol extinction (16.4 dv) was measured at the MORA1 site, where ammonium sulfate was the largest contributor to aerosol extinction, followed by particulate organic mass. The lowest aerosol extinction (12.7 dv) was measured at the WHPA1 site.

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[1] EPA's September 2003 *Guidance for Tracking Progress Under the Regional Haze Rule* specifies that progress is tracked against the 2000-2004 baseline period using corresponding averages over successive 5-year periods, i.e. 2005-2009, 2010-2014, etc. (See page 4-2 in the Guidance document.)

Specific observations for the current visibility conditions on the 20% least impaired days are as follows:

- The aerosol contribution to total extinction on the best days was less than Rayleigh, or the background scattering that would occur in clear air. Average extinction (including Rayleigh) ranged from 1.8 dv (WHPA1) to 5.0 dv (OLYM1).
- For all sites, ammonium sulfate was the largest contributor to the non-Rayleigh species of aerosol extinction

Table 6.14-2
Washington Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Most Impaired Days

Site	Deciviews (dv)	Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) (% of Mm^{-1}) and Rank*						
		Ammonium Sulfate	Ammonium Nitrate	Particulate Organic Mass	Elemental Carbon	Soil	Coarse Mass	Sea Salt
MORA1	16.4	**41% (1)**	9% (4)	31% (2)	10% (3)	1% (6)	6% (5)	1% (7)
NOCA1	13.7	**46% (1)**	8% (3)	32% (2)	7% (4)	1% (6)	5% (5)	1% (7)
OLYM1	15.2	**45% (1)**	18% (3)	22% (2)	6% (4)	1% (7)	5% (5)	4% (6)
PASA1	14.1	25% (2)	8% (3)	**51% (1)**	8% (4)	2% (6)	5% (5)	0% (7)
SNPA1	16.1	37% (1)	22% (3)	27% (2)	8% (4)	1% (7)	4% (5)	1% (6)
WHPA1	12.7	32% (2)	10% (3)	**39% (1)**	7% (5)	2% (6)	9% (4)	0% (7)

*Highest aerosol species contribution per site is highlighted in bold.

Table 6.14-3
Washington Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Least Impaired Days

Site	Deciviews (dv)	Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) (% of Mm^{-1}) and Rank*						
		Ammonium Sulfate	Ammonium Nitrate	Particulate Organic Mass	Elemental Carbon	Soil	Coarse Mass	Sea Salt
MORA1	4.9	**45% (1)**	7% (6)	19% (2)	9% (4)	1% (7)	8% (5)	11% (3)
NOCA1	3.2	**57% (1)**	9% (3)	17% (2)	5% (5)	1% (7)	6% (4)	5% (6)
OLYM1	5.0	**40% (1)**	14% (3)	19% (2)	7% (5)	1% (7)	5% (6)	14% (4)
PASA1	2.5	**53% (1)**	15% (2)	13% (3)	5% (6)	2% (7)	6% (4)	6% (5)
SNPA1	4.9	**39% (1)**	18% (2)	15% (3)	12% (4)	1% (7)	3% (6)	12% (5)
WHPA1	1.8	**55% (1)**	9% (4)	12% (2)	6% (6)	1% (7)	9% (3)	8% (5)

*Highest aerosol species contribution per site is highlighted in bold.

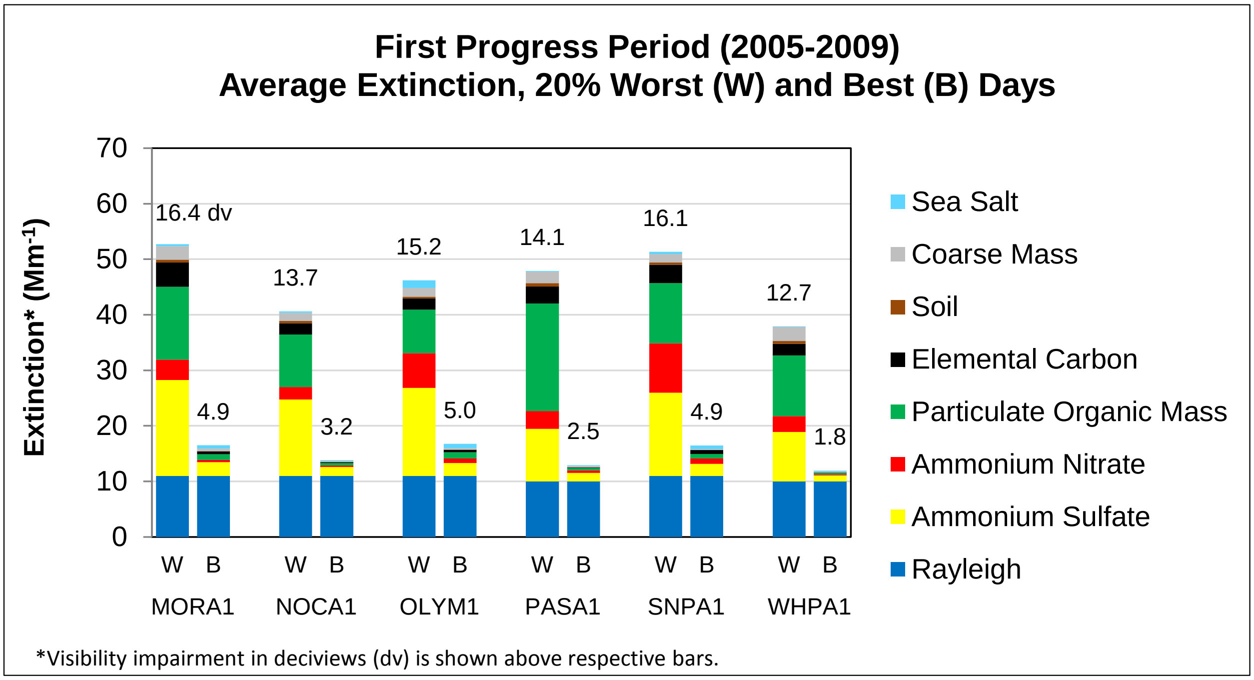

Figure 6.14-2. Average Extinction for Current Progress Period (2005-2009) for the Worst (Most Impaired) and Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

6.14.1.2 Differences between Current and Baseline Conditions

This section addresses the regulatory question, ***what is the difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions (40 CFR 51.308 (g)(3)(ii))?*** Included here are comparisons between the 5-year average baseline conditions (2000-2004) and current progress period extinction (2005-2009).

Table 6.14-4 presents the differences between the 2000-2004 baseline period average extinction and the 2005-2009 progress period average for each site in Washington for the 20% most impaired days, and Table 6.14-5 presents similar data for the least impaired days. Averages that increased are depicted in red text and averages that decreased in blue.

Figure 6.14-3 presents the 5-year average extinction for the baseline and current progress period averages for the worst days and Figure 6.14-4 presents the differences in averages by aerosol species, with increases represented above the zero line and decreases below the zero line. Figures 6.14-5 and 6.14-6 present similar plots for the best days.

For the 20% most impaired days, the 5-year average deciview metric decreased between the 2000-2004 and 2005-2009 periods at all Washington sites. Notable differences for individual species averages were as follows:

- All sites measured decreases in particulate organic mass, with the largest decreases measured at the NOCA1 site.

- Ammonium nitrate averages decreased at all sites.
- Particulate organic mass and elemental carbon averages decreased at all except the WHPA1 site.
- Ammonium sulfate decreased at all expect the PASA1 site, with the largest decrease in ammonium sulfate measured at the MORA1 site.

For the 20% least impaired days, the 5-year average deciview metric decreased at all sites except WHPA1, where the measured deciview average increased by 0.1 dv. Notable differences for individual species averages on the 20% least impaired days were as follows:

- At WHPA1, ammonium sulfate contributed to the increase in deciviews. Ammonium sulfate also increased at the NOCA1 site, but decreased at the MORA1, OLYM1, and SNPA1 sites.
- Ammonium nitrate decreased at all sites, and particulate organic mass and elemental carbon decreased at all but the WHPA1 site, where average concentrations stayed the same.

Table 6.14-4
Washington Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Most Impaired Days

Site	Deciview (dv)			Change in Extinction by Species (Mm^{-1})*						
	2000-04 Baseline Period	2005-09 Progress Period	Change in dv*	Amm. Sulfate	Amm. Nitrate	POM	EC	Soil	CM	Sea Salt
MORA1	18.2	16.4	-1.8	-6.4	-1.5	-1.9	-0.8	0.0	+0.3	+0.3
NOCA1	16.0	13.7	-2.3	-1.1	-0.4	-23.6	-1.7	-0.1	-0.2	+0.2
OLYM1	16.7	15.2	-1.5	-0.8	-2.1	-4.2	-0.7	0.0	-0.2	-0.1
PASA1	15.2	14.1	-1.1	+1.4	-0.1	-2.5	-0.3	-0.2	0.0	0.0
SNPA1	17.8	16.1	-1.7	-2.1	-2.7	-4.6	-0.9	0.0	0.0	0.0
WHPA1	12.8	12.7	-0.1	-1.0	-0.2	+1.3	+0.3	0.0	+0.8	-0.3

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

Table 6.14-5
Washington Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Least Impaired Days

Site	Deciview (dv)			Change in Extinction by Species (Mm^{-1})*						
	2000-04 Baseline Period	2005-09 Progress Period	Change in dv*	Amm. Sulfate	Amm. Nitrate	POM	EC	Soil	CM	Sea Salt
MORA1	5.5	4.9	-0.6	-0.1	-0.2	-0.4	-0.1	0.0	-0.1	+0.1
NOCA1	3.4	3.2	-0.2	+0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0
OLYM1	6.0	5.0	-1.0	-0.4	-0.4	-0.8	-0.2	0.0	-0.1	+0.2
PASA1	2.7	2.5	-0.2	0.0	-0.1	-0.2	-0.1	0.0	0.0	+0.1
SNPA1	5.5	4.9	-0.6	-0.5	-0.2	-0.2	-0.2	0.0	-0.1	+0.2
WHPA1	1.7	1.8	+0.1	+0.2	-0.1	0.0	0.0	0.0	0.0	0.0

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

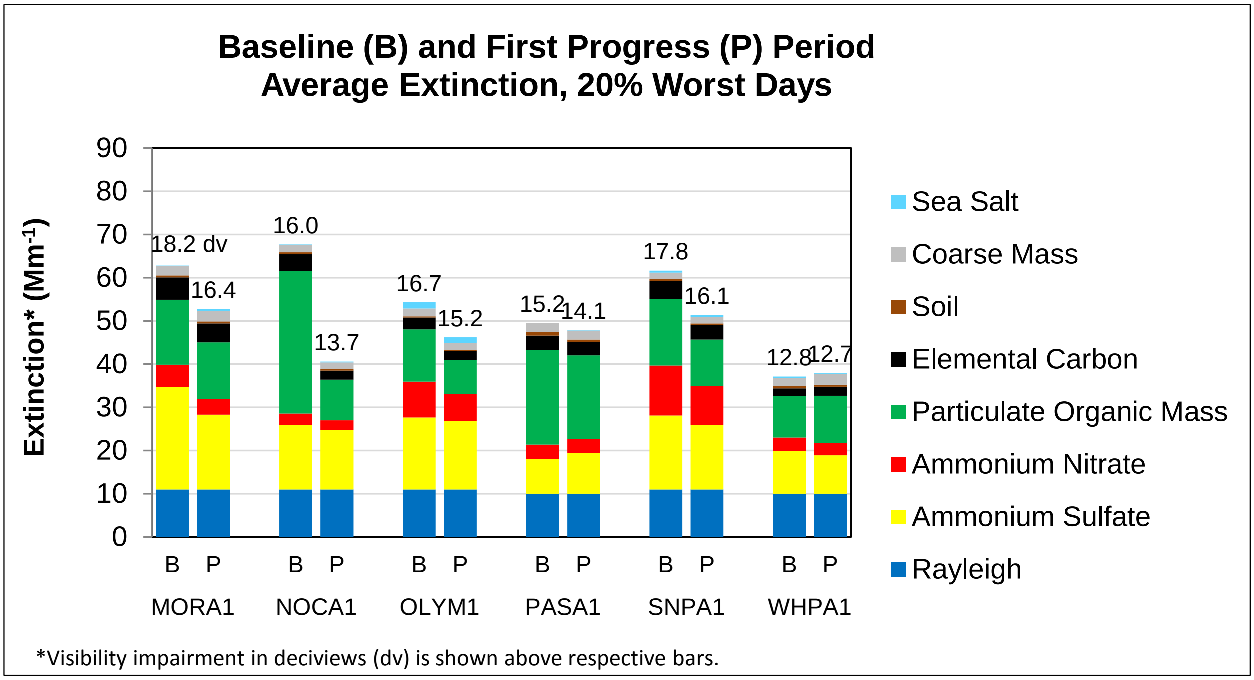

Figure 6.14-3. Average Extinction for Baseline and Progress Period Extinction for Worst (Most Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

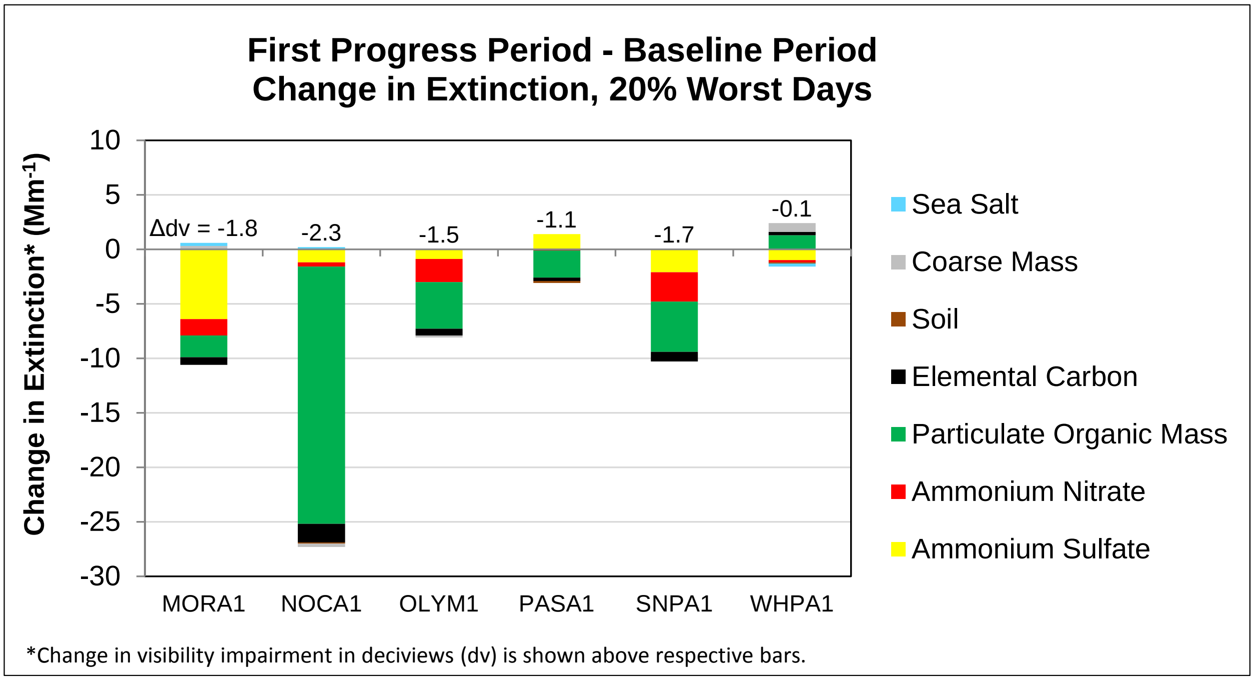

Figure 6.14-4. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Worst (Most Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

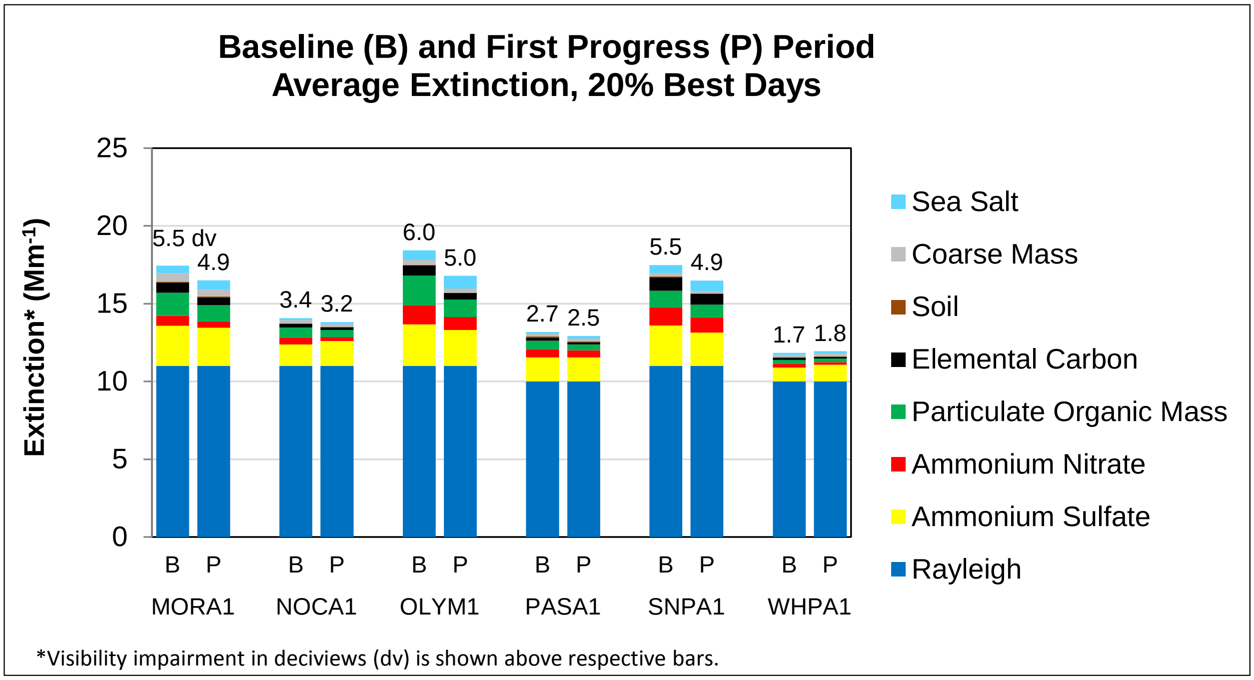

Figure 6.14-5. Average Extinction for Baseline and Progress Period Extinction for Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

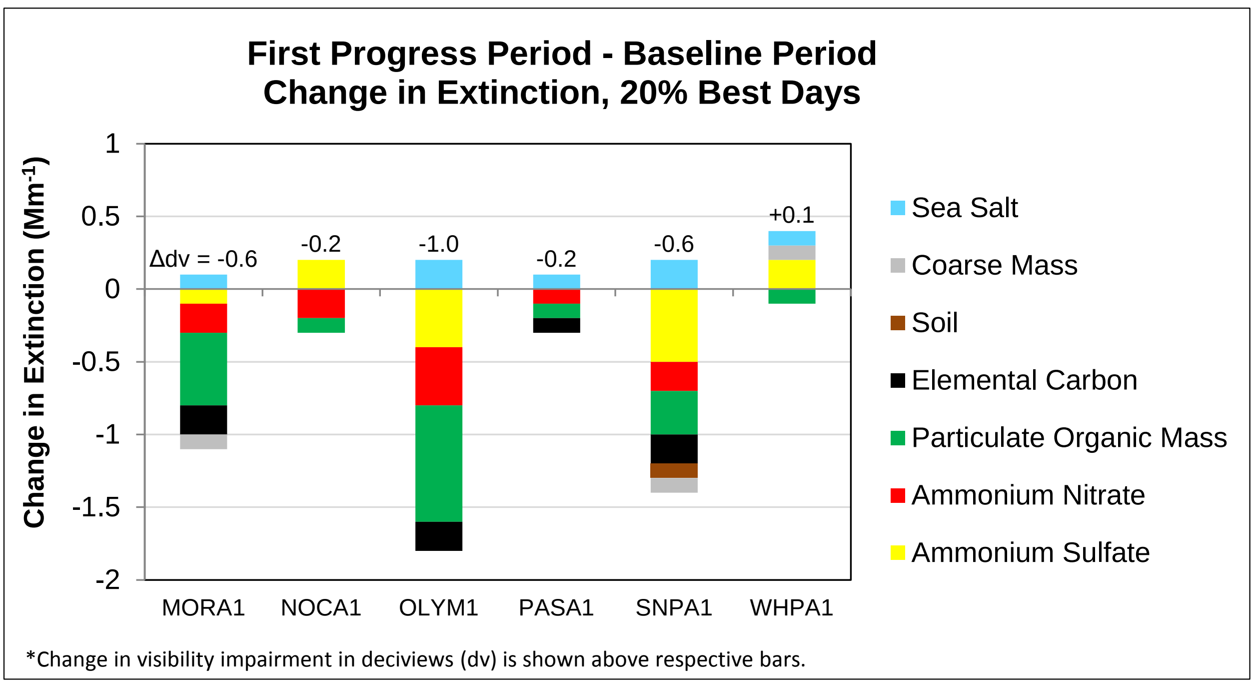

Figure 6.14-6. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

6.14.1.3 Changes in Visibility Impairment

This section addresses the regulatory question, ***what is the change in visibility impairment for the most impaired and least impaired days over the past 5 years (40 CFR 51.308 (g)(3)(iii))?*** Included here are changes in visibility impairment as characterized by annual average trend statistics, and some general observations regarding local and regional events and outliers on a daily and annual basis that affected the current 5-year progress period. The regulatory requirement asks for a description of changes over the past 5-year period, but trend analysis is better suited to longer periods of time, so trends for the entire 10-year planning period are presented here.

Trend statistics for the years 2000-2009 for each species at each site in Washington are summarized in Table 6.14-6, and regional trends were presented earlier in Section 4.1.1.[2] Only trends for aerosol species trends with p-value statistics less than 0.15 (85% confidence level) are presented in the table here, with increasing slopes in red and decreasing slopes in blue.[3] In some cases, trends may show decreasing tendencies while the difference between the 5-year averages do not (or vice versa), as discussed in Section 3.1.2.2. In these cases, the 5-year average for the best and worst days is the important metric for RHR regulatory purposes, but trend statistics may be of value to understand and address visibility impairment issues for planning purposes.

For each site, a more comprehensive list of all trends for all species, including the associated p-values, is provided in Appendix N. Additionally, the appendix includes plots depicting 5-year, annual, monthly and daily average extinction for each site. These plots are intended to provide a fairly comprehensive compilation of reference information for individual states to investigate local and regional events and outliers that may have influenced changes in visibility impairment as tracked using the 5-year deciview metrics. Note that similar summary products are also available from the WRAP TSS website (http://vista.cira.colostate.edu/tss/). Some general observations regarding changes in visibility impairment at sites in Washington are as follows:

- The largest changes in 5-year averages at the sites was a decrease in average particulate organic mass measured at the NOCA1 site. This difference was influenced by a high particulate organic mass event in September and October of 2003 which raised the baseline average high.
- Ammonium sulfate, ammonium nitrate, particulate organic mass, and elemental carbon all showed either decreasing or insignificant trends at all sites, with the

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[2] Annual trends were calculated for the years 2000-2009, with a trend defined as the slope derived using Theil statistics. Trends derived from Theil statistics are useful in analyzing changes in air quality data because these statistics can show the overall tendency of measurements over long periods of time, while minimizing the effects of year-to-year fluctuations which are common in air quality data. Theil statistics are also used in EPA's National Air EPA's National Air Quality Trends Reports (http://www.epa.gov/airtrends/) and the IMPROVE program trend reports (http://vista.cira.colostate.edu/improve/Publications/improve_reports.htm)
[3] The significance of the trend is represented with p-values calculated using Mann-Kendall trend statistics. Determining a significance level helps to distinguish random variability in data from a real tendency to increase or decrease over time, where lower p-values indicate higher confidence levels in the computed slopes.

exception of elemental carbon on the worst days at the WHPA1 site, which showed an increasing trend.

Table 6.14-6
Washington Class I Area IMPROVE Sites
Change in Aerosol Extinction by Species
2000-2009 Annual Average Trends

Site	Group	Annual Trend* (Mm^{-1}/year)						
		Ammonium Sulfate	**Ammonium Nitrate**	**Particulate Organic Mass**	**Elemental Carbon**	**Soil**	**Coarse Mass**	**Sea Salt**
MORA1	20% Best	--	0.0	**-0.1**	0.0	--	0.0	--
	20% Worst	**-0.8**	**-0.2**	--	**-0.2**	--	--	0.0
	All Days	**-0.4**	**-0.1**	**-0.3**	**-0.1**	--	--	--
NOCA1	20% Best	--	0.0	0.0	0.0	--	--	--
	20% Worst	**-0.2**	--	--	--	--	0.0	0.0
	All Days	--	0.0	--	--	--	0.0	0.0
OLYM1	20% Best	--	**-0.1**	**-0.2**	0.0	--	0.0	--
	20% Worst	**-0.3**	**-0.5**	**-0.7**	**-0.2**	--	--	**0.1**
	All Days	**-0.1**	**-0.2**	**-0.3**	**-0.1**	--	0.0	0.0
PASA1	20% Best	--	0.0	0.0	0.0	--	--	--
	20% Worst	--	**-0.2**	--	**-0.2**	0.0	--	--
	All Days	--	**-0.1**	--	**-0.1**	--	--	--
SNPA1	20% Best	**-0.1**	**-0.1**	0.0	0.0	--	0.0	**0.1**
	20% Worst	**-0.5**	**-0.7**	**-0.5**	**-0.2**	--	--	--
	All Days	**-0.3**	**-0.3**	**-0.2**	**-0.1**	--	--	**0.1**
WHPA1	20% Best	--	0.0	--	--	--	--	--
	20% Worst	--	--	--	**0.1**	--	**0.1**	**-0.1**
	All Days	--	--	--	--	--	--	--

*(--) Indicates statistically insignificant trend (<85% confidence level). Annual averages and complete trend statistics for all significance levels are included for each site in Appendix N.

6.14.2 Emissions Data

Included here are summaries depicting differences between two emission inventory years that are used to represent the 5-year baseline and current progress periods. The baseline period is represented using a 2002 inventory developed by the WRAP for use in the initial WRAP state SIPs, and the progress period is represented by a 2008 inventory which leverages recent WRAP inventory work for modeling efforts, as referenced in Section 3.2.1. For reference, Table 6.14-7 lists the major emitted pollutants inventoried, the related aerosol species, some of the major sources for each pollutant, and some notes regarding implications of these pollutants. Differences between these baseline and progress period inventories, and a separate summary of annual emissions from electrical generating units (EGUs), are presented in this section.

Table 6.14-7
Washington
Pollutants, Aerosol Species and Major Sources

Emitted Pollutant	Related Aerosol	Major Sources	Notes
Sulfur Dioxide (SO_2)	Ammonium Sulfate	Point Sources; On- and Off-Road Mobile Sources	SO_2 emissions are generally associated with anthropogenic sources such as coal-burning power plants, other industrial sources such and refineries and cement plants, and both on- and off-road diesel engines.
Oxides of Nitrogen (NO_X)	Ammonium Nitrate	On- and Off-Road Mobile Sources; Point Sources; Area Sources	NO_X emissions are generally associated with anthropogenic sources. Common sources include virtually all combustion activities, especially those involving cars, trucks, power plants, and other industrial processes.
Ammonia (NH_3)	Ammonium Sulfate and Ammonium Nitrate	Area Sources; On-Road Mobile Sources	Gaseous NH_3 has implications in particle formation because it can form particulate ammonium. Ammonium is not directly measured by the IMPROVE program, but affects formation potential of ammonium sulfate and ammonium nitrate. All measured nitrate and sulfate is assumed to be associated with ammonium for IMPROVE reporting purposes.
Volatile Organic Compounds (VOCs)	Particulate Organic Mass (POM)	Biogenic Emissions; Vehicle Emissions; Area Sources	VOCs are gaseous emissions of carbon compounds, which are often converted to POM through chemical reactions in the atmosphere. Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions (see Section 3.2.1).
Primary Organic Aerosol (POA)	POM	Wildfires; Area Sources	POA represents organic aerosols that are emitted directly as particles, as opposed to gases. Wildfires in the west generally dominate POA emissions, and large wildfire events are generally sporadic and highly variable from year-to-year.
Elemental Carbon (EC)	EC	Wildfires; On- and Off-Road Mobile Sources	Large EC events are often associated with large POM events during wildfires. Other sources include both on- and off-road diesel engines.
Fine Soil	Soil	Windblown Dust; Fugitive Dust; Road Dust; Area Sources	Fine soil is reported here as the crustal or soil components of $PM_{2.5}$.
Coarse Mass (PMC)	Coarse Mass	Windblown Dust; Fugitive Dust	Coarse mass is reported by the IMPROVE Network as the difference between PM_{10} and $PM_{2.5}$ mass measurements. Coarse mass is not separated by species in the same way that $PM_{2.5}$ is speciated, but these measurements are generally associated with crustal components. Similar to crustal $PM_{2.5}$, natural windblown dust is often the largest contributor to PMC.

6.14.2.1 Changes in Emissions

This section addresses the regulatory question, ***what is the change over the past 5 years in emissions of pollutants contributing to visibility impairment from all sources and activities within the State (40 CFR 51.308 (g)(4))?*** For these summaries, emissions during the baseline years are represented using a 2002 inventory, which was developed with support from the WRAP for use in the original RHR SIP strategy development (termed plan02d). Differences between inventories are represented as the difference between the 2002 inventory, and a 2008 inventory which leverages recent inventory development work performed by the WRAP for the WestJumpAQMS and DEASCO$_3$ modeling projects (termed WestJump2008). Note that the comparisons of differences between inventories does not necessarily reflect a change in emissions, as a number of methodology changes and enhancements have occurred between development of the individual inventories, as referenced in Section 3.2.1. Inventories for all major visibility impairing pollutants are presented for major source categories, and categorized as either anthropogenic or natural emissions. State-wide inventories totals and differences are presented here, and inventory totals on a county level basis are available on the WRAP Technical Support System website (http://vista.cira.colostate.edu/tss/).

Table 6.14-8 and Figure 6.14-7 present the differences between the 2002 and 2008 sulfur dioxide (SO_2) inventories by source category. Tables 6.14-9 and Figure 6.14-8 present data for oxides of nitrogen (NO_X), and subsequent tables and figures (Tables 6.14-10 through 6.14-15 and Figures 6.14-9 through 6.14-14) present data for ammonia (NH_3), volatile organic compounds (VOCs), primary organic aerosol (POA), elemental carbon (EC), fine soil, and coarse mass. General observations regarding emissions inventory comparisons are listed below.

- Decreases for point source inventories were reported for all parameters, with the largest decreases in SO_2, NO_X, VOCs, fine soil, and coarse mass. Note that decreases in SO_2 and NO_X are consistent with the summary of annual EGU emissions included in Section 6.14.2.2.
- Area source inventories showed decreases in all parameters except NO_X, with the largest decreases reported for SO_2 and VOCs. These changes may be due to a combination of population changes and differences in methodologies used to estimate these emissions, as referenced in Section 3.2.1. One methodology change was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to increases in area source inventory totals, but decreases in off-road mobile totals.
- On-road mobile source inventory comparisons showed decreases in most parameters, especially NO_X and VOCs, with slight increases in POA, EC, and coarse mass. Reductions in NO_X and VOC are likely influenced by federal and state emissions standards that have already been implemented. The increases in POA, EC, and coarse mass occurred in all of the WRAP states for on-road mobile inventories, regardless of reductions in NO_X and VOCs, indicating that these increases were likely due use of different on-road models, as referenced in Section 3.2.1.

- Off-road mobile source inventories showed decreases in NO_X, SO_2, and VOCs, and increases in fine soil and coarse mass, which was consistent with most contiguous WRAP states. These differences were likely due to a combination of actual changes in source contributions and methodology differences, as referenced in Section 3.2.1. As noted previously, one major methodology difference was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to decreases in the off-road inventory totals, but increases in area source totals.
- For most parameters, especially POAs, VOCs, and EC, natural fire emission inventory estimates decreased (except for a slight increase in fine soil), and anthropogenic fire estimates increased (except for a decrease in VOCs). Note that these differences are not necessarily reflective of changes in monitored data, as the baseline period is represented by an average of 2000-2004 fire emissions, and the progress period is represented only by the fires that occurred in 2008, as referenced in Section 3.2.1. Also, methodology differences likely contributed to fine soil (for natural fire) and VOCs (for anthropogenic fire) not tracking with the other parameters.
- Comparisons between VOC inventories showed large decreases in biogenic emissions, which was consistent with other contiguous WRAP states. Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions, as referenced in Section 3.2.1.
- Coarse mass decreased for the windblown dust inventory comparisons and the combined fugitive/road dust inventories. Large variability in changes in windblown dust was observed for the contiguous WRAP states, which was likely due in large part to enhancements in dust inventory methodology, as referenced in Section 3.2.1, rather than changes in actual emissions.

Table 6.14-8
Washington
Sulfur Dioxide Emissions by Category

Source Category	Sulfur Dioxide Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point	52,885	15,465	-37,420
Area	7,311	3,220	-4,090
On-Road Mobile	5,543	994	-4,548
Off-Road Mobile	13,913	703	-13,210
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	1,411	1,450	39
Total Anthropogenic	**81,063**	**21,833**	**-59,229 (-73%)**
Natural Sources			
Natural Fire	1,641	315	-1,325
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**1,641**	**315**	**-1,325 (-81%)**
All Sources			
Total Emissions	**82,703**	**22,149**	**-60,555 (-73%)**

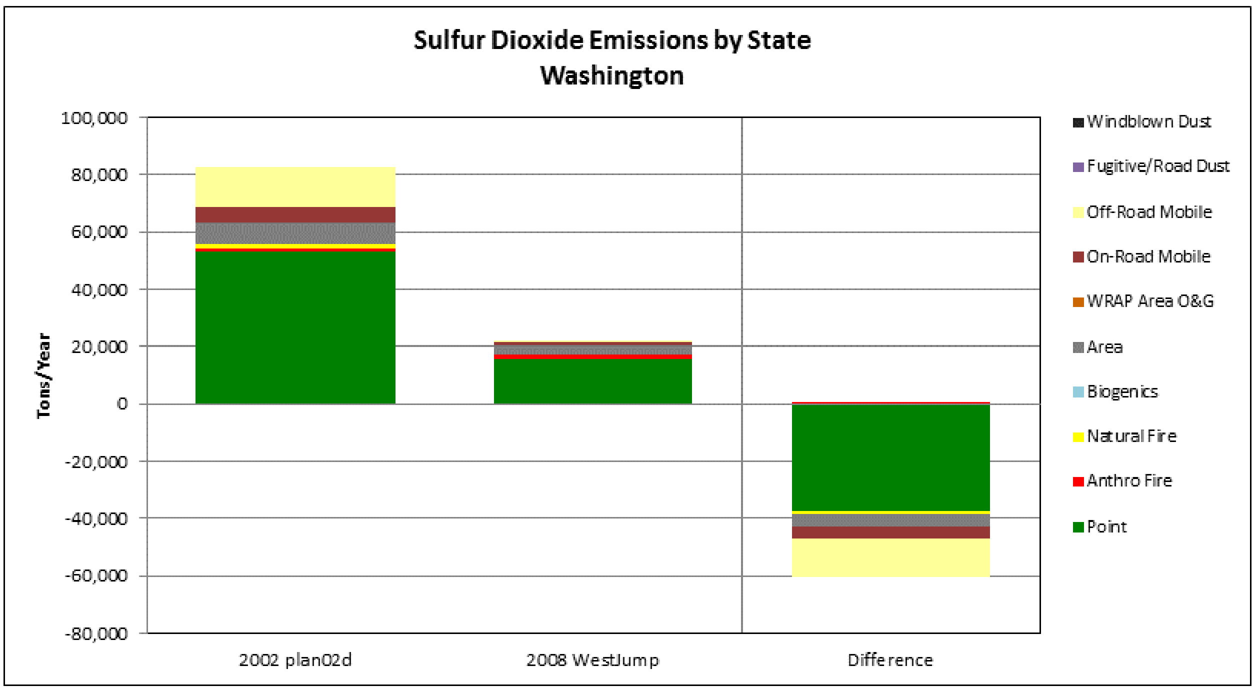

Figure 6.14-7. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Sulfur Dioxide by Source Category for Washington.

Table 6.14-9
Washington
Nitrogen Oxide Emissions by Category

Source Category	Oxides of nitrogen Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	43,355	38,418	-4,937
Area	17,587	50,287	32,700
On-Road Mobile	201,991	141,442	-60,548
Off-Road Mobile	84,710	38,096	-46,613
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	6,821	10,269	3,448
Total Anthropogenic	**354,464**	**278,512**	**-75,952 (-21%)**
Natural Sources			
Natural Fire	5,997	2,236	-3,761
Biogenic	17,923	3,845	-14,077
Wind Blown Dust	0	0	0
Total Natural	**23,920**	**6,081**	**-17,839 (-75%)**
All Sources			
Total Emissions	**378,384**	**284,593**	**-93,790 (-25%)**

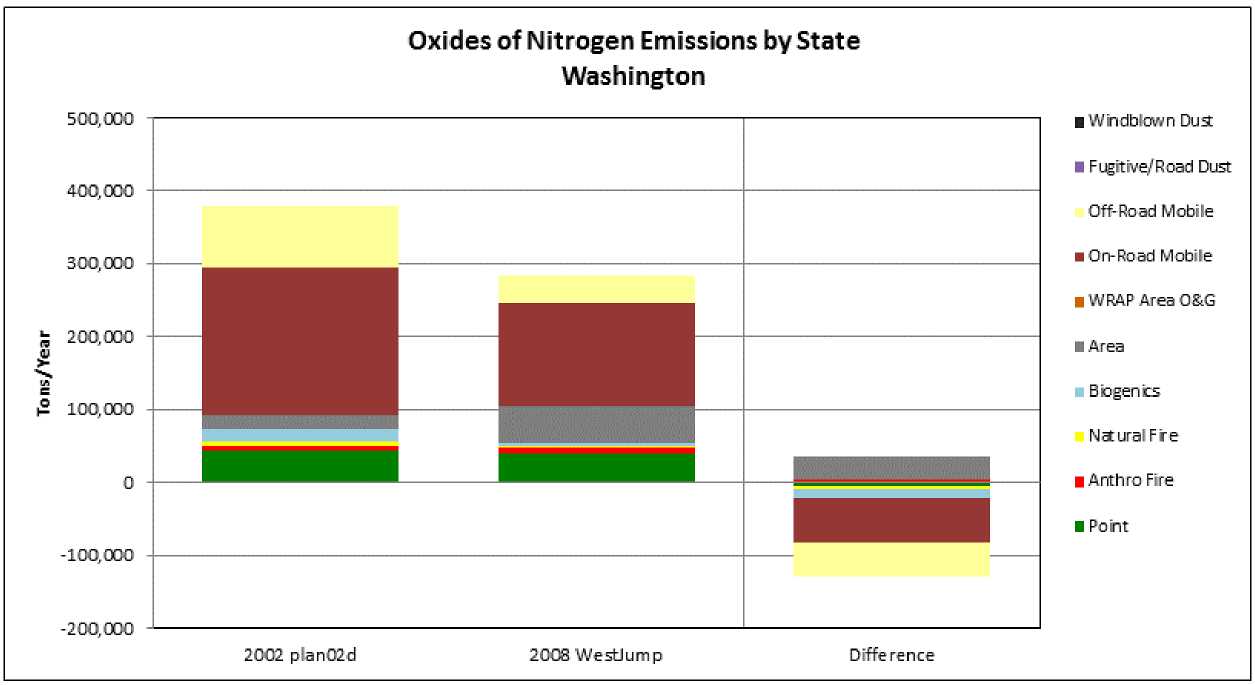

Figure 6.14-8. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Oxides of nitrogen by Source Category for Washington.

Table 6.14-10
Washington
Ammonia Emissions by Category

Source Category	Ammonia Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point	3,863	441	-3,422
Area	45,218	44,368	-851
On-Road Mobile	5,211	2,543	-2,668
Off-Road Mobile	57	43	-14
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	3,439	7,152	3,713
Total Anthropogenic	**57,789**	**54,548**	**-3,241 (-6%)**
Natural Sources			
Natural Fire	1,265	1,556	291
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**1,265**	**1,556**	**291 (23%)**
All Sources			
Total Emissions	**59,054**	**56,104**	**-2,950 (-5%)**

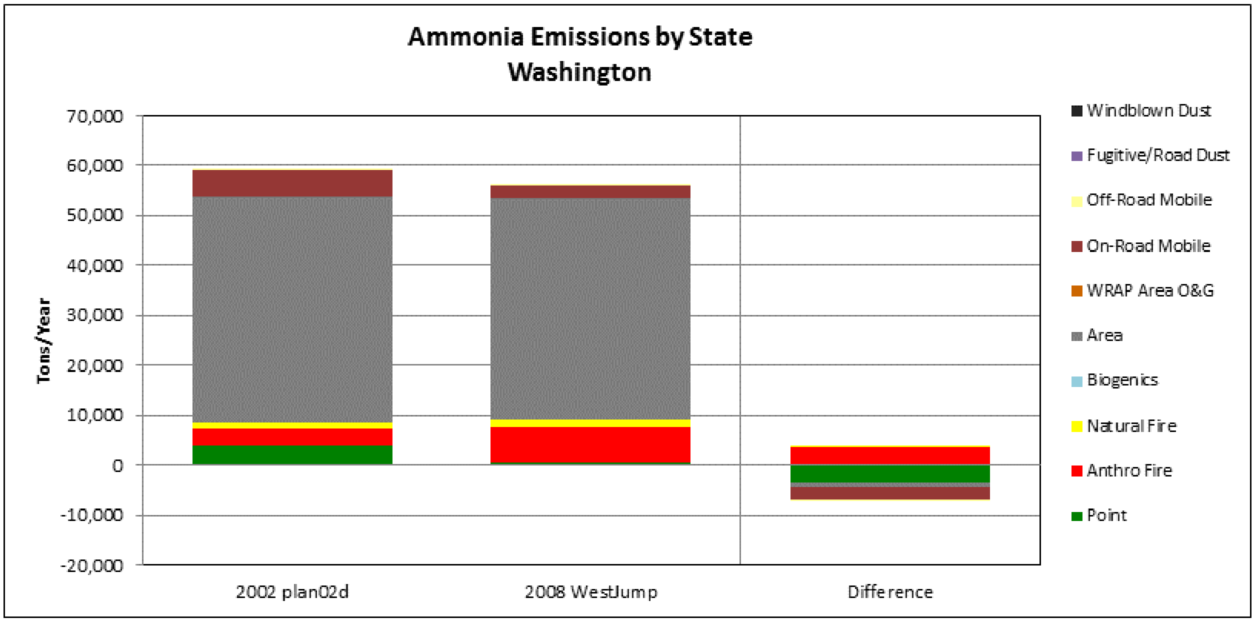

Figure 6.14-9. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Ammonia by Source Category for Washington.

Table 6.14-11
Washington
Volatile Organic Compound Emissions by Category

Source Category	Volatile Organic Compound Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point	18,651	12,706	-5,945
Area	151,680	102,173	-49,507
On-Road Mobile	140,181	59,343	-80,838
Off-Road Mobile	61,601	52,264	-9,337
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	14,858	10,258	-4,600
Total Anthropogenic	**386,971**	**236,744**	**-150,227 (-39%)**
Natural Sources			
Natural Fire	13,160	2,301	-10,859
Biogenic	642,736	224,471	-418,264
Wind Blown Dust	0	0	0
Total Natural	**655,896**	**226,772**	**-429,124 (-65%)**
All Sources			
Total Emissions	**1,042,867**	**463,516**	**-579,351 (-56%)**

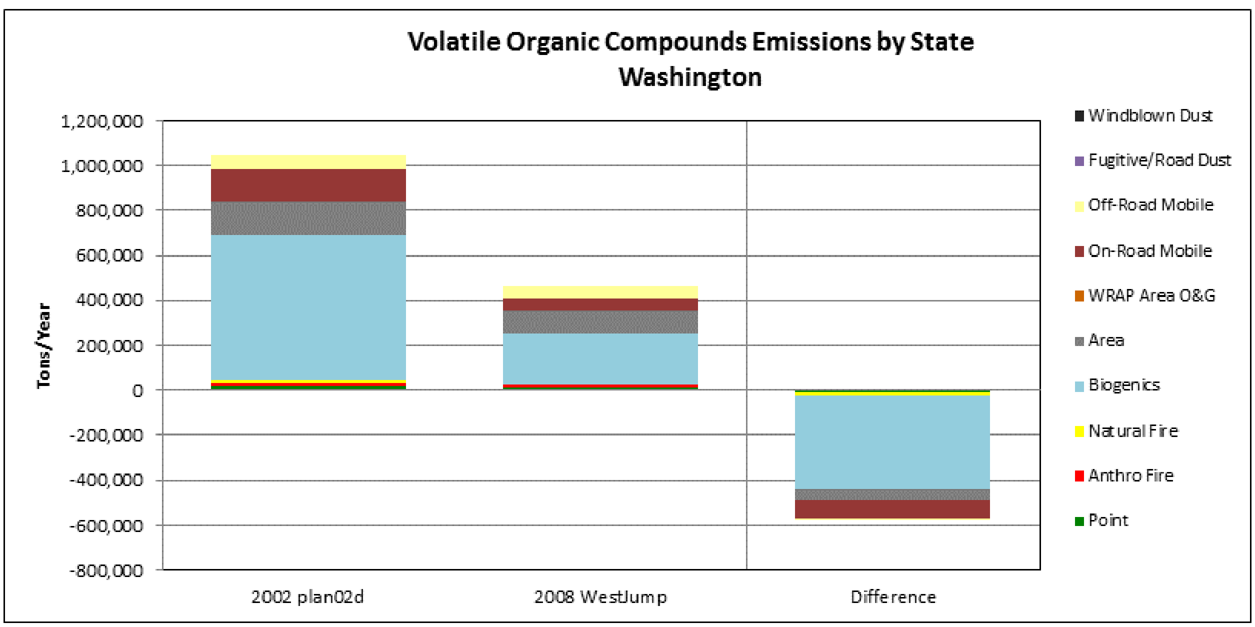

Figure 6.14-10. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Volatile Organic Compounds by Source Category for Washington.

Table 6.14-12
Washington
Primary Organic Aerosol Emissions by Category

Source Category	Primary Organic Aerosol Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	763	24	-739
Area	16,577	12,392	-4,185
On-Road Mobile	1,821	3,557	1,737
Off-Road Mobile	1,948	1,559	-389
Area Oil and Gas	0	0	0
Fugitive and Road Dust	928	825	-103
Anthropogenic Fire	10,305	20,461	10,156
Total Anthropogenic	**32,341**	**38,818**	**6,477 (20%)**
Natural Sources			
Natural Fire	17,931	4,399	-13,532
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**17,931**	**4,399**	**-13,532 (-75%)**
All Sources			
Total Emissions	**50,273**	**43,218**	**-7,055 (-14%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

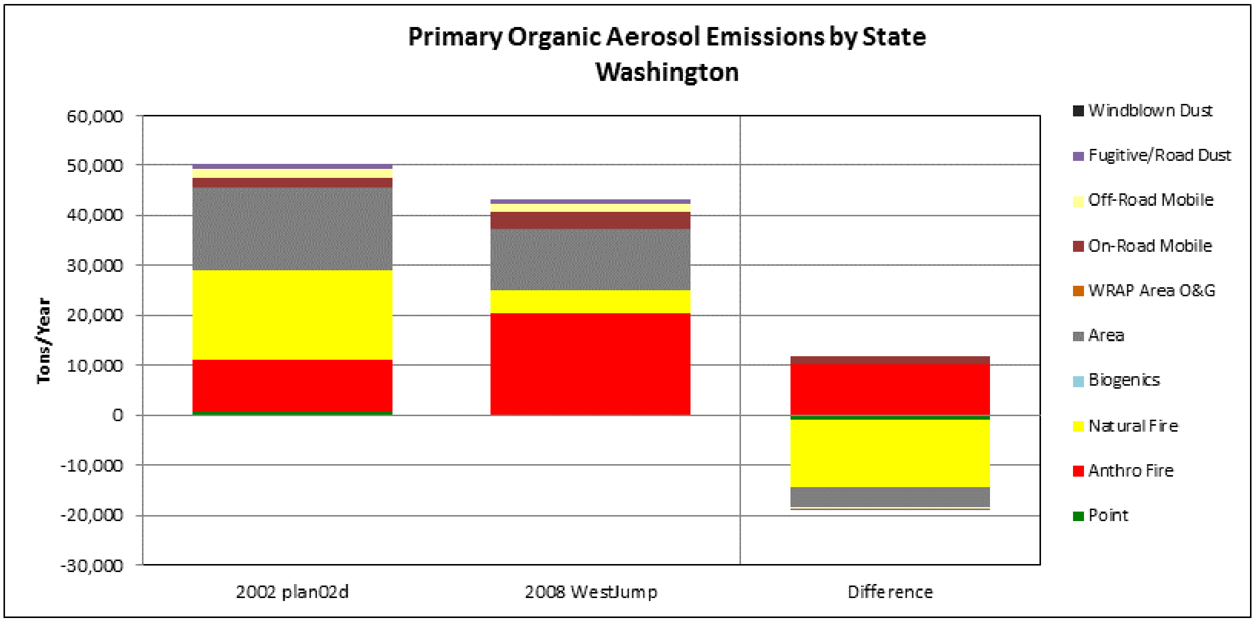

Figure 6.14-11. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Primary Organic Aerosol by Source Category for Washington.

Table 6.14-13
Washington
Elemental Carbon Emissions by Category

Source Category	Elemental Carbon Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	144	22	-122
Area	2,180	2,284	103
On-Road Mobile	2,003	5,698	3,695
Off-Road Mobile	4,213	1,948	-2,265
Area Oil and Gas	0	0	0
Fugitive and Road Dust	64	24	-40
Anthropogenic Fire	780	3,033	2,253
Total Anthropogenic	**9,385**	**13,008**	**3,623 (39%)**
Natural Sources			
Natural Fire	3,717	721	-2,996
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**3,717**	**721**	**-2,996 (-81%)**
All Sources			
Total Emissions	**13,102**	**13,729**	**627 (5%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

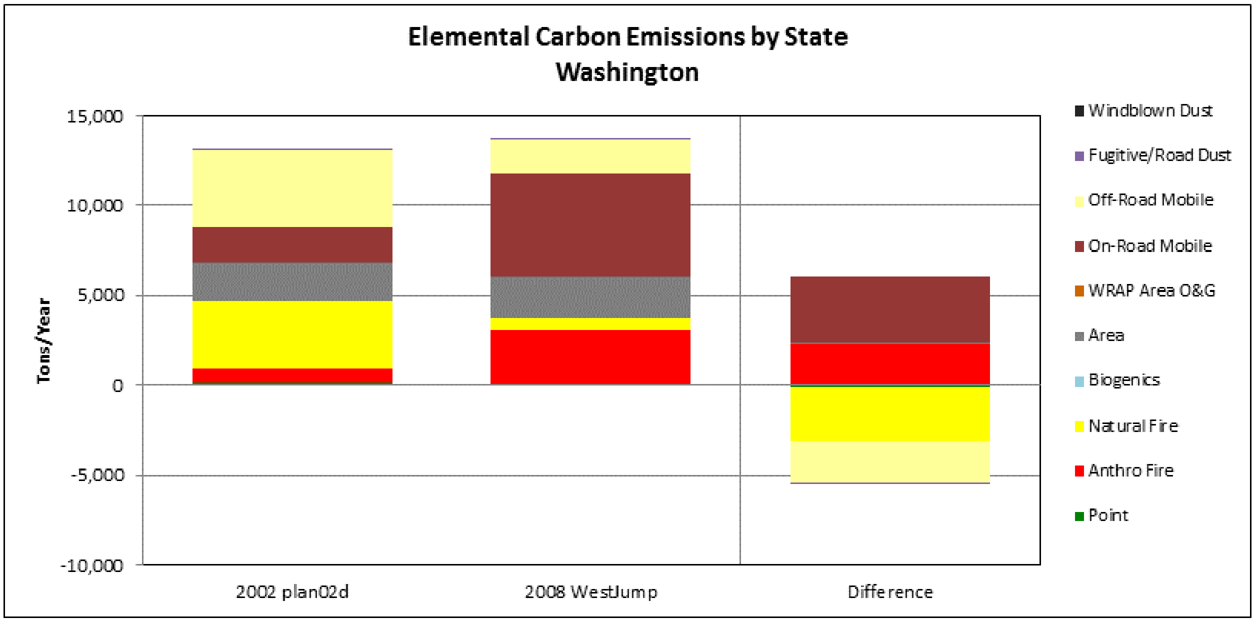

Figure 6.14-12. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Elemental Carbon by Source Category for Washington.

Table 6.14-14
Washington
Fine Soil Emissions by Category

Source Category	Fine Soil Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point*	2,257	355	-1,902
Area	12,708	5,726	-6,982
On-Road Mobile	1,154	602	-552
Off-Road Mobile	0	109	109
Area Oil and Gas	0	0	0
Fugitive and Road Dust	15,776	15,158	-619
Anthropogenic Fire	3,869	7,479	3,610
Total Anthropogenic	**35,764**	**29,428**	**-6,336 (-18%)**
Natural Sources			
Natural Fire	1,139	1,637	498
Biogenic	0	0	0
Wind Blown Dust	5,401	4,520	-882
Total Natural	**6,540**	**6,156**	**-384 (-6%)**
All Sources			
Total Emissions	**42,304**	**35,585**	**-6,719 (-16%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

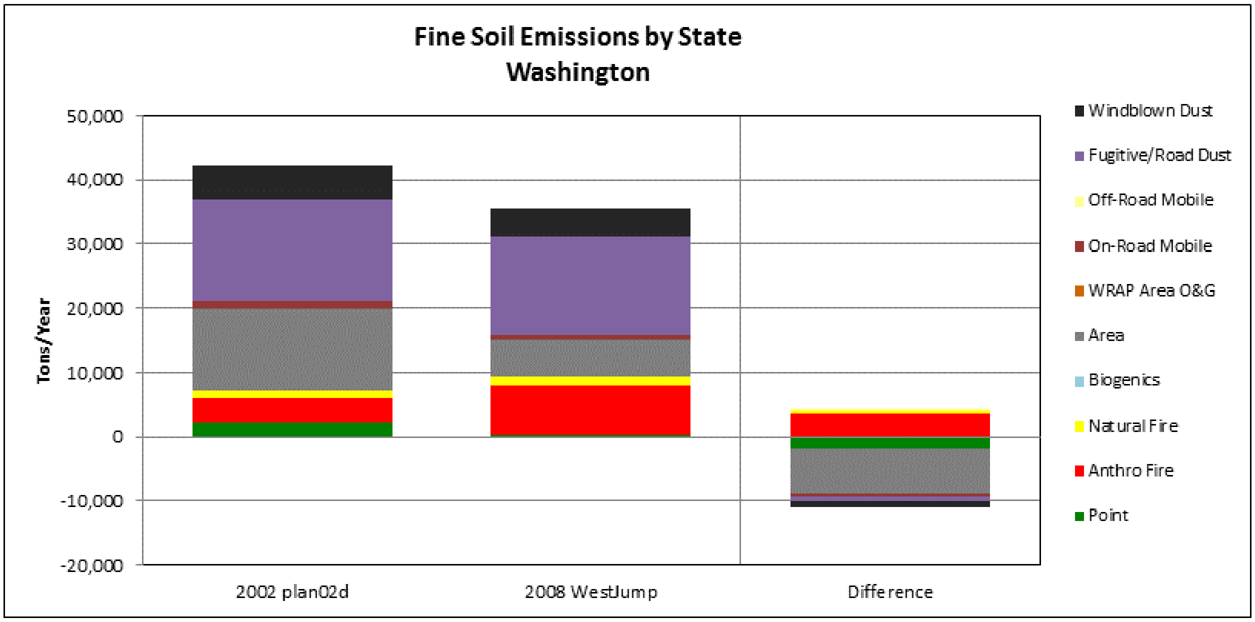

Figure 6.14-13. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Fine Soil by Source Category for Washington.

Table 6.14-15
Washington
Coarse Mass Emissions by Category

Source Category	Coarse Mass Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point*	6,244	866	-5,377
Area	2,083	650	-1,433
On-Road Mobile	1,079	6,313	5,234
Off-Road Mobile	0	181	181
Area Oil and Gas	0	0	0
Fugitive and Road Dust	92,749	81,331	-11,417
Anthropogenic Fire	806	3,925	3,119
Total Anthropogenic	**102,961**	**93,267**	**-9,694 (-9%)**
Natural Sources			
Natural Fire	3,856	844	-3,012
Biogenic	0	0	0
Wind Blown Dust	48,612	40,679	-7,934
Total Natural	**52,469**	**41,523**	**-10,946 (-21%)**
All Sources			
Total Emissions	**155,430**	**134,789**	**-20,640 (-13%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

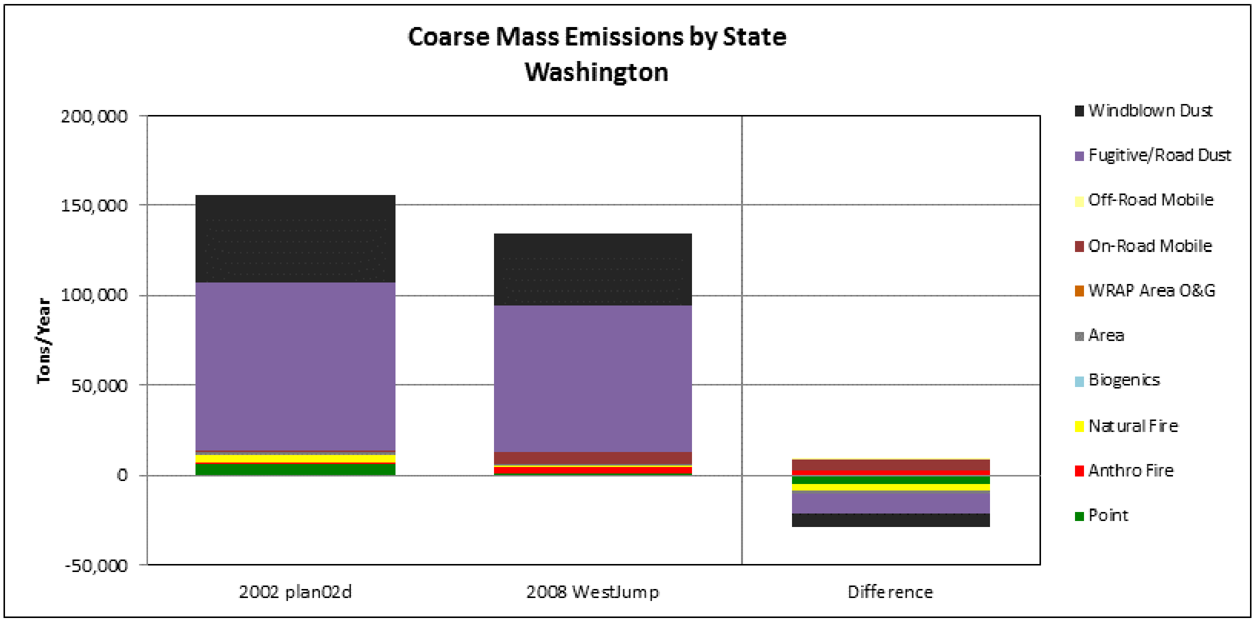

Figure 6.14-14. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Coarse Mass by Source Category for Washington.

6.14.2.2 EGU Summary

As described in previous sections, differences between the baseline and progress period inventories presented here do not necessarily represent changes in actual emissions because numerous updates in inventory methodologies have occurred between the development of the separate inventories. Also, the 2002 baseline and 2008 progress period inventories represent only annual snapshots of emissions estimates, which may not be representative of the current 5-year monitoring period. To show a major example of year-to-year changes in emissions, annual emission totals for Washington coal-fired electrical generating units (EGU) are presented here. EGU emissions are some of the more consistently reported emissions, as tracked in EPA's Air Markets Program Database for permitted Title V facilities in the state (http://ampd.epa.gov/ampd/). RHR implementation plans are required to pay specific attention to certain major stationary sources, including EGUs, built between 1962 and 1977.

Figure 6.14-17 presents a sum of annual NO_X and SO_2 emissions as reported for Washington coal-fired EGU sources between 1996 and 2010. While these types of facilities are targeted for controls in state regional haze SIPs, it should be noted that other controls separate from the RHR may have been implemented. The chart shows a sharp decline in SO_2 emissions between 2000 and 2003, and smaller but steady declines in NO_X. The decline in SO_2 during the baseline period is due to controls approved by the EPA as Reasonable Attributable Visibility Impairment (RAVI) BART. Note that RHR BART requirements for additional NO_X emission reductions became effective on January 1, 2013.

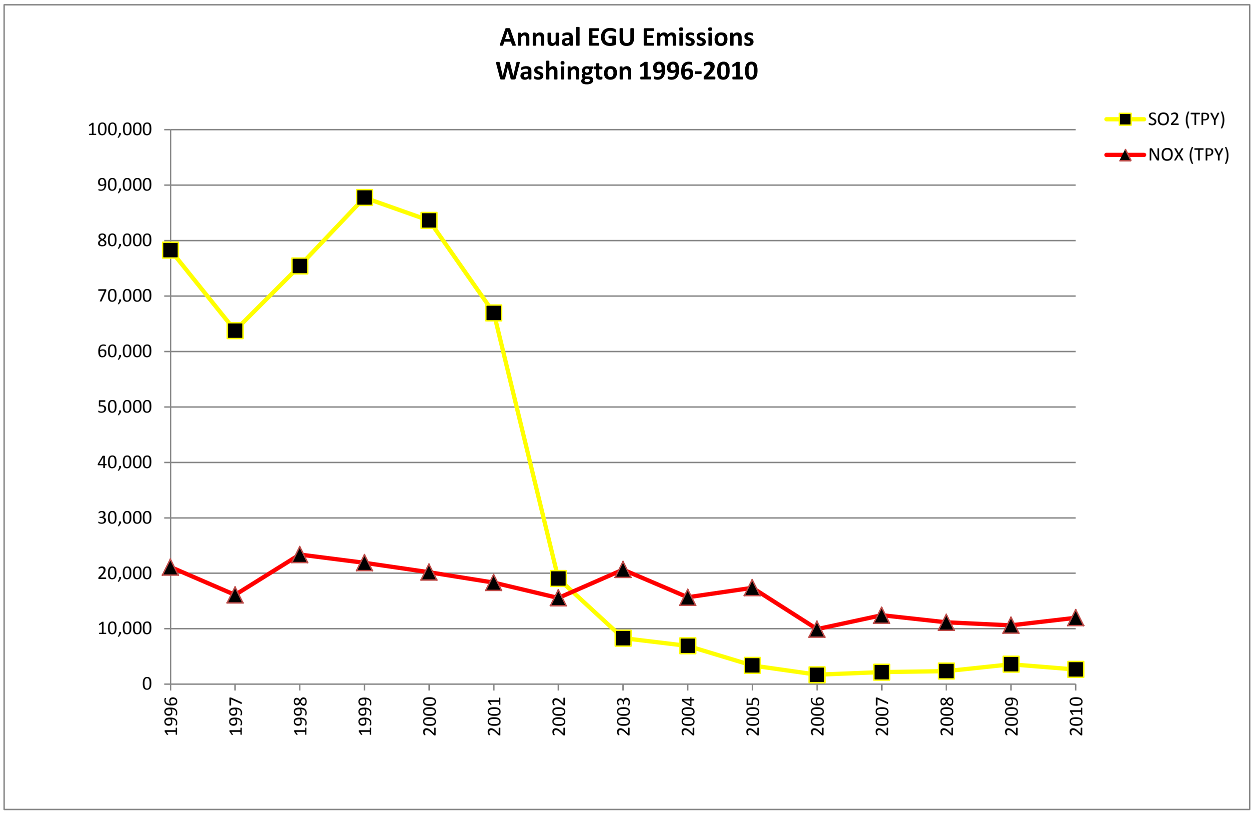

Figure 6.14-8. Sum of EGU Emissions of SO_2 and NO_X reported between 1996 and 2010 for Washington.