

APPENDIX C

COSTS AND BENEFITS OF ACHIEVING THE CURRENT PM₁₀ AND OZONE STANDARDS

1.0 CURRENT PM₁₀ STANDARD RESULTS IN BRIEF

Based on projected emission levels for the year 2010, this analysis estimates that 45 counties need additional reductions beyond those currently mandated in the Clean Air Act (CAA) and partial attainment of the current ozone national ambient air quality standard (NAAQS) to meet the current particulate matter (PM₁₀) NAAQS. The control cost associated with achieving partial attainment in 31 of these counties and full attainment in 14 counties is estimated to be \$1.1 billion (1990 dollars). The estimated national annual monetized benefits associated with partial attainment of the current standard is approximately \$5.3 billion to \$5.4 billion.

2.0 CURRENT OZONE STANDARD RESULTS IN BRIEF

Based on projected emissions levels for the year 2010, this analysis estimates that 9 nonattainment areas (82 counties) are projected to need additional reductions beyond those currently mandated in the CAA to meet the current ozone NAAQS. The control cost associated with achieving partial attainment in 8 nonattainment areas (69 counties) and full attainment in 1 nonattainment area (13 counties) is estimated to be \$0.6 billion (1990 dollars). The estimated national annual monetized benefits associated with partial attainment of the current standard is approximately \$1.2 billion to \$1.6 billion.

3.0 INTRODUCTION

The 2010 CAA baseline discussed in Chapter 4 contains all control measures mandated by the CAA to meet the current PM₁₀ and ozone standards. Also included in this baseline is a NO_x cap-and-trade program for utilities and large industrial boilers located in the 37-States of the Ozone Transport Assessment Group (OTAG) that is being adopted to facilitate attainment of the current ozone standard. Starting from this baseline, this analysis projects that several areas do not attain the current PM₁₀ and ozone standards. Therefore, in this analysis, additional control measures are selected for specific areas with the goal of attaining the current standards in the

analysis year 2010.

This appendix presents the incremental emission reduction, air quality, and cost impacts associated with control measures selected to meet the current PM₁₀ and ozone standards, as well as the benefits associated with the estimated air quality improvements. The following sections in this chapter cover:

- Emissions, air quality, and cost impacts for the current PM₁₀ standard only;
- Emissions, air quality, and cost impacts for the current ozone standard;
- Emission reduction, air quality improvement, and control cost results for the current PM₁₀ standard;
- Benefits of attaining the current PM₁₀ standard;
- Benefits of attaining the current ozone standard; and
- Analytical uncertainties, limitations, and potential biases.

4.0 ANALYSES OF THE CURRENT PM₁₀ STANDARD

This section presents the benefits and emission, air quality, and cost impacts associated with control measures selected to meet the current PM₁₀ standard incremental to the 2010 CAA baseline and partial attainment of the current ozone standard. The partial attainment analysis of the current ozone standard is presented in Section 5.0 of this appendix.

4.1 CURRENT PM₁₀ STANDARD EMISSIONS, AIR QUALITY, AND COST ANALYSIS RESULTS

The methodology used to select control measures for the current PM₁₀ standard differs from the methodology presented in Chapter 6 for selecting PM_{2.5}-related control measures. After PM₁₀ nonattainment counties are identified, control measures are selected to reduce PM₁₀ concentrations from the set of source category-control measure combinations in the violating county only. This model for control measure selection is believed to be consistent with current

PM₁₀ implementation practices which focus on local sources of PM₁₀ emissions. Control measures with a cost per microgram per cubic meter reduced of more than \$1 billion are not included in this analysis. A sensitivity analysis on this threshold level is conducted and presented in Appendix D. Thresholds of \$500 million and \$2 billion are examined.

The estimated number of initial and residual PM₁₀ nonattainment counties for the \$1 billion per microgram per cubic meter reduced threshold is presented in Table C.1, along with the estimated annual control cost associated with the control measures that are selected. The control measures selected are estimated to reduce the number of initial nonattainment counties by 14 at an annual cost of \$1,100 million.

Table C.1 Estimated Number of Initial and Residual Nonattainment Counties and Incremental Annual Cost for the Current PM₁₀ Standard

Control Region	Number of Counties Violating the Current PM ₁₀ Standard		Annual Cost of Partial Attainment (\$million/yr)
	Initial	Residual	
Midwest/Northeast	6	5	380
Southeast	1	0	2
South Central	4	2	230
Rocky Mountain	12	9	210
Northwest	7	4	140
West	15	11	130
Nation	45	31	1,100

Table C.2 presents the average baseline and post-control PM₁₀ concentrations by control region for the 45 initial and 31 residual nonattainment counties. The regional average annual

values for the residual nonattainment areas indicate that projected residual nonattainment is driven by 24-hour rather than annual violations (i.e., all the average annual average concentration values are less than 50 $\mu\text{g}/\text{m}^3$).

4.2 CURRENT PM₁₀ STANDARD BENEFITS ANALYSIS

The methodology (e.g., post-control air quality estimation, concentration-response functions, economic valuation) used to estimate national benefits associated with partial and full attainment of the current PM₁₀ standard is identical to the methodology presented in Chapter 12 for estimating benefits associated with the PM_{2.5} NAAQS alternatives. Partial and full attainment benefits for the current PM₁₀ standard are estimated incremental to partial and full attainment, respectively, of the current ozone standard.

Table C.3 presents national annual health and welfare benefits attributable to partial attainment of the current PM₁₀ standard. Partial attainment PM benefits are estimated as approximately \$5.3 billion to \$5.4 billion annually. The portion of the population in the year 2010 expected to live in the nonattainment counties is approximately 24.0 million. Not presented in Table C.7 are full attainment PM₁₀ benefits. Estimation of full attainment benefits is more uncertain than partial attainment estimation because the sources from which additional emissions will be reduced are unknown. An explanation of this limitation is presented in Section 12.9 of Chapter 12. Despite the limitation, full attainment estimates are presented here for completeness purposes. National annual monetized benefits associated with full attainment of the current PM₁₀ standard are estimated at approximately \$12.4 billion to \$13.8 billion, annually. Both partial and full attainment benefits estimates are likely to be underestimated due to the inability to quantify all benefits categories. See Section 12.10 in Chapter 12 for a discussion of the benefits analysis limitations.

Table C.2 Average Initial and Post-Control PM₁₀ Concentrations for Projected Initial and Residual Nonattainment Counties for the Current PM₁₀ Standard^a

Control Region	Initial Nonattainment Counties				Residual Nonattainment Counties			
	Initial		Post-Control		Initial		Post-Control	
	Annual	24 Hour	Annual	24 Hour	Annual	24 Hour	Annual	24Hour
Midwest/Northeast	39.6	252.5	35.6	216.9	41.2	272.0	36.6	229.5
Southeast	42.8	157.1	41.2	151.3	--	--	--	--
South Central	39.2	168.8	35.9	153.7	41.2	177.0	36.9	157.0
Rocky Mountain	30.8	196.4	28.9	183.3	27.4	206.3	26.2	194.5
Northwest	33.6	192.4	31.5	183.5	34.0	219.2	32.2	207.5
West	44.1	236.5	42.6	229.7	45.8	260.6	45.2	257.3
Nation	37.9	213.7	35.7	200.0	37.9	235.9	36.1	221.7

a Initial nonattainment incremental to 2010 CAA baseline and partial attainment of the current ozone standard.

TABLE C.3 PM₁₀: National Annual Health and Welfare Benefits Estimates^a
 Estimates are incremental to partial attainment of the current ozone NAAQS
 (year = 2010)

ENDPOINT ^b	Partial Attainment Scenario	
	Incidences Reduced	Monetized Benefits (billions of 1990\$)
*1. Mortality^c: short-term exposure	620	\$2.950
	600	\$2.860
long-term exposure		
*2. Chronic Bronchitis	7,710	\$2.010
Hospital Admissions:		
*3. all respiratory (all ages)	330	\$0.004
all resp. (ages 65+)	780	\$0.010
pneumonia (ages 65+)	280	\$0.004
COPD (ages 65+)	240	\$0.004
*4. congestive heart failure	210	\$0.003
*5. ischemic heart disease	230	\$0.005
*6. Acute Bronchitis	1,720	\$0
*7. Lower Respiratory Symptoms (# of days)	17,840	\$0
*8. Upper Respiratory Symptoms (# of cases)	6,300	\$0
shortness of breath	15,050	\$0
asthma attacks	17,010	\$0.001
*9. Work Loss Days	179,490	\$0.015
*10. Minor Restricted Activity Days (MRADs)	1,490,350	\$0.057
*11. Consumer Cleaning Cost Savings	N/A	\$0.039
*12. Visibility	N/A	\$0.320
TOTAL HEALTH BENEFITS		
using short-term mortality		\$5.4
using long-term mortality		\$5.3

N/A = not applicable

^a Totals may not completely agree due to rounding

^b Only endpoints denoted with an * are aggregated into total benefits estimates

^c Mortality estimates must be aggregated using either short-term exposure or long-term exposure but not both due to double-counting issues

5.0 ANALYSES OF THE CURRENT OZONE STANDARD

This section presents the benefits, and emission and cost impacts associated with control measures selected to meet the current ozone standard incremental to the 2010 CAA baseline.

5.1 OZONE EMISSIONS AND COST ANALYSIS

The methodology used to select control measures for the current ozone standard is nearly identical to the methodology presented in Chapter 7 for selecting control measures for the alternative 8-hour standards. The chief difference is that a National Ozone Strategy is not applied for the current ozone standard prior to local control measure selection. After ozone nonattainment areas are identified and emission reduction targets are established, VOC and/or NO_x control measures are selected from the set of control measure-source combinations from inside nonattainment boundaries. Control measures with an average annual incremental cost per ton of more than \$10,000 are not included in this analysis. A sensitivity analysis on this threshold level is conducted and presented in this chapter. Thresholds of \$7,000, \$20,000, and no cut-off are examined.

Table C.4 presents the cost results for partial attainment of the current ozone standard under alternative dollar per ton control measure selection thresholds. Total annual control costs increase as the dollar per ton threshold is gradually lifted.

Table C.5 presents the VOC and NO_x reductions achieved as a percent of reductions needed under alternative dollar per ton control measure selection thresholds. The percent of VOC reductions achieved ranges from 30 to 38 percent, and the percent of NO_x reductions achieved ranges from 52 to 62 percent.

Table C.4 Estimated Annual Control Cost for the Current Ozone Standard Under Alternative Dollar Per Ton Control Measure Selection Thresholds

\$/Ton Control Measure Selection Threshold^a	Annual Cost (\$million/year)
\$7,000	300
\$10,000	610
\$20,000	820
No Cut-Off	1,100

a The \$10,000 per ton control measure selection threshold is considered in the main analysis; all other thresholds are sensitivity analyses.

Table C.5 National Summary of Local VOC and NO_x Emission Reductions Achieved as Percent of Reductions Needed for the Current Ozone Standard Under Alternative Dollar Per Ton Control Measure Selection Thresholds^a

\$/Ton Control Measure Selection Threshold^b	2010 CAA Baseline Emissions (tons per day)		Target Reductions (tons per day)		Reductions Achieved Relative to Targets (tons per day)		Percent Achieved Relative to Targets	
	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
\$7,000	5,368	2,199	1,723	515	509	266	30%	52%
\$10,000	5,368	2,199	1,723	515	610	285	35%	55%
\$20,000	5,368	2,199	1,723	515	643	302	37%	59%
No Cut-Off	5,368	2,199	1,723	515	657	320	38%	62%

a Emission reduction targets and achieved reductions are incremental to the 2010 CAA Baseline. Reductions in pollutants not targeted in each area are not included in this table.

b The \$10,000 per ton control measure selection threshold is considered in the main analysis; all other thresholds are sensitivity analyses.

5.2 OZONE BENEFITS ANALYSIS

The methodology (e.g., post-control air quality estimation, concentration-response functions, economic valuation) used to estimate national benefits associated with partial and full attainment of the current ozone standard is identical to the methodology presented in Chapter 12 for estimating benefits associated with the ozone NAAQS alternatives. Partial and full attainment benefits for the current ozone standard are estimated incremental from the 2010 baseline.

Table C.6 through and C.8 present national annual health and welfare benefits attributable to partial attainment of the current ozone standard. Partial attainment ozone benefits are estimated as approximately \$1.2 to \$1.6 billion, annually. The portion of the population in the year 2010 expected to live in the identified nonattainment areas is approximately 51.4 million. Not presented in Tables C.6 through C.8 are full attainment benefits associated with the current ozone NAAQS. Full attainment ozone benefits estimation is limited for the same reason as the PM full attainment analysis. Given this limitation, ancillary PM benefits are proportionally scaled to ozone benefits. See Section 12.9 for a discussion of this limitation and the proportional scaling procedure. Despite the limitation, full attainment estimates are presented here for completeness purposes. National annual monetized benefits associated with full attainment of the current ozone NAAQS are estimated as approximately \$3.5 billion to \$4.8 billion, annually. Both partial and full attainment benefits estimates are likely to be underestimated due to the inability to quantify all benefits categories. See Section 12.10 in Chapter 12 for a discussion of the benefits analysis limitations.

TABLE C.6 Ozone : National Annual Health Benefits Estimates^a
 Estimates are incremental to the 2010 CAA Baseline
 (year = 2010)

ENDPOINT ^b	Partial Attainment Scenario	
	Incidences Reduced	Monetized Benefits (billions of 1990 \$)
Ozone Health: *1. Mortality	120	\$0.570
Hospital Admissions *2. all respiratory (all ages)	520	\$0.007
all resp. (ages 65+)	1,620	\$0
pneumonia (ages 65+)	620	\$0.010
COPD (ages 65+)	200	\$0.003
emer. dept. visits for asthma	230	\$0.002
*3. Acute Respiratory Symptoms (any of 19)	52,360	\$0.001
asthma attacks	110	\$0
MRADs	1,140	\$0
*4. Mortality from air toxics	1	\$0.003
Ancillary PM Health: *1. Mortality^c: short-term exp.	50	\$0.240
long-term exposure	150	\$0.700
*2. Chronic Bronchitis	340	\$0.090
Hospital Admissions: *3. all respiratory (all ages)	60	\$0.001
all resp. (ages 65+)	40	\$0
pneumonia (ages 65+)	10	\$0
COPD (ages 65+)	10	\$0
*4. congestive heart failure	10	\$0
*5. ischemic heart disease	10	\$0
*6. Acute Bronchitis	300	\$0
*7. Lower Respiratory Symptoms	3,110	\$0
*8. Upper Respiratory Symptoms	280	\$0
shortness of breath	560	\$0
asthma attacks	3,320	\$0
*9. Work Loss Days	33,140	\$0.003
*10. Minor Restricted Activity Days (MRADs)	276,160	\$0.011
TOTAL MONETIZED HEALTH BENEFITS	N/A	\$0.920
using short-term PM mortality	N/A	\$1.380
using long-term PM mortality		

N/E = not estimated

N/A = not applicable

^a Totals may not completely agree due to rounding

^b Only endpoints denoted with an * are aggregated into total benefits estimates

^c Mortality estimates must be aggregated using either short-term exposure or long-term exposure but not both due to double-counting issues

TABLE C.7 Ozone : National Annual Welfare Benefits Estimates^a

Estimates are incremental to the 2010 CAA Baseline
(millions of 1990\$; year = 2010)

Category	Partial Attainment Scenario: Monetized Benefits
Commodity Crops	\$38
Fruits and Vegetables	\$147
Commercial Forests	\$4
Worker Productivity	\$14
Consumer Cleaning Cost Savings	\$2
Visibility	\$29
TOTAL MONETIZED WELFARE BENEFITS	\$234

TABLE C.8 Ozone : Total National Benefits Estimates^a

Estimates are incremental to the 2010 CAA Baseline
(billions of 1990\$; year = 2010)

Category	Partial Attainment Scenario: Monetized Benefits
Health Benefits	\$0.92 - \$1.4
Welfare Benefits	\$0.23
TOTAL MONETIZED BENEFITS	\$1.2 - \$1.6

6.0 ANALYTICAL UNCERTAINTIES, LIMITATIONS, AND POTENTIAL BIASES

Generally, the same uncertainties, limitations, and potential biases cited in Sections 6.7, 7.6, and 12.10 apply to the analyses and results presented in this chapter.

^a Totals may not completely agree due to rounding