BART Alternative Visibility Modeling for the Riley Boiler at TASCO – Nampa Factory

State of Idaho
Department of Environmental Quality
1410 North Hilton
Boise, ID 83706

October 19, 2011

This page intentionally left blank for correct double-sided printing.

Executive Summary

The Amalgamated Sugar Company LLC (TASCO) has requested a revision to the BART determination for the coal-fired Riley Boiler at their Nampa Factory, and has proposed a BART Alternative. The revised BART includes Spray Dry Flue Gas Desulfurization (Spray Dry FGD) for sulfur dioxide (SO_2) control, Low NO_x burners (LNB) for nitrogen oxides (NO_x) control, and a baghouse for particulate matter (PM) control. The proposed BART Alternative replaces the Spray Dry FGD with a) LNB controls on two (non-BART) Babcock and Wilcox (B&W) boilers, and b) credits SO_2, NO_x and PM emission reductions from shutting down 3 pulp dryers. This report describes new modeling to assess the resulting visibility changes at Class I areas within 300 km of the facility.

The modeling was completed in accordance with the three-state BART Modeling Protocol which underwent an extensive review and approval process and formed the basis for much of the BART modeling conducted in the Pacific Northwest. In order to compare the BART Alternative impacts with the selected BART control scheme on the same basis, both scenarios were modeled with emissions from all the sources included in the BART Alternative; i.e. the pulp dryers and the non-BART B&W Boilers. In this report, the term "BART" (in quotation marks) denotes the selected BART technology for the Riley boiler (LNB) along with emissions from the other emission sources (B&W Boilers and pulp dryers) affected by the alternative in their pre-BART condition.

Model results for the "BART Alternative" scenario indicate that visibility improves an additional 0.159 Δdv on the 22nd highest day at Strawberry Mountain Wilderness and 0.101Δdv at Eagle Cap in comparison to the "BART" scenario. The number of days above 0.5 Δdv is reduced by 11 more days at Strawberry Mountain and 23 more days at Eagle Cap, with a total reduction of 41 more days at all the Class I areas combined over the three-year modeling period.

Although the "BART Alternative" scenario reduces the largest visibility impacts during the winter when both modeled and monitored regional haze impacts were highest, the shift from SO_2 control to additional NO_x control will also result in a slightly greater visibility impairment in the best visibility months of March – June when sulfate dominates the relatively clear air at the Starkey IMPROVE site, representing Eagle Cap and Strawberry Mountain wilderness areas. However, this impairment from the BART Alternative in the non-winter months is small in comparison to the visibility benefits projected in the winter months, and it is clear that the proposed BART Alternative produces greater reductions on more high-impact days than the "BART" scenario, and is therefore a preferred approach for reducing regional haze.

In addition to the greater visibility improvements, the BART Alternative provides greater ozone mitigation benefits by more than doubling the NO_x reductions over those of the "BART" scenario (from 2.7 to 6.5 tons per day). DEQ photochemical modeling indicates that this will rank amongst the top ozone mitigation measures being evaluated in our efforts to mitigate ozone and avoid an ozone non-attainment designation. This is important to the State of Idaho because of the health and economic disadvantages that non-attainment status may bring and the potential restrictions that the region could incur in the areas of industrial growth, transportation improvements, and agricultural and prescribed burning.

Introduction

The Amalgamated Sugar Company LLC (TASCO) at Nampa, Idaho has requested revision of the initial Best Available Retrofit Technology (BART) determination for NO_x and approval of a BART Alternative to control visibility-impairing pollutant emissions from the Riley Boiler at their Nampa Factory. The BART determinations (as revised) include Spray Dry Flue Gas Desulfurization (Spray Dry FGD) for sulfur dioxide (SO_2) control, Low NO_x burners (LNB) for nitrogen oxides (NO_x) control, and a baghouse for particulate matter (PM) control. The proposed BART Alternative replaces the Spray Dry FGD with a) LNB controls on two (non-BART) Babcock and Wilcox (B&W) boilers, and b) SO_2, NO_x and PM emission reduction credits for shutting down 3 pulp dryers. Modeling results documenting the visibility impacts of the revised BART and the proposed BART Alternative along with an Alternative Benchmark scenario are described in this report. The benchmark scenario provides a common pre-BART basis against which the regional haze impacts of both the BART and BART Alternative scenarios can be compared.

Control Scenarios Modeled

The revised BART and BART Alternative determinations are discussed in the Statement of Basis prepared in conjunction with this permitting action. This report addresses the relative differences in regional haze impacts for the modeled control scenarios and the measured patterns of aerosol extinction and visibility degradation at the Class I areas where the impacts occur. The modeling summarized in this memo involves the following scenarios, with computer runs identified by run identification numbers:

"BART" Modeling Scenario

This scenario, (Run ID wzI10495) includes Riley Boiler BART emissions along with benchmark emissions of sources affected by the BART Alternative. Note, BART (without quotation marks) refers to the BART determination control technology involving only the Riley Boiler, while "BART" (with quotations) refers to this modeling scenario, which includes the other affected emission sources:

- Riley Boiler with existing baghouse, Spray Dry FGD, and LNB
- B&W Boilers #1 and #2 (benchmark emissions of sources affected by the BART Alternative)
- Pulp Dryers, full operation (benchmark emissions of sources affected by the BART Alternative)

"BART Alternative" Modeling Scenario

This scenario (Run ID wzI10493) includes the BART NO_x controls on the Riley boiler, along with Low-NO_x burners on two other non-BART Babcock and Wilcox (B&W) boilers. The B&W NO_x controls along with credits for shutting down three pulp dryers, is proposed by TASCO as an alternative for SO_2 control using Spray-Dry FGD.

- Riley Boiler with existing baghouse and LNB
- B&W Boilers #1 and #2 with LNB
- Pulp Dryers shut down (North, Center, South)

"Alternative Benchmark" Modeling Scenario
This scenario (Run ID wzI10492) includes benchmark or pre-BART emissions from the Riley Boiler and the other sources affected by the BART Alternative scenario. It provides a common benchmark for comparison of the "BART" and "BART Alternative" scenarios on an equivalent basis:

- Riley Boiler with existing baghouse
- B&W Boilers #1 and #2, full operation
- Pulp Dryers, full operation

Methods

The dispersion and visibility modeling described in this report is based on stack parameters and emission rates provided by TASCO. The location and stack parameters for all sources involved in the modeling of all scenarios are presented in Table 1 and the emission rates for the same sources are presented in Table 2.

DEQ used the CALPUFF (v 6.112) air dispersion modeling system to determine the delta-deciview (Δdv) visibility impacts, the number of days per year above the 0.5 Δdv threshold, and the number of days per the three–year period above the 0.5 Δdv threshold. The modeling was performed in accordance with the *BART Modeling Protocol*[1], which was jointly developed by the states of Idaho, Washington, and Oregon, and which has undergone public, Federal Land Manager (FLM) and EPA review and approval. This is the identical protocol used for DEQ's *Subject-to-BART* modeling completed in support of the initial BART Tier II operating permit.[2] The meteorological and CALPUFF computational domains for the Nampa Factory are shown in Figure 1 along with the source location (red dot) and the Class I areas (red with black outlines) within 300 km of the source. Class I areas included in this analysis and identifying abbreviations used in Figure 1 are shown in Table 1. The Class I areas are primarily wilderness areas managed by the United States Forest Service, with the exception of Craters of the Moon Wilderness Area, managed by the National Park Service. None of the Class I areas within 300 miles of Nampa are managed by the United States Fish and Wildlife Service.

Table 1 Class I Areas Included in Modeling Analysis

Eagle Cap Wilderness, OR (eaca2)	Sawtooth Wilderness Area, ID (sawt2)
Strawberry Mountain Wilderness, OR (stmo2)	Selway-Bitterroot Wilderness Area, ID/MT (selw4)
Hells Canyon Wilderness Area, ID/OR (heca2)	Craters of the Moon Wilderness Area, ID (crmowild)
Jarbidge Wilderness Area, ID/NV (jarb2)	

The meteorological inputs to CALPUFF for the analysis were the same data set used previously for the *Subject-to-BART* analysis and the *BART Determination* modeling. The meteorological inputs were prepared by Geomatrix, Inc. (now Environ International) under the direction of representatives from the states of Washington, Idaho, and Oregon, using *Fifth Generation*

[1] *Modeling Protocol for Washington, Oregon and Idaho: Protocol for the Application of the CALPUFF Modeling System Pursuant to the Best Available Retrofit Technology (BART) Regulation.* http://www.deq.idaho.gov/air/prog_issues/pollutants/haze_BART_modeling_protocol.pdf

[2] Tier II Operating Permit No. T2-2009.0105, issued September 7, 2010.

Mesoscale Meteorological Model (MM5) data generated by the University of Washington. The result was a CALMET output file for the three-year period from 2003 through 2005 that covers the entire Pacific Northwest at a 4-km resolution.[3]

Primary particulate matter from these sources is a relatively small contributor to regional haze. Nevertheless, detailed particulate matter speciation was estimated using National Park Service particulate speciation spreadsheets for dry bottom pulverized coal-fired boilers with and without Spray Dry FGD.[4]

The resulting speciated emissions of direct particulate matter emissions can be seen in Table 3. Note, the sulfate (SO_4) in Table 3 is shown as (and input to CALPUFF) as pounds per hour SO_4. However, when totaling the aerosol species under "Total PM_{10}" it is converted to a stoichiometric equivalent mass of ammonium sulfate ($(NH_4)_2SO_4$), since this is the form it assumes in the ambient air, and the mass that is measured in a source test.

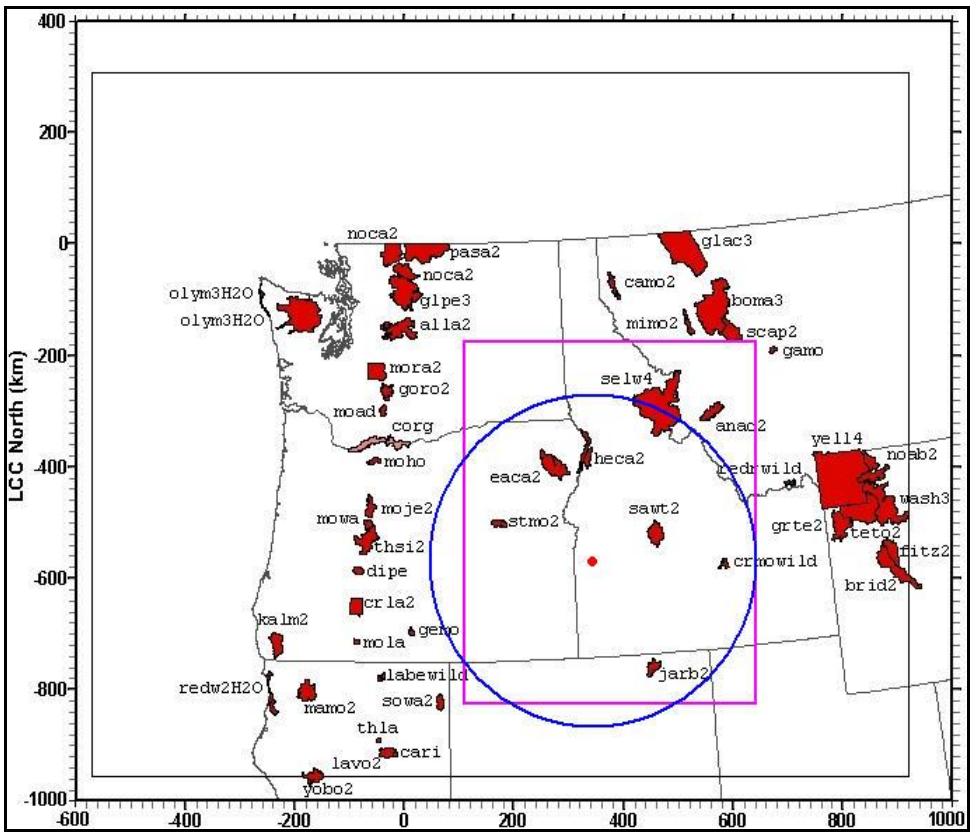

Figure 1 Meteorological (black) CALPUFF (pink) domains with Class I areas within 300-km radius (blue) of TASCO Nampa Factory (red dot).

---

[3] CALMET Statistical Report, CALMET Fields for BART Modeling, Idaho, Oregon and Washington, Geomatrix Consultants, Inc., Lynnwood WA 98036, July 2006.

[4] National Park Service, *Particulate Matter Speciation, Coal-Fired Boiler PM_{10}*, http://www.nature.nps.gov/air/Permits/ect/ectCoalFiredBoiler.cfm

Table 2 Source Locations and Stack Parameters

Unit	BART Control Equipment	Easting (m)	Northing (m)	Elevation (m)	Stack Height (m)	Stack Diameter (m)	Stack Exit Temperature (K)	Stack Exit Velocity (m/s)
Stack Parameters for "Alternative Benchmark" Scenario (Run ID wzl10492)								
Riley Boiler	Existing Baghouse	534.406	4828.031	753	74.7	3.35	445.9	12.0
B&W 1&2	(n/a)	534.406	4828.031	753	74.7	3.35	445.9	12.0
South Pulp Dryer	(n/a)	534.413	4828.087	753	23.5	3.017	348.5	4.9
Center Pulp Dryer	(n/a)	534.413	4828.099	753	21	3.017	353.4	7.0
North Pulp Dryer	(n/a)	534.415	4828.106	753	27.7	2.13	346.4	6.3
Stack Parameters for "BART" Scenario (with affected sources) (Run ID wzl10495)								
Riley Boiler	FGD + LNB (60.7% Control)	534.406	4828.031	753	74.7	3.35	403.8	11.2
B&W 1&2	LNB (Each 55% Control)	534.406	4828.031	753	74.7	3.35	445.9	12.0
South Pulp Dryer	(n/a)	534.413	4828.087	753	23.5	3.017	348.5	4.9
Center Pulp Dryer	(n/a)	534.413	4828.099	753	21	3.017	353.4	7.0
North Pulp Dryer	(n/a)	534.415	4828.106	753	27.7	2.13	346.4	6.3
Stack Parameters for "BART Alternative" Scenario (Run ID wzl10493)								
Riley Boiler	LNB (60.7% Control)	534.406	4828.031	753	74.7	3.35	440.0	11.7
B&W 1&2	LNB (Each 55% Control)	534.406	4828.031	753	74.7	3.35	440.0	11.7

Table 3 Emission Rates used in CALPUFF Modeling [a]

Unit	Control Equipment	SO_2 lb/hr	SO_4 lb/hr	NOX lb/hr	HNO_3 lb/hr	NO_3 lb/hr	PMC lb/hr	PMF lb/hr	EC lb/hr	SOA lb/hr	Total PM_{10} lb/hr[b]
Emissions from all Sources in Alternative Benchmark Scenario (Run ID wzl10492)											
Riley Boiler	Existing Baghouse	522.3	6.7	373.8	0	0	0.5	0.5	0	2.3	12.5
B&W 1&2 [c]	(n/a)	435.0	30.7	227	0	0	2.1	2.1	0	10.5	56.9
South Pulp Dryer	(n/a)	7.5	0.01	80.2	0	0.01	0	31.3	0	5.3	36.6
Center Pulp Dryer	(n/a)	7.5	0.01	80.2	0	0.01	0	31.3	0	5.3	36.6
North Pulp Dryer	(n/a)	2.9	0.01	30.8	0	0.01	0	14.2	0	5.3	19.5
"Alternative Benchmark" Scenario Totals:		*975.1*	*37.43*	*792*	*0*	*0.03*	*2.6*	*79.4*	*0*	*28.7*	*162.2*
Emissions from all sources in "BART" Scenario (with affected sources) (Run ID wzl10495)											
Riley Boiler	Selected BART (FGD + LNB)	104	2.8	147	0	0	0.5	0.5	0	1	5.9
B&W 1&2 [c]	Existing Control, B&W Boilers 1&2	435	30.7	227	0	0	2.1	2.1	0	10.5	56.9
South Pulp Dryer	(n/a)	7.5	0.01	80.2	0	0.01	0	31.3	0	5.3	36.6
Center Pulp Dryer	(n/a)	7.5	0.01	80.2	0	0.01	0	31.3	0	5.3	36.6
North Pulp Dryer	(n/a)	2.9	0.01	30.8	0	0.01	0	14.2	0	5.3	19.5
"BART" Scenario Totals:		*556.8*	*33.5*	*565.2*	*0*	*0.03*	*2.6*	*79.4*	*0*	*27.4*	*155.5*
"BART Alternative" Emissions after Implementation (Pulp Dryers shut down) (Run ID wzl10493)											
Riley Boiler	LNB (60.7% Control)	522.3	6.7	147	0	0	0.5	0.5	0	2.3	12.5
B&W 1&2 [c]	LNB (Each 55% Control)	435	30.7	103	0	0	2.1	2.1	0	10.5	56.9
"BART Alternative" Scenario Totals:		*957.3*	*37.4*	*250*	*0*	*0*	*2.6*	*2.6*	*0*	*12.8*	*69.4*

(a) Pollutant emissions for sulfur dioxide (SO_2), Nitrogen oxides ($NO_x = NO + NO_2$), nitric acid (HNO_3) and speciated particulate matter species (SO_4), particulate nitrate (NO_3), coarse particulate matter 2.5 – 10μm in aerodynamic diameter (PMC), fine particulate matter < 2.5μm in diameter (PMF), elemental carbon (EC), secondary organic aerosol (SOA), and total particulate matter 10μm and less in aerodynamic diameter (PM_{10}).

(b) Total PM_{10} is not used directly in the model but represents total of PM species for information only. SO_4 is added into total PM_{10} as ammonium sulfate (SO_4 lb/hr x (132/96)).

(c) B&W Boilers 1&2 refer to two (non-BART) Babcock &Wilcox Boilers, Units 1 and 2 that operate at the Nampa Factory in addition to the Riley Boiler

BART Alternative Modeling Results

"BART" and "BART Alternative" Model Detailed Results

Detailed model results showing regional haze impacts at all seven Class I areas within 300 km of the source are summarized for the "BART" scenario in Table 4, and for the "BART Alternative" scenario in Table 5. It is important to emphasize that both the "BART" and the "BART Alternative" results shown in Table 4 and Table 5 include all emission sources involved in the BART determinations and in the BART Alternative, so that comparison can be made on an equivalent basis, with the full precursor mix accounted for from all affected sources. Overall (three-year) results for all scenarios are summarized in Table 6 to facilitate comparisons.

In its 2005 BART guidelines, EPA determined that a source whose 98th percentile daily average haze impact (haze index) is greater than 0.5 deciview above natural background is considered to contribute to regional haze. Impacts above 1.0 deciview are considered to cause regional haze impacts. By selecting the 98th percentile, the top 7 days in any year, or top 21 days in three years, EPA intended to minimize the effects of extreme meteorology and conservative assumptions. Table 4 and Table 5 highlight the two averaging periods generally used in BART modeling analyses:

- 8th highest Δdv value for each of the years modeled (2003-2005), representing the 98th percentile (8/365 = 0.02) cutoff for Δdv in the each year. In addition the numbers of days in each year above the 0.5 Δdv threshold are shown.
- 22nd highest value for the entire period from 2003 through 2005, representing the 98th percentile (22/1095 = 0.02) cutoff for Δdv over three years. In addition the numbers of days in all three years above the 0.5 Δdv threshold are shown.

The pre-BART, 3-year modeled impacts shown in Table 4 and Table 5 indicate that the "Alternative Benchmark" scenario does not "contribute" (>0.5Δdv) to regional haze at Craters of the Moon, Jarbidge, Sawtooth and Selway-Bitterroot wilderness areas, the Class I areas east of Nampa. On the other hand, this benchmark scenario does "cause" regional haze impacts (>1.0Δdv) at the 3 Class I areas east of the facility, i.e. Eagle Cap, Strawberry Mountain and Hells Canyon wilderness areas. In addition, Table 4 and Table 5 show that the meteorology in 2004 resulted in the highest modeled impacts and most days above the 0.5Δdv threshold at all sites. Figure 2 clearly shows that the model-predicted visibility impacts at Eagle Cap (due to the existing Riley boiler) were highest in the winter season, and that January 2004 had the highest predicted impacts during the three-year model period. In addition, from day 60 through day 280, only 3 days in 3 years appear to exceed the 0.5Δdv threshold for a 98th percentile day "contributing" to a haze at a Class I area. Since this frequency (3 days in 660) represents only 0.45% of the non-winter days, it suggests that the Riley boiler does not "contribute" to the haze impacts, at the level defined by EPA, outside of the October – February period. However it does "cause" haze impacts (>1 Δdv) at the western-most 3 Class I areas during the winter time when non-carbon impacts are the greatest.

Comparison to Measured Extinction at IMPROVE monitoring sites

To gain confidence in model results, it is useful to examine how model results behave in comparison to monitored aerosol extinction at IMPROVE monitoring sites. For this purpose, it is useful to understand how light extinction is determined from aerosol species concentrations and

how extinction relates to the "haze index" or changes in visibility relative to the background visibility in terms of delta deciviews (Δdv). Light extinction (b_{ext}) is computed from aerosol species concentrations and reported in units of reciprocal megameters (Mm^{-1}) according to the equation:

$$b_{ext} = 3\ f(RH)\ [(NH_4)_2SO_4] + 3\ f(RH)\ [NH_4NO_3] + 4[OC] + 1[Soil] + 0.6[Coarse\ Mass] + 10[EC] + b_{Ray} \qquad \text{(Eqn 1)}$$

Equation 1 applies to either measured or modeled aerosol concentrations, where:

f(RH) are monthly averaged relative humidity coefficients, specifically tabulated for each Class I area each month,
b_{Ray} is Raleigh scattering due to air molecules, Mm^{-1}
$[(NH_4)_2SO_4]$ is the ammonium sulfate concentration formed from SO_s, $\mu g/m^3$
$[NH_4NO_3]$ is the ammonium nitrate concentration formed from NO_x, $\mu g/m^3$
[OC] is the organic carbon concentration, $\mu g/m^3$ (equivalent to "SOA" in Table 3)
[Soil] is the fine geologic particulate matter, $\mu g/m^3$ (equivalent to "PMF" in Table 3),
[Coarse Mass] is the coarse particulate matter, $\mu g/m^3$ (equivalent to "PMC" in Table 3), and
[EC] is the elemental carbon, $\mu g/m^3$

Light extinction is not measured directly at IMPROVE sites, but is calculated based on aerosol measurements of the species in Equation 1. In this document, the terms "measured extinction" or "monitored extinction" refer to light extinction calculated by Equation 1 based on direct aerosol filter measurements and reported by the IMPROVE monitoring program. When source emissions are modeled to estimate light extinction impacts resulting from those emissions, the resulting $b_{ext\ (source)}$ is compared to background extinction, $b_{ext\ (bkg)}$, to predict the haze index in terms of delta-deciviews:

$$\Delta dv = 10\ ln\ [\ (\ b_{ext\ (bkg)} + b_{ext\ (source)}\ )\ /\ (\ b_{ext\ (bkg)}\ )\ ] \qquad \text{(Eqn 2)}$$

A time series view of 2004 light extinction based on measured aerosol concentrations and modeled pre-BART Riley Boiler concentrations at Hells Canyon (Figure 3) again suggests that the winter months experience the highest visibility impacts and that the January 2004 stagnation episode produced the greatest monitored and modeled aerosol extinction over the 3 year period. The similarity in monitor-based and modeled annual patterns shown in Figure 3 suggests that the model captures the seasonal variation in haze conditions well and that both the observed and modeled visibility impacts are highest in the winter time and much lower from March to mid-October.

Summary of "BART" results.

The visibility improvement for the "BART" scenario, in comparison to the Alternative Benchmark scenario (Table 4) shows a reduction in the three-year 22nd highest Δdv of 0.689 Δdv at Eagle Cap, the most impacted area, and 0.119 Δdv at Jarbidge Wilderness, the least impacted area. Similarly, the number of days in three years above the 0.5 Δdv threshold at Eagle Cap decreases from 195 days to 149 days, a 46 day reduction, while Jarbidge is projected to see only a three day reduction. The sum of days in 3 years above 0.5 Δdv at all seven Class I areas decreases from 455 days for the Alternative Benchmark scenario to 316 days for the "BART" scenario, a reduction of 139 days overall.

Summary of "BART Alternative" Results

The visibility improvement for the "BART Alternative" scenario in comparison to the "Alternative Benchmark" scenario (Table 5) shows a reduction in the three-year 22nd highest Δdv at Eagle Cap from 2.201 to 1.411Δdv, a visibility improvement of 0.790 Δdv. The number of days in the three-year period above the 0.5 Δdv threshold at Eagle Cap decreases from 195 days to 126 days, a 69 day reduction, while Jarbidge is projected to see a three day reduction, identical to the "BART" scenario. The sum of days above 0.5 Δdv at all the Class I areas combined drops from 455 for the "Alternative Benchmark" scenario to 275 days for the "BART Alternative" scenario, a reduction of 180 days. A very small visibility degradation appears at Selway-Bitterroot Wilderness Area.

Table 4 Summary of Visibility Impacts for TASCO-Nampa "BART" Scenario

Class I Area	Operating Scenario	Change in Visibility Compared Against 20% Best Days (Natural Background)							
		Δdv larger than 0.5 from one year period						Δdv > 0.5 over 3 yr	
		2003		2004		2005		2003-2005	
		8th high Δdv[a]	Days > 0.5Δdv[b]	8th high Δdv[a]	Days > 0.5Δdv[b]	8th high Δdv[a]	Days > 0.5Δdv[b]	22nd Highest[c]	Total Days[d] >0.5Δdv
Eagle Cap Wilderness, OR	"Alternative Benchmark" (wzI10492)	1.611	48	2.212	72	2.178	75	2.201	195
	"BART"[e] (wzI10495)	1.103	30	1.551	55	1.509	64	1.512	149
	Visibility Improvement[f]	*0.508*	*18*	*0.661*	*17*	*0.669*	*11*	*0.689*	*46*
Craters of the Moon NM Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.336	1	0.407	6	0.318	3	0.393	10
	"BART"[e] (wzI10495)	0.239	0	0.273	3	0.233	1	0.267	4
	Visibility Improvement[f]	*0.097*	*1*	*0.134*	*3*	*0.085*	*2*	*0.126*	*6*
Hells Canyon Wilderness ID/OR	"Alternative Benchmark" (wzI10492)	1.269	27	1.693	51	1.515	51	1.582	129
	"BART"[e] (wzI10495)	0.884	20	1.163	32	1.049	35	1.092	87
	Visibility Improvement[f]	*0.385*	*7*	*0.530*	*19*	*0.466*	*16*	*0.490*	*42*
Jarbidge Wilderness, NV	"Alternative Benchmark" (wzI10492)	0.275	1	0.379	3	0.420	4	0.375	8
	"BART"[e] (wzI10495)	0.192	1	0.256	2	0.278	2	0.256	5
	Visibility Improvement[f]	*0.083*	*0*	*0.123*	*1*	*0.142*	*2*	*0.119*	*3*
Sawtooth Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.470	7	0.519	8	0.435	3	0.470	18
	"BART"[e] (wzI10495)	0.340	2	0.349	4	0.293	0	0.319	6
	Visibility Improvement[f]	*0.130*	*5*	*0.170*	*4*	*0.142*	*3*	*0.151*	*12*
Selway-Bitterroot Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.317	0	0.587	8	0.492	7	0.439	15
	"BART"[e] (wzI10495)	0.212	0	0.387	1	0.327	2	0.281	3
	Visibility Improvement[f]	*0.105*	*0*	*0.200*	*7*	*0.165*	*5*	*0.158*	*12*
Strawberry Mountain Wilderness, OR	"Alternative Benchmark" (wzI10492)	1.419	18	0.882	22	2.308	40	1.462	80
	"BART"[e] (wzI10495)	0.987	13	0.644	15	1.677	34	1.076	62
	Visibility Improvement[f]	*0.432*	*5*	*0.238*	*7*	*0.631*	*6*	*0.386*	*18*
All Areas	***Reduction in Total Days > Δdv, all Class I Areas Combined***	***2003:***	***36***	***2004:***	***58***	***2005:***	***45***	***3-Yr:***	***139***

(a) The 8th highest delta-deciview impact for the calendar year.
(b) Total number of days in 1 year that exceeded 0.5 delta deciviews.
(c) The 22nd highest delta-deciview impact for the three-year period.
(d) Total number of days in the three-year period that exceed 0.5 delta deciviews.
(e) "BART" (with quotations) refers to the Riley Boiler with Spray Dry FGD and LNB controls plus the pre-BART emissions of the B&W boilers 1&2 and three pulp dryers so that the results may be compared to the "BART Alternative" and the "Alternative Benchmark" scenarios on an equivalent basis.
(f) Visibility improvement is calculated as the difference between the "Alternative Benchmark" scenario and the "BART" scenario modeled values.

Table 5 Summary of Visibility Impacts for TASCO-Nampa "BART Alternative" Scenario

Class I Area	Operating Scenario	Change in Visibility Compared Against 20% Best Days (Natural Background)							
		Δdv larger than 0.5 from one year period						Δdv > 0.5 over 3 yr	
		2003		2004		2005		2003-2005	
		8th high Δdv[a]	Days > 0.5Δdv[b]	8th high Δdv[a]	Days > 0.5Δdv[b]	8th high Δdv[a]	Days > 0.5Δdv[b]	22nd Highest[c]	Total Days[d] >0.5Δdv
Eagle Cap Wilderness, OR	"Alternative Benchmark" (wzI10492)	1.611	48	2.212	72	2.178	75	2.201	195
	"BART Alternative" (wzI10493)	0.921	22	1.434	49	1.469	55	1.411	126
	Visibility Improvement [e]	0.690	26	0.778	23	0.709	20	0.790	69
Craters of the Moon NM Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.336	1	0.407	6	0.318	3	0.393	10
	"BART Alternative" (wzI10493)	0.230	0	0.260	2	0.200	1	0.245	3
	Visibility Improvement [e]	0.106	1	0.147	4	0.118	2	0.148	7
Hells Canyon Wilderness ID/OR	"Alternative Benchmark" (wzI10492)	1.269	27	1.693	51	1.515	51	1.582	129
	"BART Alternative" (wzI10493)	0.758	17	1.173	31	1.044	32	1.059	80
	Visibility Improvement [e]	0.511	10	0.520	20	0.471	19	0.523	49
Jarbidge Wilderness, NV	"Alternative Benchmark" (wzI10492)	0.275	1	0.379	3	0.420	4	0.375	8
	"BART Alternative" (wzI10493)	0.193	1	0.252	2	0.251	2	0.234	5
	Visibility Improvement [e]	0.082	0	0.127	1	0.169	2	0.141	3
Sawtooth Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.470	7	0.519	8	0.435	3	0.470	18
	"BART Alternative" (wzI10493)	0.268	1	0.340	4	0.278	1	0.307	6
	Visibility Improvement [e]	0.202	6	0.179	4	0.157	2	0.163	12
Selway-Bitterroot Wilderness, ID	"Alternative Benchmark" (wzI10492)	0.317	0	0.587	8	0.492	7	0.439	15
	"BART Alternative" (wzI10493)	0.206	0	0.383	2	0.329	2	0.298	4
	Visibility Improvement [e]	0.111	0	0.204	6	0.163	5	0.141	11
Strawberry Mountain Wilderness, OR	"Alternative Benchmark" (wzI10492)	1.419	18	0.882	22	2.308	40	1.462	80
	"BART Alternative" (wzI10493)	0.737	10	0.540	11	1.487	30	0.917	51
	Visibility Improvement [e]	0.682	8	0.342	11	0.821	10	0.545	29
All Areas	***Reduction in Total Days > 0.5 dv, all Class I Areas Combined***	***2003:***	***51***	***2004:***	***69***	***2005:***	***60***	***3-Yr:***	***180***

(a) The 8th highest delta-deciview impact for the calendar year.
(b) Total number of days in 1 year that exceeded 0.5 delta deciviews.
(c) The 22nd highest delta-deciview impact for the three-year period.
(d) Total number of days in the three-year period that exceed 0.5 delta deciviews.
(e) Visibility improvement is calculated as the difference between the "Alternative Benchmark" scenario and the "BART Alternative" scenario modeled values.

Table 6 Summary of scenarios and net visibility improvement from "BART Alternative" in comparison to "BART" scenario

Class I Area	"Alternative Benchmark"[a] (wzI10492)		"BART"[b] (wzI10495)		"BART Alternative"[c] (wzI10493)		Net Visibility Improvement ("BART" – "BART Alternative")	
	22nd Highest [d]	Total Days >0.5Δdv [e]	22nd Highest [d]	Total Days [e] >0.5Δdv	22nd Highest [d]	Total Days >0.5Δdv [e]	Δdv Reduction, 22nd Highest Day	Decrease in No. of Days >0.5 Δdv
Eagle Cap Wilderness, OR	2.201	195	1.512	149	1.411	126	0.101	23
Craters of the Moon Wilderness, ID	0.393	10	0.267	4	0.245	3	0.022	1
Hells Canyon Wilderness, ID/OR	1.582	129	1.092	87	1.059	80	0.033	7
Jarbidge Wilderness, NV	0.375	8	0.256	5	0.234	5	0.022	0
Sawtooth Wilderness, ID	0.47	18	0.319	6	0.307	6	0.012	0
Selway-Bitterroot Wilderness, ID	0.439	15	0.281	3	0.298	4	-0.017	-1
Strawberry Mountain Wilderness, OR	1.462	80	1.076	62	0.917	51	0.159	11
Total Number of Days with Improved Visibility:		455		316		275		41

(a) Includes pre-BART emissions of all sources involved in BART and the BART Alternative: Riley Boiler, B&W Boilers 1&2 and pulp dryers.
(b) Includes all sources involved in BART and the BART Alternative under "BART" operations: Riley Boiler (LNB + SD-FGD), B&W Boilers 1&2, three pulp dryers operating.
(c) Includes all sources involved in BART and the BART Alternative under BART Alternative operations: Riley Boiler (LNB), B&W Boilers 1&2 (LNB), three pulp dryers shut down.
(d) The 22nd highest Δdv value for the three-year period (2003 – 2005).
(e) Total number of days in the three-year period that exceed 0.5 Δdv.

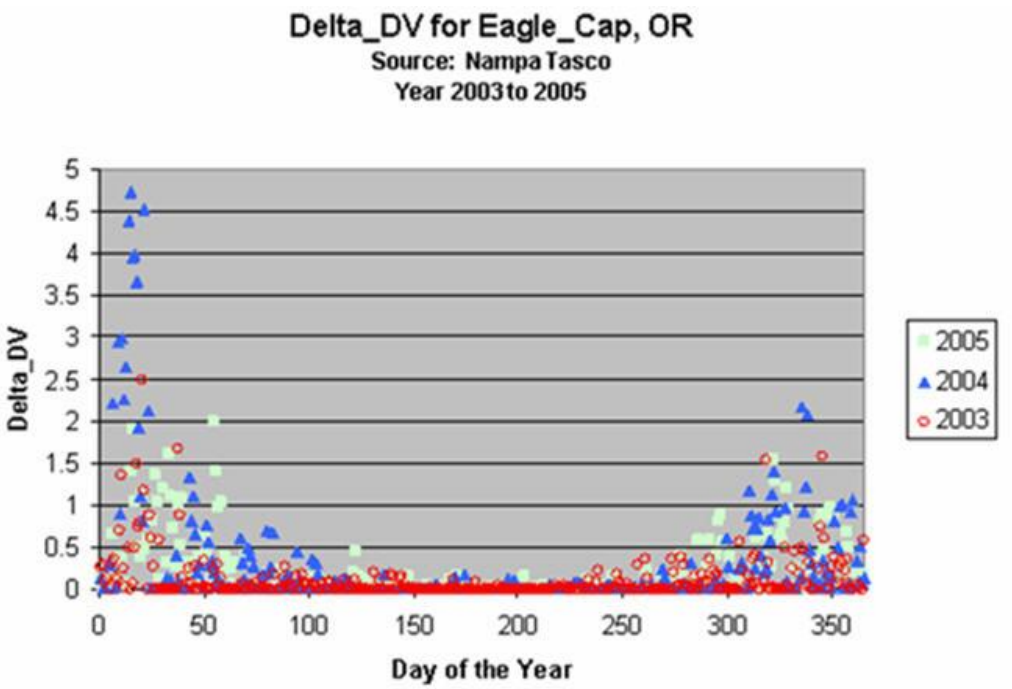

Figure 2 **Modeled seasonal variation in delta-deciview impacts due to TASCO's Riley Boiler (existing control), over the three model years**

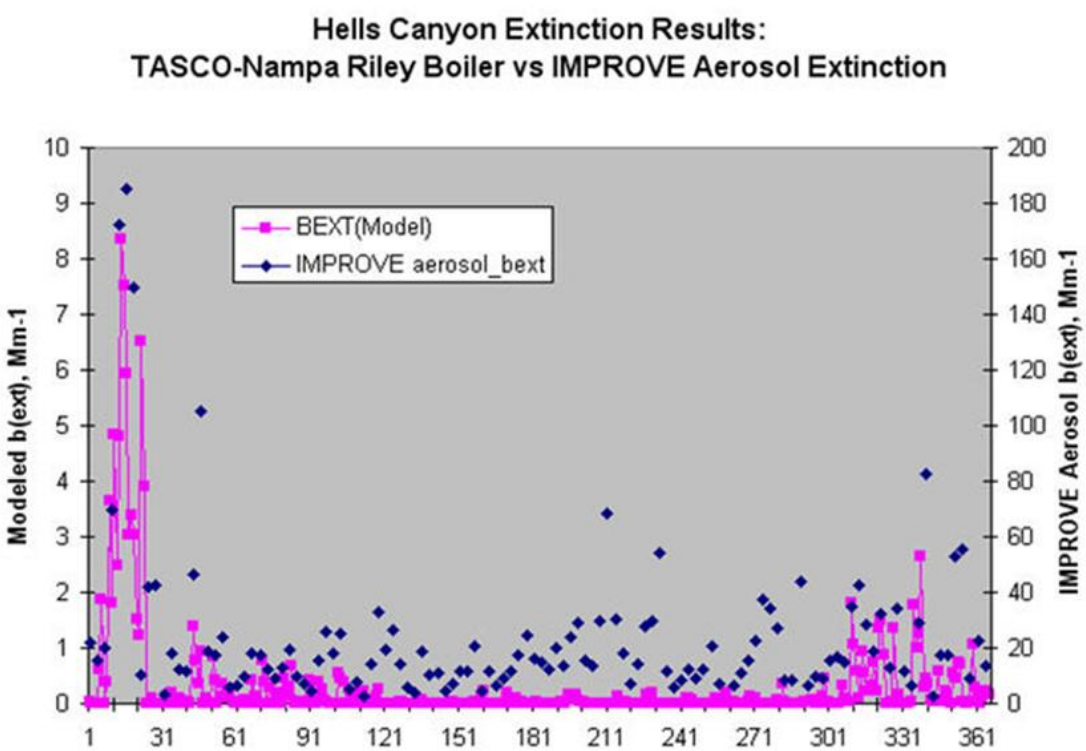

Figure 3 **Comparison of modeled extinction due to the Riley Boiler (existing control) (left axis) and measured total aerosol extinction at the Hells Canyon IMPROVE site (right axis).**

Other Considerations

In preliminary discussion of the proposed changes with FLMs, questions were raised about finding sufficient alternative controls at the facility to include in a BART alternative and about the effect on visibility impacts that would result from reducing the level of SO_2 control and replacing it with increased NO_x control. As a result, DEQ reassessed the selection of emission sources included in BART Alternative modeling and evaluated whether inordinate visibility impacts were projected to shift impacts to other Class I areas or to other seasons. This section describes those evaluations.

Availability of other Emission Sources for Inclusion in the BART Alternative

Alternatives to the control of SO_2 emissions by Spray Dry-FGD were proposed by TASCO, in light of both the high cost and the environmental impairment due to the waste stream produced by Spray Dry FGD. During the evaluation, the FLMs suggested that in seeking alternative emission reductions, DEQ should examine the entire facility-wide emission inventory to determine if other emission sources, in addition to the two B&W Boilers and the Pulp Dryers could be considered for inclusion as part of a BART Alternative. DEQ examined the primary regional haze precursors in the facility-wide emission inventory for the TASCO Nampa Factory in the most recent statewide point source emissions inventory (2010). The pulp dryers had been shut down by 2010 and did not appear in this inventory, but were included as reductions in the BART Alternative. The facility-wide emissions of NO_x, SO_2 and PM_{10} are shown in Figure 4, Figure 5, and Figure 6 (respectively). These charts indicate that the Riley Boiler and the B&W boiler Units 1 & 2 together comprise 97% of the total facility-wide NO_x emissions, 99% of the SO_2 emissions and 98% of PM_{10} emissions. This review confirmed that the emission sources contributing the greatest share of visibility-impairing emissions from the Nampa Factory are included in the proposed BART Alternative and that no other significant visibility-impairing pollutant emission sources are available at the facility for inclusion in the BART Alternative control plan.

Effects on Visibility from Replacing SO_2 Control with Additional NO_x Control

The proposed BART Alternative replaces the Spray-Dry Flue Gas Desulfurization SO_2 control on the Riley Boiler with additional NO_x controls on the two Babcock & Wilcox boilers and with additional NO_x, SO_2 and PM_{10} reductions achieved by shutting down the 3 pulp dryers. Visibility reductions resulting from this proposed change would potentially be limited if the highest regional haze impacts were primarily caused by sulfate, or if sulfate was a predominant contributor in any particular season during which the facility contributes to significant visibility degradation. To assess the importance of nitrate, sulfate and primary particulate matter to the regional haze levels, DEQ investigated the monitored impacts at all the Class I areas and seasons most impacted by the TASCO Nampa Factory. IMPROVE aerosol monitoring data[5] for the modeling period are presented in this section to provide a multi-year evaluation of pre-BART visibility conditions and their seasonal variation.

[5] Western Regional Air Partnership (WRAP), WRAP-TSS Web site, September 2011. http://vista.cira.colostate.edu/TSS/Results/Monitoring.aspx

Most Impacted Areas

The modeled visibility impacts from sources at the TASCO Nampa plant were highest at the Class I areas at the west end of the Snake River Valley: Eagle Cap, Strawberry Mountain and Hells Canyon wilderness areas. These areas also experience the highest monitored aerosol impacts, with the exception of isolated wildfire impacts that affect sites throughout the west. Monitoring data for the years of the modeling study, 2003, 2004 and 2005 are shown in Figure 7, Figure 8, and Figure 9 (respectively), for the Starkey IMPROVE site. The Starkey site is located between Eagle Cap and Strawberry Mountain and is intended to represent both of these Wilderness areas. Figure 10, Figure 11, and Figure 12 show the measured aerosol extinction for the same three years at Hells Canyon IMPROVE site. The three Class I areas represented by these two IMPROVE sites reflect very similar patterns of observed seasonal visibility degradation and aerosol composition. A review of Figure 7 through Figure 12 indicates that:

- The greatest non-carbon impacts are in the winter, when nitrate predominates extinction (80 to 150 Mm^{-1}) and sulfate is relatively low. This aerosol formation regime generally occurs from November through February.
- The greatest carbon impacts occur in the summer, sometimes extending into fall, when carbon predominates extinction (~120 – 280 Mm^{-1}), likely from wildfires in the region, nitrate is negligible, and sulfate is relatively low (< 10Mm^{-1}). It is important to note that ammonium nitrate is volatile at summertime temperatures and does not exist as an aerosol that can impact visibility during these warmer seasons.
- The season with the best visibility (lowest extinction) is spring, when sulfate predominates. During this period, most sulfate impacts appear to be between about 5 and 10 Mm^{-1}, with the highest sulfate impact in 3 years reaching just over 20 Mm^{-1}. Nevertheless, the observed aerosol impacts in the spring are relatively low compared to winter and summer when extinction reaches 120 to 300 Mm^{-1} most years.

The Starkey IMPROVE site represents the two Class I areas with greatest modeled impacts from the TASCO Nampa boilers so seasonal regional haze impacts measured at Starkey were examined in more detail. Daily extinction values for measured aerosol species were obtained from the WRAP-TSS[5] and summarized into monthly average extinction values. Figure 13 shows monthly averaged total extinction at Starkey, and average extinction by species for all days in the three-year modeling period, 2003 – 2005. Error bars representing the 95% Confidence Intervals (CI) are also shown to indicate variability. The total extinction line demonstrates that average extinction is the highest in the summer and fall months, as a result of high organic carbon. The colder months of November through February experience the second highest total extinction and the predominant species is ammonium nitrate. The season with the best visibility (lowest average extinction) is spring (March through June) when average aerosol extinction is half to a third of that in the higher seasons. Sulfate predominates for most of the spring months averaging around 5 – 7 Mm^{-1} with very little variability. Carbon increases to levels comparable to sulfate in May and June.

Figure 14 shows the monthly average extinction pattern for the 20% of days observed each month with the worst visibility conditions. For the worst 20% of days, the greatest contributors to regional haze impacts are carbon in the summer and fall and nitrate in the winter. Again,

sulfate predominates in the spring when visibility conditions are best, yet still contributes only about 8 – 12 Mm^{-1} when averaged over the 20% of days with the highest extinction.

Less Impacted Areas

The TASCO Nampa Factory modeled impacts for the "Alternative Benchmark" scenario revealed that the other Class I areas further away and to the east of Nampa experienced modeled visibility impacts ranging from only 17 to 21% of the impacts at Eagle Cap, for the 22nd highest Δdv days. None of the 22nd highest days exceed 0.5Δdv, the EPA suggested threshold for "contributing" to a haze problem. The measured haze impacts at Craters, Jarbidge, Sawtooth and Selway-Bitterroot were also much lower than those at Starkey and Hells Canyon. The measured aerosol extinction charts for 2003, 2004 and 2005 are shown for Sawtooth Wilderness in Figure 15, Figure 16, and Figure 17 (respectively); for Jarbidge Wilderness in Figure 18, Figure 19, and Figure 20; for Craters of the Moon Wilderness in Figure 21, Figure 22, and Figure 23; and for the Selway-Bitterroot Wilderness Area in Figure 24, Figure 25, and Figure 26. It should be noted, that the scale for each extinction figure changes, and while the highest (nitrate-impacted) days at Starkey and Hells Canyon reach 100 to 180 Mm^{-1}, the highest nitrate-impacted days at the more distant sites east of Nampa have total extinction levels reaching only 40 to 55 Mm^{-1}.

The observed aerosol extinction charts for the eastern group of Class I areas indicate that:

- At Jarbidge, Sawtooth and Selway-Bitterroot wilderness areas, measured nitrate aerosol extinction was very low, even in winter, suggesting very little impact from the TASCO Nampa Factory. Carbon dominated at these sites during the summer wildfire season, peaking around 130 Mm^{-1} at Sawtooth and over 350 Mm^{-1} at Selway-Bitterroot. Sulfate was more significant in the spring with most days below 5 - 6 Mm^{-1} and only a few days in the range 10 – 20 Mm^{-1}.
- At Craters of the Moon Wilderness Area (Figure 21 through Figure 23) the highest observed aerosol extinction resulted from nitrate in winter, up to 55 Mm^{-1}, and carbon in the summer up to 100 Mm^{-1}. Sulfate at Craters of the Moon was similar in magnitude to sulfate at all the other sites, typically around 5 - 10 Mm^{-1} or less, and never exceeds 20 Mm^{-1}, similar to the other Class I areas. This appears to be indicative of a very consistent regional background, with very little variation amongst all 7 Class I area.

Overview of Seasonal Visibility Analysis

The above analysis of seasonal visibility impacts suggests that the greatest impacts occur at Starkey and Hells Canyon as a result of wintertime nitrate impacts and summer/fall organic carbon impacts, probably from wildfires. A review of sulfate impacts at all the Class I areas (above) suggests that the level of springtime sulfate impacts (Figure 13 and Figure 14) at the Starkey IMPROVE site (~ 6 Mm^{-1} on the average day and 8 - 12 Mm^{-1} on the highest 20% of days) approximates a regional background level, similar to the levels apparent at the Class I areas east of Nampa (Jarbidge, Sawtooth, Craters of the Moon and Selway-Bitterroot) where TASCO Nampa emissions were found to not "contribute" significantly to the modeled extinction.

To confirm the seasonality of the modeled impacts at Eagle Cap, the 22 highest days from the "Alternative Benchmark", "BART" and "BART Alternative" scenarios were plotted in

Figure 27. All of the highest 22 days were observed in the winter time, and the "BART Alternative" results showed a slight improvement over the "BART" results.

It may be concluded that the "BART Alternative" scenario results in greater reductions in haze on the 98th percentile days, and more days below the 0.5Δdv threshold than the "BART" scenario because it more effectively addresses the primary aerosol contributor (nitrates) during the most impacted season at the most impacted Class I areas. This overall improvement comes at the price of slightly less improvement during the best visibility period in the spring, when sulfate is a much smaller, but still predominant contributor to visibility degradation. Thus, the reduction in SO_2 control in lieu of more NO_x control results in slightly less visibility improvement on the clearest days in the spring (< 5Mm^{-1}). Nevertheless, greater overall improvement in visibility conditions occurs with the "BART Alternative" in comparison to the "BART" scenario.

Additional Environmental Benefits in Reducing Ozone

The Treasure Valley, including the Boise River and Snake River Valleys and stretching from Mountain Home, Idaho to Malheur County, Oregon, has been struggling with elevated summertime ozone conditions for a number of years. As shown in Figure 28, the Treasure Valley area remains perilously close to exceeding the ozone National Ambient Air Quality Standard (NAAQS). In 2008, the area escaped non-attainment by less than a part per billion. In 2010 the area was again very close to the proposed (but now deferred) range of the revised ozone NAAQS (60 – 70 ppb). DEQ believes that a recession-induced reduction in traffic, perhaps along with beneficial weather patterns has helped to avoid a non-attainment designation in recent years but that as traffic increases and weather varies, the attainment status of this area is precarious. As a result, Idaho has taken unprecedented steps to lower VOC and NO_x ozone precursor emissions, including Stage II vapor control requirements and the nation's only vehicle testing program (to our knowledge) that was not mandated by EPA in an ozone non-attainment plan. This testing program, started in June 2010 in Canyon County, where the TASCO Nampa Factory is located and was recently evaluated to determine the emission reductions it is providing. Based on MOVES modeling results, DEQ determined that the program provides approximately a 6.3% reduction in VOCs and a 2.7% reduction in NO_x. The NO_x reductions correspond to a 162 ton per year reduction or an annualized reduction of 0.4 tons per day.

In its ongoing effort to be proactive in addressing the ozone problem, DEQ assessed the ozone mitigation benefits of a number of potential control measures in the CMAQ photochemical model, ranging from VMT reductions to reductions in emissions from lawn and garden equipment and solvent degreasing controls, etc. DEQ found that while VOC plus NO_x reductions are most effective, NO_x reductions of around 2 tons per day from the TASCO Factory is expected to result in a reduction of the peak 8-hour ozone concentration of approximately 0.1 part per billion (ppb) on high ozone days. This is a better reduction than many of the other options, including further seasonal lowering of the Reid Vapor Pressure in gasoline, a 54% VOC reduction from a solvent-degreasing regulatory program, a 10% reduction in lawn and garden emissions, and a 10% reduction in vehicle refueling emissions.

Ozone mitigation is only beneficial in the summertime. Thus, when TASCO's winter processing campaign is over in the spring, less boiler capacity is required and at times the B&W Boilers 1&

2 are not used, in which case summer ozone benefits from lowering the NO_x emissions from the B&W boilers would not contribute to ozone mitigation. However, TASCO has confirmed that in addition to the Riley Boiler, the B&W boilers usually operate about 30 days during the summer ozone season (range is 20 to 60 days). As a result, on a significant number of summer days, DEQ anticipates that the BART Alternative will provide ozone reduction benefits in the Treasure Valley.

The "BART Alternative" scenario, achieves 6.5 tons per day of NO_x reductions in comparison to the "Alternative Benchmark", more than double the 2.7 tons per day reduction from the "BART" scenario. This quantity represents the greatest NO_x reduction of any ozone control measures DEQ has evaluated to date. While NO_x-only controls are not as effective as combined NO_x plus VOC controls, this large reduction, in conjunction with VOC-only controls should be sufficient to significantly reduce the number of unhealthy days and may help to avoid a non-attainment designation in the next few years.

Conclusions

This air quality modeling analysis addresses the visibility impacts of the "BART" and "BART Alternative" control scenarios for the BART-subject Riley Boiler at TASCO's Nampa Factory. The "BART" scenario results in an overall 36% reduction in acid gas emissions, while the "BART Alternative" scenario results in a 31% reduction, however total acid gas plus particulate matter emissions for the two scenarios are virtually identical. TASCO's alternative proposal involves replacing Spray Dry Flue Gas Desulfurization SO_2 controls on the Riley Boiler with low-NO_x burner controls on two non-BART boilers, along with shutting down three pulp dryers. While the total emissions of all species are similar, the "BART Alternative" achieves greater improvements in visibility because the most severe non-carbon visibility impairment at the Class I areas nearest the Nampa Factory is dominated by ammonium nitrate in the winter and replacing some of the SO_2 control with increased NO_x control provides greater reductions on more poor visibility days. An analysis of seasonal aerosol extinction observations indicates that while the greatest improvements will occur in the winter when impacts are greatest, there will be a small visibility impairment in the spring when the visibility conditions are best and a low-level sulfate background dominates the extinction.

Nevertheless, overall modeled improvements show that the modeled visibility degradation on the 22nd highest impacted day at Eagle Cap was reduced by an additional 0.101 Δdv for the "BART Alternative" scenario in comparison to the "BART" scenario, and there were projected to be 23 less days at Eagle Cap over the 0.5 Δdv threshold. Taking a broader geographic view, the combined number of days at all seven areas above the 0.5 Δdv threshold were reduced by an additional 41 days for the "BART Alternative" scenario in comparison to the "BART" scenario.

Finally, the "BART Alternative" scenario provides significantly greater NO_x reductions than the "BART" scenario (2.4 times greater), and therefore is preferred by DEQ over the "BART" scenario for additional environmental benefits it is expected to bring to the ozone mitigation efforts in the Treasure Valley, in addition to the improved visibility expected for Class I Areas in the region.

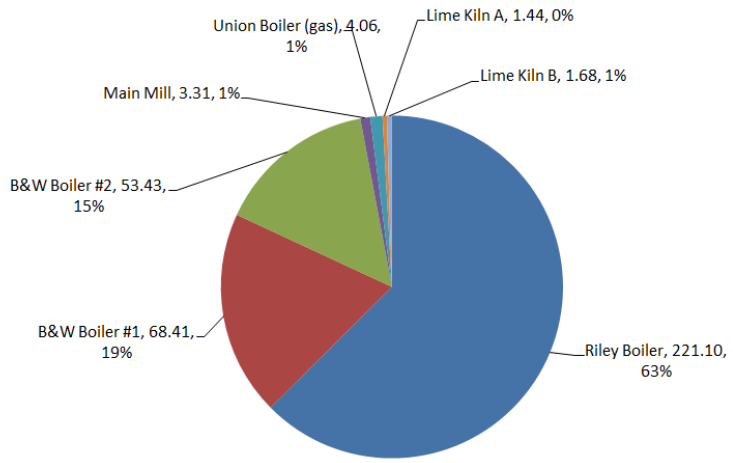

Figure 4 TASCO Nampa Facility-Wide NO_x Emissions

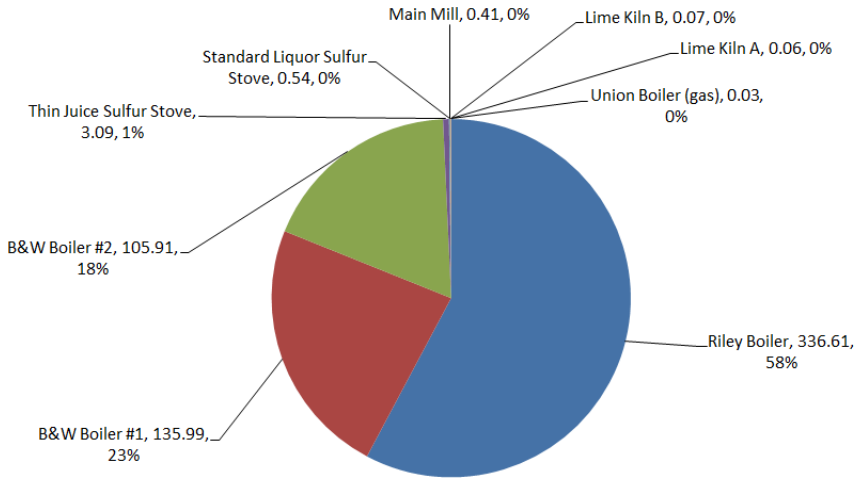

Figure 5 TASCO Nampa Facility-Wide SO2 Emissions

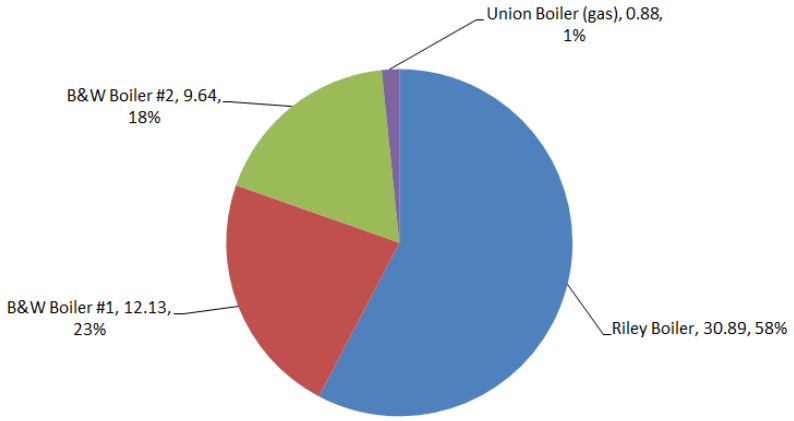

Figure 6 TASCO Nampa Facility-Wide PM_{10} Emissions

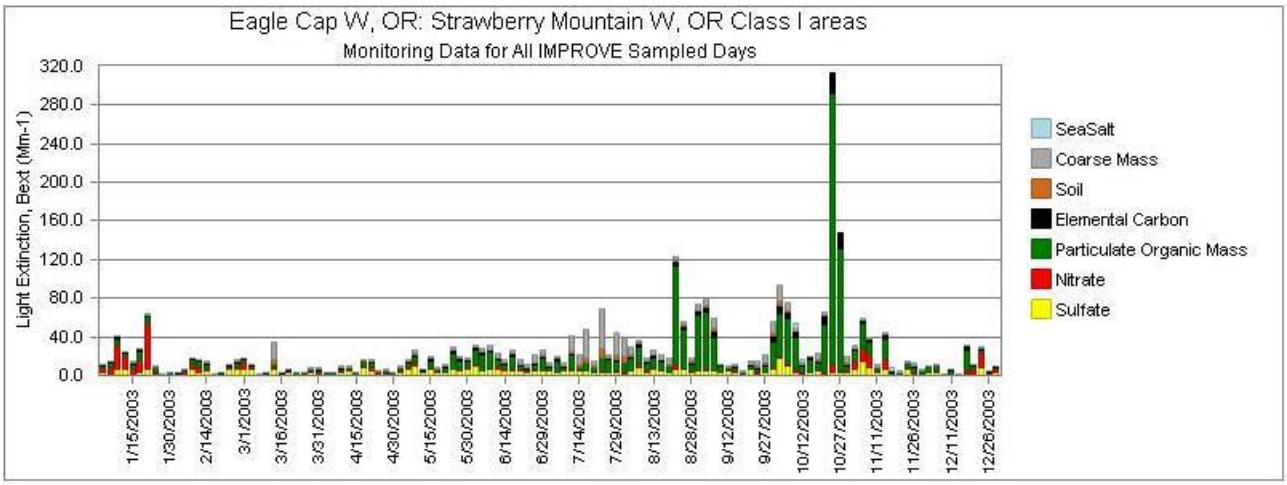

Figure 7 Light extinction (Mm-1) based on measured aerosol concentrations at Starkey IMPROVE site, representing Eagle Cap and Strawberry Mountain, 2003.

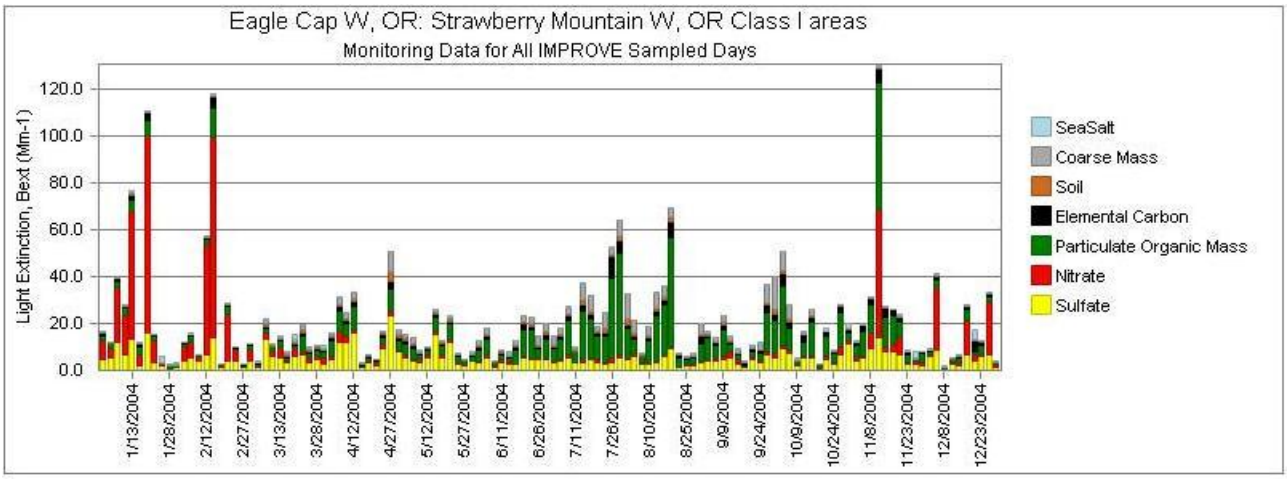

Figure 8 Light extinction (Mm-1) based on measured aerosol concentrations at Starkey IMPROVE site, 2004.

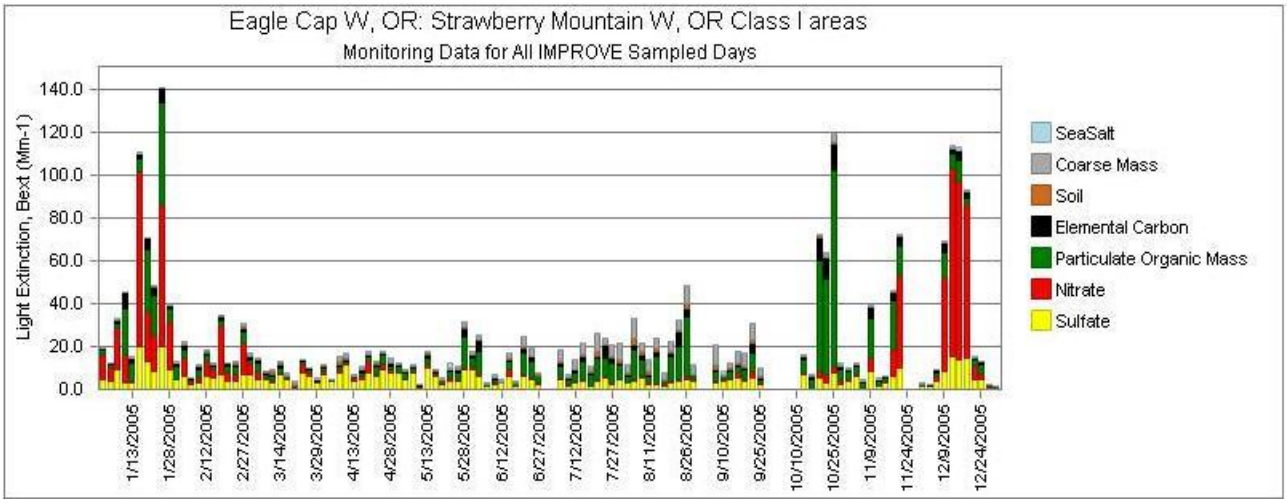

Figure 9 Light extinction (Mm-1) based on measured aerosol concentrations at Starkey IMPROVE site, 2005.

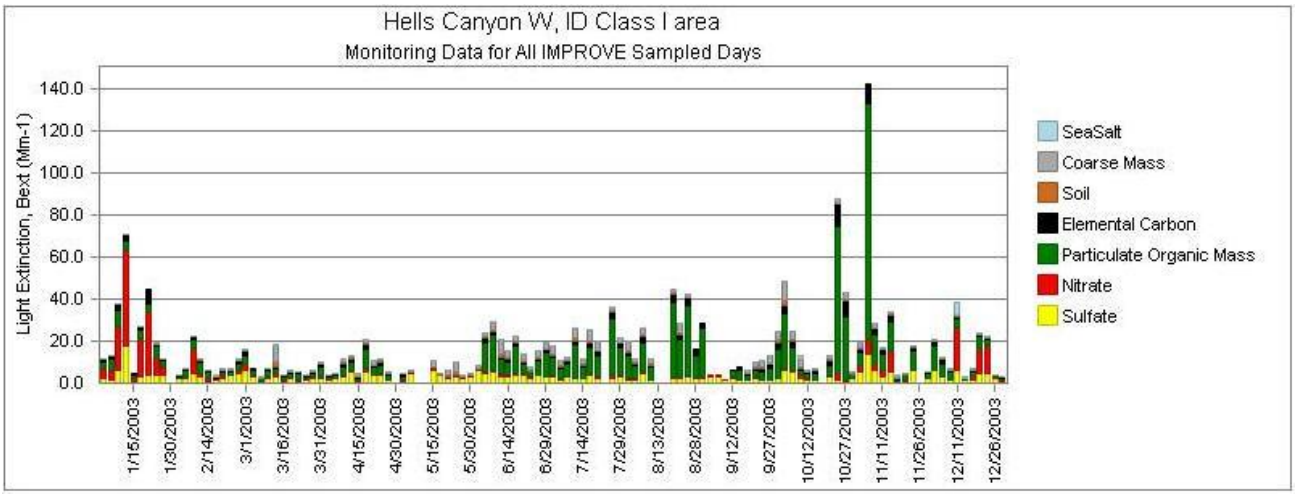

Figure 10 Light extinction (Mm-1) based on measured aerosol concentrations at Hells Canyon IMPROVE site, 2003.

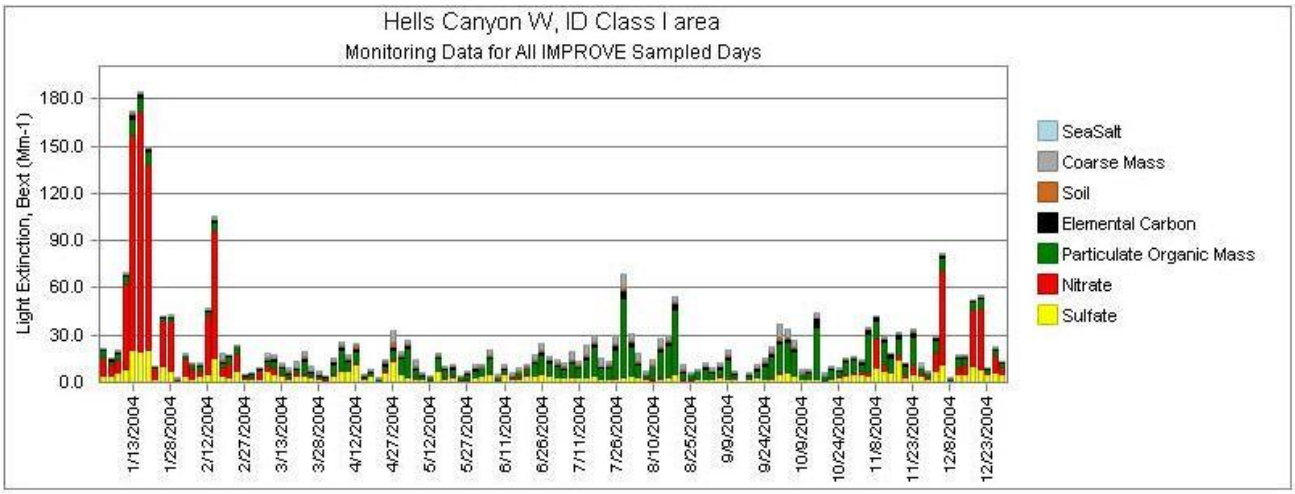

Figure 11 Light extinction (Mm-1) based on measured aerosol concentrations at Hells Canyon IMPROVE site, 2004.

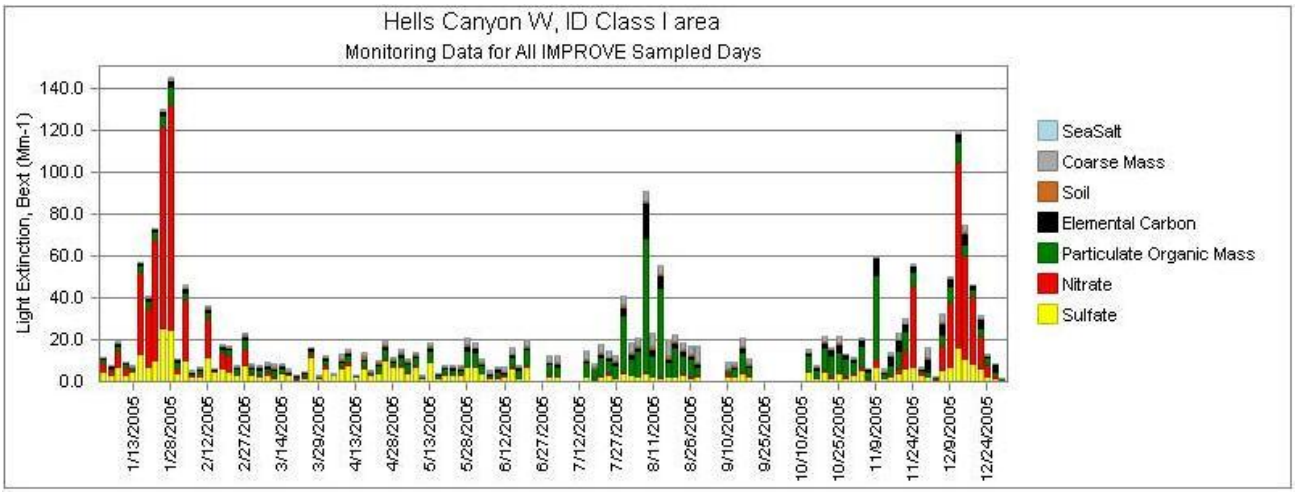

Figure 12 Light extinction (Mm-1) based on measured aerosol concentrations at Hells Canyon IMPROVE site, 2005.

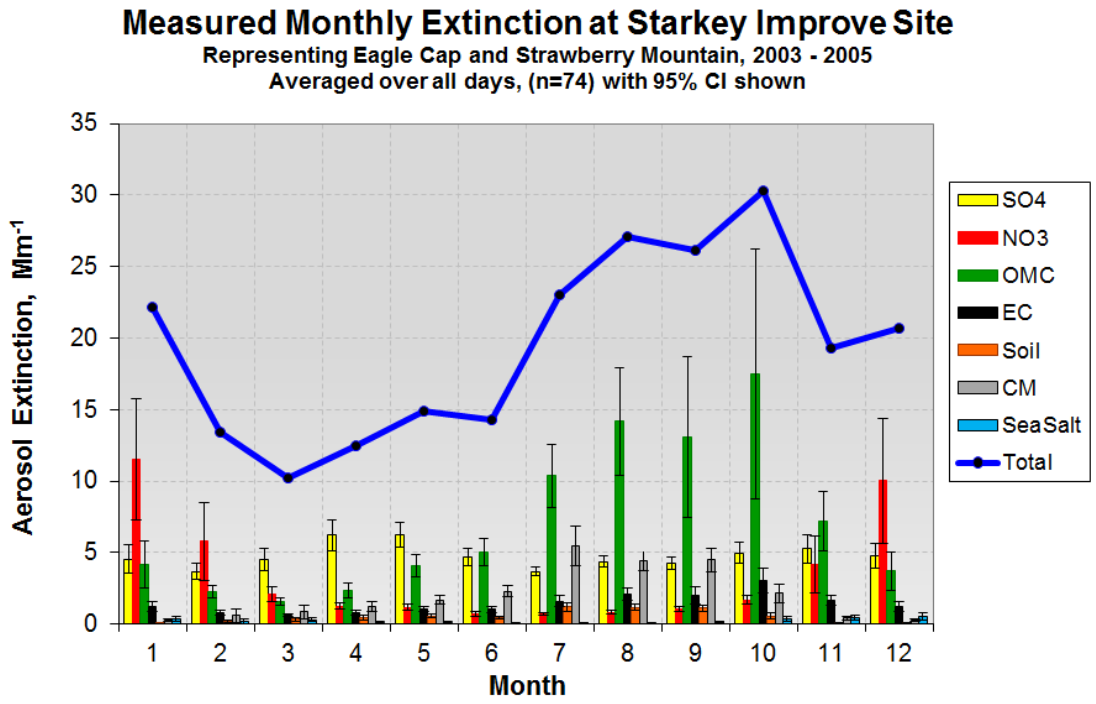

Figure 13 **Light extinction (Mm-1) based on measured aerosol concentrations at Starkey IMPROVE Site, All Days, 2003 - 2005.**

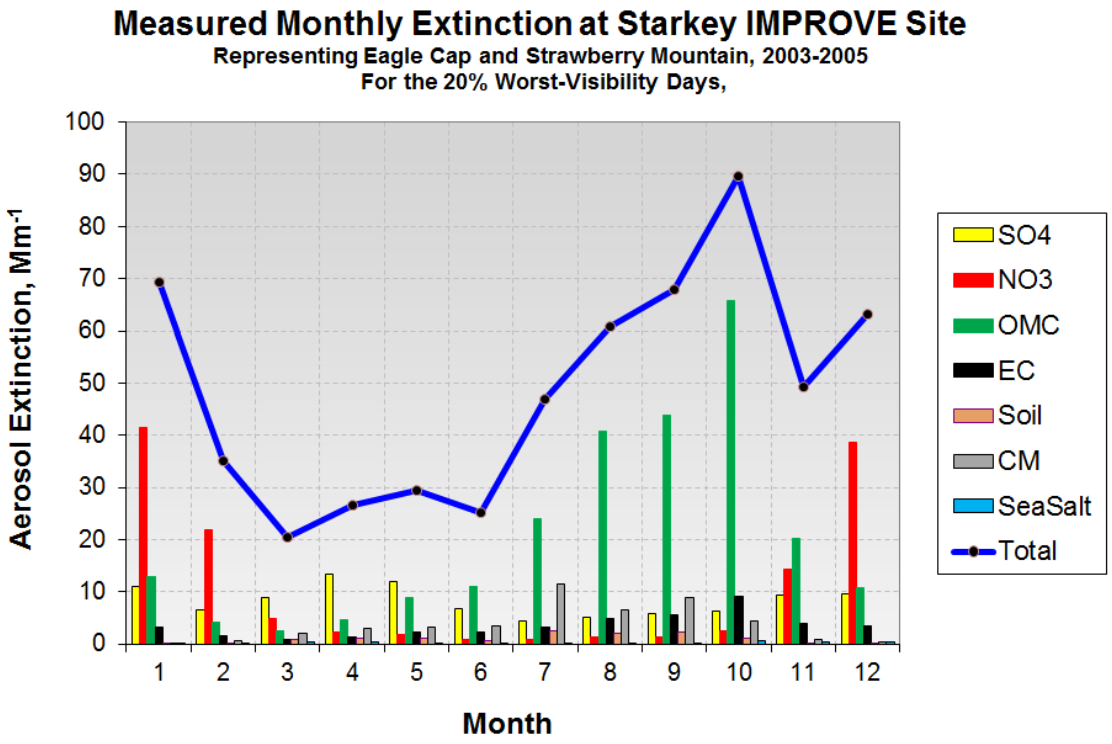

Figure 14 **Light extinction (Mm-1) based on measured aerosol concentrations at Starkey IMPROVE Site, for 20% Worst Visibility Days, 2003-2005**

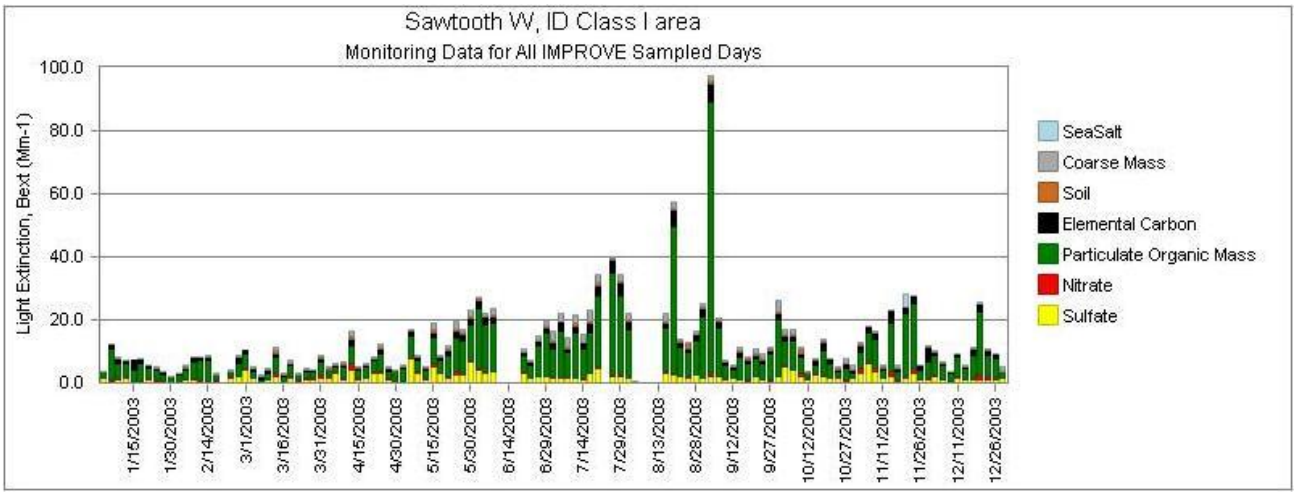

Figure 15 Light extinction (Mm-1) based on measured aerosol concentrations at Sawtooth Wilderness IMPROVE site, 2003.

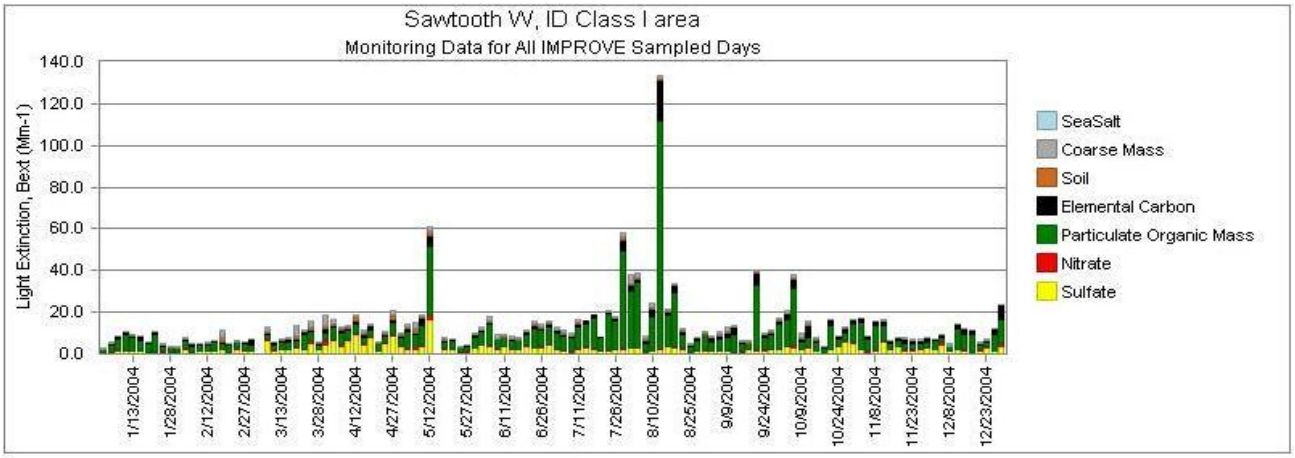

Figure 16 Light extinction (Mm-1) based on measured aerosol concentrations at Sawtooth Wilderness IMPROVE site, 2004.

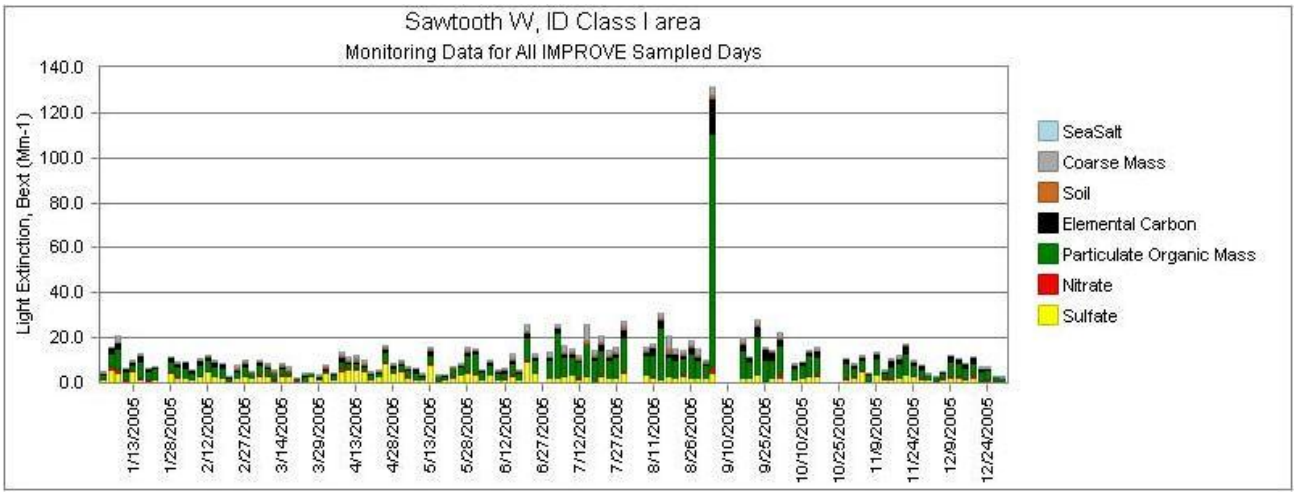

Figure 17 Light extinction (Mm-1) based on measured aerosol concentrations at Sawtooth Wilderness IMPROVE site, 2005.

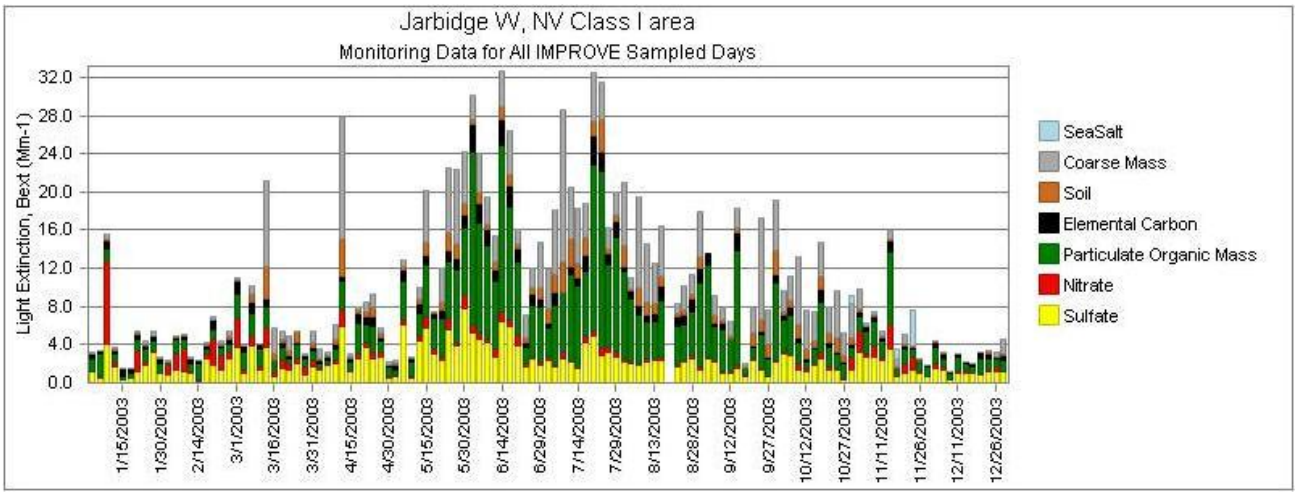

Figure 18 Light extinction (Mm-1) based on measured aerosol concentrations at Jarbidge Wilderness IMPROVE site, 2003.

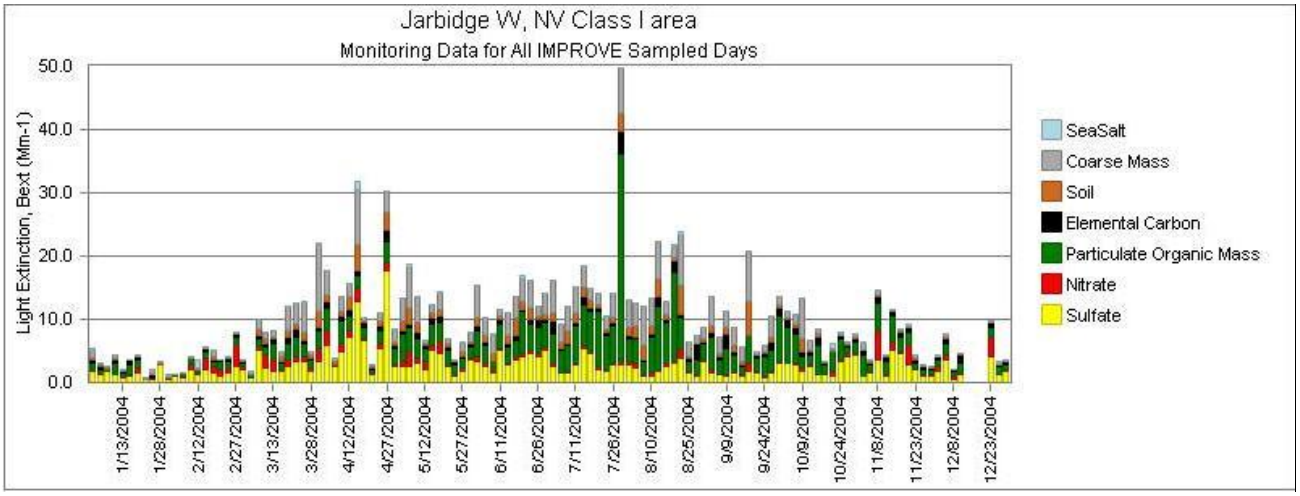

Figure 19 Light extinction (Mm-1) based on measured aerosol concentrations at Jarbidge Wilderness IMPROVE site, 2004.

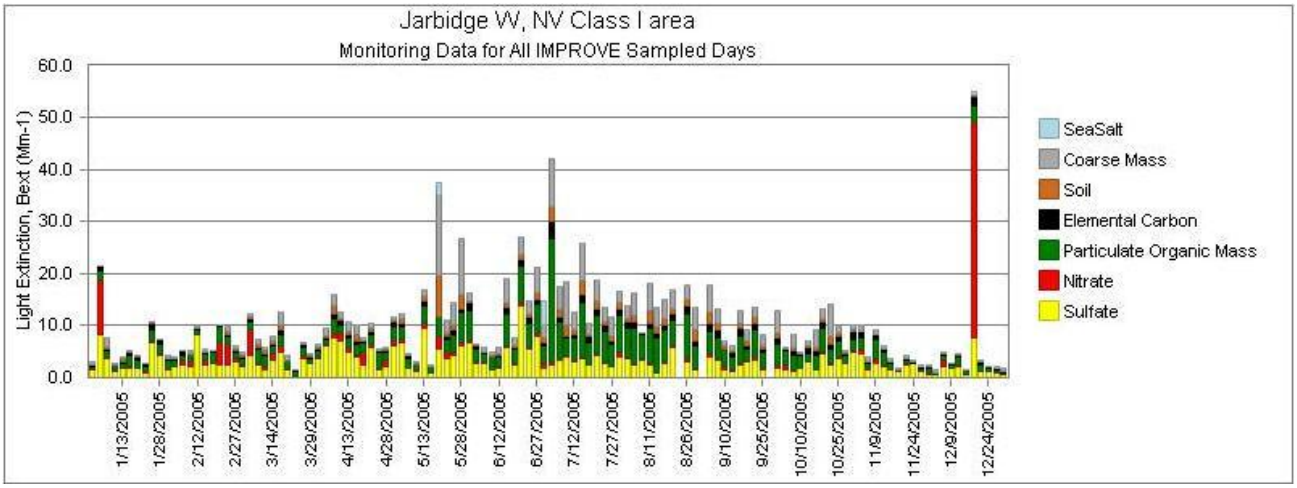

Figure 20 Light extinction (Mm-1) based on measured aerosol concentrations at Jarbidge Wilderness IMPROVE site, 2005.

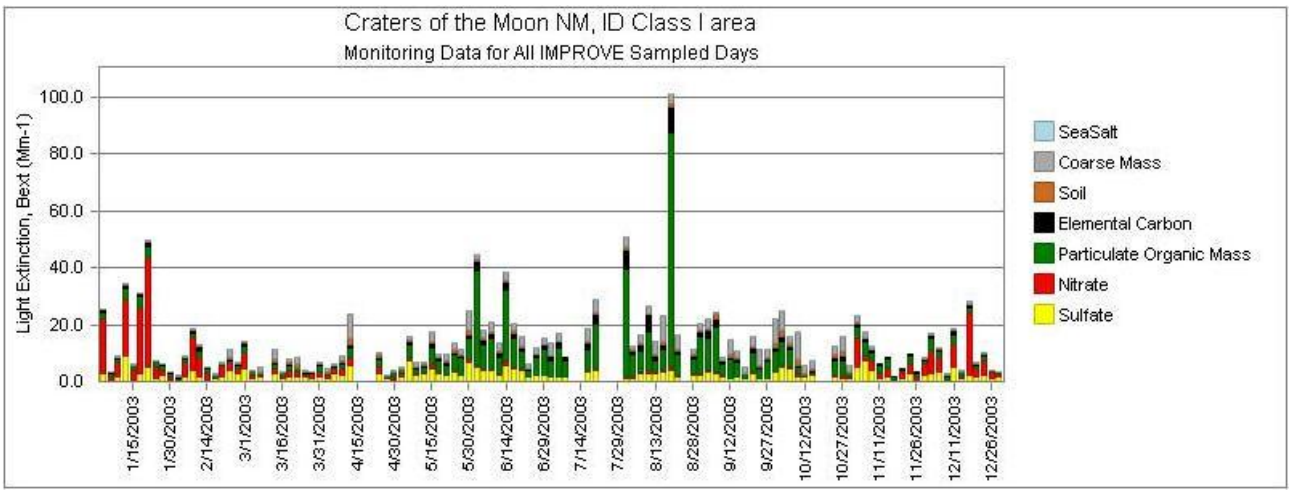

Figure 21 Light extinction (Mm-1) based on measured aerosol concentrations at Craters of the Moon Wilderness IMPROVE site, 2003.

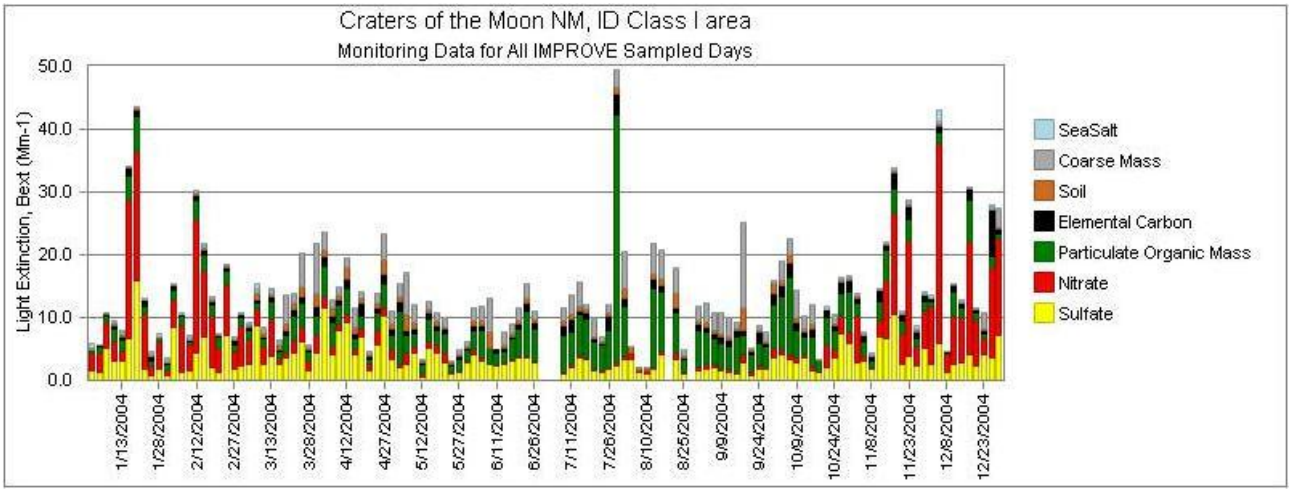

Figure 22 Light extinction (Mm-1) based on measured aerosol concentrations at Craters of the Moon Wilderness IMPROVE site, 2004.

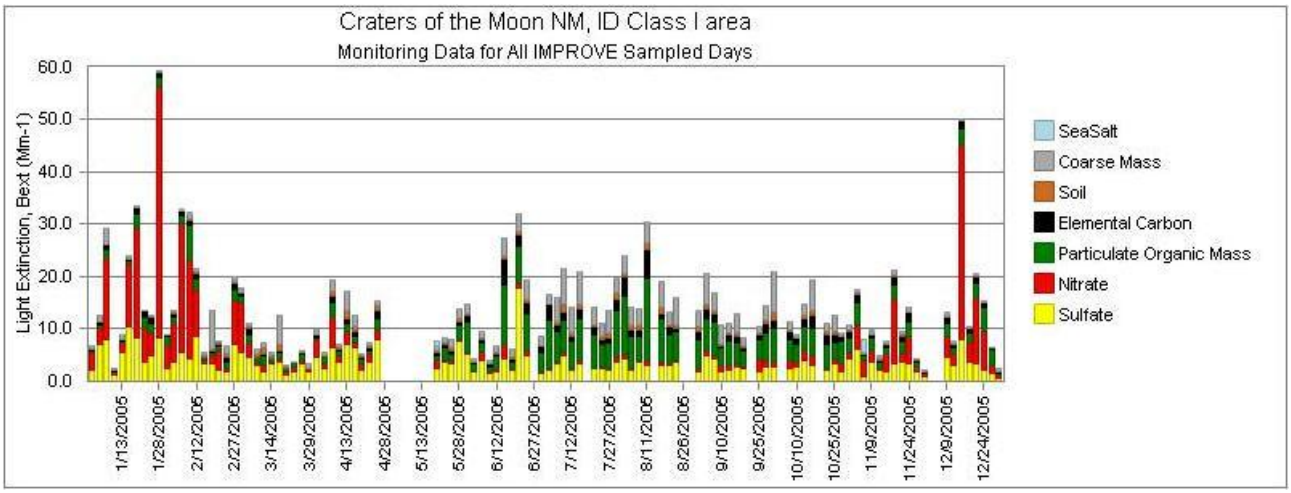

Figure 23 Light extinction (Mm-1) based on measured aerosol concentrations at Craters of the Moon Wilderness IMPROVE site, 2005.

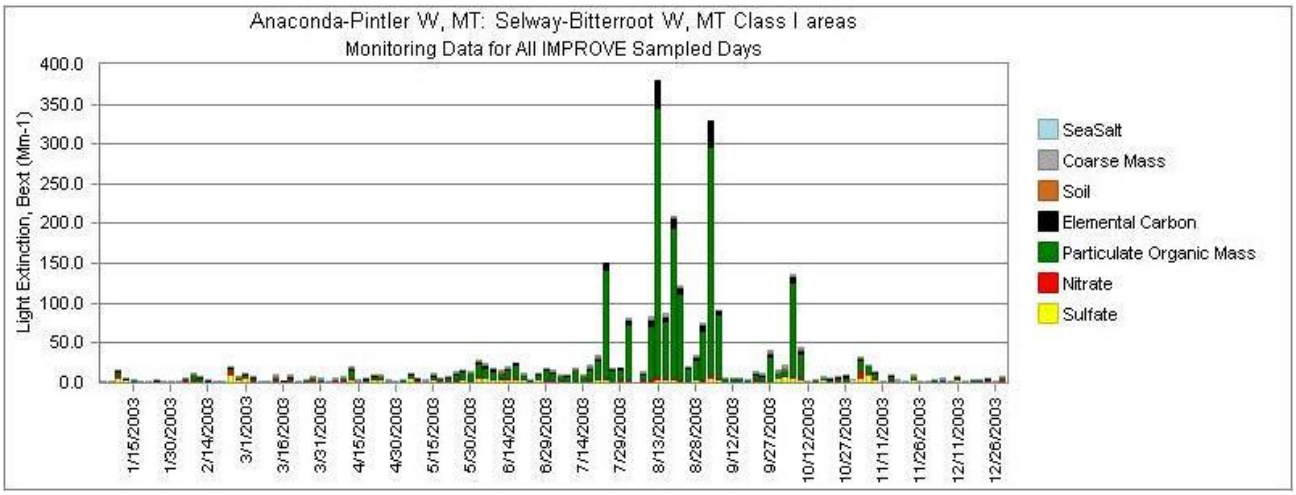

Figure 24 Light extinction (Mm-1) based on measured aerosol concentrations at Selway-Bitterroot Wilderness IMPROVE site, 2003.

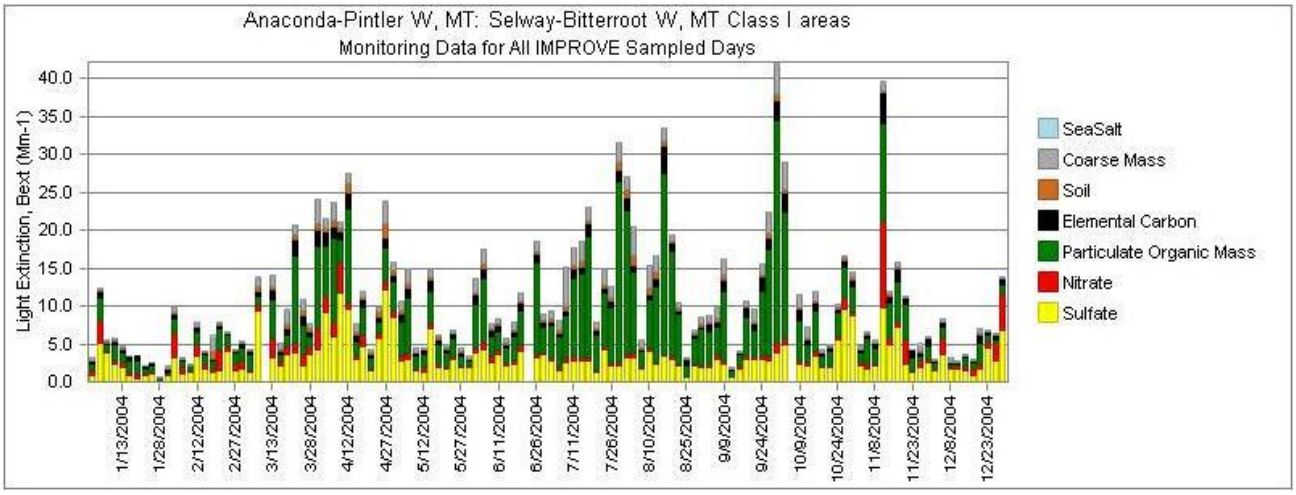

Figure 25 Light extinction (Mm-1) based on measured aerosol concentrations at Selway-Bitterroot Wilderness IMPROVE site, 2004.

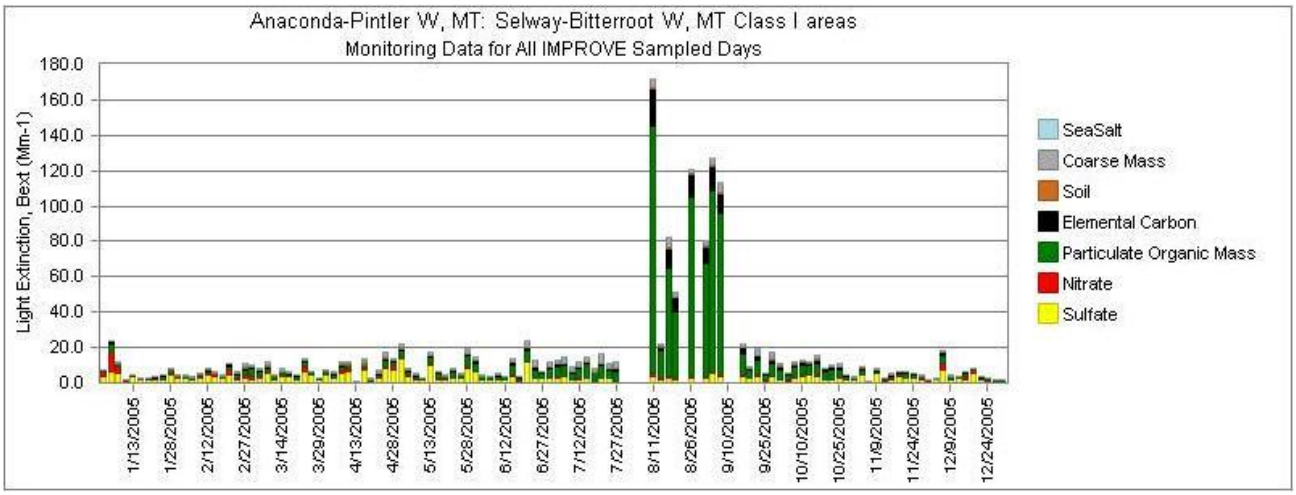

Figure 26 Light extinction (Mm-1) based on measured aerosol concentrations at Selway-Bitterroot Wilderness IMPROVE site, 2005.

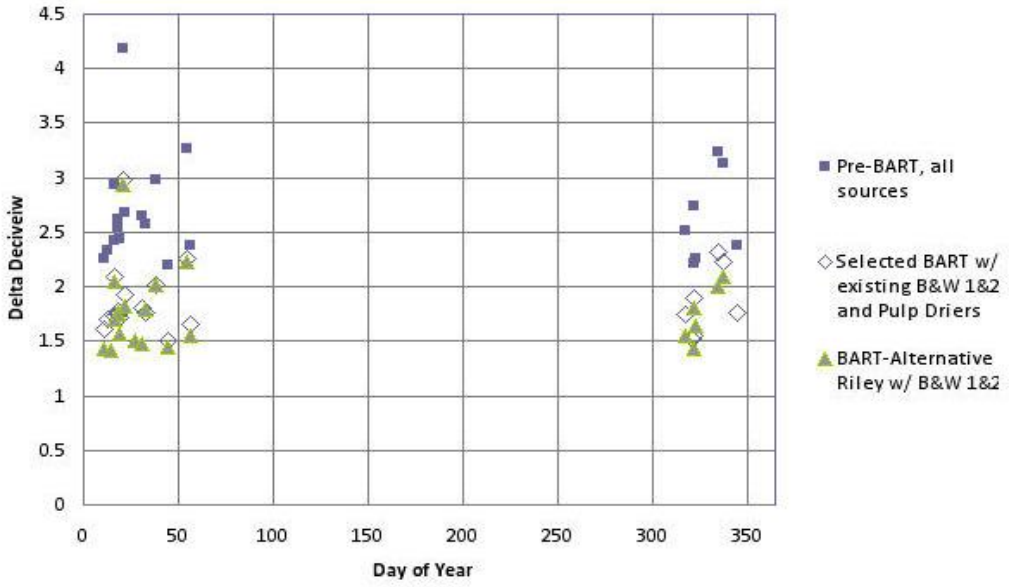

Figure 27 Seasonal variation in the modeled three-year highest 22 impacted days at Eagle Cap Wilderness for the pre-BART "Alternative Benchmark", selected "BART", and "BART Alternative" Scenarios.

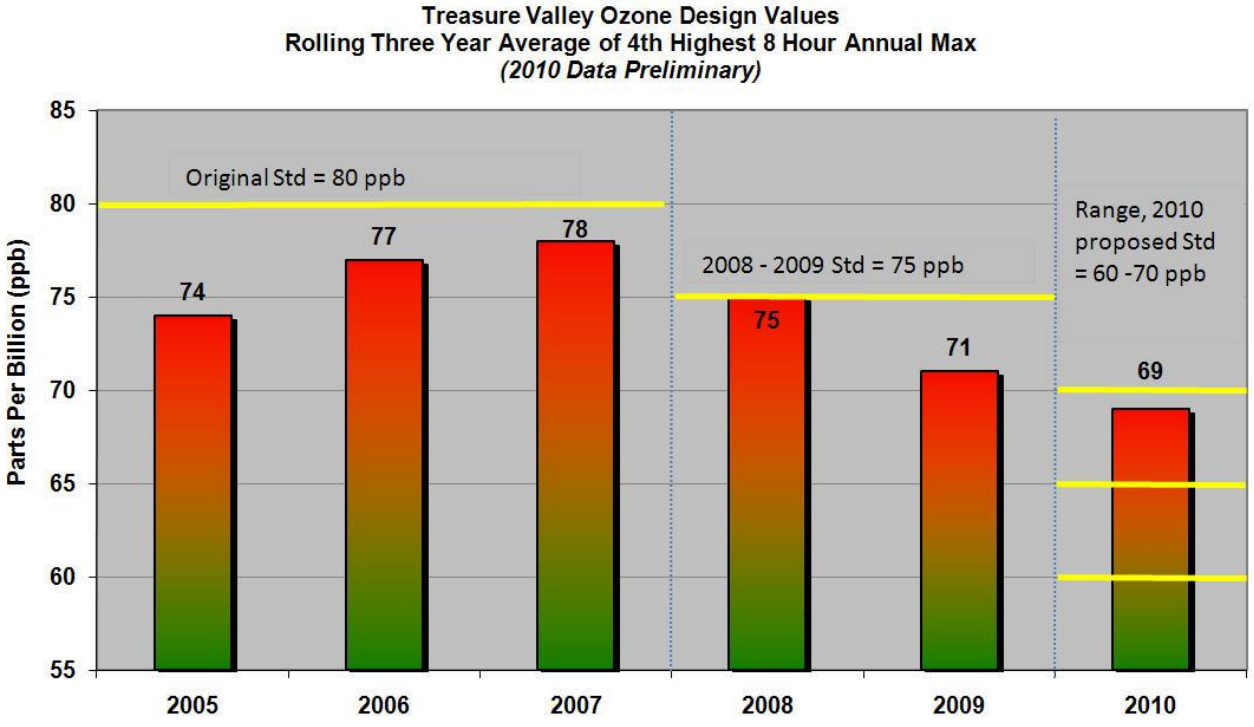

Figure 28 History of Treasure Valley Ozone Design Values and NAAQS.