Appendix A

WRAP Regional Summary Report

The "Western Regional Air Partnership Regional Haze Rule Reasonable Progress Summary Report" contains analyses for 15 states in the western region of the United States and is available at: http://www.wrapair2.org/RHRPR.aspx. The Summary Report section for California can be downloaded from the same website, as Section 6.3, under the State Summaries (and State Specific Appendices):
California (pdf) (1.1 MB, 39 pages), Appendix C (pdf) (2.6 MB, 154 pages.)

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Appendix B

Emission Inventory
2013 Almanac

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NOx Emissions (TPD)

Statewide	2000	2005	2010	2015	2020
Electric Utilities	60.6	26.8	23.1	25.3	26.8
Cogeneration	28.7	18.1	15.9	17.2	20.6
Oil And Gas Production (Combustion)	24.7	14.4	10.2	9	8.4
Petroleum Refining (Combustion)	46.9	25.6	20.2	19.7	19.6
Manufacturing And Industrial	145.2	80.3	63.1	65.3	64.9
Food And Agricultural Processing	42	36.3	28.3	15.3	9.5
Service And Commercial	72.1	49.6	46.5	45.8	47.2
Other (Fuel Combustion)	20.1	17.2	12.3	14.7	13.5
Sewage Treatment	0.4	0.4	0.4	0.5	0.5
Landfills	0.6	1	1	1.1	1.2
Incinerators	1.7	2.1	2.6	2.7	2.9
Soil Remediation	0.1	0.1	0.1	0.1	0.1
Other (Waste Disposal)	0.1	0	0	0	0
Laundering	0	0	0	0	0
Degreasing	0	0	0	0	0
Coatings And Related Process Solvents	0.1	0.1	0	0.1	0.1
Printing	0	0	0	0	0
Adhesives And Sealants	0	0	0	0	0
Other (Cleaning And Surface Coatings)	0.1	0.1	0.1	0.2	0.2
Oil And Gas Production	3.6	2.7	2.2	2	1.8
Petroleum Refining	9.9	5.4	13.8	2.3	2.3
Petroleum Marketing	0.7	0.2	0.2	0.3	0.3
Other (Petroleum Production And Marketing)	0	0	0	0	0
Chemical	1.8	2	1.7	1.9	2
Food And Agriculture	0.7	0.2	0.1	0.2	0.2
Mineral Processes	101.2	103.3	54.4	57	61.9
Metal Processes	1.5	1.1	1	0.7	0.7
Wood And Paper	3.8	2.5	1	1	1.1
Glass And Related Products	13.7	10.1	5.8	4.1	4.4
Electronics	0	0	0	0	0
Other (Industrial Processes)	3.4	2.7	9.1	1.1	1.4
Consumer Products	0	0	0	0	0
Architectural Coatings And Related Process Solvents	0	0	0	0	0
Pesticides/Fertilizers	0	0	0	0	0
Asphalt Paving / Roofing	0	0	0	0	0
Residential Fuel Combustion	80.6	68.1	59.9	59.3	59
Farming Operations	0	0	0	0	0
Construction And Demolition	0	0	0	0	0

NOx Emissions (TPD) (continued)

Statewide	2000	2005	2010	2015	2020
Paved Road Dust	0	0	0	0	0
Unpaved Road Dust	0	0	0.1	0	0
Fugitive Windblown Dust	0	0	0	0	0
Structural and Automobile Fires	0.2	0.2	0.2	0.2	0.2
Managed Burning And Disposal	15	16.6	14.7	14.6	14.6
Cooking	0	0	0	0	0
Other (Miscellaneous Processes)	0	0	0	0	0
Light Duty Passenger (Lda)	463.7	249.8	157.4	83.7	50.5
Light Duty Trucks - 1 (Ldt1)	166.8	66.9	39.2	26.6	17.6
Light Duty Trucks - 2 (Ldt2)	265.3	148.1	101	56.9	32.2
Medium Duty Trucks (Mdv)	117	127.2	107.1	75.5	52.2
Light Heavy Duty Gas Trucks - 1 (Lhdv1)	28.1	49.6	47.9	41	34.4
Light Heavy Duty Gas Trucks - 2 (Lhdv2)	9.7	5.6	4.2	3.3	2.6
Medium Heavy Duty Gas Trucks (Mhdv)	18.3	12	10.5	6.5	4.1
Heavy Heavy Duty Gas Trucks (Hhdv)	11.3	4	3.9	3.5	3.2
Light Heavy Duty Diesel Trucks - 1 (Lhdv1)	24.6	98	102.1	74.7	53.6
Light Heavy Duty Diesel Trucks - 2 (Lhdv2)	23.7	27.1	25.8	18.9	13.8
Medium Heavy Duty Diesel Trucks (Mhdv)	161.7	162.7	100.6	64.7	32.2
Heavy Heavy Duty Diesel Trucks (Hhdv)	706.3	728.3	432	286.2	192.6
Motorcycles (Mcy)	4.4	7.5	9.1	9.1	9.5
Heavy Duty Diesel Urban Buses (Ub)	44.2	35.7	34.2	30.2	26.5
Heavy Duty Gas Urban Buses (Ub)	2.8	2.2	2.2	2	1.9
School Buses - Gas (Sbg)	1	0.8	0.7	0.5	0.5
School Buses - Diesel (Sbd)	10.8	10	7.3	6.8	5.9
Other Buses - Gas (Obg)	2.7	4.4	3.5	2.7	1.9
Other Buses - Motor Coach - Diesel (Obc)	12.4	12.3	8.2	5.5	2.8
All Other Buses - Diesel (Obd)	7.5	7.6	5.1	4	2.1
Motor Homes (Mh)	14.6	8.9	8	5.9	4.5
Aircraft	42.6	45.8	53.2	57.7	64.1
Trains	198.8	157.4	95.6	111.3	109.7
Ships And Commercial Boats	0.2	0.1	0.1	0.1	0.1
Ocean Going Vessels	170.5	218.2	196.1	236.2	224.9
Commercial Harbor Craft	83.4	74.3	63.6	44.9	36.5
Recreational Boats	16.6	20.5	19.5	18.6	18.4
Off-Road Recreational Vehicles	0.4	1.5	1.4	2.7	3
Off-Road Equipment	339.5	307.3	188.7	163.9	126.9
Farm Equipment	154	132.5	106.9	81.4	59.7
Fuel Storage And Handling	0	0	0	0	0
Total (TPD)	**3782**	**3214**	**2323**	**1887**	**1553**

SOx Emissions (TPD)

Statewide	2000	2005	2010	2015	2020
Electric Utilities	5.4	4.1	5	5.1	5.5
Cogeneration	1.8	1.2	1.1	1.2	1.4
Oil And Gas Production (Combustion)	7.4	1.3	2.1	0.6	0.6
Petroleum Refining (Combustion)	12.8	11.9	18.9	8.9	8.1
Manufacturing And Industrial	9.1	6.3	7.6	8.7	8.4
Food And Agricultural Processing	1.1	0.7	0.6	0.4	0.4
Service And Commercial	3	2.5	2.8	3	3.1
Other (Fuel Combustion)	0.4	0.9	0.4	0.4	0.4
Sewage Treatment	0.2	0.2	0.2	0.3	0.3
Landfills	0.2	0.5	0.5	0.5	0.5
Incinerators	0.1	0.3	0.5	0.6	0.6
Soil Remediation	0	0	0	0	0
Other (Waste Disposal)	0	0	0	0	0
Laundering	0	0	0	0	0
Degreasing	0	0	0	0	0
Coatings And Related Process Solvents	0	0	0	0	0
Printing	0	0	0	0	0
Adhesives And Sealants	0	0	0	0	0
Other (Cleaning And Surface Coatings)	0	0	0	0.1	0.1
Oil And Gas Production	0.1	0.1	0.1	0.1	0.1
Petroleum Refining	56.6	40.1	5	4.7	4.2
Petroleum Marketing	0	0	0	0	0
Other (Petroleum Production And Marketing)	0	0	0	0	0
Chemical	2.9	3.4	2.6	2.6	3
Food And Agriculture	1.8	0.3	0.5	0.5	0.6
Mineral Processes	20.7	18.9	12.4	13.3	14.9
Metal Processes	0.2	0	0.1	0.1	0.1
Wood And Paper	0.7	0	0	0	0
Glass And Related Products	6.6	2.9	2.5	1.8	1.9
Electronics	0	0	0	0	0
Other (Industrial Processes)	0.8	1	1.4	0.5	0.7
Consumer Products	0	0	0	0	0
Architectural Coatings And Related Process Solvents	0	0	0	0	0
Pesticides/Fertilizers	0	0	0	0	0
Asphalt Paving / Roofing	0	0	0	0	0
Residential Fuel Combustion	5.4	3.8	3.4	2.7	2.7
Farming Operations	0	0	0	0	0
Construction And Demolition	0	0	0	0	0

SOx Emissions (TPD) (continued)

Statewide	2000	2005	2010	2015	2020
Paved Road Dust	0	0	0	0	0
Unpaved Road Dust	0	0	0	0	0
Fugitive Windblown Dust	0	0	0	0	0
Structural and Automobile Fires	0	0	0	0	0
Managed Burning And Disposal	3.6	3.6	3.5	3.6	3.6
Cooking	0	0	0	0	0
Other (Miscellaneous Processes)	0	0	0	0	0
Light Duty Passenger (Lda)	2.7	1.8	1.9	2	1.8
Light Duty Trucks - 1 (Ldt1)	0.7	0.3	0.3	0.3	0.3
Light Duty Trucks - 2 (Ldt2)	1.4	0.9	0.9	1	0.9
Medium Duty Trucks (Mdv)	0.6	1	1	1	1
Light Heavy Duty Gas Trucks - 1 (Lhdv1)	0.1	0.2	0.3	0.3	0.3
Light Heavy Duty Gas Trucks - 2 (Lhdv2)	0	0	0	0	0
Medium Heavy Duty Gas Trucks (Mhdv)	0	0	0	0	0
Heavy Heavy Duty Gas Trucks (Hhdv)	0	0	0	0	0
Light Heavy Duty Diesel Trucks - 1 (Lhdv1)	0.2	0.7	0.1	0.1	0.1
Light Heavy Duty Diesel Trucks - 2 (Lhdv2)	0.2	0.2	0	0	0
Medium Heavy Duty Diesel Trucks (Mhdv)	1.2	1.4	0.1	0.1	0.2
Heavy Heavy Duty Diesel Trucks (Hhdv)	4.9	5.8	0.6	0.7	0.8
Motorcycles (Mcy)	0	0	0	0	0
Heavy Duty Diesel Urban Buses (Ub)	0.4	0.4	0	0	0
Heavy Duty Gas Urban Buses (Ub)	0	0	0	0	0
School Buses - Gas (Sbg)	0	0	0	0	0
School Buses - Diesel (Sbd)	0.1	0.1	0	0	0
Other Buses - Gas (Obg)	0	0	0	0	0
Other Buses - Motor Coach - Diesel (Obc)	0.1	0.1	0	0	0
All Other Buses - Diesel (Obd)	0.1	0.1	0	0	0
Motor Homes (Mh)	0.1	0	0	0	0
Aircraft	3	3.2	3.5	3.8	4.2
Trains	8.4	7.5	0.6	0.1	0.1
Ships And Commercial Boats	0	0	0	0	0
Ocean Going Vessels	120.9	155.1	41.6	8.1	10.2
Commercial Harbor Craft	0.9	0.9	0.4	0.4	0.4
Recreational Boats	0	0	0	0	0
Off-Road Recreational Vehicles	0	0.1	0	0.1	0.1
Off-Road Equipment	1.4	1.6	0.2	0.2	0.2
Farm Equipment	1	0.9	0.1	0.1	0.1
Fuel Storage And Handling	0	0	0	0	0
Total (TPD)	**289.3**	**286.3**	**122.8**	**78**	**81.9**

VOC Emissions (TPD)

Statewide	2000	2005	2010	2015	2020
Electric Utilities	4.8	3.2	2.4	2.4	2.4
Cogeneration	3	1.8	1.7	2.1	2.5
Oil And Gas Production (Combustion)	2.9	2.6	2.6	2.3	2.1
Petroleum Refining (Combustion)	1.8	2.9	2.6	3	3
Manufacturing And Industrial	11.7	6.6	7.5	7.8	8.3
Food And Agricultural Processing	5.1	4.9	3.8	2.8	2.3
Service And Commercial	5.6	4	4.9	5.2	5.4
Other (Fuel Combustion)	2.2	1.4	1.1	1	0.9
Sewage Treatment	0.6	0.7	1.1	0.7	0.8
Landfills	13.7	10.6	11.4	12.3	13.1
Incinerators	0.2	3.2	1.3	1.5	1.5
Soil Remediation	0.3	0.5	0.4	0.4	0.4
Other (Waste Disposal)	22.6	27.6	27.6	24.8	26.3
Laundering	1.6	2.2	2.1	1.8	1.9
Degreasing	64.1	32.5	33.6	38.1	43
Coatings And Related Process Solvents	90.8	67.3	57.4	64.9	71.6
Printing	24	18.8	17.4	18.8	20.1
Adhesives And Sealants	26.4	19.9	19.8	20.5	21.3
Other (Cleaning And Surface Coatings)	6.2	5.2	7.2	8.1	8.9
Oil And Gas Production	58.6	42.1	37.3	34.3	31
Petroleum Refining	38.4	12.3	16.4	11.9	11.9
Petroleum Marketing	109.4	80.6	80.1	81.8	84.5
Other (Petroleum Production And Marketing)	0.4	0.3	15.9	0.3	0.3
Chemical	22.6	18.4	15.8	17.1	20.2
Food And Agriculture	15.2	16.4	17.7	18.8	20.6
Mineral Processes	6.8	6	4.1	4.2	4.7
Metal Processes	1.3	0.5	0.4	0.4	0.4
Wood And Paper	3.6	2.9	2.5	2.5	2.7
Glass And Related Products	0.2	0	0	0	0
Electronics	0.9	0.4	0.3	0.3	0.3
Other (Industrial Processes)	19.2	19.9	20.6	10.5	12.5
Consumer Products	255.2	230.4	213	202.2	210.6
Architectural Coatings And Related Process Solvents	119.7	104.6	87.7	76.4	79.8
Pesticides/Fertilizers	59.1	47.1	36.8	42	41.9
Asphalt Paving / Roofing	27	28.4	29	30.6	31.9
Residential Fuel Combustion	95.4	71.5	57.5	57.8	57.8
Farming Operations	174.8	177	178.9	149.7	155.5
Construction And Demolition	0	0	0	0	0

VOC Emissions (TPD) (continued)

Statewide	2000	2005	2010	2015	2020
Paved Road Dust	0	0	0	0	0
Unpaved Road Dust	0	0	0.3	0	0
Fugitive Windblown Dust	0	0	0	0	0
Structural and Automobile Fires	0.6	0.7	0.7	0.7	0.7
Managed Burning And Disposal	43.2	45.1	42.6	42.6	42.5
Cooking	6	6.3	6.7	7.1	7.6
Other (Miscellaneous Processes)	1.9	1.9	1.9	1.9	1.9
Light Duty Passenger (Lda)	500.8	283.9	191.8	90.1	51.9
Light Duty Trucks - 1 (Ldt1)	165.8	74.5	52.2	31	21.5
Light Duty Trucks - 2 (Ldt2)	160.5	93.7	72.8	43.5	29.4
Medium Duty Trucks (Mdv)	59	63.8	62.8	49.2	41.5
Light Heavy Duty Gas Trucks - 1 (Lhdv1)	16.5	30.2	29.2	21	17.3
Light Heavy Duty Gas Trucks - 2 (Lhdv2)	12.5	5.3	2.9	1.6	1.1
Medium Heavy Duty Gas Trucks (Mhdv)	20	10.4	7.6	3.6	2
Heavy Heavy Duty Gas Trucks (Hhdv)	8	2.6	1.9	0.8	0.4
Light Heavy Duty Diesel Trucks - 1 (Lhdv1)	0.7	3.2	4	3.3	2.7
Light Heavy Duty Diesel Trucks - 2 (Lhdv2)	0.7	0.9	0.9	0.8	0.7
Medium Heavy Duty Diesel Trucks (Mhdv)	8	7.9	5.1	2.8	1.8
Heavy Heavy Duty Diesel Trucks (Hhdv)	37.1	38.6	23.7	13.8	14.3
Motorcycles (Mcy)	48.5	48.4	41.5	31.6	31.1
Heavy Duty Diesel Urban Buses (Ub)	1.5	1.4	1.3	1.2	1.1
Heavy Duty Gas Urban Buses (Ub)	1.8	1.3	1.1	0.9	0.9
School Buses - Gas (Sbg)	1.5	1.1	0.7	0.5	0.3
School Buses - Diesel (Sbd)	0.8	0.7	0.5	0.1	0.1
Other Buses - Gas (Obg)	2.2	2.2	1.5	1.1	0.9
Other Buses - Motor Coach - Diesel (Obc)	0.6	0.6	0.4	0.2	0.2
All Other Buses - Diesel (Obd)	0.5	0.5	0.3	0.1	0.1
Motor Homes (Mh)	8.3	3.8	2.5	1.5	0.9
Aircraft	26.5	26.2	27.8	30.3	33.8
Trains	11.5	12.2	8.3	7.6	6.1
Ships And Commercial Boats	0	0	0	0	0
Ocean Going Vessels	6.9	8.8	8.3	11.2	14.5
Commercial Harbor Craft	5.3	5.1	4.8	4.3	4.2
Recreational Boats	143.8	126.5	107.1	87.5	72.4
Off-Road Recreational Vehicles	30.1	39.8	36.6	32.2	31.5
Off-Road Equipment	195.4	177.4	132.3	110.9	100.1
Farm Equipment	30.1	26.2	20.7	14.9	10.7
Fuel Storage And Handling	50.3	35.7	20.5	14.9	12.3
Total (TPD)	**2902.3**	**2261.6**	**1943.2**	**1624.1**	**1560.9**

PM2.5 Emissions (TPD)

Statewide	2000	2005	2010	2015	2020
Electric Utilities	6.9	5.6	5.1	4.8	5
Cogeneration	3.7	2.9	3	2.6	3.2
Oil And Gas Production (Combustion)	1.9	1.8	2.1	1.9	1.7
Petroleum Refining (Combustion)	4	3.4	3.4	1.8	1.8
Manufacturing And Industrial	8.9	5.9	5.9	4.8	4.8
Food And Agricultural Processing	2.4	2.2	1.7	1.3	1.1
Service And Commercial	5.1	3.9	4.8	4.5	4.7
Other (Fuel Combustion)	4.6	3.6	0.7	0.6	0.5
Sewage Treatment	0	0	0	0	0
Landfills	0.3	3.1	0.3	0.5	0.5
Incinerators	0.1	0.3	0.2	0.1	0.1
Soil Remediation	0	0	0	0	0
Other (Waste Disposal)	0.1	0.1	0	0	0.1
Laundering	0	0	0	0	0
Degreasing	0	0	0	0.1	0.1
Coatings And Related Process Solvents	1.1	1.8	1.7	1.8	2
Printing	0	0.2	0.2	0.2	0.2
Adhesives And Sealants	0	0	0	0	0
Other (Cleaning And Surface Coatings)	0	0	0.1	0.8	0.8
Oil And Gas Production	0.1	0.1	0	0	0
Petroleum Refining	2	3.3	3	1.5	1.5
Petroleum Marketing	0.1	0	0	0	0
Other (Petroleum Production And Marketing)	0	0	0	0	0
Chemical	3.1	1.9	1.6	1	1.1
Food And Agriculture	4	3.6	3.3	3.5	3.9
Mineral Processes	24.1	26.1	22.7	22.9	24.8
Metal Processes	1	0.8	0.7	0.4	0.4
Wood And Paper	9.5	9.1	6.6	7.3	8.1
Glass And Related Products	1.4	1.8	0.6	0.5	0.5
Electronics	0	0	0	0	0
Other (Industrial Processes)	7.4	9.2	13.9	1.5	1.7
Consumer Products	0	0	0	0	0
Architectural Coatings And Related Process Solvents	0	0	0	0	0
Pesticides/Fertilizers	0	0	0	0	0
Asphalt Paving / Roofing	0	0	0	0	0
Residential Fuel Combustion	96	71.2	56.4	55.5	55.5
Farming Operations	28.5	21.8	21.4	21.1	20.9
Construction And Demolition	15.4	15.3	16.2	17.9	20.3

PM2.5 Emissions (TPD) (continued)

Statewide	2000	2005	2010	2015	2020
Paved Road Dust	23.9	24.3	26.1	24.8	25.4
Unpaved Road Dust	27.8	27.9	25.5	27.1	27.1
Fugitive Windblown Dust	175.3	67.2	49	48.8	48.5
Structural and Automobile Fires	1	1.1	1.1	1.1	1.2
Managed Burning And Disposal	51.4	53.7	50.6	50.4	50.3
Cooking	25.8	26.5	28.1	29.8	31.6
Other (Miscellaneous Processes)	0.3	0.3	0.3	0.3	0.3
Light Duty Passenger (Lda)	15.5	12.3	11.4	11	11.2
Light Duty Trucks - 1 (Ldt1)	3.5	1.9	1.7	1.6	1.5
Light Duty Trucks - 2 (Ldt2)	5.3	4.4	4.1	4	4.1
Medium Duty Trucks (Mdv)	2	3.5	3.4	3.3	3.4
Light Heavy Duty Gas Trucks - 1 (Lhdv1)	0.3	0.7	0.7	0.7	0.7
Light Heavy Duty Gas Trucks - 2 (Lhdv2)	0.1	0.1	0.1	0.1	0.1
Medium Heavy Duty Gas Trucks (Mhdv)	0.1	0.1	0.1	0.1	0.1
Heavy Heavy Duty Gas Trucks (Hhdv)	0	0	0	0	0
Light Heavy Duty Diesel Trucks - 1 (Lhdv1)	0.4	1.3	1.5	1.3	1.1
Light Heavy Duty Diesel Trucks - 2 (Lhdv2)	0.4	0.4	0.4	0.4	0.3
Medium Heavy Duty Diesel Trucks (Mhdv)	6.3	6.4	4.2	2.4	1.6
Heavy Heavy Duty Diesel Trucks (Hhdv)	23.7	24.6	17.4	6.2	5.5
Motorcycles (Mcy)	0.1	0.1	0.1	0.1	0.1
Heavy Duty Diesel Urban Buses (Ub)	1.4	1.2	1.2	1.2	1.2
Heavy Duty Gas Urban Buses (Ub)	0	0	0	0	0
School Buses - Gas (Sbg)	0	0	0	0	0
School Buses - Diesel (Sbd)	0.7	0.6	0.5	0.2	0.2
Other Buses - Gas (Obg)	0	0	0	0	0
Other Buses - Motor Coach - Diesel (Obc)	0.4	0.4	0.3	0.1	0.1
All Other Buses - Diesel (Obd)	0.4	0.4	0.2	0.1	0.1
Motor Homes (Mh)	0.2	0.2	0.2	0.1	0.1
Aircraft	7.8	7.5	7.7	8.2	8.9
Trains	4.2	4.4	2.7	2.9	2.5
Ships And Commercial Boats	0	0	0	0	0
Ocean Going Vessels	15.2	19.5	7.1	4.1	5.3
Commercial Harbor Craft	3.4	3.1	2.6	1.7	1.2
Recreational Boats	6.2	5.9	4.9	4	3.3
Off-Road Recreational Vehicles	0.2	0.3	0.3	0.3	0.3
Off-Road Equipment	16.9	16.9	11.7	10	7.8
Farm Equipment	8.5	7.6	6.1	4.5	3.3
Fuel Storage And Handling	0	0	0	0	0
Total (TPD)	**660.4**	**523.8**	**446.9**	**409.8**	**413.7**

Appendix C

Deciview Record (2000-2012)

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Table C-1
Worst Days Deciview Record*

IMPROVE Monitor	Baseline Average (2000-2004)	2005	2006	2007	2008	2009	2010	2011	2012**	2018 RPGs
TRIN*	17.4	na	19.7	13.9	23.1	12.7	12.4	13.9	17.1	**16.4**
LABE	15.1	13.5	14.4	12.2	16.9	13.9	10.4	11.7	15.9	**14.4**
LAVO	14.1	12.4	14.1	14.1	22.4	17.1	12.8	11.7	14.3	**13.3**
BLIS	12.6	12.0	12.5	14.8	16.8	12.0	10.0	11.2	11.0	**12.3**
HOOV	12.9	10.4	10.5	12.6	15.5	12.0	8.8	8.6	9.8	**12.5**
YOSE	17.6	15.7	15.9	17.7	18.6	16.5	12.8	14.4	13.9	**16.7**
KAIS*	15.5	15.2	na	16.2	17.4	14.1	13.1	13.7	12.8	**14.9**
SEQU	25.4	23.1	23.4	24.7	24.7	21.0	20.1	21.2	20.6	**22.7**
DOME*	19.4	na	na	20.9	19.3	17.6	16.7	17.1	17.0	**18.1**
REDW*	18.5	18.1	20.8	18.2	19.8	18.9	na	17.2	16.5	**17.8**
PORE	22.8	22.3	22.0	22.4	22.1	21.3	22	20.2	20.1	**21.3**
PINN	18.5	18.1	17.9	18.3	19.8	17.8	15.1	16.4	15.6	**16.7**
RAFA	18.8	18.3	20.2	20.6	19.6	17	16.6	16.5	15.7	**17.3**
SAGA*	19.9	19.5	17.4	17.4	17.9	na	na	na	14.3	**17.4**
SAGO	22.2	21.5	19.9	21.5	20.2	19.2	16.7	15.9	16.1	**19.9**
AGTI*	23.5	21.2	na	22.0	21.0	19.4	18.4	18.1	17.8	**21.6**
JOSH	19.6	19.4	18.1	18.1	16.7	16.8	14.7	14.2	14.9	**17.9**

Table C-2
Best Days Deciview Record*

IMPROVE Monitor	Baseline Average (2000-2004)	2005	2006	2007	2008	2009	2010	2011	2012**
TRIN*	3.4	na	2.1	3.9	4.0	2.6	1.9	2.8	2.2
LABE	3.2	2.9	2.4	3.6	2.6	2.5	2.5	3.1	2.3
LAVO	2.7	2.5	2.2	2.9	2.8	2.4	1.6	2.1	1.8
BLIS	2.5	2.1	2.0	2.7	2.2	1.9	1.6	2.1	1.5
HOOV	1.4	1.1	1.3	1.7	1.2	1.1	0.9	1.3	0.9
YOSE	3.4	3.2	3.4	3.9	2.0	2.3	1.8	2.7	2.8
KAIS*	2.3	1.2	na	1.8	1.4	1.8	1.1	1.5	1.0
SEQU	8.8	7.2	7.7	9.2	9.3	6.2	5.7	7.5	6.8
DOME*	5.1	na	na	5.7	4.9	4.8	3.9	5.6	3.7
REDW*	6.1	5.7	5.9	6.0	5.4	4.9	na	6.7	4.7
PORE	10.5	9.8	9.6	8.9	9.5	7.8	8.0	8.8	6.9
PINN	8.9	8.0	7.9	8.5	8.4	7.2	7.2	7.6	7.0
RAFA	6.4	5.0	5.2	6.8	5.9	4.6	4.2	4.5	4.3
SAGA*	4.8	4.3	4.4	5.4	3.7	na	na	na	2.7
SAGO	5.4	4.1	5.0	5.5	4.4	3.6	3.0	3.3	3.5
AGTI*	9.6	6.9	na	9.0	7.5	6.3	6.8	6.0	6.7
JOSH	6.1	5.5	5.7	5.7	5.1	4.4	4.5	4.3	4.2

** Complete data was not available for the years marked "na."*
*** Data made available February 28, 2014 is outside the Mid-Course Review time frame but is shown here for continuity, and to illustrate further progress.*

Table C-3
Statewide 2018 Reasonable Progress Goal Summary using 2012 Data

IMPROVE Monitor	California Class I Area(s)	Best Days Baseline (dv)	Best Days (2008-2012) (dv)	Visibility Change (dv)	Worst Days Baseline (dv)	Worst Days (2008-2012) (dv)	Visibility Change (dv)	2018 RPG (dv)	Progress to 2018 RPG by 2012
NORTHERN CALIFORNIA									
TRIN	Marble Mountain W. Yolla Bolly-Middle Eel W.	3.4	2.7	0.7	17.4	15.8	1.6	**16.4**	160%
LABE	Lava Beds N.M. South Warner W.	3.2	2.6	0.6	15.1	13.7	1.4	**14.4**	200%
LAVO	Lassen Volcanic N.P. Caribou W. Thousand Lakes W.	2.7	2.1	0.6	14.1	15.6	-1.5	**13.3**	-188%
SIERRA CALIFORNIA									
BLIS	Desolation W. Mokelumne W.	2.5	1.9	0.6	12.6	12.2	0.4	**12.3**	133%
HOOV	Hoover W.	1.4	1.1	0.3	12.9	10.9	2	**12.5**	500%
YOSE	Yosemite N.P. Emigrant W.	3.4	2.3	1.1	17.6	15.2	2.4	**16.7**	267%
KAIS	Ansel Adams W. Kaiser W. John Muir W.	2.3	1.4	0.9	15.5	14.2	1.3	**14.9**	217%
SEQU	Sequoia N.P. Kings Canyon N.P.	8.8	7.1	1.7	25.4	21.5	3.9	**22.7**	144%
DOME	Dome Lands W.	5.1	4.6	0.5	19.4	17.5	1.9	**18.1**	146%
COASTAL CALIFORNIA									
REDW	Redwood N.P.	6.1	5.4	0.7	18.5	18.1 *(missing 2010)*	0.4	**17.8**	57%
PORE	Point Reyes N.S.	10.5	8.2	2.3	22.8	21.2	1.6	**21.3**	107%
PINN	Pinnacles W. Ventana W.	8.9	7.5	1.4	18.5	16.9	1.6	**16.7**	89%
RAFA	San Rafael W.	6.4	4.7	1.7	18.8	17.1	1.7	**17.3**	113%
SOUTHERN CALIFORNIA									
SAGA	San Gabriel W. Cucamonga W.	4.8	3.2	1.6	19.9	16.1 *(2008,2012 only)*	3.8	**17.4**	152%
SAGO	San Gorgonio W. San Jacinto W.	5.4	3.6	1.8	22.2	17.6	4.6	**19.9**	200%
AGTI	Agua Tibia W.	9.6	6.7	2.9	23.5	18.9	4.6	**21.6**	242%
JOSH	Joshua Tree N.P.	6.1	4.5	1.6	19.6	15.4	4.2	**17.9**	247%

W = Wilderness N.M. = National Monument N.P. = National Park N.S. = National Seashore

Appendix D

Technical Analyses of Factors Impeding Progress

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Purpose of Focused Technical Analysis

The annual deciview levels in California are trending downward over the long-term, as measured by the IMPROVE monitors, indicating diminishing light extinction from haze-causing pollutants in ambient air. Episodic events, such as wildfires and dust storms, cause short-term increases in the concentrations of these pollutants. These events are predominately natural in origin, but can be significant. Some of the episodic wildfire emissions are substantial enough to skew an annual average, and influence the five-year average trend. There are other activities, beyond the regulatory jurisdiction of the State of California, which also influence the deciview levels at some sites. The following Case Studies analyze the data from three monitoring sites to explain how these events and activities impede short-term progress in otherwise long-term visibility improvements.

ARB examined five-year deciview average trends at the IMPROVE monitors representing California's Class 1 Areas and selected the three IMPROVE monitors that did not show short-term progress in the reporting period ending with 2011 IMPROVE monitoring data. Individually, the BLIS, LAVO, and REDW monitors have collected data for over twenty years and show long-term visibility improvements. The ARB emissions inventory shows continuous reductions in emissions from the RH Plan control strategy, which should assure improved visibility. Closer examination of the monitoring data comprising the five-year averages through 2011, shows how reasonable progress from the reductions in anthropogenic emissions within California's jurisdiction is sometimes masked by uncontrollable factors. These uncontrollable factors are pollution from natural events and man-made emissions beyond the regulatory jurisdiction of individual states.

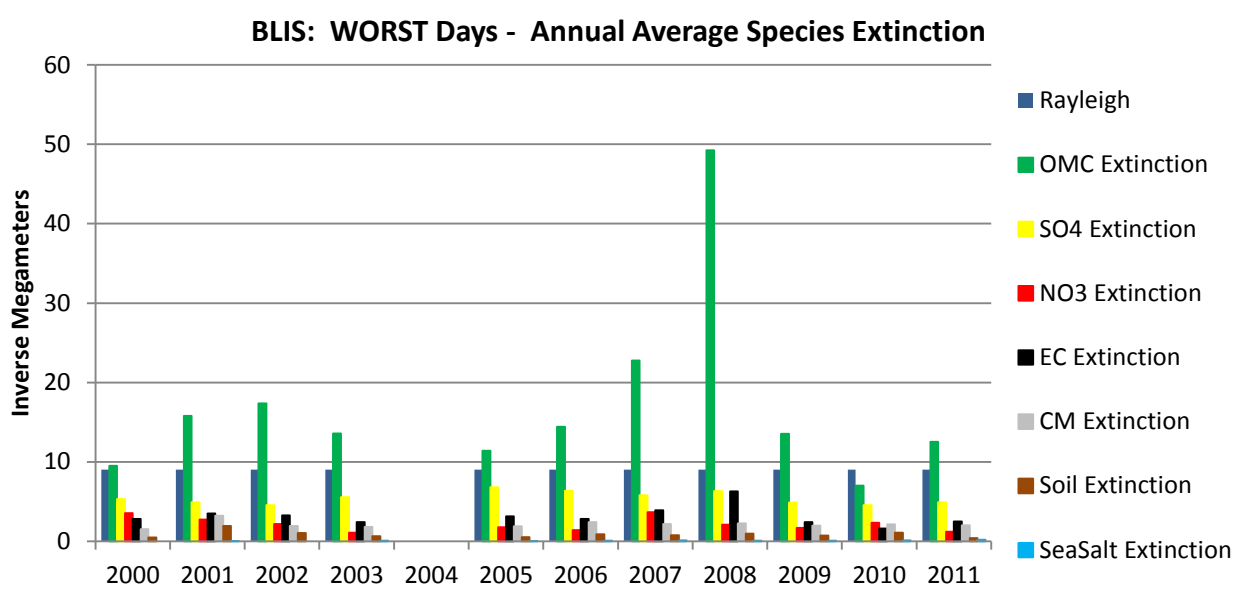
IMPROVE monitoring data for 2012 was posted to the WRAP-TSS website, on February 28, 2014. See http://vista.cira.colostate.edu/tss/Results/HazePlanning.aspx to use the interactive Haze Planning tool and view the monitoring data and recent five-year deciview averages.

Case Study: BLIS

Wildfire Impacts

Organic carbon (OMC) is the primary driver of haze on Worst Days at BLIS. Figure D-1 shows that in every year in the past decade, except 2010, OMC has contributed more than any other species to light extinction on Worst Days. The years with higher OMC extinction correlate with wildfire smoke impacts. Notably, in 2010, when no significant wildfires affected BLIS, the OMC contribution to extinction was less than natural Rayleigh gas scattering. Rayleigh scattering consists mainly of light scattering from atmospheric gases that are smaller in diameter than the wavelength of incoming light. Additional light scattering and light absorption by larger particulate matter are what adds to haze. Gaps in data in 2004 meant that neither Best nor Worst Days averages could be calculated that year.

Figure D-1
Species Driving Light Extinction at BLIS on Worst Days



Note: There was insufficient data to calculate the Worst Days average in 2004.

Figure D-2 shows the relationship between OMC light extinction and deciview for each sampling day at BLIS since 1990. Although there are wildfire impact days in almost every year in the past decade, the magnitude of natural wildfire smoke impacts at BLIS is most obvious in 2008. Fifty-seven named wildfires were burning at the same time in California, consuming more than one million acres of primarily forested natural areas. The American River Complex wildfire (20,500 acres) was the largest of the six named fires within 50 miles of the BLIS monitor during June through August. Figure D-2 shows that in 2008, daily OMC extinction and deciview levels reached the highest levels in 21

years of recordkeeping at BLIS. The five worst deciview days in 2008 had OMC extinction values 5-33 times the average levels for that time of year. Those five days alone caused a 3.0 deciview increase in the Worst Days annual average for 2008.

Figure D-2
Historical Record of OMC Extinction and Deciview Levels at BLIS

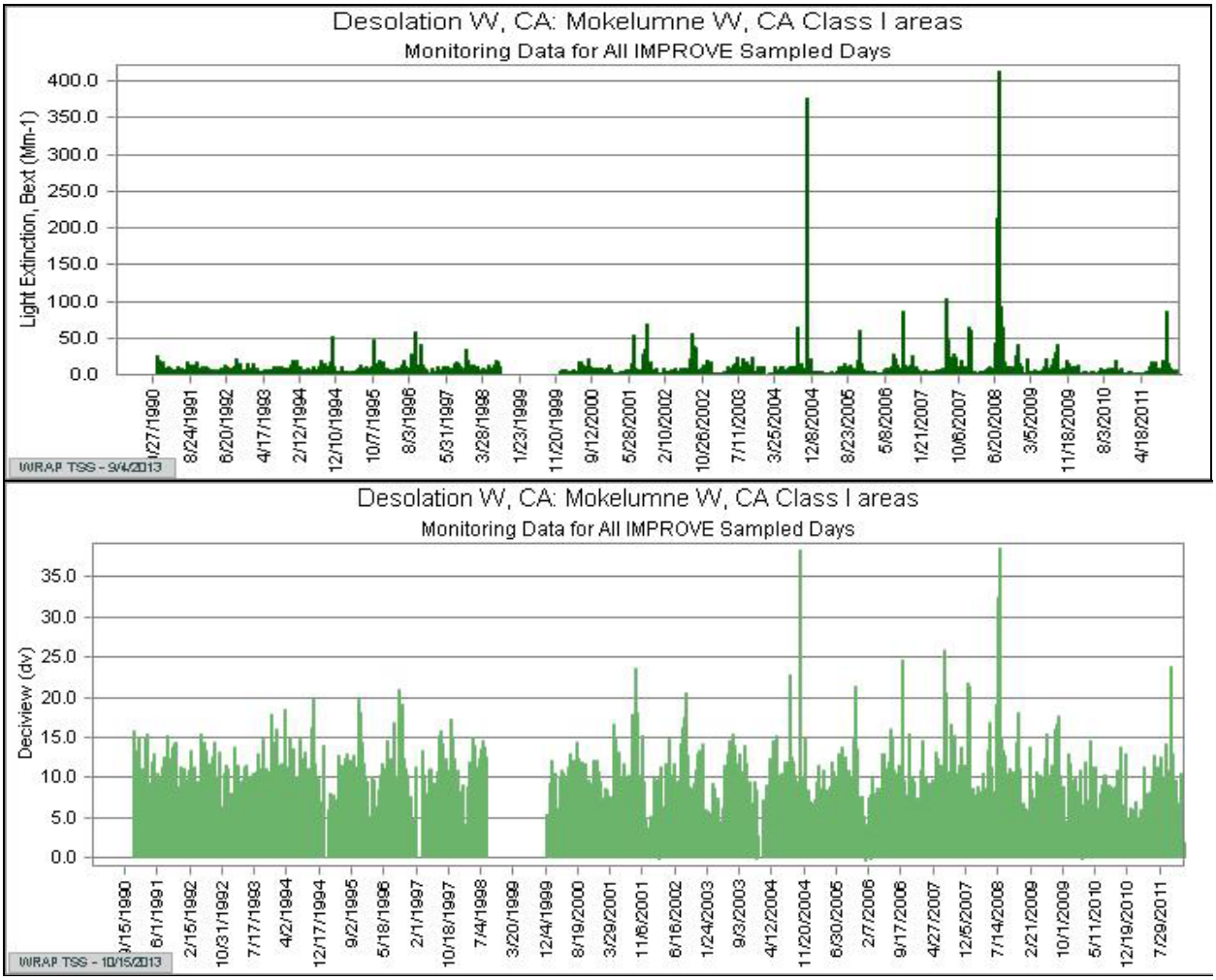


Table D-1 shows how the Worst Days annual averages pattern for OMC light extinction (green column) corresponds with that for deciviews (last column) in the past decade. The slopes of the trend lines from 2000-2011, for each species contribution, are shown on the bottom line. The slopes indicate that almost all species are trending downward in their contribution to light extinction (haze) since 2000. The increasing trend in light extinction due to sea salt was not analyzed further because its contribution to light extinction is negligible, and the source is natural. Elemental carbon (EC) is occasionally elevated from wildfire smoke, but the annual average Worst Days EC extinction level is decreasing over the long term due to the strict regulation of diesel-fuel combustion emissions, which also generate EC. The dramatic decrease in nitrate extinction is

attributed to NOx source controls. The high OMC light extinction in 2008 correlates with the Lightning Strike Complex Fires.

Table D-1
Annual Averages for Worst Days
Light Extinction (in Inverse Megameters) and Deciviews at BLIS

Year*	Sulfate Extinction	Nitrate Extinction	Organic Carbon Extinction	Elemental Carbon Extinction	Fine Soil Extinction	Coarse Mass Extinction	Sea Salt Extinction	Rayleigh Gas Extinction	Deciview
2000	5.29	3.55	9.5	2.8	0.47	1.51	0	9	11.6
2001	4.91	2.74	15.78	3.48	1.91	3.21	0.01	9	13.4
2002	4.56	2.15	17.36	3.26	1.04	1.91	0	9	13.4
2003	5.54	1.06	13.57	2.42	0.62	1.78	0.06	9	12.2
2005	6.79	1.77	11.4	3.12	0.51	1.86	0.03	9	12
2006	6.34	1.38	14.42	2.81	0.86	2.42	0.05	9	12.5
2007	5.79	3.67	22.75	3.88	0.77	2.17	0.11	9	14.8
2008	6.3	2.08	49.24	6.29	0.94	2.25	0.08	9	16.8
2009	4.86	1.69	13.54	2.42	0.69	1.97	0.07	9	12
2010	4.52	2.31	7	1.58	1.09	2.13	0.09	9	10
2011	4.89	1.19	12.51	2.49	0.4	1.99	0.18	9	11.2
SLOPE	***-0.01***	***-0.09***	***0.45***	***-0.02***	***-0.03***	***-0.003***	***0.01***	***constant***	***-0.05***

**Insufficient sampling points for calculating Worst Days averages for 2004.*

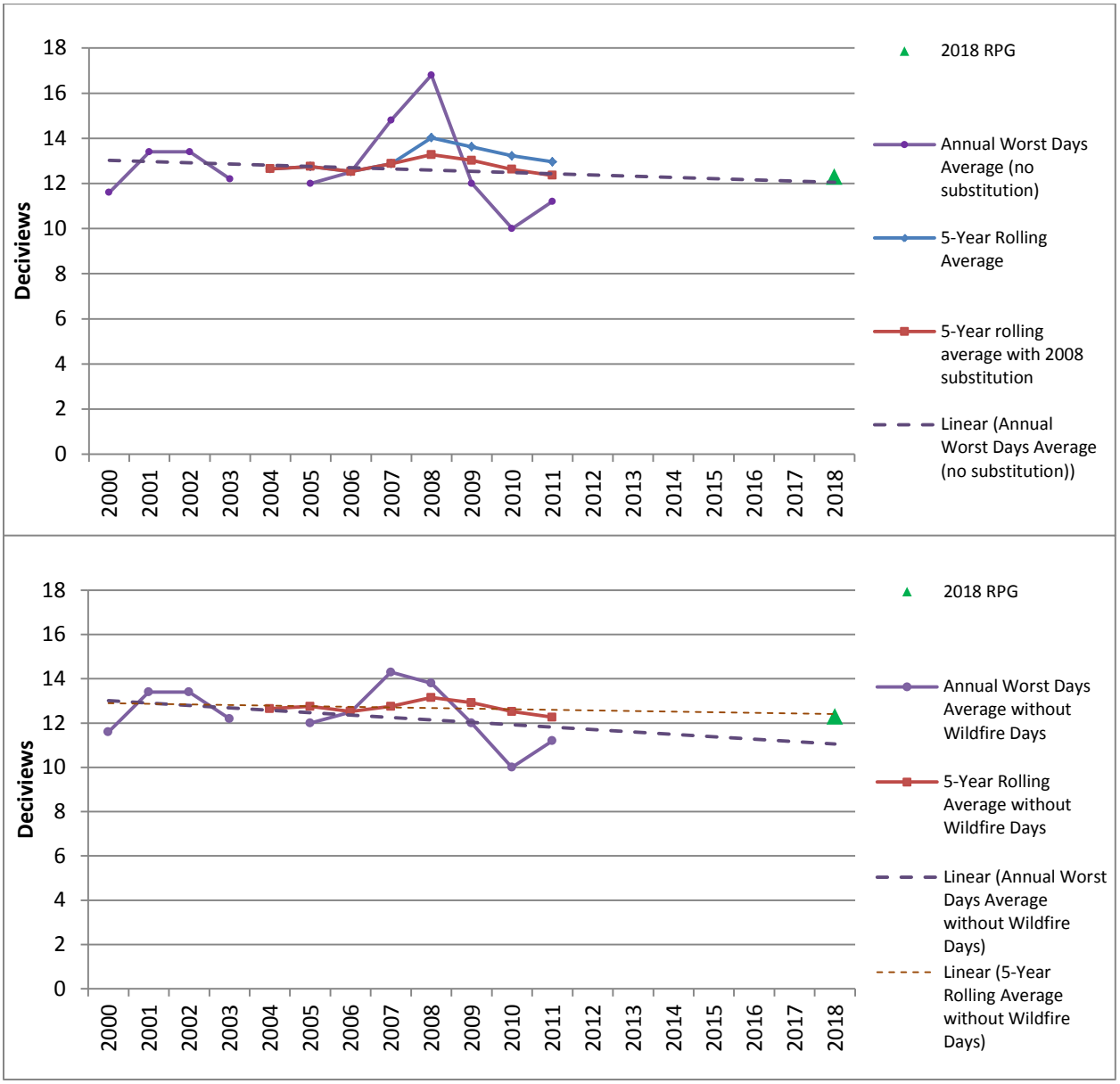
Although the annual Worst Days deciview average trends downwards, further analysis shows that elevated OMC extinction on Worst Days in 2008 subsequently impeded the rate of progress measured by the 5-year rolling average. If the top five Worst Days occurring during the Lightning Strike Complex Fires are excluded, recalculation of the 2008 OMC light extinction average becomes 17.0 inverse megameters, and the slope of the trendline for OMC becomes -0.01 (decreasing trend.) If those same top five Worst Days are not included in the Worst Days annual average by deciviews, the 2008 deciview level would be 13.8 dv. As shown in Table D-2, the 5-year rolling average changes to a decreasing trendline.

Table D-2
BLIS without Wildfire Days

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Slope
Deciview	11.6	13.4	13.4	12.2		12	12.5	14.8	16.8	12	10	11.2	**-0.05**
5-year Rolling Average					12.7	12.8	12.5	12.9	14.0	13.6	13.2	13.0	**0.11**
Recalculated 2008 Deciview	11.6	13.4	13.4	12.2		12	12.5	14.8	13.8	12	10	11.2	**-0.10**
Recalculated 5-year Rolling Average					12.7	12.8	12.5	12.9	13.3	13.0	12.6	12.4	**-0.01**

Annual deciview values and the forecast trendlines to 2018 (dashed line) are plotted in Figure D-3 to show progress to the 2018 RPG. The trendlines are regression lines that display a straight-line trend based on available data. While they cannot forecast a long-term glide path, they illustrate the sensitivity of trends to single point changes. The top graph shows how the 5-year rolling average for Worst Days would change with the substitutions made for 2008. In the absence of large wildfire impacts, visibility at BLIS is improving, even though the 2008 data dampens progress for the 5-year rolling average from 2008 through 2011. Wildfire smoke also led to several Worst Days in 2007 at BLIS. If those days are also removed from annual average calculations, the rolling averages for 2007 through 2011 improve even more, as shown in the lower graph.

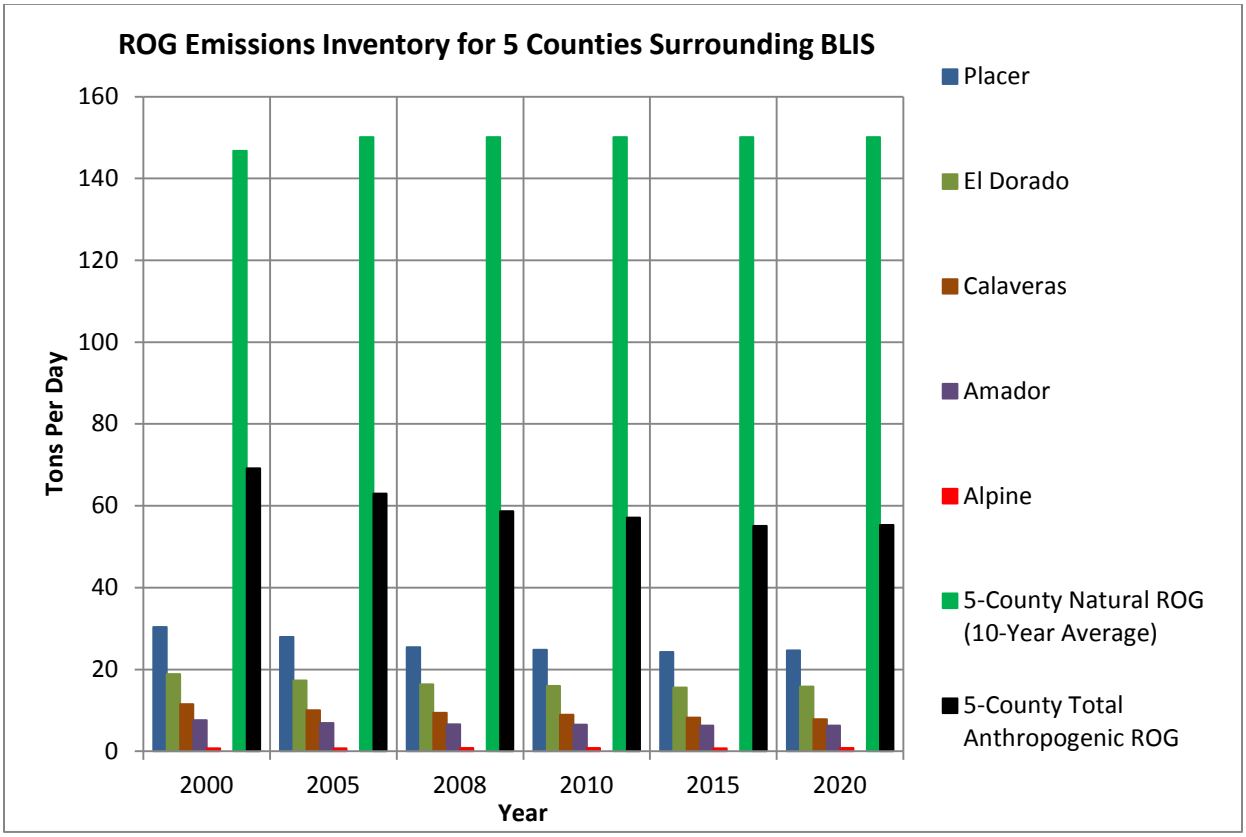
Figure D-3
BLIS: Worst Days Averages with Wildfire Adjustments



The BLIS monitor is located in El Dorado County. It represents the Desolation Wilderness in Placer and El Dorado Counties and the Mokelumne Wilderness in Alpine, Amador and Calaveras counties. A quick examination of the emissions inventories for these surrounding counties further illustrates the impact of wildfires. Total organic gas (TOG) emissions are used as a surrogate for OMC because they include the building blocks for organic aerosol molecules, in the absence of a precise inventory of directly emitted organic aerosols.

The local emissions inventory of Reactive Organic Gases (ROG) from anthropogenic sources in these counties is decreasing. The 10-year average of natural ROG sources (predominately from biogenic emissions) is included for comparison. Emissions from natural sources make up more than 50 percent of the ROG inventory. Figure D-4 shows that despite natural source emissions, anthropogenic source control strategies are effectively reducing precursor emissions. The summary result is that the annual Worst Days deciview average at BLIS is trending downward, despite the progress impeded by the impacts of uncontrollable sources on visibility.

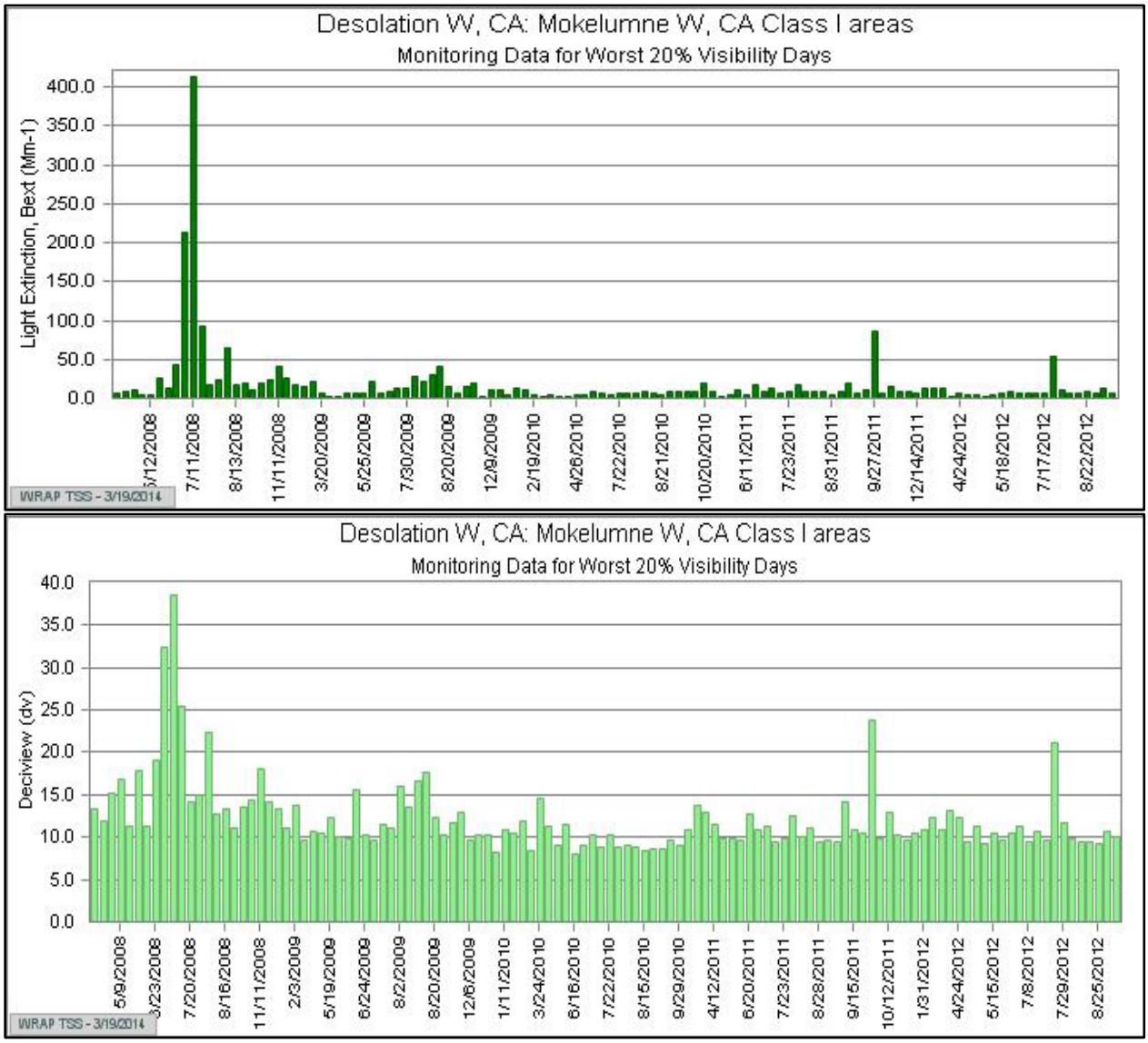
Figure D-4
Local Inventory Changes Over Time



Impact of 2012 data for BLIS

The 2012 Worst Days deciview average for BLIS is 11.0 dv. The five-year Worst Days Rolling Average for the years 2008-2012 at BLIS is 12.2 dv. Both of these deciview values are below 12.3 dv, the 2018 RPG for BLIS. The years after 2008 were low wildfire impact years at BLIS, as indicated by the OC extinction levels on the Worst Days from 2008 through 2012, shown below in Figure D-5. The single high OMC extinction days in 2011 and 2012 contribute to high deciview days, but the remaining days have deciview levels slightly lower than those prior to 2008, shown in Figure D-2.

Figure D-5
Recent OMC Extinction and Deciview Levels at BLIS on Worst Days (2008-2012)

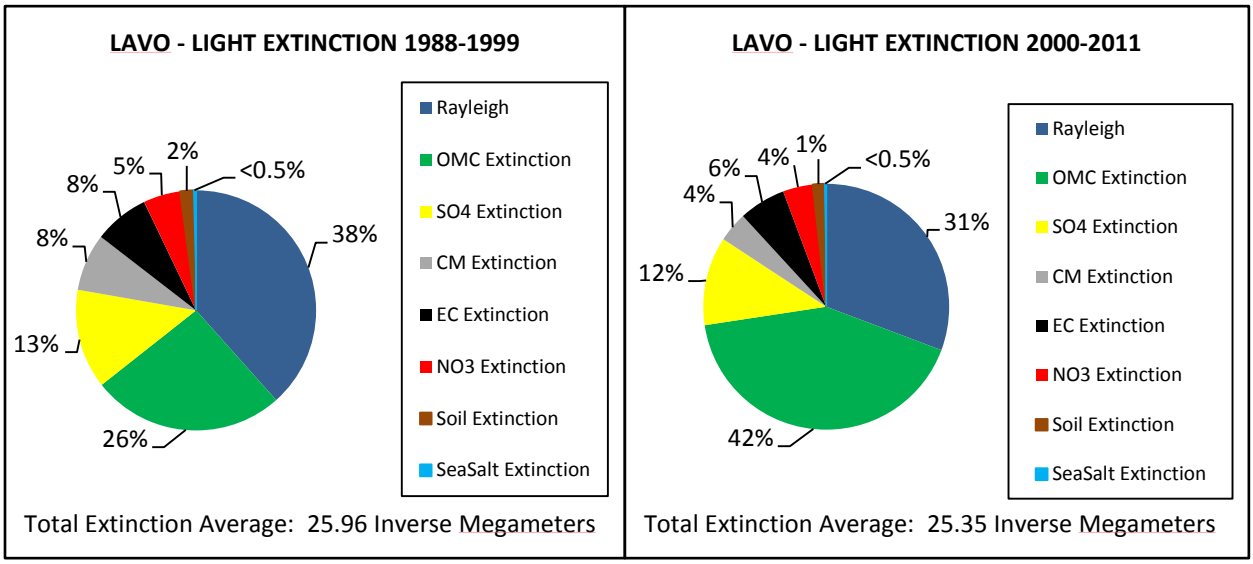


Case Study: LAVO

Wildfire Impacts

Data has been collected at the LAVO monitoring site since 1988. Comparing pre-2000 data for all sampling days with that from 2000-2011 shows that OMC contributions to total light extinction increased 60 percent while other contributions decreased slightly on average. The net effect is a very slight decrease in the decadal deciview average, for all monitored days. Figure D-6 shows light extinction for all sampling days over two decades. The Best Days annual average is improving, as is the average for all Sampling Days. The following analysis shows that wildfire smoke, rather than anthropogenic sources, are skewing long-term progress on Worst Days.

Figure D-6
Changes in Light Extinction at LAVO – All Sampling Days

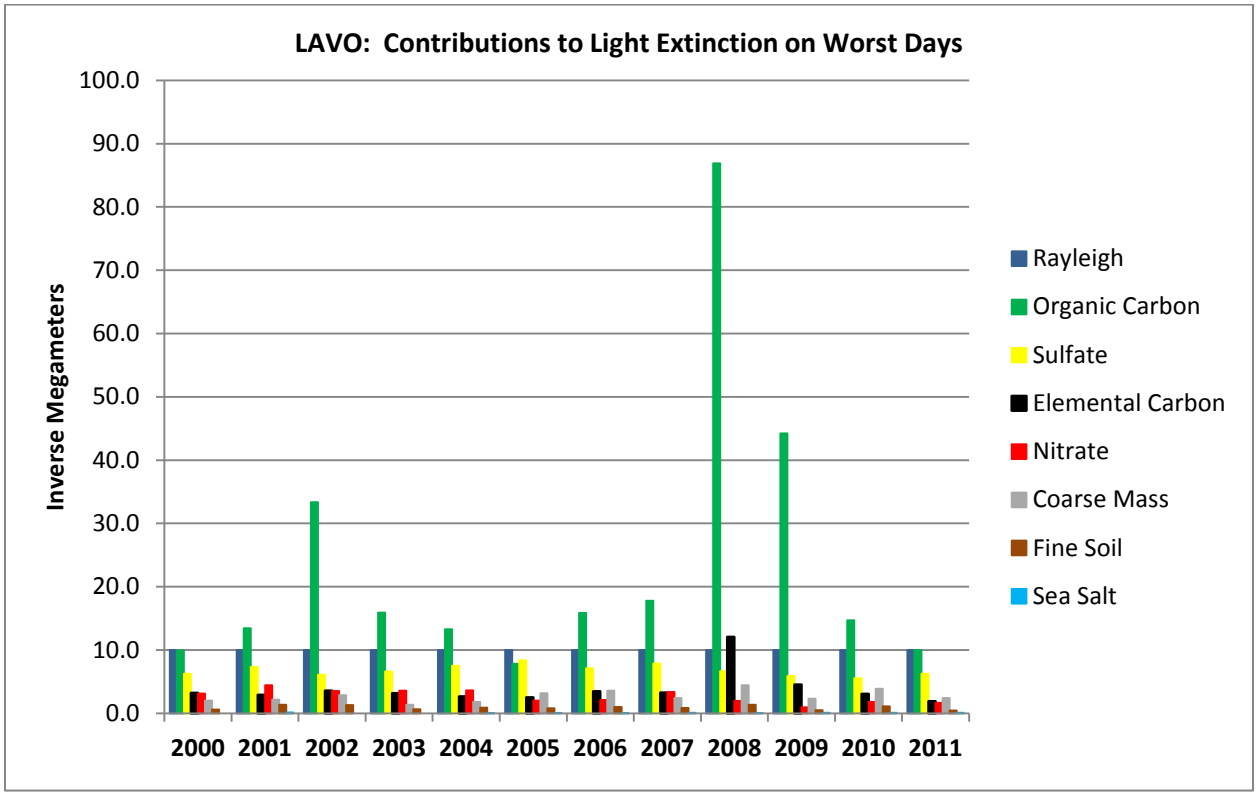


Wildfire Smoke and OMC Extinction

Worst Days occur most frequently June through September at LAVO. Elevated organic mass extinction tracks with the occurrence of Worst Days. OMC extinction at LAVO can be about 40 percent of total extinction on Worst Days. No Best Days occurred in July or August from 2000 through 2011, when organic mass extinction contributions are normally at their highest. The fire season begins in May or June and can run through November, depending on moisture conditions. There are almost no residences having the potential to generate woodsmoke near LAVO, which is why there is very low organic matter extinction in winter months. This pattern is the basis for suggesting that wildfire smoke alone can skew the annual deciview levels and mask progress in reducing anthropogenic emissions.

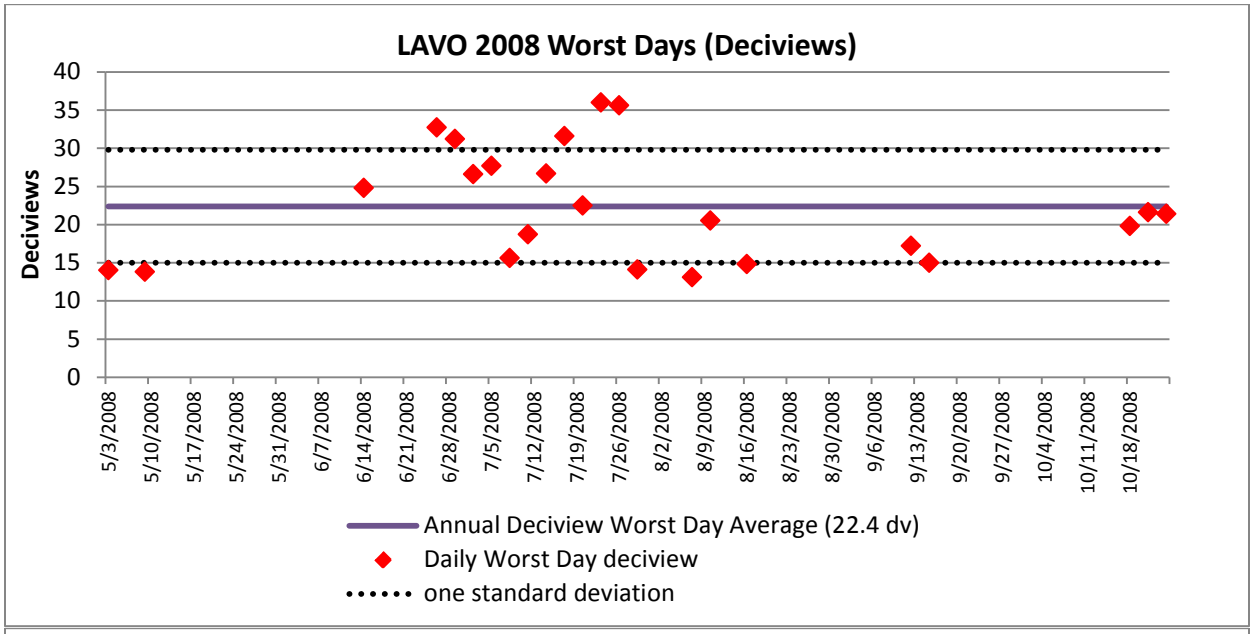
The long-term Worst Days deciview average for 1989 through 2011 is 14.3 dv, higher than the 2000-2004 baseline average of 14.1 dv. In the recent years of 2002, 2008, and 2009, both averages were exceeded. In those specific years, large wildfires occurred in southern Oregon or northern California with wildfire smoke impacting the monitor. Every other year since 2000 was equal to or below the baseline Worst Day average (14.1dv.) Figure D-7 shows the particle species and Rayleigh contribution to light extinction on Worst Days since 2000, demonstrating the influence of OMC contributions to haze.

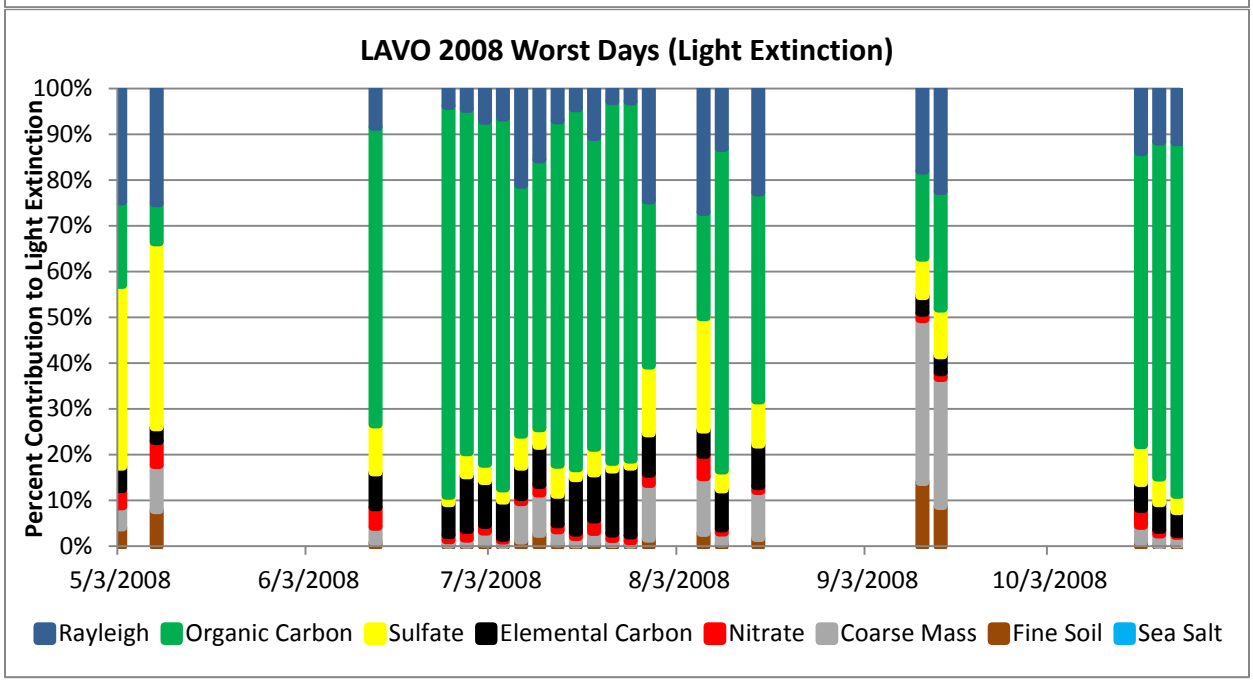
Figure D-7
Relative Contributions to Total Light Extinction at LAVO



The charts in Figure D-8 compare the Worst Days deciview levels for 2008 with the contributions to light extinction on those days. The highest deciview values correlate with the highest OMC contributions to light extinction, and coincide with the timing of the 2008 Lightning Strike Complex fires. There is a 23-deciview spread between the minimum and maximum values for Worst Days in 2008, with the two highest values almost two standard deviations from the average. OMC has the highest contribution to light extinction in every Worst Day above the Worst Day annual average, evidence of its strength in controlling the twenty percent Worst Days average.

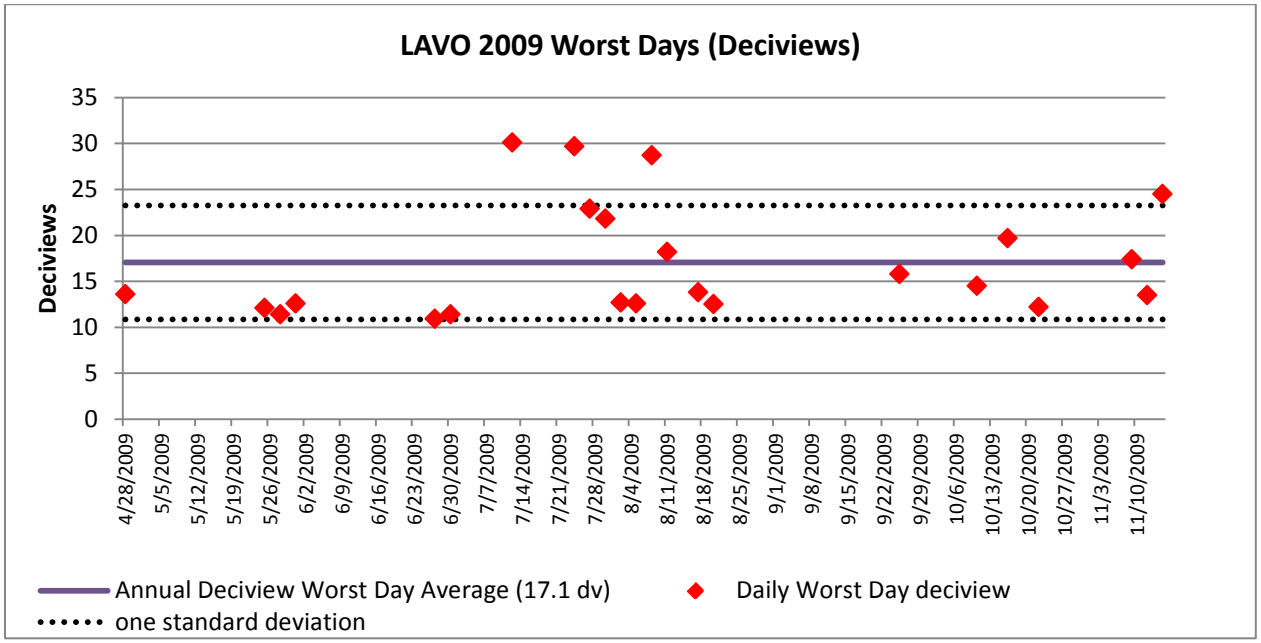
Figure D-8
Comparison of Deciview Value and Causes of Light Extinction (2008)

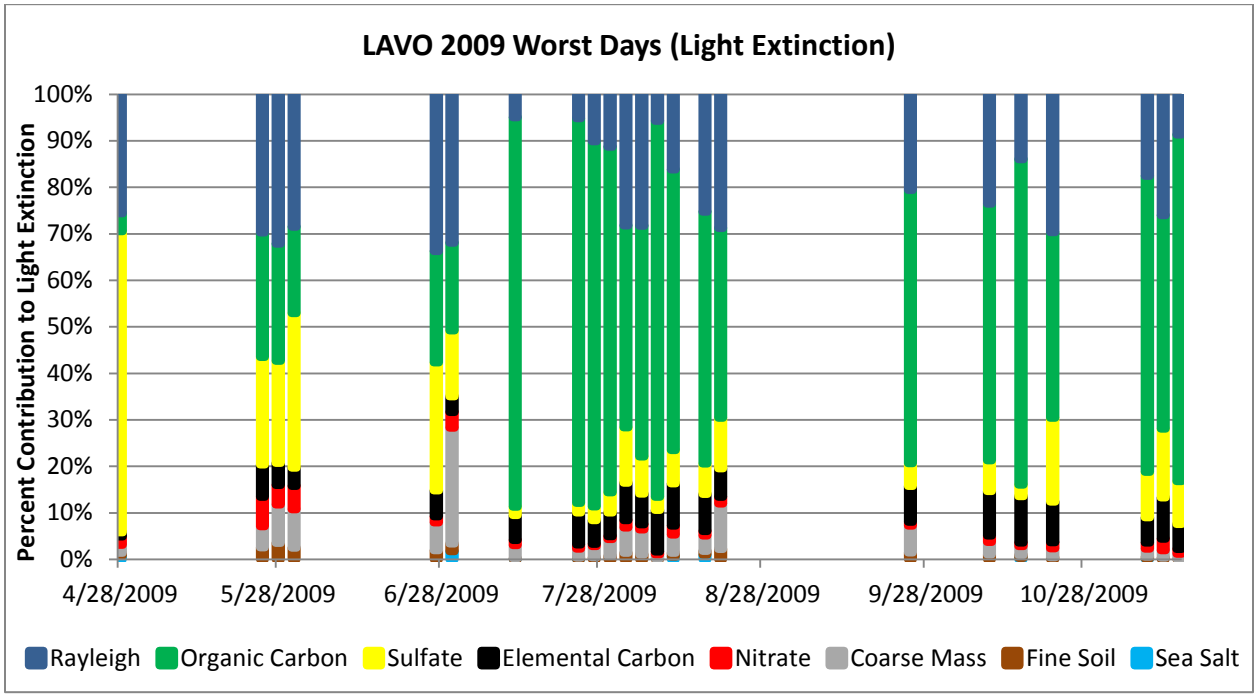




Several very high deciview days also occur in 2009. Two in July are more than two standard deviations from the average. They correspond with high OMC extinction days, as shown in Figure D-9. At that time, there were several wildfires close to the southeastern corner of Shasta County, where the LAVO monitor is located, as shown in Figure D-10. As with 2008, all of the days above the annual average for Worst Days were driven by elevated OMC.

Figure D-9
Comparison of Deciview Value and Causes of Light Extinction (2009)





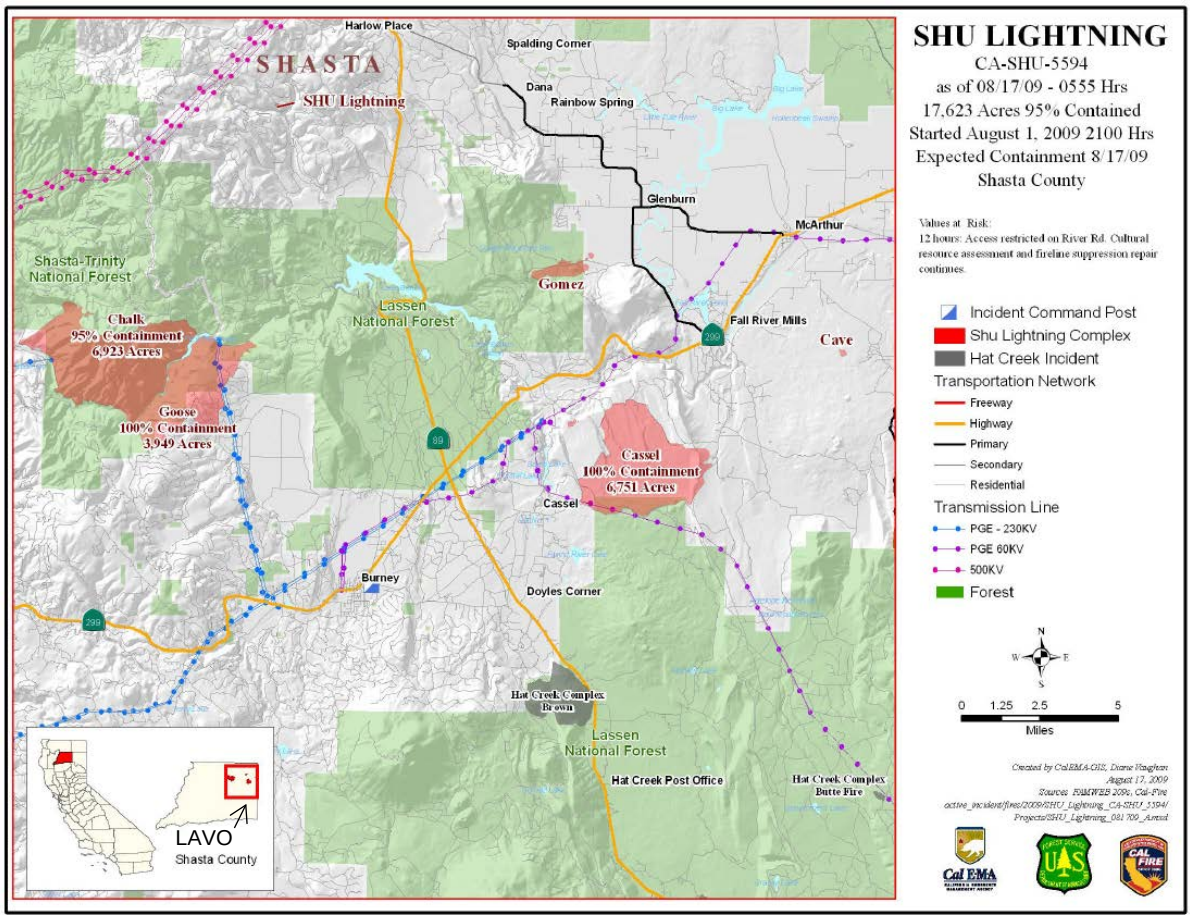
The Table D-3 lists the dates of wildfires in counties close to LAVO, to compare with deciview levels at the same time. There is fluctuation in the monitor values over the

several weeks of active and smoldering fires, as the wind shifts and alters the tracks of smoke plumes.[11]

Table D-3
Large Wildfires (>500 acres)

Year	*Fire Name*	*Location & Acreage*	*Dates*
2008	*Lightning Strike Complex*	*See Figure 8*	*6/22 through 8/11/2008*
2009	*Backbone*	*Trinity Alps/Trinity County*	*7/7/09*
2009	*Tennant*	*Macdoel/Siskiyou County*	*7/19/09*
2009	*Dodge Complex SHU Lightning*	*Lassen County, 1,601 acres Shasta County, 17,623 acres*	*8/1 through 8/18, 2009*
2009	*Hat Creek Complex*	*Lassen/Shasta Counties, 11,269 acres*	*8/1 through 8/26, 2009*
2009	*Day*	*Lassen County*	*8/27/09*
2009	*Silver*	*Meadow Valley/Plumas County*	*9/19/09*

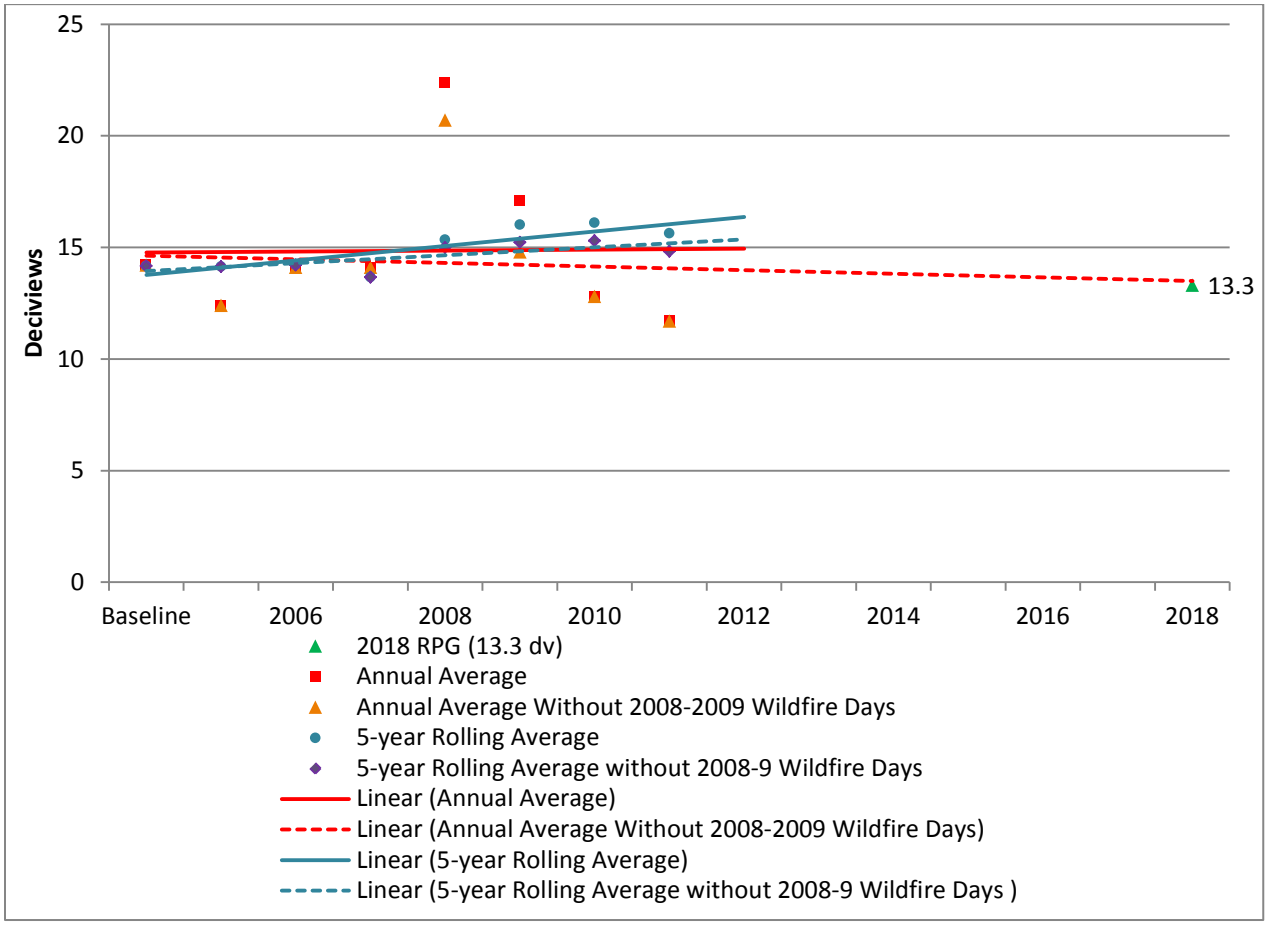
Figure D-10
Location of 2008 Wildfires near LAVO



[11] http://www.arb.ca.gov/smp/wildfire/wildfire.htm

There is a ten-deciview spread between the highest (22.4 dv in 2008) and lowest (11.7dv in 2011) Worst Days annual averages in the past ten years at LAVO. The large variation is shown in Figure D-11. The two most recent years, 2010 and 2011, are actually below the 2018 RPG of 13.3 dv, in contrast with the two highest values in the two prior years. Both 2008 and 2009 are in five-year averaging periods for several consecutive years, flattening the linear forecast trendline for the five-year rolling average shown as the dashed blue line in Figure D-11. They also flatten the linear forecast trendline for the annual Worst Days deciview average, shown as the solid brown line. As previously noted, these trendlines do not forecast a long-term glide path, but they do illustrate the sensitivity of the short-term slope to single year point values.

Figure D-11
Forecast Trend Lines for LAVO

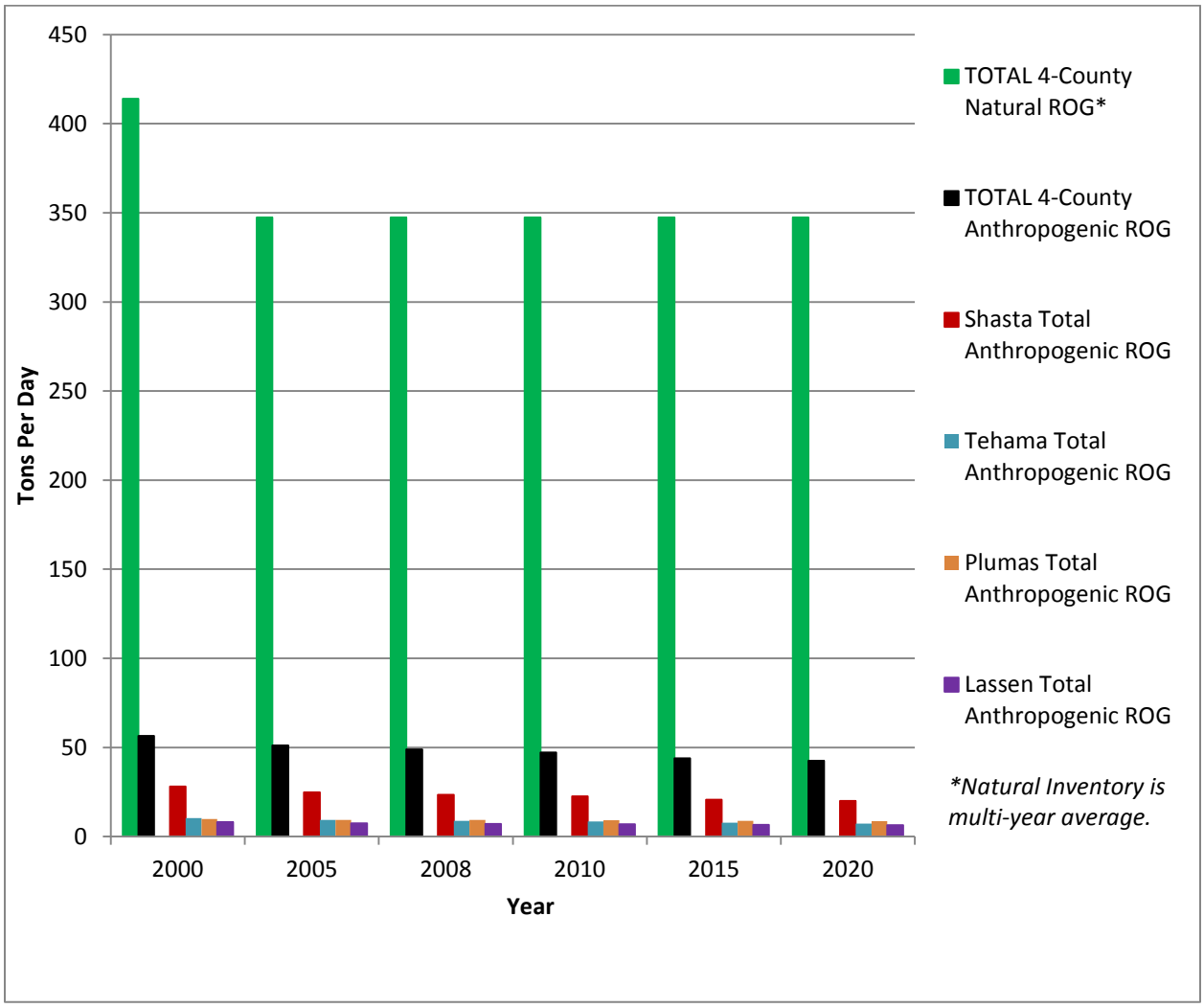


If the two wildfire-impacted years of 2008 and 2009 are excluded from the Worst Days annual averages, the linear forecast trendline (dashed red line) approaches the 2018 RPG. Otherwise, the annual average trendline (solid red line) is level. The solid blue line shows the forecast trendline for the five-year rolling average. If only the highest smoke-impacted days are removed from the calculation of the 2008 and 2009 Worst Days averages (the new values for 2008 and 2009 are the orange triangles), the five-

year average begins to level out (dashed blue line). This demonstrates the impact of outlier days from wildfire smoke on the rolling averages and forecasts. In 2010 and 2011, the annual averages for Worst Days were actually lower (better) than the 2018 RPG.

Reductions in the anthropogenic emissions inventory support a forecast of improved visibility, as shown in Figure D-12. Emissions of NOx, ROG, and SOx are all declining in the four counties surrounding LAVO. PM is the only increasing category due primarily to the formula predicting growth in road dust as vehicle miles traveled increases with population growth. Coarse Mass and Fine Soil are major components of road dust, but neither of these haze pollutants is a strong light extinguisher and both have limited impact on the Worst Days averages.

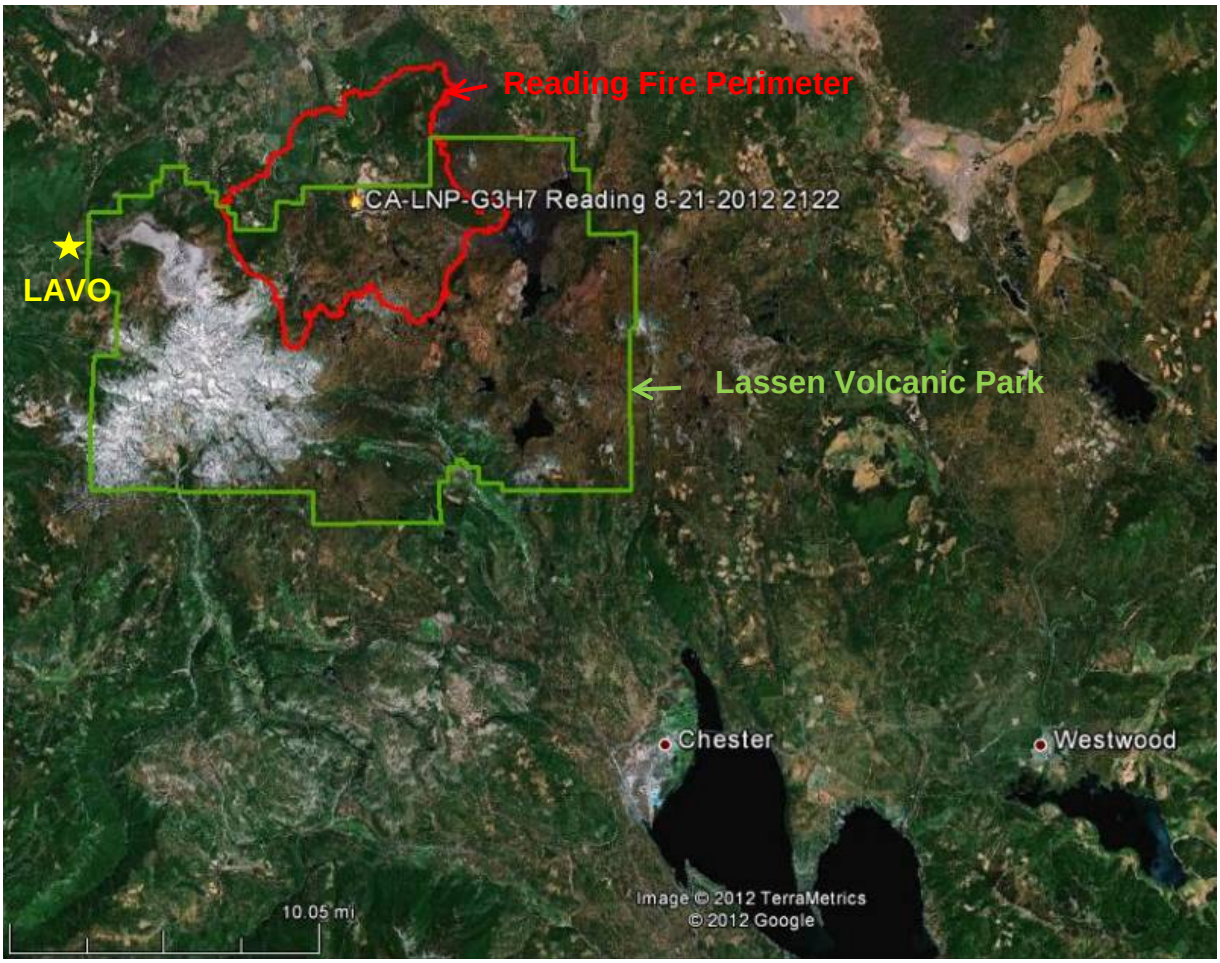
Figure D-12
Local Inventory Changes over Time



Impact of 2012 data for LAVO

The 2012 Worst Days deciview average for LAVO is 14.3 dv. The five-year Worst Days Rolling Average for the years 2008-2012 at LAVO is 15.6 dv. Both of these deciview values are above 13.3 dv, the 2018 RPG for LAVO. While the Worst Days deciview annual averages were decreasing each year since the high year of the 2008-2012 period, wildfire smoke in 2012 reversed the trend. In that year, a lightning strike wildfire started June 23 and burned more than 28,000 acres of predominately forested land through the containment date of August 22. As Figure D-13 below illustrates, the fire was located within 15 miles of the monitor.

Figure D-13
Reading Fire of 2012



Despite prevailing winds from the southwest, occasional easterly winds brought smoke to the LAVO monitor location. As a result, seven of the 23 Worst Days in 2012 occurred during that period. One of the days, August 19, 2012, recorded 41.9 dv, the highest deciview level measured since recordkeeping began in 1989. That value was nearly twice the next highest deciview level measured in 2012 (21.6 dv) and the OMC mass

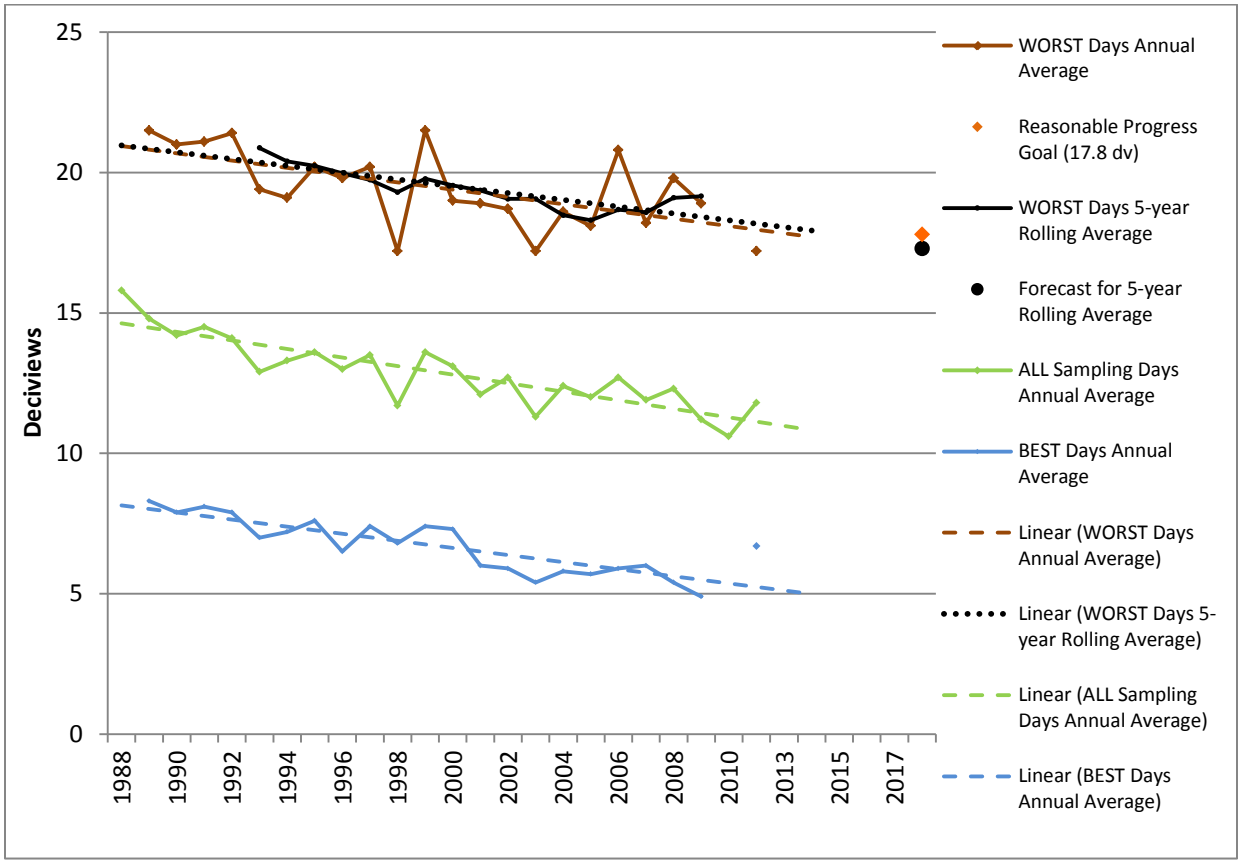
concentration that day was 12.3 times the average OMC mass on Worst Days that year. If that single high deciview day value is removed, and the Worst Days average recalculated for 2012, it would be 13.0 dv, lower than the 2018 RPG of 13.3 dv.

Case Study: REDW

Impacts from Pacific Offshore Shipping and Wildfire Smoke

Since 1988, when data was first collected at REDW, all the long-term trends indicate that visibility is improving. Figure D-14 plots the Worst Days annual averages (brown), the All Sampling Days annual averages (green), the Best Days annual averages (blue), and the required rolling Worst Days 5-year averages (black). Examining this data further explains why visibility improvement appears to level off using the 2005-2009 and 2007-2011 five-year averages. Figure D-12 shows the years 2006, 2008, and 2009 were the only years since 2000 above the long-term Worst Days annual average trendline (dashed brown line.) All three years skew the reported five-year average in Table 3 of the Progress Report and warrant further analysis.

Figure D-14
Long-Term Trends at REDW



If the long-term 5-year rolling average linear trend line (black dotted line) is extended to 2018, the 5-year deciview average is predicted to be 17.3 dv. That is actually lower than the RPG of 17.8 dv. The annual Worst Days averages are also trending downward (brown dashed line) and could reach 17.1 dv by 2018. The Best and Worst Days annual averages are not available for 2010 due to incomplete data, however, the

average of all avaliable data indicates that visibility was improving in 2010 also. The following discussion examines what caused the averages for 2006, 2008, and 2009 to be above the trendline.

Figure D-15 shows that sea salt, organic carbon, and sulfates contributed the most to light extinction on the Worst Days in 2006, 2008, and 2009. The year 2007 is included for comparison because the Worst Day deciview average is just under the long-term trendline for Worst Days. It is also one of the years in both the 2005-2009 and 2007-2011 five-year averages. Seasonal contributions to light extinction by particles on the Worst Days for all the years show that the summer months have the most Worst Days at REDW. This is the time of year when organic mass and sulfate mass concentrations are usually at their highest at all California IMPROVE monitors. Sea salt is not analyzed further because it is a natural contributor to light extinction.

Figure D-15
Particle Contributions to Light Extinction on Worst Days

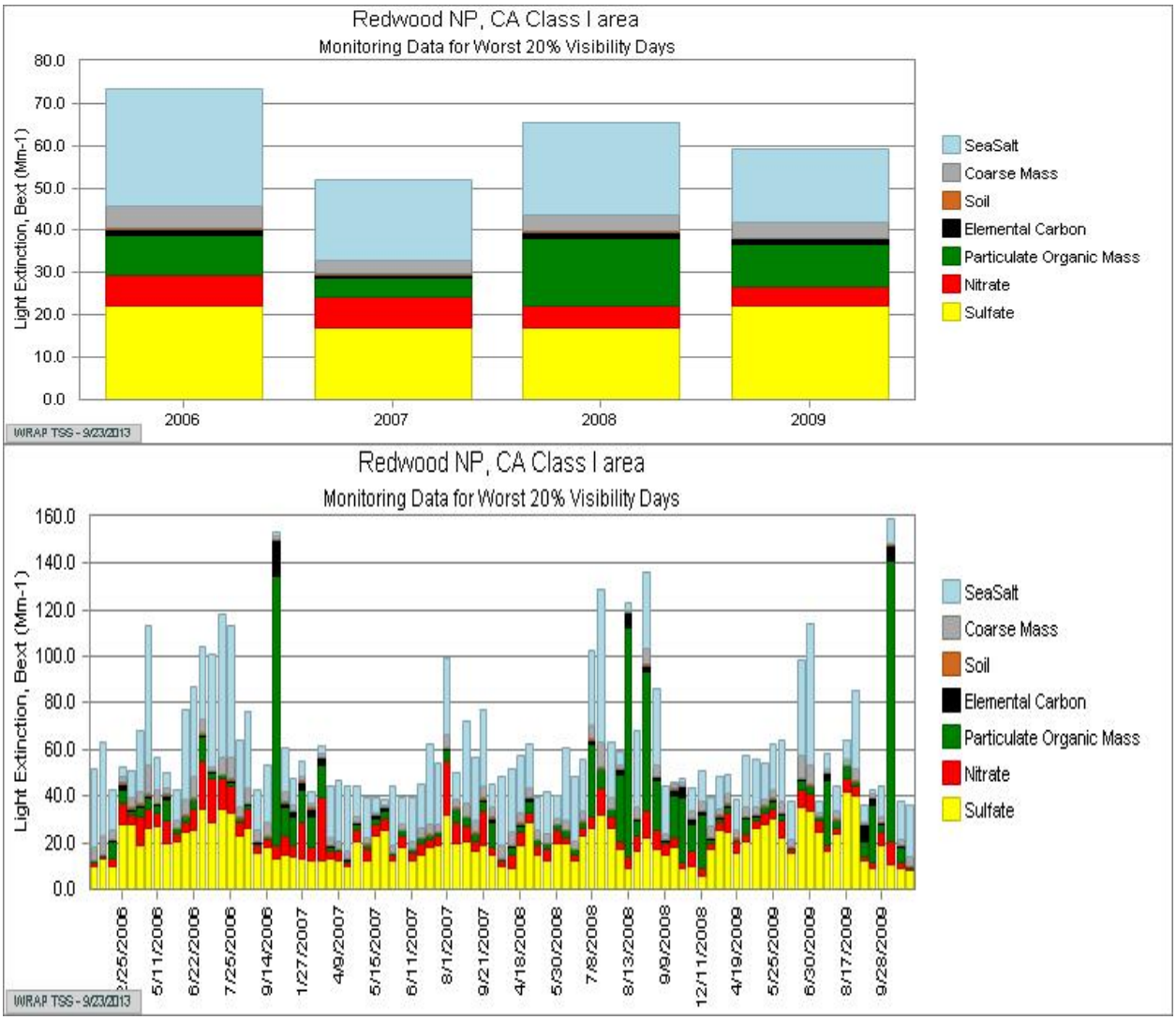
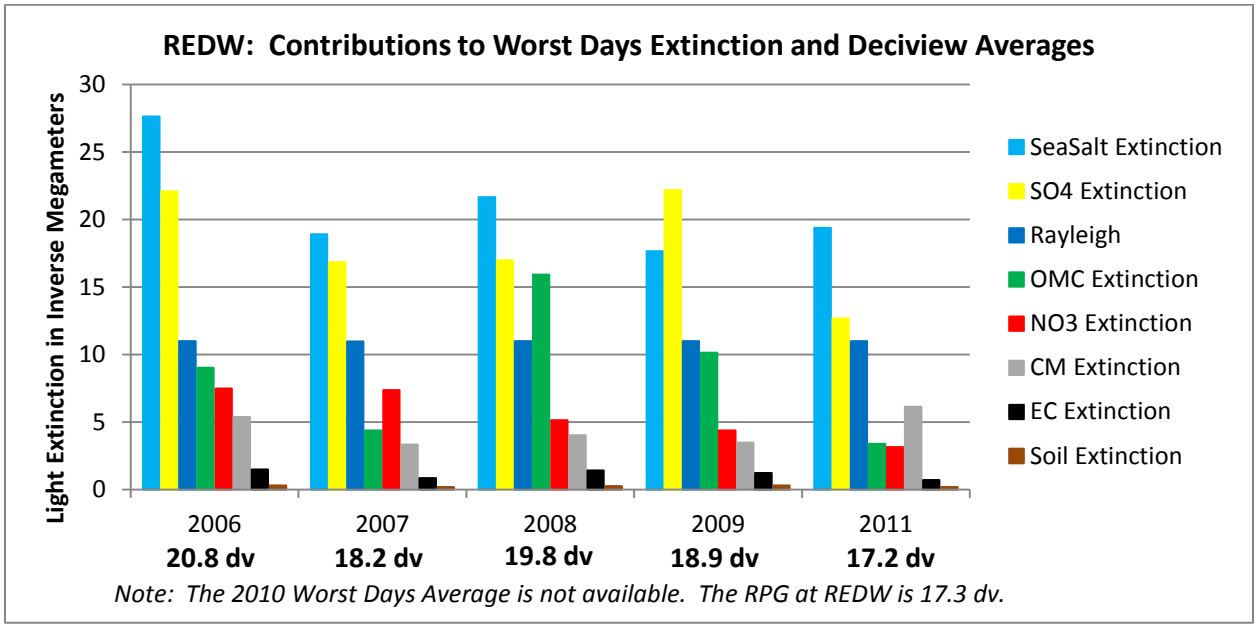


Figure D-16 shows the particle and natural Rayleigh gas scattering contributions to total light extinction for the Worst Days annual averages at REDW. Rayleigh is a natural and constant component of light extinction. Sea salt is a major natural component of haze found in coastal areas; the concentrations vary daily with ocean breezes. Disregarding sea salt and Rayleigh, sulfates are the strongest contributor to light extinction on Worst Days at REDW in the most recent years. Elevated deciview levels also occur when OMC light extinction is elevated, as it was in 2006, 2008, and 2009. Nitrate contributions are steadily declining, showing the effectivenes of California's NOx control measures over time. The three remaining constitutuents – Coarse Mass, Elemental Carbon, and Fine Soil – have fluctuating contributions that are not significant enough in light extinction to impair visibility improvement at this time.

Figure D-16
Comparison of Light Extinction and Recent Deciview Levels



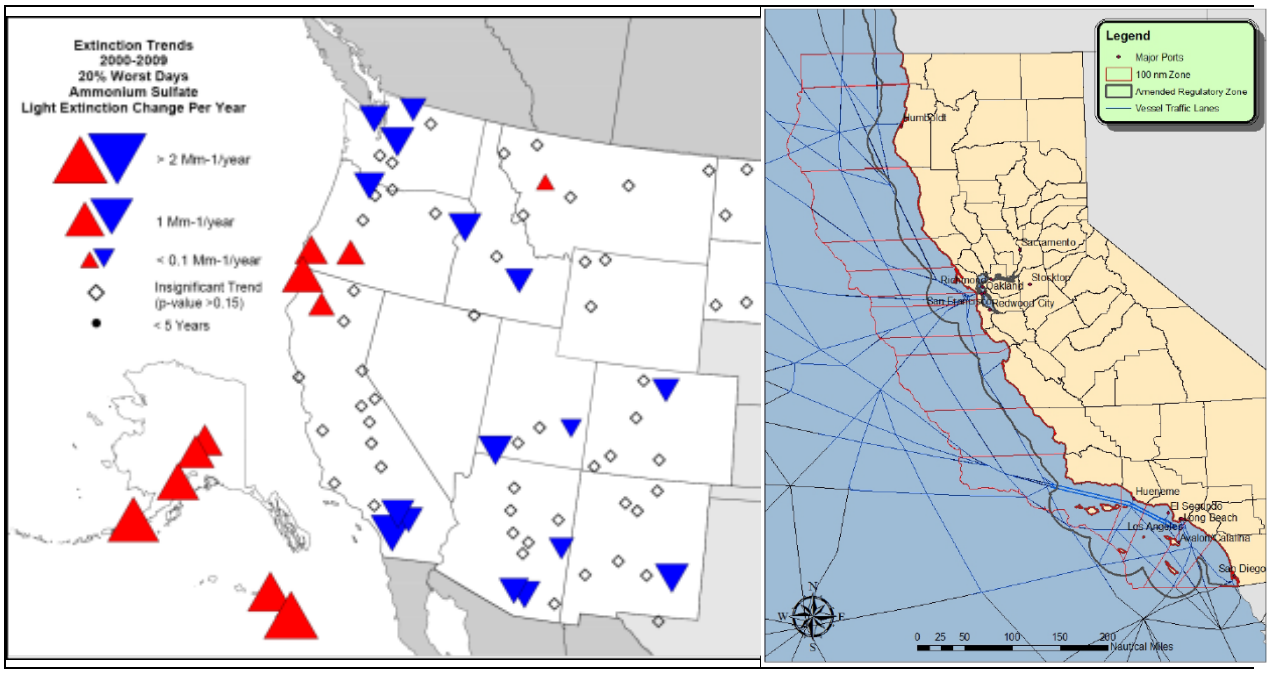
Whether the annual Worst Days average is below or above the long-term trend line appears to depend on the relative contributions of sulfates and OMC to light extinction in any given year. Trends in the emissions inventory for sources of SOx and reactive organic gases (ROG) gases, as precursors of sulfates and OMC, can be examined further to explain the high years.

The REDW monitor is located at 244 meters above sea level, within one mile of the Pacific Ocean, at the mouth of the Klamath River. The delta of the Klamath River is undeveloped, limiting the anthropogenic sources nearest REDW to local two-lane roads to a scenic overlook and a few homes and buildings. The REDW monitor is exposed to ocean fogs year-round, offshore emissions from ocean-going vessels, and smoke drainage down the Klamath River from inland wildfires during the dry season in the mountains. Elevated humidity also supports the formation of nitrates at lower

temperatures in the winter, although relatively few Worst Days occur then at REDW. Light extinction by sulfates, nitrates, and organic aerosols is heightened by elevated relative humidity, another factor causing higher haze levels at coastal locations nationwide.

The WRAP Summary Report shows an increase in sulfate extinction on Worst Days at four monitors near the Pacific coast at the Oregon-California border (REDW, TRIN, KALM, and CRLA). This area has very few SOx-emitting sources other than the influence from offshore shipping emissions, compared to more populated areas along the coast. The relative magnitude of offshore shipping emissions has a greater impact on this sparsely populated area. The location of shipping lanes is shown in Figure D-17 for comparison.

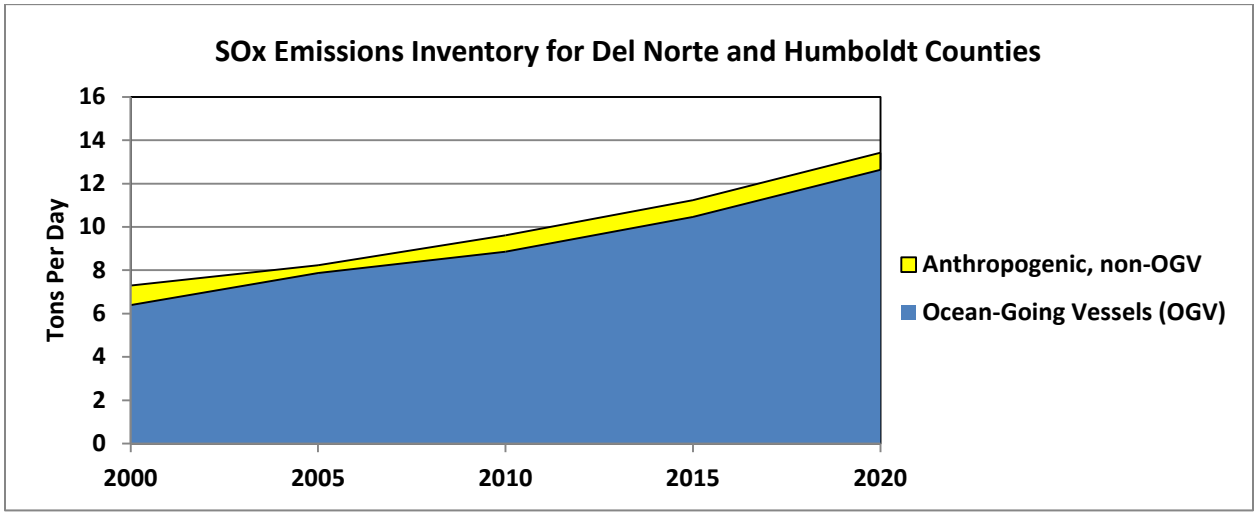
Figure D-17
Sulfate Extinction Trends Near Shipping Lanes



In the past decade traffic in these shipping lanes has increased dramatically in response to changes in global production and shipment of goods from Asia to North American markets. California has developed an inventory of emissions from ocean-going vessels (OGV) in shipping lanes within 100 nautical miles of the California coast. Since 2005, California has also implemented several control measures aimed at reducing in-port emissions and in-transit emissions for ships within 24 nautical miles of the California coastline. Vessels travelling outside the State's jurisdictional control boundary may still burn higher sulfur fuel until after 2012, when international agreements to reduce the emissions from sulfur fuels begin scheduled implementation.

Figure D-18 shows the increase in the relative magnitude of OGV SOx emissions within one hundred miles offshore of Del Norte and Humboldt Counties, north and south of REDW. The emissions are backcast and forecast, with growth and control factors applied, using 2008 as the base year. The emissions do not include the shipping emissions offshore the Oregon coast, a little more than 30 miles north of the REDW monitor, nor do they include emissions from Curry County in Oregon, the sparsely populated county north of the interstate border. The ocean-going vessel emissions of SOx along the California coast alone overwhelm the local anthropogenic sources of SOx from the two coastal California counties surrounding REDW and containing Redwood National Park.

Figure D-18
Anthropogenic Emissions near REDW

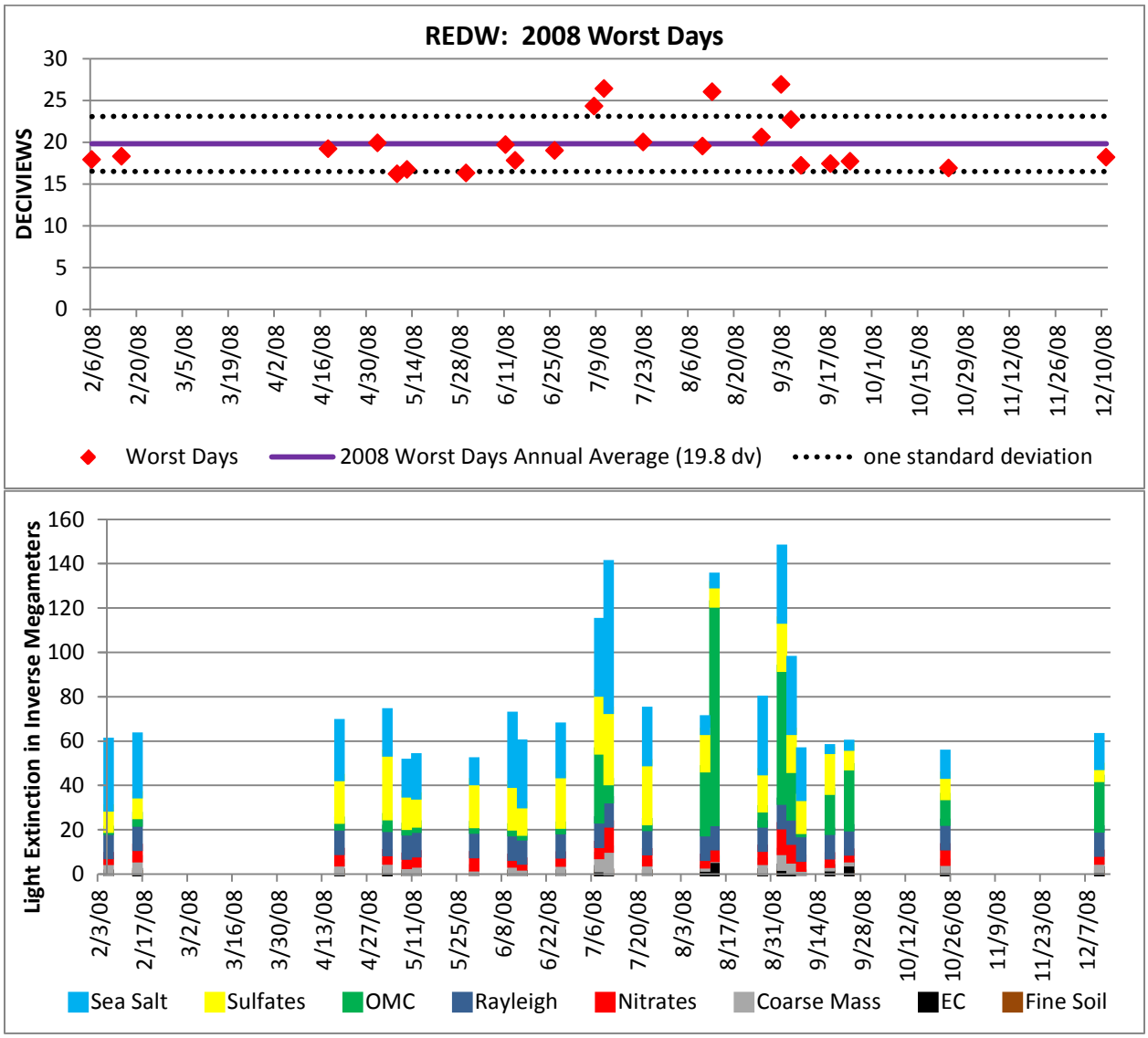


Forecasted growth in Pacific shipping will continue to impact REDW. Continued reductions of other anthropogenic sources of NOx and ROG will offset potential increases in sulfate formation by lessening nitrate and OMC formation. As evidence, the Worst Days annual average for 2011 already achieves the 2018 RPG. The relative reduction in OMC light extinction in 2011 occurred because there were fewer wildfire smoke incidents impacting REDW.

As shown in Figure D-19, wildfire smoke in the summer of 2008 also impacted REDW. Beginning in late June and lasting into September, nighttime drainage of wildfire smoke down the Klamath River was trapped in the marine layer near REDW. Figure D-19 illustrates how wildfire smoke results in high OMC contributions to light extinction. If just the highest of the smoke-related OMC-driven Worst Days is removed from the calculation of the annual average for 2008, the deciview level would be 19.3 dv. If the three highest smoke days during that time are removed, the Worst Days average would be 18.6 dv. When the Worst Days average in a single year is skewed due to very high wildfire smoke influence on a few days, both the annual average and the rolling averages are also elevated by this natural source. These statistics mask progress

made by reductions in anthropogenic emissions. The 2018 RPG at REDW is 17.8dv. In 2011, the Worst Days average was 17.2 dv.

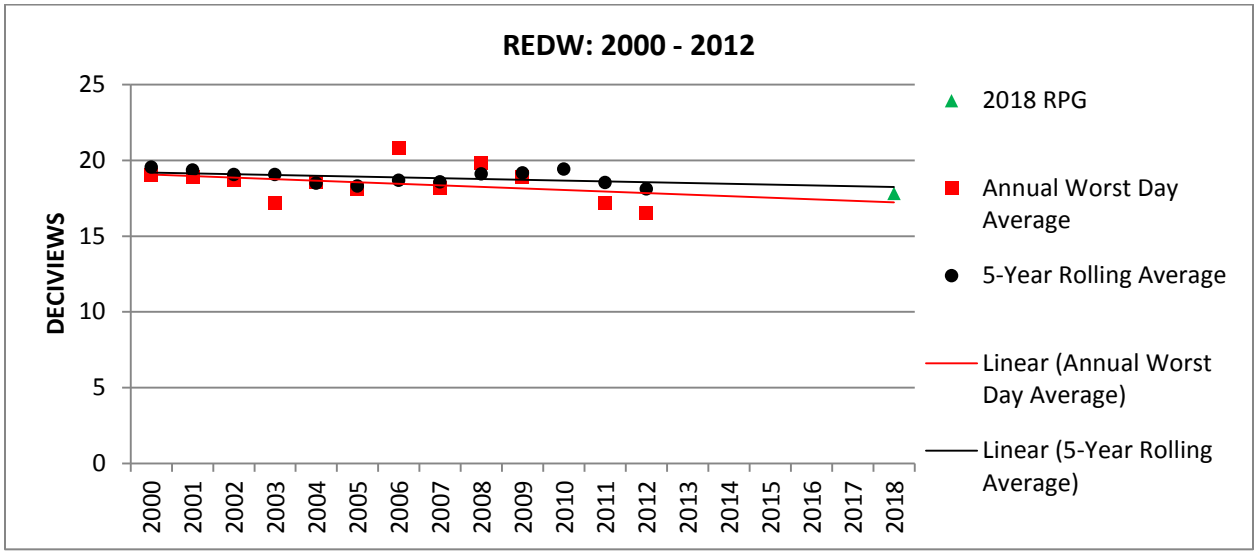
Figure D-19
Wildfire Smoke affects Deciview Calculation



Impact of 2012 data for REDW

In 2011, and again in 2012, wildfire smoke impacts were not significant at REDW. The Worst Days annual average was 17.2 dv in 2011, and even lower in 2012, at 16.5 dv. Both of these values are below the 2018 RPG for REDW, 17.8 dv. The Worst Days annual average could not be calculated for 2010, giving additional weight to the 2008 value in the most recent five-year averaging period. The 2008 Worst Days annual average skews the rolling 5-year average through 2012, masking progress made by reductions in anthropogenic emissions. Comparing the baseline period average of 18.5 dv with the most recent five-year average of 18.1 dv for 2008-2012, indicates that visibility is improving at REDW, even if the rate of progress is slowed by high wildfire smoke days in the calculations for 2008. This improving visibility trend is shown by the linear trendlines in Figure D-20.

Figure D-20
Wildfire Smoke affects Deciview Calculation



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Appendix E

Comments of Federal Land Management Agencies with CARB Responses

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Comments and Responses to the Letter from the U.S. Department of the Interior, National Park Service, dated March 27, 2014

1. **<u>Comment</u>: "Please briefly discuss the major federal and state regulations beyond those implemented specifically under CA's Regional Haze Plan that were included in CA's reasonable progress goals, as these earlier requirements, plus those listed in Table 1, appear to account for most of the emissions reductions observed since 2000 in CA."**

<u>Response</u>: The RH plan includes a discussion of the regulations used to establish the 2018 RPGs. The 2018 RPGs were based on rules adopted by the end of the baseline period, including those with quantifiable reductions scheduled for implementation after 2004 and before 2018. The RH Plan also described the State strategy for continual adoption and implementation of measures to reduce emissions, for which reductions had not been quantified for the RH Plan modeling of the 2018 RPGs. The Progress Report lists new and modified rules adopted 2005 through 2011, which clearly have provided additional emission reduction benefits through 2020 that go beyond the emission reductions included in the RH Plan.

2. **<u>Comment</u>: "Please clarify if CA's Smoke Management Program meets the enhanced smoke management goals for states submitting plans under 40 CFR 51.309. Are Class I Areas identified as sensitive receptors in CA's Smoke Management Plan?"**

<u>Response</u>: California elected to prepare its RH Plan pursuant to 40 CFR 51.308. California's Smoke Management Program was established in State regulation at Title 17 California Code of Regulations sections 80100- 80330. Class 1 Areas are listed and defined in the regulation and must be listed as sensitive smoke receptors in smoke management plans prepared by those conducting prescribed burns, with provisions made to minimize smoke impacts. The Progress Report has been updated to clarify that California's Smoke Management Program identifies Class 1 areas as sensitive receptors.

3. **<u>Comment</u>: "Please also provide a summary in tons/per year [for the emissions inventory], since the conversion from tons per day to tons per year likely differs for different emissions categories."**

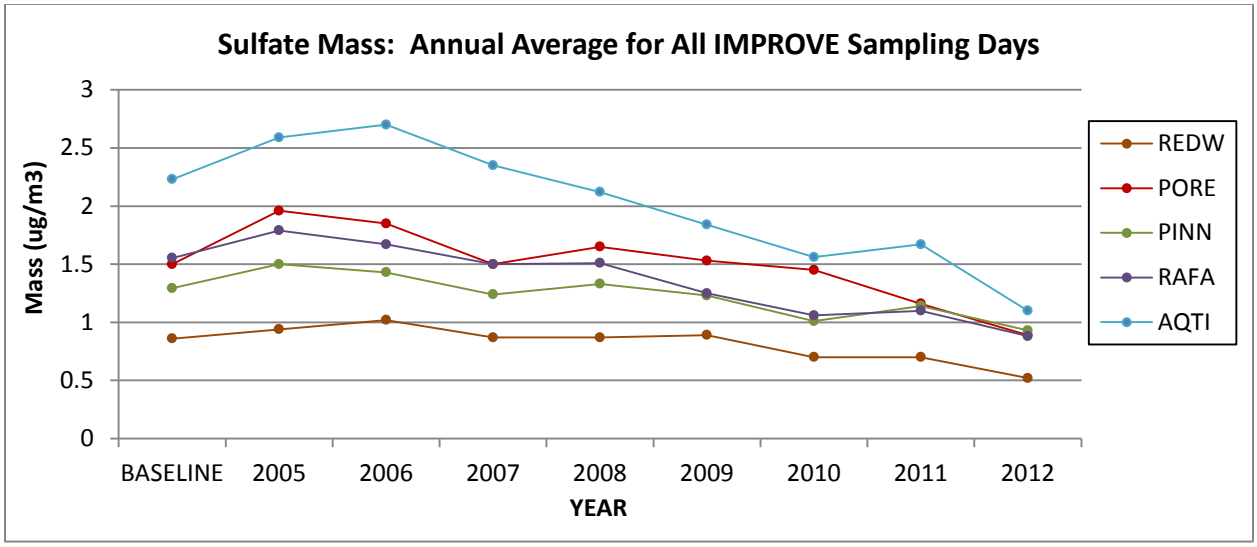
<u>Response</u>: The California emissions inventory shown in the RH Progress Report is in tons per day, using the annual average. To obtain the emissions in tons per year, each daily value can be multiplied by 365. The Progress Report has been updated to include a statement to calculate tons per year.

4. **<u>Comment</u>: "Please cite or include in Appendix A the Western Regional [Air] Partnership Reasonable Progress Summary Report for California."**

<u>Response</u>: A citation and link has been added to Appendix A of the Progress Report for the California Section of the WRAP Reasonable Progress Summary Report, in addition to the link for the entire report.

5. **<u>Comment</u>: "Please add to the discussion of impacts from off shore shipping that the North American Emissions Control Area international treaty limits sulfur dioxide content in fuels for marine vessels operating within 200 nautical miles of the US and Canadian coastlines, beginning in 2012."**

<u>Response</u>: Appendix D Case Study REDW includes a discussion of the impacts from off shore shipping. The benefits of the North American Emissions Control Area will begin to be reflected in the data beginning in 2012. Since the 2012 data became available after the Progress Report was prepared, California did not include an extensive analysis of this data. The summary graph below shows that sulfate is being reduced at all coastal sites with a sharp decline in 2012.



6. **Comment: "CARB concludes that CA emissions reductions are sufficient to meet 2018 Reasonable Progress Goals. Please add a table comparing current emissions and current projections through 2020 to the 2018 emission projections that were used to set the Reasonable Progress Goals."**

Response: California is constantly making improvements to its emissions inventory both in methodology and data used to forecast. These updates and refinements are based on the best available information about changes in regulations, population, business, vehicle and travel data, and control technology implementation for the base year of an inventory update. These updates can cause emissions to increase or decrease relative to a previous inventory. Since the modeling that the RPGs were based on looked at changes on a relative basis, comparing inventories on a relative basis is most appropriate. When comparing the RH Plan inventories with the Progress Plan inventories, Progress Plan emissions are being reduced at a greater rate for all pollutants compared to the RH Plan. Based on this comparison, California concluded that the emission reductions are sufficient to meet the 2018 RPGs.

7. **Comment: "CARB asserts [that] CA emissions reductions are sufficient to lessen CA's impact, and specifically CA's contributions to ammonium nitrate, at neighboring Class 1 Areas. WRAP provided the western states with particulate source apportionment analyses using the CAMx regional air quality model for 2002 and 2018 inventories [including Crater Lake National Park in Oregon and Grand Canyon National Park in Arizona.] We suggest that [California] include such example plots to support CARB's demonstration."**

Response: The plots referenced in your comment have not been updated by the WRAP since the RH Plan. As explained in Table 8.1 of the RH Plan, nitrates cause less than 10 percent of light extinction (haze) on Worst Days, on average, at Crater Lake in Oregon and at the Grand Canyon in Arizona. Nitrates are the second strongest extinguishers of light when compared to the other haze pollutants; therefore reducing their formation from NOx emissions is still an important visibility strategy. Due to new control measures, California NOx emissions will continue to decline beyond the levels included in the RH Plan.

Comments and Responses to the Letter from the U.S. Department of Agriculture, Forest Service, dated April 8, 2014

1. **<u>Comment</u>: A review of the US EPA's "Interim Air Quality Policy" and ARB's "Title 17" indicate that natural fires managed-for-resource-benefits (those meeting the objectives defined in Land/Resource Management Plans) to be considered as prescribed burns whereas the "Exceptional Event Rule" consider these as naturally ignited fires. We look forward to addressing this discrepancy with CARB. The FLMs and the California Air Resources Board (CARB) need to continue a dialogue in developing strategies, before the revision of the SIP in 2019, that can lead to less severe wildfires and thus attain the reduction required on targeted "worst days".**

<u>Response</u>: ARB will continue this discussion at a policy level through the regular Air and Land Managers meetings of policy makers from the public land management and air quality agencies in California. The technical issues relating to planned and unplanned burns and air quality will continue to be discussed by the technical staff participating in the regular meetings of California's Interagency Air and Smoke Council. Both of these forums have operated for more than a decade to explore these issues, develop protocols, and advance practicable policies.

United States Department of the Interior

NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225-0287

TRANSMITTED VIA ELECTRONIC MAIL - NO HARDCOPY TO FOLLOW

N3615 (2350)

March 27, 2014

Christine Suarez-Murias
California Air Resources Board
1001 I Street
Sacramento, CA 95812

Dear Ms. Suarez-Murias:

Thank you for the opportunity to review and comment on California's Regional Haze Plan 2014 Progress Report. We agree with California Air Resources Board (CARB)'s conclusion, consistent with the periodic reporting requirements of 40 CFR 51.308(g), that the emissions reductions under California's Regional Haze Plan and other CARB requirements are sufficient for California and neighboring states to meet the 2018 Reasonable Progress Goals set in the State's Regional Haze plan. We also agree that no further revision of the Regional Haze Plan is needed at this time to meet the 2018 goals.

We suggest some additions to the draft Progress Report to better support California's demonstration:

- Section 2.1: Status of Emissions Control Strategies: Please briefly discuss the major federal and state regulations beyond those implemented specifically under CA's Regional Haze Plan that were included in CA's reasonable progress goals, as these earlier requirements, plus those listed in Table 1, appear to account for most of the emissions reductions observed since 2000 in CA.
- Section 2.1: Please clarify if CA's Smoke Management Program meets the enhanced smoke management goals for states submitting plans under 40 CFR 51.309. Are Class I areas identified as sensitive receptors in CA's Smoke Management Plan? Section 1.3 is clear that wildfire is a major uncontrollable source impacting visibility in Class I areas in CA. A discussion of the possible role of prescribed fire in reducing wildfire smoke impacts to visibility is beyond the scope of this progress review, but is a topic for further discussion in developing the regional haze plan due in 2018.
- Section 2.4 Emissions Inventory: CARB presents emissions in tons/day in Table 2 and Figure 3 that indicate decreasing emissions from 2000 to 2020. Please also provide a

summary in tons/year, since the conversion from tons per day to tons per year likely differs for different emission source categories. Please cite or include in Appendix A the Western Regional Partnership (WRAP) Regional Haze Reasonable Progress Summary Report for CA[1]. Annual emissions in Tables 6.3-8 through 6.3-15 in this summary or from the 2011 National Emissions Inventory are more readily compared to those of other western states.

- Section 4 Changes Impeding Visibility Progress: Please add to the discussion of impacts from off shore shipping that the North American Emission Control Area international treaty limits sulfur dioxide content in fuels for marine vessels operating within 200 nautical miles of the US and Canadian coastlines, beginning in 2012. These requirements will result in lower contributions from marine sources to Class I areas in CA.
- Section 5 Current Control Strategy: CARB concludes that CA emissions reductions are sufficient to meet 2018 Reasonable Progress Goals. Please add a table comparing current emissions and current projections through 2020 to the 2018 emission projections that were used to set the Reasonable Progress Goals.
- CARB asserts than CA emissions reductions are sufficient to lessen CA's impact, and specifically CA's contributions to ammonium nitrate, at neighboring Class I areas. WRAP provided the western states with particulate source apportionment analyses using the CAMx regional air quality model for 2002 and 2018 inventories. Example plots for Crater Lake National Park in Oregon and Grand Canyon National Park in Arizona are enclosed. We suggest that you include such example plots to support CARB's demonstration.

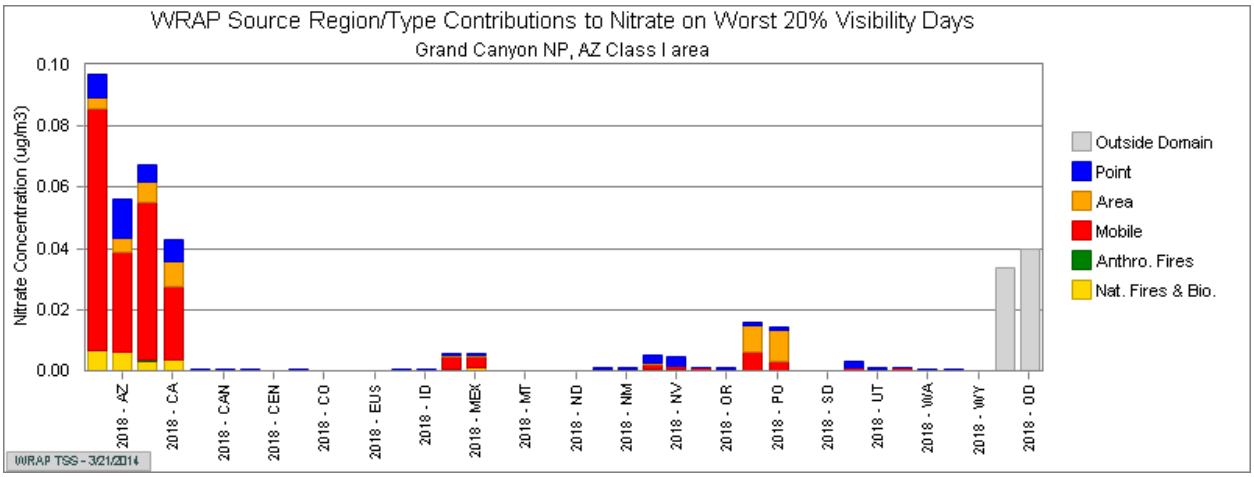
We appreciate the opportunity to work closely with CARB to improve visibility in our Class I national park and wilderness areas. We agree that reducing haze is a regional effort, and we will continue to work with California and other western states to plan for the next Regional Haze State Implementation Plans due in 2018. If you have questions, please call Pat Brewer at (303) 969-2153.

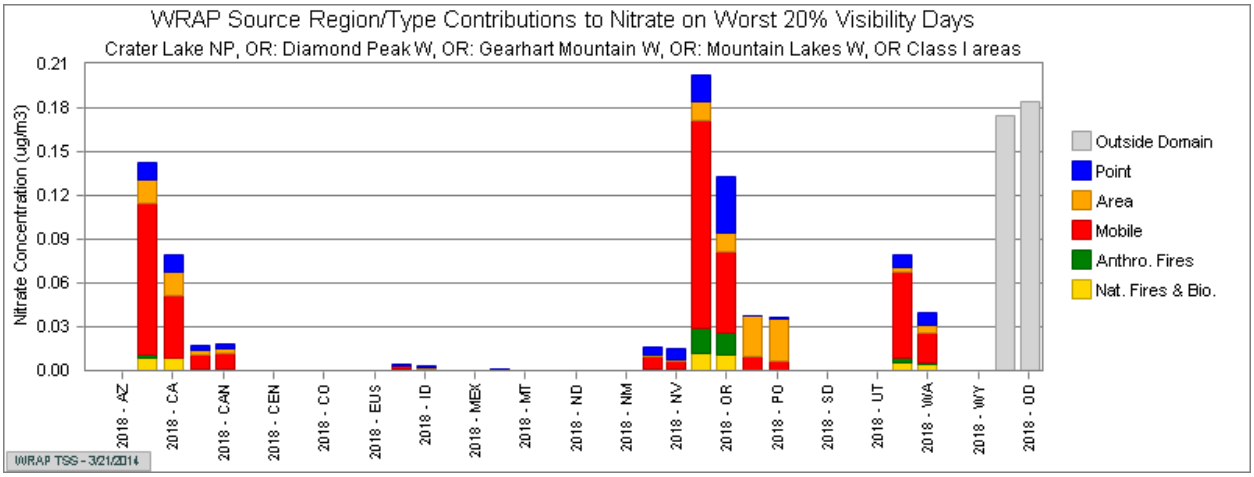
Sincerely,

Pat Brewer for

Susan Johnson
Chief, Policy, Planning, and Permit Review Branch

[1]http://www.wrapair2.org/documents/6.0%20STATE%20AND%20CLASS%20I%20AREA%20SUMMARIES/6.03%20California/WRAP_RHRPR_Sec_6_State_Summaries-California.pdf


WRAP Source Region/Type Contributions to Nitrate on Worst 20% Visibility Days
Grand Canyon NP, AZ Class I area
Nitrate Concentration (ug/m3)
0.10
0.08
0.06
0.04
0.02
0.00
2018 - AZ
2018 - CA
2018 - CAN
2018 - CEN
2018 - CO
2018 - EUS
2018 - ID
2018 - MEX
2018 - MT
2018 - ND
2018 - NM
2018 - NV
2018 - OR
2018 - PO
2018 - SD
2018 - UT
2018 - WA
2018 - WY
2018 - OD
Outside Domain
Point
Area
Mobile
Anthro. Fires
Nat. Fires & Bio.
WRAP TSS - 3/21/2014


WRAP Source Region/Type Contributions to Nitrate on Worst 20% Visibility Days
Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Nitrate Concentration (ug/m3)
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
2018 - AZ
2018 - CA
2018 - CAN
2018 - CEN
2018 - CO
2018 - EUS
2018 - ID
2018 - MEX
2018 - MT
2018 - ND
2018 - NM
2018 - NV
2018 - OR
2018 - PO
2018 - SD
2018 - UT
2018 - WA
2018 - WY
2018 - OD
Outside Domain
Point
Area
Mobile
Anthro. Fires
Nat. Fires & Bio.
WRAP TSS - 3/21/2014

USDA United States Department of Agriculture | Forest Service | Pacific Southwest Region

Regional Office, R5
1323 Club Drive
Vallejo, CA 94592
(707) 562-8737 Voice
(707) 562-9240 Text (TDD)

File Code: 2580
Date: APR 08 2014

Christine M. Suarez-Murias, AICP
Air Pollution Specialist
California Air Resources Board
1001 I Street
Sacramento, CA 95812

Dear Ms. Suarez-Murias:

Thank you for your continued excellent outreach and collaboration in protecting and improving visibility in our Class I Wilderness Areas. On January 29, 2014, we received an invitation to comment on the draft report entitled, *California Regional Haze Plan 2014 Progress Report.* The Regional Haze Rule (RHR) published in 2000 required all states to submit visibility State Implementation Plans (SIP) using 2000-2004 as the base years. SIPs must be revised every 10 years and a progress report submitted every 5 years to demonstrate improvement. California has 29 Class I areas with 20 of them being managed by the Forest Service. This is the first progress report that will be submitted to the EPA after Federal Land Manager (FLM) review and subsequent public review.

The Air Resources Board (ARB) adopted the California Regional Haze Plan (RH Plan) in January, 2009, and transmitted it to the U.S. EPA in March of 2009. The U.S. EPA approved the RH Plan in June of 2011. The RH Plan included California's strategy for reaching the first Reasonable Progress Goals (RPGs) in 2018. The 2018 RPGs are visibility improvement benchmarks on a path to the long term goal of natural background conditions by 2064. The 2018 RPGs were developed by the ARB for each Class 1 area in California, in consultation with other affected states and the FLMs.

The data presented in table 3 shows the statewide 2018 RPG Summary and indicates all 29 of the Class I areas are showing improvement on the "best days" as required under the RHR. At 9 sites the current conditions already meet the 2018 RPGs. Three Class I Areas, Lassen Volcanic, Desolation and Redwood show the least progress and the analysis indicates smoke from wildfire as the principle reason. The years with most wildfire occurrence show the least progress in the category of "worst visibility days".

California has determined that the RHR control strategies are sufficient for meeting the 2018 RPGs goals. Three factors, wildfires, Asian dust storms and marine shipping emissions have slowed progress of the worst visibility days at a few sites but are considered natural and/or outside the control of the state.

Our goal for the Pacific Southwest Region is to retain and restore ecological resilience of the National Forest lands to achieve sustainable ecosystems that provide a broad range of services to humans and other organisms. Ecologically healthy and resilient landscapes, rich in biodiversity, will have greater capacity to adapt and thrive in the face of natural disturbances and large scale threats to sustainability, especially under changing and uncertain future environmental conditions such as those driven by climate change and increasing human use.

California's Smoke Management Program (SMP) has resulted in reduced incidences of prescribed burns impacting public health, but it should be recognized that it does impede the pace and scale of restoration that can reduce the negative impacts of wildfire on reaching the 2064 natural background targets in some areas. Indicators suggest that disturbance impacts already outpace the benefits of restoration work. A review of the US EPA's "Interim Air Quality Policy" and ARB's "Title 17" indicate that natural fires managed-for-resource-benefits (those meeting the objectives defined in Land/Resource Management Plans) to be considered as prescribed burns whereas the "Exceptional Event Rule" consider these as naturally ignited fires. We look forward to addressing this discrepancy with CARB. The FLMs and the California Air Resources Board (CARB) need to continue a dialogue in developing strategies, before the revision of the SIP in 2019, that can lead to less severe wildfires and thus attain the reduction required on targeted "worst days".

Based on the data shown and the progress reported, we feel CARB has successfully demonstrated a technically sound path for improving visibility in Class I areas. We have determined that this Interim report satisfies the Regional Haze requirement and does not require further analysis. However, if the state further modifies the SIP or applies additional strategies we will request an analysis of the visibility impacts.

Thanks for the opportunity to be involved in the review process. We value our good working relationship with CARB and look forward to continued collaboration. If you have any questions, please contact Trent Procter at 559-783-3308 / tprocter@fs.fed.us or Dr. Suraj Ahuja at 916-616-3881 / sahuja@fs.fed.us/.

Sincerely,

Jeanne Wade Evans

for RANDY MOORE
Regional Forester

cc: Suraj Ahuja, Phil Bowden, Trent Procter

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