Summary of the updated Regulatory Impact Analysis (RIA) for the Reconsideration of the 2008 Ozone National Ambient Air Quality Standard (NAAQS)

On September 16, 2009, EPA committed to reconsidering the ozone NAAQS standard promulgated in March 2008. The ozone NAAQS will be selected from the proposed range of 0.060 to 0.070 ppm, based on this reconsideration of the evidence available at the time the last standard was set. Today's proposed rule also includes a separate secondary NAAQS, for which this RIA provides only qualitative analysis due to the limited nature of available EPA guidance for attaining this standard

This supplement to the RIA contains an updated illustrative analysis of the potential costs and human health and welfare benefits of nationally attaining a new primary ozone standard. The basis for this updated economic analysis is the RIA published in March 2008 with a few significant changes. These changes reflect the more stringent range of options being proposed by the Administrator. It also reflects some significant methodological improvements to air pollution benefits estimation, which EPA has adopted since the ozone standard was last promulgated. These significant changes include the following:

- In March 2008, the Administrator lowered the primary ozone NAAQS from 0.084 ppm to 0.075 ppm. The RIA which accompanied that rule analyzed a less stringent alternative standard of 0.079 ppm, and two more stringent standards of 0.065 and 0.070 ppm. This RIA supplement presents an analysis of three alternative standards within the proposed range: 0.060, 0.065 and 0.070 ppm. Because today's proposed rule is a reconsideration, each alternative standard is compared against the prior standard of 0.084 ppm. Per Executive Order 12866 and the guidelines of OMB Circular A-4, this Regulatory Impact Analysis (RIA) also presents analyses of two alternative standards, 0.075 ppm and 0.055 ppm. It is important to note that as the stringency of the standards increases, we believe that the uncertainty in the estimates of the costs and benefits also increases. This is explained in more detail in sections 2 and 3 of this supplement.

- We have adopted several key methodological updates to benefits assessment since the 2008 Ozone NAAQS RIA. These updates have already been incorporated into previous RIAs for the proposed Portland cement NESHAP, proposed NO_2 NAAQS, and Category 3 Marine Diesel Engine Rule, and are therefore now incorporated in this analysis. Significant updates include:

    - We removed the assumption of no causality for ozone mortality, as recommended by the National Academy of Science (NAS).

- We included two more ozone multi-city studies, per NAS recommendation.
- We revised the Value of a Statistical Life (VSL) to be consistent with the value used in current EPA analyses.
- We removed thresholds from the concentration-response functions for $PM_{2.5}$, consistent with EPA's Integrated Science Assessment for Particulate Matter.

Structure of this Updated RIA

As part of the ozone NAAQS reconsideration, this RIA supplement takes as its foundation the 2008 ozone NAAQS RIA. Detailed explanation of the majority of assumptions and methods are contained within that document and should be relied upon, except as noted in this summary.

This supplement itself consists of four parts:

- Section 1 provides an overview of the changes to the analysis and summary tables of the illustrative cost and benefits of obtaining a revised standard and several alternatives.
- Section 2 contains a supplemental benefit and cost analysis for standard alternatives at 0.055 and 0.060 ppm.
- Section 3 contains a supplemental benefits analysis outlining the adopted changes in the methodology, updated results for standard alternatives 0.065, 0.070 and 0.075 ppm using the revised methodology and assumptions.
- Section 4 contains supplemental evaluation of a separate secondary ozone NAAQS in the range of 7 to 15 ppm-hr, as well as a less stringent of 21 ppm-hr. This supplemental provides an explanation of the extreme difficulty of quantifying the costs and benefits of a secondary standard at this time.

S1.1 Results of Benefit-Cost Analysis

This updated RIA consists of multiple analyses, including an assessment of the nature and sources of ambient ozone; estimates of current and future emissions of relevant ozone precursors; air quality analyses of baseline and alternative control strategies; illustrative control strategies to attain the standard alternatives in future years; estimates of the incremental costs and benefits of attaining the alternative standards, together with an examination of key uncertainties and limitations; and a series of conclusions and insights gained from the analysis. It is important to recall that this RIA rests on the analysis done in 2008; no new air quality modeling or other assessments were completed except those outlined above.

The supplement includes a presentation of the benefits and costs of attaining various alternative ozone National Ambient Air Quality Standards in the year 2020. These estimates only include areas assumed to meet the current standard by 2020. They do not include the costs or benefits of attaining the alternate standards in the San Joaquin Valley and South Coast air basins in California, because we expect that nonattainment designations under the Clean Air Act for these areas would place them in categories afforded extra time beyond 2020 to attain the ozone NAAQS.

In Table S1.1below, the individual row estimates reflect the different studies available to describe the relationship of ozone exposure to premature mortality. These monetized benefits include reduced health effects from reduced exposure to ozone, reduced health effects from reduced exposure to $PM_{2.5}$, and improvements in visibility. The ranges within each row reflect two PM mortality studies (i.e. Pope and Laden).

Ranges in the total costs column reflect different assumptions about the extrapolation of costs as discussed in Chapter 5 of the 2008 Ozone NAAQS RIA. The low end of the range of net benefits is constructed by subtracting the highest cost from the lowest benefit, while the high end of the range is constructed by subtracting the lowest cost from the highest benefit. The presentation of the net benefit estimates represents the widest possible range from this analysis.

Table S1.2 presents the estimate of total ozone and $PM_{2.5}$-related premature mortalities and morbidities avoided nationwide in 2020 as a result of this regulation.

Table S1. 1: Total Monetized Costs with Ozone Benefits and $PM_{2.5}$ Co-Benefits in 2020 (in Billions of 2006$)*

	Ozone Mortality Function	Reference	Total Benefits **		Total Costs ***	Net Benefits	
			3%	7%	7%	3%	7%
0.075 ppm	Multi-city	Bell et al. 2004	$6.9 to $15	$6.4 to $13	$7.6 to $8.8	$-1.9 to $7.4	$-2.4 to $5.4
		Schwartz 2005	$7.2 to $16	$6.8 to $13	$7.6 to $8.8	$-1.6 to $8.4	$-2.1 to $5.4
		Huang 2005	$7.3 to $16	$6.9 to $13	$7.6 to $8.8	$-1.5 to $8.4	$-2.0 to $5.4
	Meta-analysis	Bell et al. 2005	$8.3 to $17	$7.9 to $14	$7.6 to $8.8	$-0.50 to $9.4	$-1.0 to $6.4
		Ito et al. 2005	$9.1 to $18	$8.7 to $15	$7.6 to $8.8	$0.30 to $10	$-0.20 to $7.4
		Levy et al. 2005	$9.2 to $18	$8.8 to $15	$7.6 to $8.8	$0.40 to $10	$-0.10 to $7.4
0.070 ppm	Multi-city	Bell et al. 2004	$13 to $29	$11 to $24	$19 to $25	$-12 to $10	$-14 to $5.0
		Schwartz 2005	$15 to $30	$12 to $25	$19 to $25	$-10 to $11	$-13 to $6.0
		Huang 2005	$15 to $30	$13 to $26	$19 to $25	$-10 to $11	$-12 to $7.0
	Meta-analysis	Bell et al. 2005	$18 to $34	$16 to $29	$19 to $25	$-7.0 to $15	$-9.0 to $10
		Ito et al. 2005	$21 to $37	$18 to $31	$19 to $25	$-4.0 to $18	$-6.0 to $12
		Levy et al. 2005	$21 to $37	$18 to $31	$19 to $25	$-4.0 to $18	$-6.0 to $12
0.065 ppm	Multi-city	Bell et al. 2004	$22 to $47	$19 to $40	$32 to $44	$-22 to $15	$-25 to $7.0
		Schwartz 2005	$24 to $49	$21 to $42	$32 to $44	$-20 to $17	$-23 to $9.0
		Huang 2005	$25 to $50	$22 to $42	$32 to $44	$-19 to $18	$-23 to $10
	Meta-analysis	Bell et al. 2005	$31 to $56	$27 to $48	$32 to $44	$-13 to $24	$-17 to $16
		Ito et al. 2005	$36 to $61	$32 to $53	$32 to $44	$-8.0 to $29	$-13 to $20
		Levy et al. 2005	$36 to $61	$32 to $53	$32 to $44	$-7.0 to $29	$-12 to $20
0.060 ppm	Multi-city	Bell et al. 2004	$35 to $73	$30 to $61	$52 to $90	$-55 to $21	$-60 to $9.0
		Schwartz 2005	$39 to $78	$34 to $66	$52 to $90	$-51 to $26	$-56 to $14
		Huang 2005	$41 to $78	$35 to $66	$52 to $90	$-49 to $26	$-55 to $14
	Meta-analysis	Bell et al. 2005	$53 to $91	$46 to $78	$52 to $90	$-37 to $39	$-44 to $26
		Ito et al. 2005	$63 to $100	$55 to $87	$52 to $90	$-27 to $48	$-35 to $35
		Levy et al. 2005	$63 to $100	$56 to $87	$52 to $90	$-27 to $48	$-34 to $35
0.055 ppm	Multi-city	Bell et al. 2004	$53 to $110	$45 to $90	$78 to $130	$-77 to $32	$-85 to $12
		Schwartz 2005	$61 to $120	$52 to $100	$78 to $130	$-69 to $42	$-78 to $22
		Huang 2005	$63 to $120	$54 to $100	$78 to $130	$-67 to $42	$-76 to $22
	Meta-analysis	Bell et al. 2005	$84 to $140	$74 to $120	$78 to $130	$-46 to $62	$-56 to $42
		Ito et al. 2005	$100 to $160	$90 to $140	$78 to $130	$-30 to 82	$-40 to $62
		Levy et al. 2005	$100 to $160	$91 to $140	$78 to $130	$-30 to $82	$-39 to $62

*All estimates rounded to two significant figures. As such, they may not sum across columns. Only includes areas required to meet the current standard by 2020, does not include San Joaquin and South Coast areas in California.
**Includes ozone benefits, and $PM_{2.5}$ co-benefits. Range was developed by adding the estimate from the ozone premature mortality function to estimates from the $PM_{2.5}$ premature mortality functions from Pope et al. and Laden et al. Tables exclude unquantified and nonmonetized benefits.
***Range reflects lower and upper bound cost estimates. Data for calculating costs at a 3% discount rate was not available for all sectors, and therefore total annualized costs at 3% are not presented here. Additionally, these estimates assume a particular trajectory of aggressive technological change. An alternative storyline might hypothesize a much less optimistic technological trajectory, with increased costs, or with decreased benefits in 2020 due to a later attainment date.

Table S1.2: Summary of Total Number of Annual Ozone and $PM_{2.5}$-Related Premature Mortalities and Premature Morbidity Avoided: 2020 National Benefits [A]

Combined Estimate of Mortality		0.075 ppm	0.070 ppm	0.065 ppm	0.060 ppm	0.055 ppm
NMMAPS	Bell et al. (2004)	760 to 1,900	1,500 to 3,500	2,500 to 5,600	4,000 to 8,700	5,900 to 13,000
	Schwartz	800 to 1,900	1,600 to 3,600	2,700 to 5,800	4,500 to 9,200	6,700 to 13,000
	Huang	820 to 1,900	1,600 to 3,600	2,800 to 5,900	4,600 to 9,300	6,900 to 14,000
Meta-analysis	Bell et al. (2005)	930 to 2,000	2,000 to 4,000	3,500 to 6,600	6,000 to 11,000	9,400 to 16,000
	Ito et al.	1,000 to 2,100	2,300 to 4,300	4,000 to 7,100	7,100 to 12,000	11,000 to 18,000
	Levy et al.	1,000 to 2,100	2,300 to 4,300	4,100 to 7,200	7,100 to 12,000	12,000 to 18,000
Combined Estimate of Morbidity		**0.075 ppm**	**0.070 ppm**	**0.065 ppm**	**0.060 ppm**	**0.055 ppm**
Acute Myocardial Infarction [B]		1,300	2,200	3,500	5,300	7,500
Upper Respiratory Symptoms [B]		9,900	19,000	31,000	48,000	69,000
Lower Respiratory Symptoms [B]		13,000	25,000	41,000	63,000	91,000
Chronic Bronchitis [B]		470	880	1,400	2,200	3,200
Acute Bronchitis [B]		1,100	2,100	3,400	5,300	7,600
Asthma Exacerbation [B]		12,000	23,000	38,000	58,000	83,000
Work Loss Days [B]		88,000	170,000	270,000	420,000	600,000
School Loss Days [C]		190,000	600,000	1,100,000	2,100,000	3,700,000
Hospital and ER Visits		2,600	6,700	11,000	21,000	35,000
Minor Restricted Activity Days		1,000,000	2,600,000	4,500,000	8,100,000	13,000,000

[A] Only includes areas required to meet the current standard by 2020, does not include San Joaquin Valley and South Coast air basins in California. Includes ozone benefits, and $PM_{2.5}$ co-benefits. Range was developed by adding the estimate from the ozone premature mortality function to both the lower and upper ends of the range of the $PM_{2.5}$ premature mortality functions characterized in the expert elicitation described in Chapter 6 of the 2008 RIA.
[B] Estimated reduction in premature mortality due to $PM_{2.5}$ reductions only.
[C] Estimated reduction in premature mortality due to ozone reductions only.

The following set of graphs is included to provide the reader with a richer presentation of the range of costs and benefits of the alternative standards. The graphs supplement the tables by displaying all possible combinations of net benefits, utilizing the six different ozone functions, the fourteen different PM functions, and the two cost methods. Each of the 168 bars in each graph represents a separate point estimate of net benefits under a certain combination of cost and benefit estimation methods. Because it is not a distribution, it is not possible to infer the likelihood of any single net benefit estimate. The blue bars indicate combinations where the net benefits are negative, whereas the green bars indicate combinations where net benefits are positive. Figures S1.1 through S1.5 shows all of these combinations for all standards analyzed. Figure S1.6 shows the comparison of total monetized benefits with costs using the two benefits anchor points based on Pope/Bell 2004 and Laden/Levy.

Figure S1.1:

Net Benefits for an Alternate Standard of 0.075 ppm (7% discount rate)

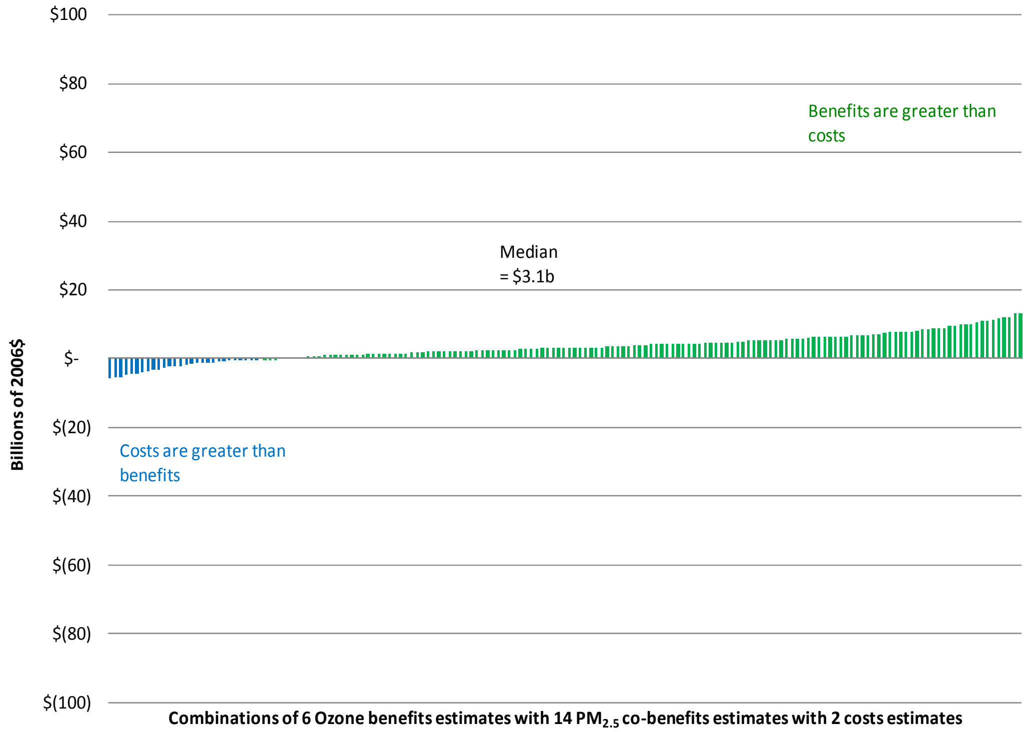
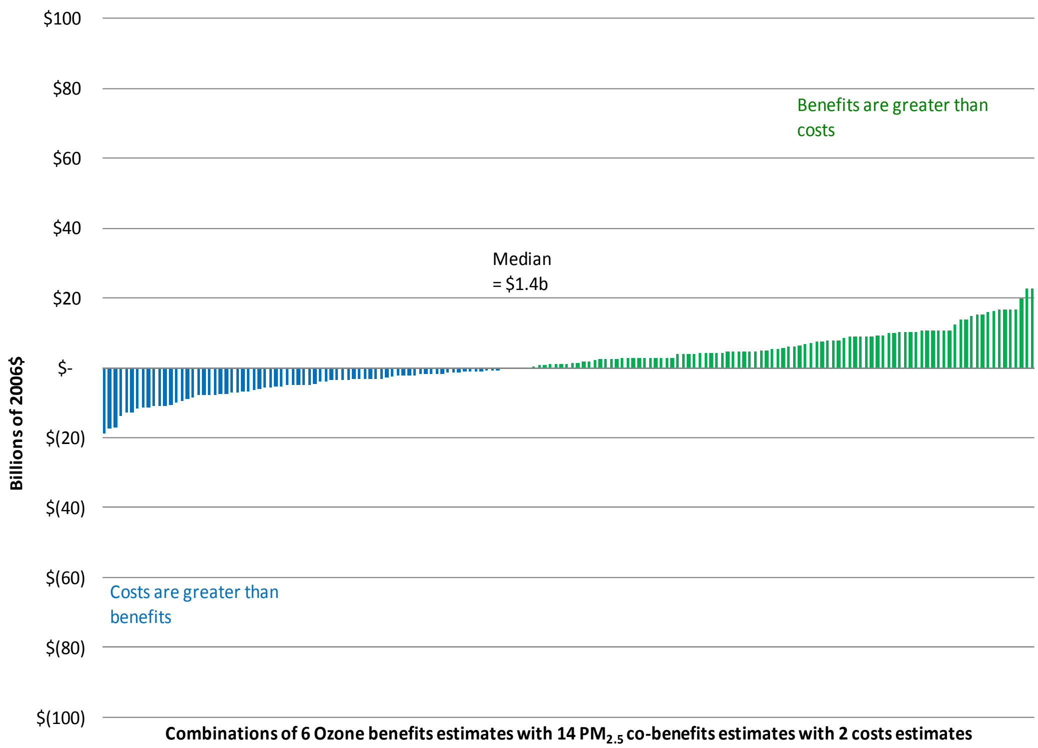


Figure S1.2:

Net Benefits for an Alternate Standard of 0.070 ppm (7% discount rate)



These graphs show all 168 combinations of the 6 different ozone mortality functions and assumptions, the 14 different PM mortality functions, and the 2 cost methods. These combinations do not represent a distribution.

Figure S1.3:

Net Benefits for an Alternate Standard of 0.065 ppm (7% discount rate)

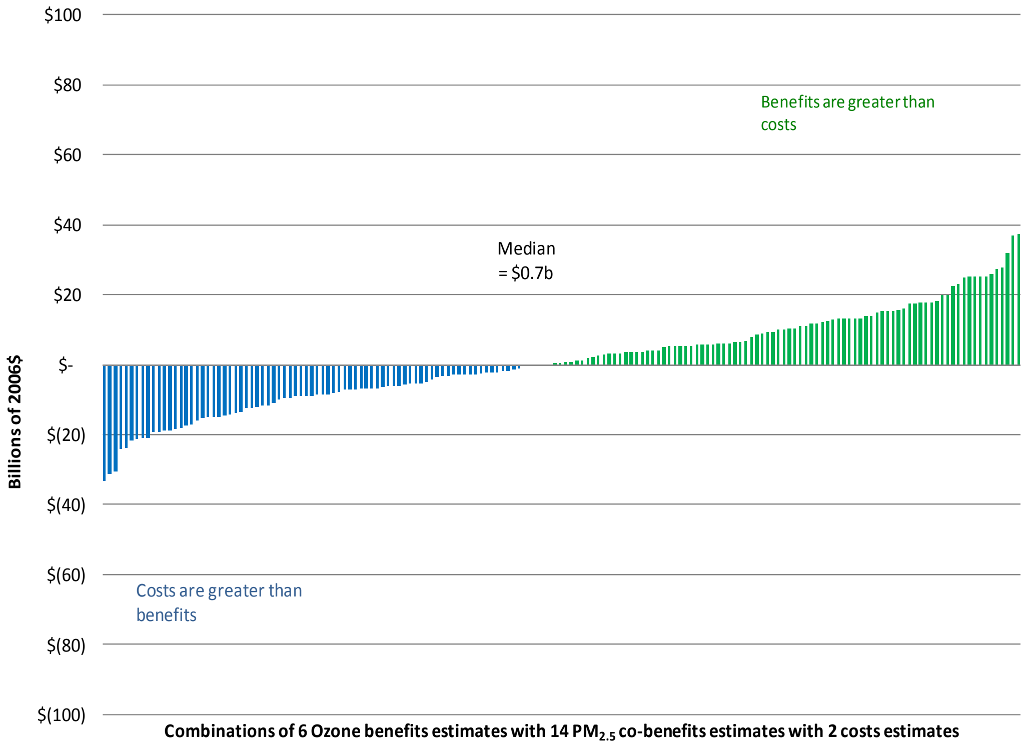
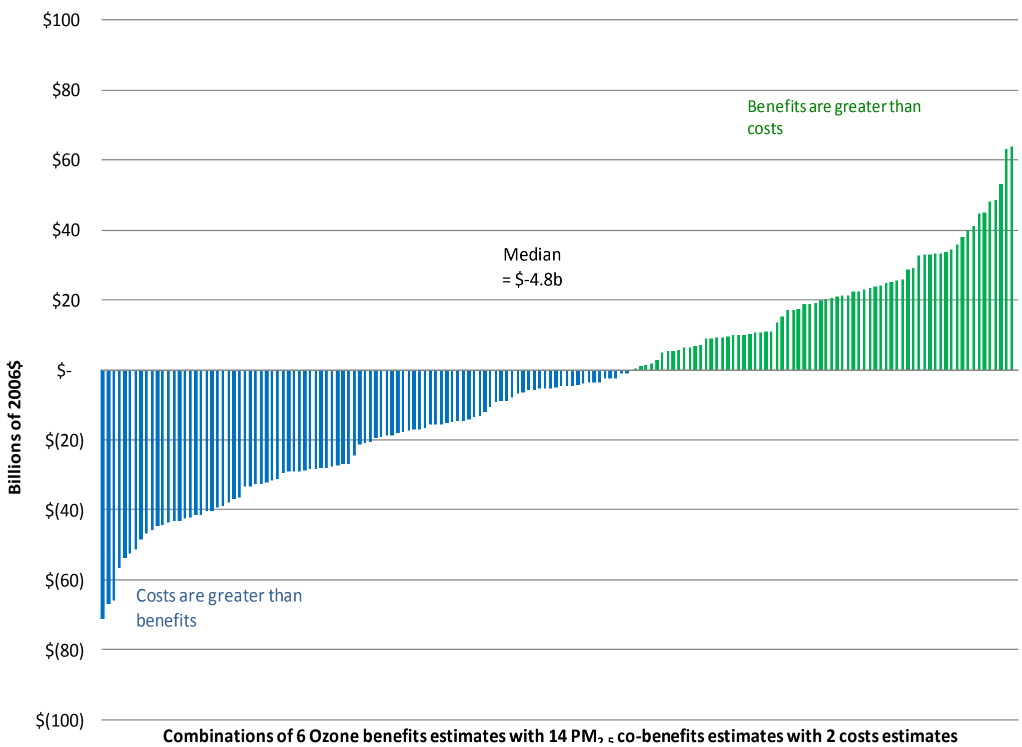


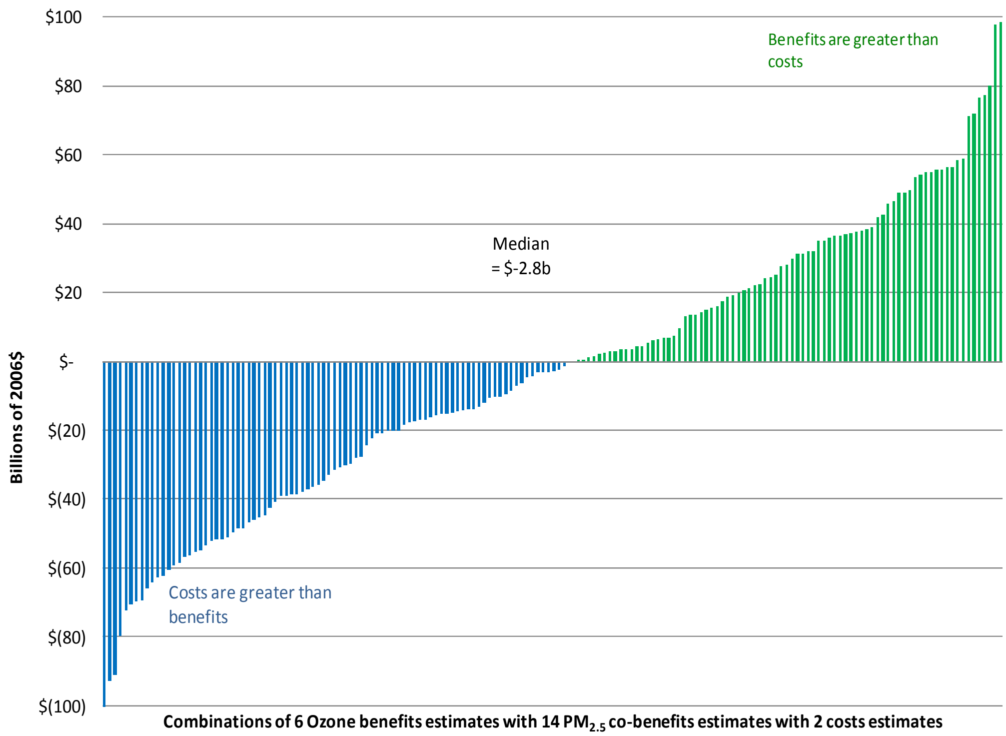
Figure S1.4:

Net Benefits for an Alternate Standard of 0.060 ppm (7% discount rate)



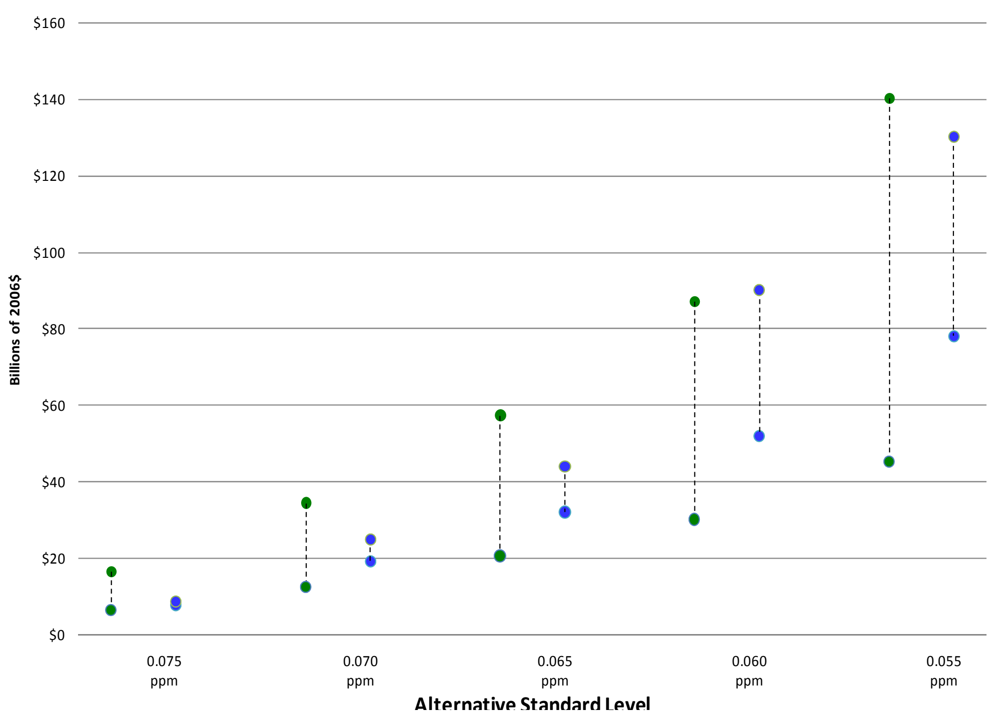
These graphs show all 168 combinations of the 6 different ozone mortality functions and assumptions, the 14 different PM mortality functions, and the 2 cost methods. These combinations do not represent a distribution.

Figure S1.5:
Net Benefits for an Alternate Standard of 0.055 ppm (7% discount rate)



This graph shows all 168 combinations of the 6 different ozone mortality functions and assumptions, the 14 different PM mortality functions, and the 2 cost methods. These combinations do not represent a distribution.

Figure S1.6:
Comparison of Total Monetized Benefits to Costs for Alternative Standard Levels in 2020 (Updated results, 7% discount rate)



The low benefits estimate is based on Pope/Bell 2004 and the high benefits estimate is based on Laden/Levy. The two cost estimates are based on two different extrapolated cost methodologies. These endpoints represent separate estimates based on separate methodologies. The dotted lines are a visual cue only, and these lines do not imply a uniform range between these endpoints.

S1.2 Analysis of the Proposed Secondary NAAQS for Ozone

Exposures to ozone have been associated with a wide array of vegetation and ecosystem effects, including those that damage or impair the intended use of the plant or ecosystem. Such effects are considered adverse to the public welfare.

Today's proposed rule contains a cumulative seasonal secondary standard, expressed as an index of the annual sum of weighted hourly concentrations (using the W126 form), set at a level in the range of 7 to 15 ppm-hours, and requests comment on a level of 21 ppm-hours. The index would be cumulated over the 12-hour daylight window (8:00 a.m. to 8:00 p.m.) during the consecutive 3-month period during the ozone season with the maximum index value (hereafter, referred to as the 12-hour, maximum 3-month W126). For reasons detailed in section 4 of this supplement, we were not able to calculate monetized costs and benefits of attainment of these levels. However, section 4 contains a detailed discussion of the relevant welfare effects, and estimates of the number of counties nationwide which would not attain each alternative secondary NAAQS, both currently and in 2020.

S1.3 Caveats and Conclusions

Of critical importance to understanding these estimates of future costs and benefits is that they are not intended to be forecasts of the actual costs and benefits of implementing revised standards. There are many challenges in estimating the costs and benefits of attaining a tighter ozone standard, which are fully discussed in 2008 Ozone NAAQS RIA and the supplement to this analysis accompanying today's proposed rule.

The estimated costs and benefits of attaining alternate ozone standards of 0.060 ppm or 0.055 ppm are highly speculative and subject to limitations and uncertainties that are unique to this analysis. We first summarize these key uncertainties:

- *The estimated number of potential non-attainment areas is uncertain. Based on present-day ozone concentrations it is clear that many areas currently exceed the ozone targets of 0.055 and 0.060. It is also clear that there will be substantial improvements in ozone air quality between now and 2020 due to existing and recently promulgated emissions reduction rules. We have used an air quality model to project ozone levels in 2020 based on certain estimates of how emissions will increase or decrease over that time period. These assumptions about forecasted emissions growth or reduction are* *highly uncertain and will depend upon economic outcomes and future policy decisions.* Additionally, the methodology for projecting future nonattainment relies upon baseline observations from the existing ozone monitoring network. This network may not include some counties that easily attain higher ozone standards, but may not attain ozone standards so far below the current NAAQS. We estimate human health benefits by adjusting monitored ozone values to just attain alternate standard levels; we can only perform this extrapolation in counties containing an ozone monitor.

- *The predicted emission reductions necessary to attain these two alternative standards are also highly uncertain. Because the hypothetical RIA control scenario left a significant portion of the country exceeding the 0.055 and 0.060 targets, we had to extrapolate the rate of ozone reduction seen in previous air quality modeling exercises to estimate the additional emissions reductions needed to meet the lower targets. The details of the approach are explained below, but for most areas of the analysis we used simple impact ratios to project the ozone improvements as a rate of NOx emissions reduced. Use of non-site-specific, linear impact ratios to determine the non-linear, spatially-varying, ozone response was a necessary limitation which results in considerable uncertainty in the extrapolated air quality targets.*

- *The costs of identified control measures accounts for an increasingly smaller quantity of the total costs of attainment.* This is a major limitation of the cost analysis. We assume a majority of the costs of attaining the tighter alternative standards will be incurred through technologies we do not yet know about. Therefore costing future attainment based upon unspecified emission reductions is inherently difficult and speculative.

The uncertainties and limitations summarized above are generally more extensive than those for the 0.075 ppm, 0.070 ppm, and 0.065 ppm analyses. However, there are significant uncertainties in both cost and benefit estimates for the full range of standard alternatives. Below we summarize some of the more significant sources of uncertainty common to all level analyzed in the 2008 ozone NAAQS RIA and this supplemental analysis:

- Benefits estimates are influenced by our ability to accurately model relationships between ozone and PM and their associated health effects (e.g., premature mortality).

- Benefits estimates are also heavily dependent upon the choice of the statistical model chosen for each health benefit.

- PM co-benefits are derived primarily from reductions in nitrates (associated with NOx controls). As such, these estimates are strongly influenced by the assumption that all PM components are equally toxic. Co-benefit estimates are also influenced by the extent to which a particular area chooses to use NOx controls rather than VOC controls.

- There are several nonquantified benefits (e.g., effects of reduced ozone on forest health and agricultural crop production) and disbenefits (e.g., decreases in tropospheric ozone lead to reduced screening of UV-B rays and reduced nitrogen fertilization of forests and cropland) discussed in this analysis in Chapter 6 of the 2008 Ozone NAAQS RIA.

- Changes in air quality as a result of controls are not expected to be uniform over the country. In our hypothetical control scenario some increases in ozone levels occur in areas already in attainment, though not enough to push the areas into nonattainment

- As explained in Chapter 5 of the 2008 Ozone NAAQS RIA, there are several uncertainties in our cost estimates. For example, the states are likely to use different approaches for reducing NOx and VOCs in their state implementation plans to reach a tighter standard. In addition, since our modeling of known controls does not get all areas into attainment, we needed to make assumptions about the costs of control technologies that might be developed in the future and used to meet the tighter alternative. For example, for the 21 counties (in four geographic areas) that are not expected to attain 0.075 ppm[1] in 2020[2], assumed costs of unspecified controls represent a substantial fraction, of the costs estimated in this analysis ranging from 50% to 89% of total costs depending on the standard being analyzed.

    - As discussed in Chapter 5 of the 2008 Ozone NAAQS RIA, advice from EPA's Science Advisory Board has questioned the appropriateness of an approach similar to one of those used here for estimating extrapolated costs. For balance, EPA also applied a methodology recommended by the Science Advisory Board in an effort to best approximate the costs of control technologies that might be developed in the future.

[1] Areas that do not meet 0.075 ppm are Chicago, Houston, the Northeastern Corridor, and Sacramento. For more information see chapter 4 section 4.1.1 of the 2008 Ozone NAAQS RIA.
[2] This list of areas does not include the San Joaquin and South Coast air basins who are not expected to attain the current 0.084 ppm standard until 2024.

- Both extrapolated costs and benefits have additional uncertainty relative to modeled costs and benefits. The extrapolated costs and benefits will only be realized to the extent that unknown extrapolated controls are economically feasible and are implemented. Technological advances over time will tend to increase the economic feasibility of reducing emissions, and will tend to reduce the costs of reducing emissions. Our estimates of costs of attainment in 2020 assume a particular trajectory of aggressive technological change. This trajectory leads to a particular level of emissions reductions and costs which we have estimated based on two different approaches, the fixed cost and hybrid approaches. An alternative storyline might hypothesize a much less optimistic technological change path, such that emissions reductions technologies for industrial sources would be more expensive or would be unavailable, so that emissions reductions from many smaller sources might be required for 2020 attainment, at a potentially greater cost per ton. Under this alternative storyline, two outcomes are hypothetically possible: Under one scenario, total costs associated with full attainment might be substantially higher. Under the second scenario, states may choose to take advantage of flexibility in the Clean Air Act to adopt plan with later attainment dates to allow for additional technologies to be developed and for existing programs like EPA's Onroad Diesel, Nonroad Diesel, and Locomotive and Marine rules to be fully implemented. If states were to submit plans with attainment dates beyond our 2020 analysis year, benefits would clearly be lower than we have estimated under our analytical storyline. However, in this case, state decision makers seeking to maximize economic efficiency would not impose costs, including potential opportunity costs of not meeting their attainment date, when they exceed the expected health benefits that states would realize from meeting their modeled 2020 attainment date. In this case, upper bound costs are difficult to estimate because we do not have an estimate of the point where marginal costs are equal to marginal benefits plus the costs of nonattainment. Clearly, the second stage analysis is a highly speculative exercise, because it is based on estimating emission reductions and air quality improvements without any information about the specific controls that would be available to do so.