Risk Assessment to Support the Review of the PM Primary National Ambient Air Quality Standards

External Review Draft

September 2009

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LIST OF ACRONYMS/ABBREVIATIONS

A/C	Air conditioning
ACS	American Cancer Society
Act	Clean Air Act
AMI	Acute Myocardial Infarction
AQS	EPA's Air Quality System
β	Slope coefficient
BenMAP	Benefits Mapping Analysis Program
BMI	Body Mass Index
BRFSS	Behavioral Risk Factor Surveillance System
CASAC	Clean Air Scientific Advisory Committee
CAA	Clean Air Act
CBSA	Core-based Statistical Area
CDC	Centers for Disease Control
CDF	Cumulative Distribution Function
CFR	Code of Federal Regulations
CHD	Coronary Heart Disease
CMAQ	Community Multiscale Air Quality
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
CPD	Cardio-pulmonary Disease
C-R	Concentration-response
CSA	Consolidated Statistical Area
CV	Cardiovascular
CVD	Cardiovascular Disease
df	Degrees of freedom
ED	Emergency Department
ER	Emergency Room
EPA	United States Environmental Protection Agency
FACA	Federal Advisory Committee Act
FIPS	Federal Information Processing System
GAM	Generalized additive model
GEOS-CHEM	Goddard Earth Observing System-Chemical Model
GLMs	Generalized linear model
HA	Hospital Admissions

HCUP	Healthcare Cost and Utilization Project
HEI	Health Effects Institute
HS	High School
ICD	International Classification of Diseases
IHD	ischemic heart disease
INF	Influence of uncertainty on risk estimates
IRP	Integrated Review Plan
ISA	Integrated Science Assessment Document
KB	Knowledge Base
km	Kilometer
K-S	Kolmogorov-Smirnov
LML	Lowest Measured Level
MCAPS	Medicare Air Pollution Study
MSA	Metropolitan Statistical Area
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NCEA	National Center for Environmental Assessment
NEI	National Emissions Inventory
NCHS	National Center for Health Statistics
NMMAPS	National Morbidity, Mortality, and Air Pollution Study
NOx	Nitrogen oxides
O_3	Ozone
OAQPS	Office of Air Quality Planning and Standards
PA	Policy Assessment Document
PM	Particulate Matter
PM_X	The legal definition for PM_X, as defined in the Code of Federal Regulations, includes both a 50% cut-point and a penetration curve. A 50% cut-point of X µm diameter means that 50% of particles with aerodynamic diameter of X are removed by the inlet and 50% pass through the inlet and are collected on the filter. Depending on the specific penetration curve specified, particles larger than X µm aerodynamic diameter are collected with an efficiently than decreases rapidly for particles larger than X while the collection efficiency for particles smaller than X increases rapidly with decreasing size until 100 % efficiency is reached.
PM_{10}	Particles with a 50% upper cut-point of 10± 0.5 µm aerodynamic diameter and a penetration curve as specified in the Code of Federal Regulations.

$PM_{2.5}$	Particles with a 50% upper cut-point of 2.5 µm aerodynamic diameter and a penetration curve as specified in the Code of Federal Regulations.
$PM_{10-2.5}$	Particles with a 50% upper cut-point of 10 µm aerodynamic diameter and a lower 50% cut-point of 2.5 µm aerodynamic diameter.
PRB	Policy-Relevant Background
RA	Risk Assessment Document
RR	Relative risk
REA	Risk and Exposure Assessment
SAB	Science Advisory Board
SEDD	State Emergency Department Databases
SID	State Inpatient Database
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
SES	Socio-economic Status
TRIM	Total Risk Integrated Methodology
TRIM.Risk	Total Risk Integrated Methodology - Risk Assessment component
UFP	Ultrafine Particles
USDA	U.S. Department of Agriculture
VNA	Voronoi Neighbor Averaging
WHI	Women's Health Initiative
WHO	World Health Organization
ZCA	Zip Code Area

1 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is presently conducting a review of the national ambient air quality standards (NAAQS) for particulate matter (PM). Sections 108 and 109 of the Clean Air Act (Act) govern the establishment and periodic review of the NAAQS. These standards are established for pollutants that may reasonably be anticipated to endanger public health and welfare, and whose presence in the ambient air results from numerous or diverse mobile or stationary sources. The NAAQS are to be based on air quality criteria, which are to accurately reflect the latest scientific knowledge useful in indicating the kind and extent of identifiable effects on public health or welfare that may be expected from the presence of the pollutant in ambient air. The EPA Administrator is to promulgate and periodically review, at five-year intervals, "primary" (health-based) and "secondary" (welfare-based) NAAQS for such pollutants. Based on periodic reviews of the air quality criteria and standards, the Administrator is to make revisions in the criteria and standards, and promulgate any new standards, as may be appropriate. The Act also requires that an independent scientific review committee advise the Administrator as part of this NAAQS review process, a function performed by the Clean Air Scientific Advisory Committee (CASAC).[1]

The current NAAQS for PM include a suite of standards to provide protection for exposures to fine and coarse particles using $PM_{2.5}$ and PM_{10}, as indicators, respectively (71 FR 61144, October 17, 2006). With regard to the primary and secondary standards for fine particles, in 2006 EPA revised the level of the 24-hour $PM_{2.5}$ standard to 35 µg/m^3 (calculated as a 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor), retained the level of the annual $PM_{2.5}$ annual standard at 15 µg/m^3 (calculated as the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors), and revised the form of the annual $PM_{2.5}$ standard by narrowing the constraints on the optional use of spatial averaging.[2] With regard to the primary and secondary

[1] The Clean Air Scientific Advisory Committee (CASAC) was established under section 109(d)(2) of the Clean Air Act (CAA or Act) (42 U.S.C. 7409) as an independent scientific advisory committee. CASAC provides advice, information and recommendations on the scientific and technical aspects of air quality criteria and NAAQS under sections 108 and 109 of the CAA. The CASAC is a Federal advisory committee chartered under the Federal Advisory Committee Act (FACA). See http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommitteesSubcommittees/CASAC%20Particulate%20Matter%20Review%20Panel for a list of the CASAC PM Panel members and current advisory activities.

[2] In the revisions to the PM NAAQS finalized in 2006, EPA tightened the constraints on the spatial averaging criteria by further limiting the conditions under which some areas may average measurements from multiple community-oriented monitors to determine compliance (see 71 FR 61165-61167, October 17, 2006) .

standards for PM_{10}, EPA retained the 24-hour PM_{10} standard at 150 $\mu g/m^3$ (not to be exceeded more than once per year on average over 3 years) and revoked the annual standard because available evidence generally did not suggest a link between long-term exposure to current ambient levels of coarse particles and health or welfare effects. These standards were based primarily on a large body of epidemiological evidence relating ambient PM concentrations to various adverse health endpoints. Secondary standards for $PM_{2.5}$ and PM_{10} were revised to be identical to the primary standards.

The next periodic review of the PM NAAQS is now underway.[3] The EPA outlined the science-policy questions that will frame this review, outlined the process and schedule that the review will follow, and provided more complete descriptions of the purpose, contents, and approach for developing the key documents for this review in the *Integrated Review Plan for the National Ambient Air Quality Standards for Particulate Matter*, henceforth referred as the IRP (EPA, 2008a).[4] The EPA is currently completing the process of assessing the latest available policy-relevant scientific information to inform the review of the PM standards. The latest draft of this assessment is contained in the *Integrated Science Assessment for Particulate Matter: Second External Review Draft,* henceforth referred to as the draft ISA (EPA, 2009a) which was released in July 2009 for review by the CASAC and for public comment. The draft ISA includes an evaluation of the scientific evidence on the health effects of PM, including information on exposure, physiological mechanisms by which PM might damage human health, and an evaluation of the epidemiological evidence including information on reported concentration-response (C-R) relationships and lag structures for PM-related morbidity and mortality associations, including consideration of effects in at-risk populations..

Drawing from the health effects evidence presented in the draft ISA as well as CASAC advice (Samet, 2009) and public comments on a *Particulate Matter National Ambient Air Quality Standards: Scope and Methods Plan for Health Risk and Exposure* Assessment, henceforth referred to as the Scope and Methods Plan (EPA, 2009b), EPA's Office of Air Quality Planning and Standards (OAQPS) has developed this draft Risk Assessment (RA) describing the quantitative assessments being conducted by the Agency to support the review of the primary PM standards. This draft document is a concise presentation of the scope, methods, key results, observations, and related uncertainties associated with the quantitative analyses

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[3] See http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_index.html for more information on the current and previous PM NAAQS reviews.

[4] On November 30, 2007, EPA held a consultation with the CASAC on the draft IRP (72 FR 63177, November 8, 2007). Public comments were also requested on the draft plan and presented at that CASAC teleconference. The final IRP incorporated comments received from CASAC and the general public on the draft plan as well as input from senior Agency managers.

performed. Revisions to this draft RA will draw upon the final ISA and will reflect consideration of CASAC and public comments on this draft.

The final ISA and final RA will inform the policy assessment and rulemaking steps that will lead to final decisions on the primary PM NAAQS. A Policy Assessment (PA) is now being prepared by OAQPS staff to provide a transparent staff analysis of the scientific basis for alternative policy options for consideration by senior EPA management prior to rulemaking. The PA is intended to help "bridge the gap" between the Agency's scientific assessments, presented in the ISA and RA, and the judgments required of the Administrator in determining whether it is appropriate to retain or revise the standards. The PA will integrate and interpret information from the ISA and the RA to frame policy options and to facilitate CASAC's advice to the Agency and recommendations on any new standards or revisions to existing standards as may be appropriate, as provided for in the Clean Air Act. A preliminary draft PA is planned for release in September 2009 to facilitate discussion on the overall structure, areas of focus, and level of detail to be included in an external review draft of the document, which EPA plans to release for CASAC review and public comment later this year. A discussion of the preliminary draft PA with CASAC will be held in conjunction with CASAC review and public comment of the draft ISA, this draft RA, and a draft assessment document that will inform the review of the secondary PM standards - *Particulate Matter Urban-Focused Visibility Assessment – External Review Draft* (EPA, 2009c).

1.1 BACKGROUND

As part of the last PM NAAQS review completed in 2006, EPA's OAQPS conducted a quantitative risk assessment to estimate risks of various health effects associated with exposure to ambient $PM_{2.5}$ and $PM_{10-2.5}$ in a number of urban study areas selected to illustrate the public health impacts of these pollutants (U.S. EPA, 2005, Chapter 4; Abt Associates, 2005). The assessment scope and methodology were developed with considerable input from the CASAC Review Panel and the public, with CASAC concluding that the general assessment methodology and framework were appropriate (Hopke, 2002). In addition, the final risk assessment took into consideration CASAC advice (Hopke, 2004; Henderson, 2005) and public comments on two drafts of the risk assessment.

The extensive assessment conducted for fine particles in the last review included estimates of risks of mortality (total non-accidental, cardiovascular, and respiratory), morbidity (hospital admissions for cardiovascular and respiratory causes), and respiratory symptoms (not requiring hospitalization) associated with recent short-term (daily) ambient $PM_{2.5}$ levels and risks of total, cardiopulmonary, and lung cancer mortality associated with long-term exposure to $PM_{2.5}$ in nine urban study areas. The risk assessment included estimates of: (1) risks of mortality, morbidity, and symptoms associated with recent ambient $PM_{2.5}$ levels; (2) risk reductions and remaining risks associated with just meeting the existing suite of $PM_{2.5}$ NAAQS (1997 standards); and (3) risk reductions and remaining risks associated with just meeting various alternative $PM_{2.5}$ standards.

The quantitative risk assessment conducted in the last review for thoracic coarse particles was much more limited than the analyses conducted for fine particles. Estimates of hospital admissions attributable to short-term exposure to $PM_{10-2.5}$ were developed for Detroit (cardiovascular and respiratory admissions) and Seattle (respiratory admissions), and estimates of respiratory symptoms were developed for St. Louis. While one of the goals of the $PM_{10-2.5}$ risk assessment was to provide estimates of the risk reductions associated with just meeting alternative $PM_{10-2.5}$ standards, EPA staff concluded that the nature and magnitude of the uncertainties and concerns associated with this portion of the risk assessment weighed against use of these risk estimates as a basis for recommending specific standard levels (U.S. EPA, 2005, p. 5-69).

Prior to the issuance of a proposed rulemaking in the last review, CASAC presented recommendations to the Administrator supporting revisions of the $PM_{2.5}$ primary standards. These recommendations placed substantial reliance on the results of the quantitative risk assessment (Henderson, 2005, pp 6-7). In a letter to the Administrator following the 2006 proposed rule (71 FR 12592, January 17, 2006), CASAC requested reconsideration of the Agency's proposed decisions and reiterated and elaborated on the scientific bases for its earlier recommendations which included placing greater weight on the result of the Agency's risk assessment. With regard to the quantitative risk assessment, CASAC concluded, "While the risk assessment is subject to uncertainties, most of the PM Panel found EPA's risk assessment to be of sufficient quality to inform its recommendations." (Henderson, 2006a, p. 3).

In the 2006 final rule, the EPA Administrator recognized that the quantitative risk assessment for fine particles was based upon a more extensive body of data and was more comprehensive in scope than the previous assessment conducted for the review completed in 1997. However, as presented in the final rulemaking notice, the Administrator was mindful of significant uncertainties associated with the risk estimates for fine particles. More specifically,

> Such uncertainties generally related to a lack of clear understanding of a number of important factors, including, for example, the shape of the concentration-response functions, particularly when, as here, effect thresholds can neither be discerned nor determined not to exist; issues related to selection of appropriate statistical models for the analysis of the epidemiologic data; the role of potentially confounding and modifying factors in the concentration-response relationships; issues related to simulating how $PM_{2.5}$ air quality distributions will likely change in any given area upon attaining a particular standard, since strategies to reduce emissions are not yet defined; and whether there

> would be differential reductions in the many components within $PM_{2.5}$ and, if so, whether this would result in differential reductions in risk. In the case of fine particles, the Administrator recognized that for purposes of developing quantitative risk estimates, such uncertainties are likely to [be] amplified by the complexity in the composition of the mix of fine particles generally present in the ambient air. (72 FR 61168, October 17, 2006).

As a result, the Administrator viewed that the quantitative risk assessment provided supporting evidence for the conclusion that there was a need to revise the $PM_{2.5}$ primary standards, but he judged that the assessment did not provide an appropriate basis to determine the level of the standards (72 FR 61168, October 17, 2006).

In a letter to the EPA Administrator following the issuance of the final rule, CASAC expressed "serious scientific concerns" regarding the final PM standards. In particular, CASAC was concerned that the Agency "did not accept our finding that the annual $PM_{2.5}$ standard was not protective of human health and did not follow our recommendation for a change in that standard" (Henderson et al, 2006b, p.1). With respect to the use of the risk assessment to inform EPA's decision on the primary $PM_{2.5}$ standard, CASAC stated, "While there is uncertainty associated with the risk assessment for the $PM_{2.5}$ standard, this very uncertainty suggests a need for a prudent approach to providing an adequate margin of safety" (Henderson et al., 2006b, p.2)

Several parties filed petitions for review following promulgation of the revised PM NAAQS in 2006. These petitions for review addressed the following issues with regard to the primary PM NAAQS: (1) selecting the level of the annual primary $PM_{2.5}$ standard, (2) retaining PM_{10} as the indicator for coarse particles and retaining the level and form of the 24-hour PM_{10} standard, and (3) revoking the PM_{10} annual standard. On judicial review, the D.C. Circuit remanded the annual primary $PM_{2.5}$ NAAQS to EPA because the Agency failed to adequately explain why the standard provided the requisite protection from both short- and long-term exposures to fine particles including protection for at-risk populations. The court upheld the Agency's use of the quantitative risk assessment to inform the decision to revise the $PM_{2.5}$ standards but not to inform the selection of level.[5] The court also upheld the decision to retain the 24-hour PM_{10} standard and revoke the annual PM_{10} standard. *American Farm Bureau Federation v. EPA*, 559 F. 3d 512, (D.C. Cir. 2009).

[5] One petition for review addressed the issue of setting the secondary $PM_{2.5}$ standards identical to the primary standards. On judicial review, the court remanded the secondary $PM_{2.5}$ NAAQS to EPA because the Agency failed to adequately explain why the standards provided the required protection from visibility impairment. *American Farm Bureau Federation v. EPA*, 559 F. 3d 512, (D.C. Cir. 2009).

1.2 CURRENT HEALTH RISK ASSESSMENT: GOALS AND PLANNED APPROACH

The goals of the current risk assessment remain largely the same as those articulated in the risk assessment conducted as part of the last review. These goals include: (a) to provide estimates of the potential magnitude of premature mortality and/or selected morbidity effects in the population associated with recent ambient levels of PM and with just meeting the current suite of PM standards and any alternative standards that might be considered in selected urban study areas, including, where data are available, consideration of impacts on at-risk populations; (b) to develop a better understanding of the influence of various inputs and assumptions on the risk estimates to more clearly differentiate alternative standards that might be considered including potential impacts on various at-risk populations; and (c) to gain insights into the distribution of risks and patterns of risk reduction and uncertainties in those risk estimates. In addition, EPA is conducting an assessment to provide nationwide estimates of the potential magnitude of premature mortality associated with long-term exposure to ambient $PM_{2.5}$ to more broadly characterize this risk on a national scale and to support the interpretation of the more detailed risk estimates generated for selected urban study areas. The overall scope and design of the risk assessment reflect efforts to achieve these goals.

The current risk assessment builds on the approach used and lessons learned in the last PM NAAQS risk assessment and attempts to reduce overall uncertainty associated with the analysis through incorporation of a number of enhancements, in terms of both the methods and data used in the analyses. In preparing the Scope and Methods Plan for the health risk/exposure assessment, EPA considered the scientific evidence presented in the first draft ISA (EPA, 2008b) and the key science policy issues raised in the IRP (EPA, 2008a). The EPA held a consultation with CASAC to solicit comments on the Scope and Methods Plan during an April 2009 CASAC meeting. Public comments were also requested (74 FR 11580, March 18, 2009). CASAC (Samet, 2009) and public comments were considered in advance of the conduct of the analyses and results presented in this draft REA. The design of the current risk assessment builds upon information presented in the draft ISA (EPA, 2009b) with particular emphasis on conclusions regarding causality determinations for specific PM-related health effect categories and discussion of the scientific strengths and weaknesses underlying key epidemiological studies addressing specific health effect endpoints of interest.

The risk assessment described in this draft document covers a variety of health endpoints for which there is adequate information to develop quantitative risk estimates. Evidence of relationships between PM and other health endpoints for which there currently is insufficient information to develop quantitative risk estimates will be discussed in the OAQPS staff Policy Assessment.

1.3 ORGANIZATION OF DOCUMENT

The remainder of this document is organized as follows. Chapter 2 provides an overview of the scope of the risk assessment, including a summary of the previous risk assessment (section 2.1), the planned approach as presented in the Scope and Methods Plan (section 2.2), a summary of CASAC comments on the Scope and Methods Plan (section 2.3) and how these comments as well as public comments were addressed in the design of the analyses (section 2.4), and summary of the alternative levels evaluated in the risk assessment including the rationale for their selection (section 2.5). Chapter 3 describes the analytical approach, methods, and data used in conducting the risk assessment. This includes a description of the approach used to generate risk estimates for the set of urban case studies included in this analysis, as well as the approaches used in addressing variability and uncertainty as part of the analysis (Appendices A, B, and C provide supplemental information regarding the data and methods used in the analysis). Chapter 4 presents the risk estimates generated for the urban case studies, including key observations resulting from review and interpretation of the results (Appendices E and F provide detailed risk estimates and sensitivity analysis results, respectively). Chapter 5 presents the approach used and results of a national-scale assessment of $PM_{2.5}$-related long-term mortality risks (Appendix G provides supplemental information to the national-scale mortality analysis). In addition, Appendix D provides supplemental information to a representativeness analysis completed for the 15 urban study areas (see Section 2.4.1).

2 SCOPE

This chapter provides an overview of the scope and key design elements of the PM risk assessment being conducted for this review, including the process that has been followed to design the analyses. Following initiation of the current PM NAAQS review, we began the design of this risk assessment by reviewing the risk assessment completed during the previous PM NAAQS review (Abt Associates, 2005; EPA, 2005, chapter 4) with an emphasis on considering key limitations and sources of uncertainty recognized in that analysis. Furthermore, as an initial step in the overall PM NAAQS review, EPA invited a wide range of external experts as well as EPA staff, representing a variety of areas of expertise (e.g., epidemiology, human and animal toxicology, statistics, risk/exposure analysis, atmospheric science) to participate in a workshop titled, "Workshop to Discuss Policy-Relevant Science to Inform EPA's Integrated Plan for the Review of the Primary PM NAAQS" (72 FR 34003, June 20, 2007). This workshop provided an opportunity for the participants to broadly discuss the key policy-relevant issues around which EPA would structure the PM NAAQS review and to discuss the most meaningful new science that would be available to inform our understanding of these issues. One session of this workshop was centered around planning for the quantitative risk/exposure assessments. Specifically, the discussions focused on the extent to which new research and/or improved methodologies were available to inform how EPA designed a quantitative risk assessment and whether it was appropriate to conduct a quantitative exposure assessment, and, if so, how that assessment might be structured.

Based in part on these workshop discussions, EPA developed a draft IRP outlining the schedule, the process, and the key policy-relevant science issues that would guide the evaluation of the air quality criteria for PM and the review of the primary and secondary PM NAAQS including initial thoughts for conducting quantitative assessments (EPA, 2007, chapter 5). On November 30, 2007, CASAC held a teleconference with EPA to provide its comments on the draft IRP (72 FR 63177, November 8, 2007). Public comments were also presented at that teleconference. A final IRP incorporating comments received from CASAC and the general public on the draft plan was issued in March 2008 (EPA, 2008a).

As a next step in the design of the quantitative assessments, EPA developed a planning document outlining the initial design for the PM NAAQS risk assessment - *Particulate Matter National Ambient Air Quality Standards: Scope and Methods Plan for Health Risk and Exposure Assessment,* henceforth Scope and Methods Plan (EPA, 2009b). This planning document was released for CASAC consultation and public review in February 2009. Based on consideration of CASAC and public comments on that Scope and Methods Plan, along with ongoing review of the latest PM-related literature, we made modifications to the scope and design of the risk assessment and completed our initial analyses.

In presenting the scope and key design elements of the current risk assessment, this chapter first provides a brief overview of the risk assessment completed for the previous PM NAAQS review in section 2.1, including key limitations and uncertainties associated with that analysis. Section 2.2 provides a summary of the initial design of the risk assessment as outlined in the Scope and Methods Plan. Next, section 2.3 summarizes comments received during the CASAC consultation on the Scope and Methods Plan. Key design elements for the current risk assessment, including modifications made to the overall scope of the assessments relative to the initial Scope and Methods Plan and explanations to support these changes are outlined in section 2.4. Finally, section 2.5 provides a summary of the alternative air quality scenarios modeled in the current assessment, including the rationale behind selection of specific alternative levels.

2.1 OVERVIEW OF THE PM NAAQS RISK ASSESSMENT FROM THE LAST REVIEW

The PM NAAQS risk assessment from the last review completed in 2006 included a broad assessment of $PM_{2.5}$-related risk and a more limited treatment of $PM_{10-2.5}$-related risk. The assessment conducted for the review completed in 2006 included estimates of risks of mortality (total non-accidental, cardiovascular, and respiratory), morbidity (hospital admissions for cardiovascular and respiratory causes), and respiratory symptoms (not requiring hospitalization) associated with recent short-term (daily) ambient $PM_{2.5}$ levels and risks of total, cardiopulmonary, and lung cancer mortality associated with long-term exposure to $PM_{2.5}$ in selected urban areas. Nine urban areas were included in this assessment to provide some sense of the variability in the $PM_{2.5}$-related risk estimates across the U.S. The areas evaluated were: Boston, MA; Detroit, MI; Los Angeles, CA; Philadelphia, PA; Phoenix, AZ; Pittsburgh, PA; San Jose, CA; Seattle, WA; and St. Louis, MO.

The EPA recognized that there were many sources of uncertainty and variability inherent in the inputs to this assessment and that there was a high degree of uncertainty in the resulting $PM_{2.5}$ risk estimates. Such uncertainties generally related to a lack of clear understanding of a number of important factors, including, for example: (a) the shape of the concentration-response (C-R) function (and whether or not a population threshold exists); (b) issues related to the selection of appropriate statistical models for the analysis of epidemiological data; (c) the role of potentially confounding and modifying factors in the C-R relationships; (d) the method for simulating how daily $PM_{2.5}$ ambient concentrations would likely change in any given area upon meeting a particular suite of standards, since strategies to reduce emissions had not yet been defined; and (e) the issue of whether there would be differential reductions in the many components within $PM_{2.5}$ and, if so, whether this would result in differential reductions in risk.

While some of these uncertainties were addressed quantitatively in the form of estimated confidence ranges around central risk estimates, other uncertainties and the variability in key inputs were not reflected in these confidence ranges, but rather were addressed through separate sensitivity analyses or characterized qualitatively (EPA, 2005, chapter 4; Abt Associates, 2005). The C-R relationships used in the quantitative risk assessment were based on findings from human epidemiological studies that relied on fixed-site, population oriented, ambient monitors as a surrogate for actual ambient $PM_{2.5}$ exposures. The assessment included a series of base case estimates that, for example, included various cutpoints intended as surrogates for alternative potential population thresholds. Other uncertainties were addressed in various sensitivity analyses (e.g., the use of single- versus multi-pollutant models, use of single versus multi-city models, use of a distributed lag model) and had a more moderate and often variable impact on the risk estimates in some or all of the cities.

The general overview and discussion of key components of the quantitative risk assessment used to develop risk estimates for $PM_{2.5}$ presented above is also applicable to the risk assessment conducted for $PM_{10-2.5}$ as part of the last review. However, the scope of the risk assessment for $PM_{10-2.5}$ was much more limited than that for $PM_{2.5}$ reflecting the much more limited body of epidemiological evidence and air quality information available for $PM_{10-2.5.}$ As discussed in section 4.5 of the Staff Paper (EPA, 2005), the $PM_{10-2.5}$ risk assessment included risk estimates for just three urban areas for two categories of health endpoints related to short-term exposure to $PM_{10-2.5}$: hospital admissions for cardiovascular and respiratory causes and respiratory symptoms (see also Abt, 2005, chapter 9).

Estimates of hospital admissions attributable to short-term exposure to $PM_{10-2.5}$ were developed for Detroit, MI (cardiovascular and respiratory admissions) and Seattle, WA (respiratory admissions), and estimates of respiratory symptoms were developed for St. Louis, MO. While one of the goals of the $PM_{10-2.5}$ risk assessment was to provide estimates of the risk reductions associated with just meeting alternative $PM_{10-2.5}$ standards, EPA staff concluded that the nature and magnitude of the uncertainties and concerns associated with this portion of the risk assessment weighed against use of these risk estimates as a basis for recommending specific standard levels (EPA, 2005, see p. 5-69). These uncertainties and concerns were summarized in the proposal notice (see FR 71 2662, January 17, 2006) and discussed more fully in the Staff Paper (EPA, 2005, chapter 4) and associated technical support document (Abt Associates, 2005).

2.2 ORIGINAL ASSESSMENT PLAN

As noted earlier, the Scope and Methods Plan reflected consideration of the design of the risk assessment completed for the last review (specifically the uncertainties and limitations associated with that assessment) as well as more recent PM-related research published since completion of the last assessment. The Scope and Methods Plan outlined a planned approach for conducting the current PM risk assessment, including broader design issues as well as more detailed aspects of the analyses. The Scope and Methods Plan also outlined plans for a population exposure analysis based on micro-environmental exposure modeling. The planned approaches for conducting both analyses are briefly summarized below.

2.2.1 Risk assessment

Key design elements for the risk assessment, as presented in the Scope and Methods Plan included:[6]

- **PM size fractions**: We planned to focus primarily on estimating risk associated with exposure to $PM_{2.5}$ with a more limited assessment of $PM_{10-2.5}$. Regarding PM components and ultrafine particles, we concluded that, based on review of evidence in the first draft ISA, there was insufficient data to support quantitative risk assessment at this time.
- **Selection of health effects categories ($PM_{2.5}$):** We planned to focus on categories for which the evidence supports a judgment that there is at least a *likely causal* relationship. However, consideration would be given to expanding the risk assessment to cover additional categories for which evidence supports a judgment that there is a *suggestive* causal relationship (e.g., reproductive, developmental outcomes), if sufficient information was available to develop risk estimates for these additional categories.
- **Selection of health effect categories ($PM_{10-2.5}$)**: We planned to build on the limited risk assessment conducted in the last review (EPA, 2005) with a focus on health effect categories that staff judged to be sufficiently *suggestive* of a causal relationship with short-term exposure to warrant analysis.
- **Selection of study areas**: We planned to expand the number of urban study areas to between 15 and 20, with selection of these study areas being based on consideration of a number of factors (e.g., availability of location-specific C-R functions and baseline incidence data, coverage for geographic heterogeneity in PM risk-related attributes, coverage for areas with more vulnerable populations). We also discussed the possibility of including more refined risk assessments for locations where more detailed exposure studies had been completed (e.g., L.A.,

[6] We have focused here on highlighting design details that have broader implications for the risk assessment and have not included some of the more detailed aspects of the planned approach. These more detailed factors were carefully considered in conducting the risk assessment described in this document, but they are not discussed as part of this discussion focusing on the overall scope of the analysis.

where a zip code level analysis of long-term $PM_{2.}$-exposure related mortality was presented in Krewski et al., 2009).

- **Simulation of air quality levels that just meet either current or alternative suites of standards**: We planned to consider the use of non-proportional air quality adjustment methods, together with the proportional approach that has been used previously. These non-proportional adjustment methods could be based on (a) historical patterns of reductions in urban areas, if these result in support for non-proportional reductions across monitors and/or (b) model-based (e.g., CMAQ) rollback designed to more realistically reflect patterns of PM reductions across monitors in an urban area.

- **Characterization of policy relevant background (PRB)**: We planned to use modeling (combination of the global-scale circulation model, GEOS-Chem, with the regional scale air quality model, CMAQ) as presented in the first draft PM ISA, rather than empirical data to characterize PRB levels for use in the risk assessment model.

- **Selection of epidemiological studies to provide C-R functions**: We planned to include both multi- and single-city studies (given advantages associated with both designs) as well as multi- and single-pollutant studies. However, we also proposed placing greater weight on the use of C-R functions reflecting adjusted single-city estimates obtained from multi-city studies.

- **Shape of the functional form of the risk model**: We planned to emphasize non-threshold C-R functions in the risk assessment model, based on the first draft ISA conclusion that there was little support in the literature for population thresholds for mortality effects associated with either long-term or short-term $PM_{2.5}$ ambient concentrations.[7] However, we stated that we may consider population thresholds as part of the sensitivity analysis.

- **Modeling of risk down to PRB versus Lowest Measured Level (LML)**: We planned to model risk down to LML for estimating risk associated with long-term $PM_{2.5}$ exposures and down to PRB for estimated risks associated with short-term $PM_{2.5}$ exposure effects.

- **Characterization of uncertainty and variability**: We planned to include a discussion in the risk assessment report on the degree to which the risk assessment covers key sources of variability related to PM risk. For uncertainty, we planned to include a qualitative discussion of key sources of uncertainty and provide ratings (low, medium and high) in terms of their potential impact on risk estimates. We also described the use of sensitivity analysis methods planned both to characterize the potential impact of sources of uncertainty on risk estimates and to provide an alternative set of reasonable estimates to supplement the main ("core") set of risk estimates generated for the urban study areas.

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[7] Note, that the draft ISA in discussing short-term exposure mortality studies while indicating support for no-threshold log-linear models, acknowledges the "possible influence of exposure error and heterogeneity of shapes across cities remains to be resolved" (draft ISA, section 6.5.2.7).

- **National-scale health impact analysis**: We planned to conduct a national-scale health impact assessment focused on mortality associated with long-term exposure to $PM_{2.5}$ using a recent conditions scenario.
- **Representativeness analysis for the urban study areas**: We planned to conduct an analysis to evaluate the representativeness of the selected urban study areas against national distributions for key PM risk-related attributes to determine whether they are nationally-representative, or more focused on a particular portion of the distribution for a given parameter.

2.2.2 Population exposure analysis

The Scope and Methods Plan also described a population exposure analysis based on micro-environmental exposure modeling using the Air Pollution Exposure Model (APEX). The planned analysis would have focused on $PM_{2.5}$ and have involved a subset of the urban study areas included in the risk assessment. The results of this analysis were planned to focus on providing insights on population exposure with respect to informing the interpretation of available epidemiological studies. For reasons presented below in section 2.4.2, this analysis will not be completed as part of the current PM NAAQS review. We have decided to continue development of the population exposure analysis methodology with the goal of considering any results from this exposure assessment in support of the next PM NAAQS review.

2.3 CASAC COMMENTS PROVIDED ON THE SCOPE AND METHODS PLAN

CASAC met on April 2, 2009 to conduct a consultation on the Scope and Methods Plan for the PM NAAQS risk assessment. Following that meeting, CASAC provided comments from the Panel, summarized below, as well as more detailed comments providing individual views from CASAC PM Panel Members (Samet, 2009).[8]

- Regarding the overall analysis, CASAC suggested that "priorities be established quickly in developing the health risk and exposure assessment, giving emphasis to those analyses that may be most informative for establishing particulate matter standards."
- With regard to the selection of health effects endpoints, CASAC recommended that EPA "provide a transparent algorithm for selecting endpoints based on the level of certainty and the relative and attributable risks." Furthermore, CASAC suggested that "weight be given to the level of classification while still considering the Administrator's obligation to set a standard with a 'margin of safety' as described in the Clean Air Act." By way of example, the letter stated that "several CASAC members do not recommend a risk assessment based on birth outcomes,

[8] See http://yosemite.epa.gov/sab/sabproduct.nsf/4620a620d0120f93852572410080d786/350899ec134552948525746600691de5!OpenDocument&TableRow=2.0#2.

in part because the level of evidence is still at the suggestive level." The letter went on to note that "one panel member proposed setting a higher priority for those health effects shown to have the highest risks in the epidemiological literature." (Samet, 2009, p.1-2).

- Regarding the inclusion of $PM_{10-2.5}$ in the risk assessment, the letter stateed that "there was support (among CASAC members) for doing a limited risk assessment for short-term exposure to $PM_{10-2.5}$ for appropriate outcomes such as hospitalization" (Samet, 2009, p.2).
- With regard to aspects of the plan related to air quality characterization, particularly characterizing policy relevant background (PRB) and simulation of ambient air levels associated with alternative standards, the letter stated that "CASAC generally supports EPA's proposed approach for estimating PRB levels." Furthermore, there was general support for the proportional rollback approach that EPA had followed in previous risk assessments. Individual comments did include support for considering a non-proportional rollback approach as an alternative to the proportional approach although several Panel members noted that there could be considerable uncertainty associated with the non-proportional approach.
- With regard to the risk assessment component, CASAC generally agreed with the planned approach to identifying C-R relationships.
- There was also strong support for the planned national scale health impact assessment for long-term exposure mortality related to $PM_{2.5}$. In fact, CASAC stated that it believed such a national assessment "should play a central role in the overall risk assessment" (Samet, 2009, p.2).
- Regarding the characterization of uncertainty, CASAC expressed support for the general approach, but did emphasize the need to carefully separate sensitivity analyses from uncertainty analyses. With regard to the approach for classifying the degree of uncertainty, CASAC suggested that EPA explore the use of "various structured approaches for describing uncertainty," noting that "recent examples may be found in the work of the World Health Organization and the Intergovernmental Panel on Climate Change" (Samet, 2009, p.2).
- Regarding the population exposure analysis, CASAC welcomed its inclusion noting that the planned analysis "rightly seeks to identify various personal and building-related factors that may account for some of the variability in $PM_{2.5}$-related health risks" (Samet, 2009, p.2). However, CASAC also noted that "more information is needed on how the results from the exposure assessment will be integrated and used to interpret epidemiological studies" (Samet, 2009, p.2). In pointing out potential benefits of the analysis, CASAC also acknowledged that the "Agency's time and resources are not unlimited" (Samet, 2009, p.2).

Comments from the CASAC PM Panel and individual Panel members were carefully considered in finalizing the scope and methods for the risk assessment described in this document.

2.4 CURRENT SCOPE AND KEY DESIGN ELEMENTS

The current scope and design of the risk assessment is based on consideration of the following: (1) lessons learned from the risk assessment conducted for the previous review, as summarized in section 2.1 (see also EPA, 2005, chapter 4; Abt Associates, 2005); (2) consideration of CASAC's advice on the Scope and Methods Plan, as described in section 2.3; and (3) public comments on the Scope and Methods Plan; and consideration of the new scientific evidence presented in the second draft ISA (EPA, 2009a). These considerations also led to our decision to continue development of the population exposure analysis methodology, rather than applying it for this review. Key design elements of the risk assessment, as well as the rationale for the decision to continue development of the population exposure analysis for consideration in the next PM NAAQS review are presented below.

2.4.1 Risk Assessment

Key design elements, along with the rationale for any differences between the design of the risk assessment as implemented and the approach described in the Scope and Methods Plan, include:

- **PM size fractions**: The risk assessment characterizes risk associated with $PM_{2.5}$-related exposures only. Careful consideration of evidence provided in the draft ISA regarding health effects potentially associated with short-term exposure to $PM_{10-2.5}$ as well as limited air quality data has resulted in the decision not to quantitatively assess risk for this size fraction as part of the current risk assessment (see section 3.3.1 for additional discussion). Furthermore, EPA staff have determined that data are too limited, at this time, to support a quantitative risk assessment for specific PM components, including ultrafine particles (UFPs). We note, however, that the evidence for health effects associated with thoracic coarse particles, UFPs, and PM components will be addressed as part of the evidence-based analysis that will be presented in the forthcoming draft PA.
- **Selection of health effects categories ($PM_{2.5}$):** The final set of health effects categories included in the risk assessment for $PM_{2.5}$ (see section 3.3.1) are consistent with those outlined in the Scope and Methods plan for $PM_{2.5}$ (i.e., those classified as having a *causal* or *likely causal* relationship with $PM_{2.5}$ exposure, as presented in the draft ISA). However, we decided not to include any of the health effect categories classified as *suggestive* of a casual relationship in the draft ISA, based on a number of considerations including: (1) CASAC Panel member views, which did not express strong support for inclusion of these less-well supported health effect categories (see section 1.3); (2) limited information available to support selection of C-R functions for specific endpoints within these health effect categories; and/or (3) lack of available baseline incidence data for these other health effect endpoints.
- **Selection of health effect categories ($PM_{10-2.5}$)**: As noted above, we have decided not to model risk related to $PM_{10-2.5}$ exposure (see section 3.3.1).

- **Selection of urban study areas**: We have included 15 urban study areas in the risk assessment, with the selection of these areas being based on a number of criteria including: (a) consideration of urban study areas evaluated in the risk assessment conducted to inform the previous PM NAAQS review; (b) consideration of locations evaluated in key epidemiological studies; (c) preference for locations with relatively elevated 24-hour and/or annual $PM_{2.5}$ monitored levels so that the assessment can provide potential insights into the degree of risk reduction associated with alternative standard levels and (d) desire to include locations that would provide coverage for different regions across the country where these regions are defined to reflect potential differences in PM sources, composition and potentially other factors which might impact PM-related risk (see section 3.3.2).[9] We note that, due to the time and resource limitations, we have not included a specialized analysis of risk based on epidemiology studies using more highly-refined exposure analysis (e.g., the study of L.A. involving zip code-level effect estimates as presented in Krewski et al., 2009). However, we have included consideration of studies with more refined surrogate measures of exposure in our discussion of uncertainty related to long-term mortality, since they can inform our interpretation of the degree of potential bias associated with the effect estimates used to model risks (see section 3.5.3).

- **Simulation of air quality levels that just meet either current or alternative standard levels**: For this analysis, we used a proportional rollback approach as the basis for simulating current and alternative standard levels for the core risk estimates that were generated.[10] However, as part of the sensitivity analysis, we also included application of a hybrid (non-proportional) adjustment procedure, which simulated a combination of regional and local controls (see section 3.2.3).

- **Characterization of PRB**: Consistent with the planned approach described in the Scope and Methods Plan, we used regional PRB estimates generated using a combination of GEOS-Chem and CMAQ modeling (these estimates were obtained directly from the assessments prepared for and summarized in the draft ISA – see section 3.2.2).

- **Selection of epidemiological studies to provide C-R functions**: In line with the planned approach outlined in the Scope and Methods Plan, in modeling risk associated with short-term $PM_{2.5}$ exposures, we focused on two large multi-city studies based on our conclusion that these studies provided more defensible effect estimates (see section 3.3.1 for additional details). C-R functions selected from

[9] An error was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. This impacts risk estimates generated for these air quality scenarios, as well as sensitivity analysis results involving this urban study area. While we have removed discussion of these risk estimates (and sensitivity analysis results) form the body of this report, there was insufficient time after identifying this error to either generate corrected risk estimates or remove the erroneous risk estimates from the summary tables (presented in Appendix E and F). We will correct this error and release updated results for the Pittsburgh study area as soon as is practicable and will include the corrected results in the next version of this document.

[10] As described in section 3.1, the risk assessment includes a set of core risk estimates based on application of model inputs having the greatest support in the literature. The analysis also includes a reasonable alternative set of risk estimates generated as part of the sensitivity analysis, where these estimates, while not having as much support as the core risk results, are still based on inputs having a reasonable degree of support in the literature.

several single city studies were also included in our analysis to provide coverage for additional health effect endpoints associated with short-term $PM_{2.5}$ exposures (e.g., emergency department visits). Modeling of long-term exposure-related mortality focused on the latest reanalysis of the ACS dataset (Krewski et al., 2009). This study was published after the Scope and Methods Plan was the subject of a CASAC consultation and public review and, therefore, was not included in the preliminary set of studies under consideration (EPA, 2009b, Table 3-2). However, as discussed in section 3.3.3, use of this study is consistent with the planned approach presented in the Scope and Methods Plan and, extends and expands upon previous publications presenting evaluations of the ACS long-term cohort study.

- **Characterization of uncertainty and variability**: The approach for characterizing uncertainty and variability in the current risk assessment closely follows the planned approach as outlined in the Scope and Methods Plan. However, reflecting consideration of comments received from CASAC, we have considered: (a) the WHO Guidance on Characterizing and Communicating Uncertainty In Exposure Assessment (WHO, 2008) to ensure that our approach is consistent with the recommended step-wise process described in that document, and (b) the interpretation of the results of our sensitivity analysis and the most effective ways to communicate these results as a set of reasonable additional risk estimates that supplement the core estimates, recognizing that they do not represent a formal uncertainty distribution (see section 4.3).
- **Representativeness analysis for the urban study areas**: Consistent with the approach described in the Scope and Methods Plan, EPA staff have completed a representativeness analysis providing a comparison of the 15 urban study areas against national distributions for key PM risk-related attributes to evaluate whether they are more nationally-representative, or more representative of a particular portion of the distribution for a given parameter (see section 4.4).
- **National-scale health impact analysis**: Consistent with the approach described in the Scope and Methods Plan, a national-scale $PM_{2.5}$-related long-term exposure mortality analysis, using recent air quality data for the continental U.S. has been completed (see chapter 5).

2.4.2 Population exposure analysis

Following release of the Scope and Methods Plan, we continued development of the approach for conducting a population exposure analysis, with the goal of completing the analysis as part of the current PM review. However, this additional design work further emphasized the need for clearly outlining the purpose of the analysis, including specific ways in which the results would be used to interpret the estimates generated from the risk assessment (e.g., potentially identifying sources of exposure measurement error associated with the epidemiological studies providing the C-R functions and the magnitude of the impact of those sources of error on risk estimates). When combined with consideration for CASAC comments on the Scope and Methods Plan which emphasized the same point regarding the importance of clearly outlining how the estimates from the analysis would be used, we decided to continue methods development work, rather than attempt to complete a preliminary population exposure analysis as part of this review. Development of the population exposure analysis methodology is ongoing and we anticipate considering any results from this exposure assessment within the context of the next PM NAAQS review.

2.5 ALTERNATIVE STANDARD LEVELS INCLUDED IN THE RISK ASSESSMENT

As noted earlier, EPA staff has modified the scope of the risk assessment to focus on evaluating potential public health impacts of fine particles only and consequently consideration of alternative standards to be evaluated in the risk assessment were developed exclusively for $PM_{2.5}$. Specifically, we selected alternative levels for the annual and 24-hour $PM_{2.5}$ standards that we judged to be appropriate to evaluate in the context of this quantitative risk assessment. Alternative averaging times and forms were not considered in our analyses. The averaging times and forms used in evaluating alternative levels were those associated with the current 24-hour and annual standards.[11] We note that all of the basic elements of the standards (e.g., indicator, averaging time, level, and form) will be discussed in a forthcoming draft Policy Assessment which will present staff conclusions based on both evidence-based and risk-based approaches to inform judgments that the EPA Administrator must make in deciding whether to retain or revise the existing PM standards.

In selecting alternative levels for the annual and 24-hour $PM_{2.5}$ standards for the purpose of inclusion in the quantitative risk assessment, we focused on the range of standard levels likely to be discussed in the draft PA. This range of alternative standard levels, in turn, reflects consideration of ambient air quality levels associated with health effects as reflected in key short- and long-term $PM_{2.5}$ exposure epidemiological studies discussed in the draft ISA.

As discussed further in section 3.3.3, in selecting alternative levels for consideration in the risk assessment, we placed emphasis on effect estimates reported in multi-city studies because these studies have a number of advantages compared to single-city studies including: (1) multi-city studies reflect ambient $PM_{2.5}$ levels and potential health impacts across a range of diverse locations; (2) multi-city studies “clearly do not suffer from potential omission of negative analyses due to ‘publication bias’” (EPA, 2004a, p. 8-30); and (3) multi-city studies generally have higher statistical power.

[11] The “form” of a standard defines the air quality statistic that is compared to the level of the standard in determining whether an area attains the standard. The form of the 24-hour $PM_{2.5}$ standard is the 98^{th} percentile of the distribution of 24-hour $PM_{2.5}$ concentrations at each population-oriented monitor within an area, averaged over 3 years. The form of the annual $PM_{2.5}$ standard is an annual arithmetic mean, averaged over 3 years, from single or multiple community-oriented monitors.

Specifically, regarding alternative levels for the annual $PM_{2.5}$ standard to be evaluated in this risk assessment, we first considered long-term average $PM_{2.5}$ concentrations associated with health effects observed in long-term epidemiological studies as summarized in Figure 2-2 of the draft ISA. In general, the draft ISA concludes that the association between increased risk of mortality and long-term $PM_{2.5}$ exposure "becomes more precise and consistently positive in locations with mean $PM_{2.5}$ concentrations of 13.5 μg/m^3 and above." (EPA, 2009a, section 2.3.1.2). The draft ISA also concludes that the strongest evidence for cardiovascular-related effects related to long-term $PM_{2.5}$ exposures has been reported in large, multi-city U.S.-based studies and, specifically, one of these studies, the Women's Health Initiative (WHI) Study, "reports associations between $PM_{2.5}$ and cardiovascular effects among post-menopausal women using a 1-yr average $PM_{2.5}$ concentration (mean = 13.5 μg/m^3)" (EPA, 2009a, section 2.3.1.2). In addition, we evaluated long-term average $PM_{2.5}$ concentrations in short-term exposure studies that reported statistically significant effects. More specifically, as reported in the draft ISA, both cardiovascular and respiratory morbidity effects (e.g., emergency department visits, hospital admissions) have been observed and become "more precise and consistently positive in locations with mean $PM_{2.5}$ concentrations of 13 μg/m^3 and above" (EPA, 2009a, section 2.3.1; also see Figure 2-1).[12]

Based on the available epidemiological evidence indicating effects associated with a range of annual averaged $PM_{2.5}$ concentrations, as briefly described above, we selected levels of 12 and 13 μg/m^3 as the alternative annual standard levels to be evaluated in the quantitative risk assessment.

In identifying alternative levels for the 24-hour $PM_{2.5}$ standard to be evaluated in this risk assessment, we considered the ambient $PM_{2.5}$ levels associated with mortality and morbidity effects as reported in key short-term epidemiological studies. We focused on the 98th percentile $PM_{2.5}$ ambient levels reported in two multi-city studies that provided C-R functions used in the core risk assessment, Zanobetti and Schwartz (2009) and Bell et al. (2008). The focus on the 98th percentile of the 24-hour $PM_{2.5}$ concentrations observed in the epidemiological studies is consistent with the approach used in the prior PM NAAQS review and is consistent with the current form of the 24-hour $PM_{2.5}$ standard.

The draft ISA presents 98th percentile 24-hour $PM_{2.5}$ values for each of the 112 urban areas included in the Zanobetti and Schwartz (2009) short-term mortality study (EPA, 2009a, Figure 6-22). We evaluated the trend in these county-level 98th percentile 24-hour $PM_{2.5}$

[12] We note that the association between long-term mean ambient $PM_{2.5}$ levels and statistically-significant health effects reported in short-term exposure studies would be dependent on the specific relationship between day-to-day variation in the 24-hour $PM_{2.5}$ levels (in the underlying study counties) and the associated long-term mean $PM_{2.5}$ levels (i.e., the association between mean $PM_{2.5}$ levels and short-term health effects, would not hold for counties with notably different relationships between short-term day-to-day variation and longer-term mean $PM_{2.5}$ levels).

levels in conjunction with the statistical significance of the associated county-level effect estimates. If we had found an association between the air quality levels and statistically significant effect estimates (i.e., higher 98th percentile $PM_{2.5}$ levels were consistently associated with statistically significant effect estimates), then it would have been reasonable to consider the lowest 98th percentile $PM_{2.5}$ level associated with the set of counties for which a statistically significant effect estimates was observed as the basis for selecting an alternative standard level for evaluation in this risk assessment. However, no such association was observed. Rather, we observed mixed results with no clear correlation between 98th percentile air quality levels and statistically significant effect estimates. Therefore, we focused on the overall range of 98th percentile values across the entire set of counties and considered the lower quartile of that distribution as representative of a reasonably cautious approach for identifying alternative levels for consideration in the risk assessment. The 10th and 25th percentiles values were 25.5 and 29.8 µg/m^3, respectively (Zanobetti, 2009). We note that the overall 98th percentile value across the entire set of urban areas analyzed in Zanobetti and Schwartz. (2009) was 34.3 µg/m^3 (EPA, 2009a, Figure 2-1; Zanobetti and Schwartz, 2009)

Next, we completed a similar analysis of the county-level ambient air quality data (Bell, 2009) for the 202 counties associated with the Bell et al. (2008) study. Analysis of the overall distribution of 98th percentile values across the entire dataset resulted in identifying 10th and 25th percentile values of about 24.4 and 29.3 µg/m^3, respectively. We note that the overall 98th percentile value across the entire set of counties analyzed in Bell et al. (2008)) was 34.2 µg/m^3 (EPA, 2009a, Table 6-11; Bell, 2009).

Based on the available epidemiological evidence indicating effects associated with a range of 98th percentile 24-hour $PM_{2.5}$ concentrations, as briefly described above, we selected levels of 25 and 30 µg/m^3 as the alternative 24-hour standard levels to be evaluated in this quantitative risk assessment.

Once alternative levels were identified for the annual and 24-hour PM standards, the next step was to identify specific combinations of these standard levels to be considered in the risk assessment. In selecting the pairing of annual and 24-hour standard levels, we considered which standard was predicted to be controlling across the set of 15 urban study areas (either the annual or 24-hour standard will be the "controlling standard" at a given location, depending on the design value associated with that location).[13] Ultimately, for this risk assessment, the goal was to select combinations of annual and 24-hour levels that would result in a mixture of behavior in terms of which standards would control across the various urban study areas. For example, with the 12/35 combination, the annual level of 12 µg/m^3 is the

[13] The controlling standard is the standard which requires the greatest percentage reduction to get the design value monitor to meet that standard - see section 3.3.3 for additional detail on the issue of controlling standards.

controlling standard for all 15 urban study areas, while with the 12/25 combination, the annual standard is the controlling standard at some locations and the 24-hour standard is the controlling standard at other locations. Consideration of these factors resulted in a set of four alternative combinations of annual and 24-hour standards being identified for inclusion in the risk assessment.

The full set of air quality scenarios included in the risk assessment, including the recent conditions air quality scenario and current standards scenario along with the four alternative sets of standards are as follows:

- Recent conditions (risk estimates based on ambient $PM_{2.5}$ monitoring data for the analysis period – 2005 to 2007)
- Current $PM_{2.5}$ NAAQS: annual 15 $\mu g/m^3$; 24-hour 35 $\mu g/m^3$
- Alternative $PM_{2.5}$ standards: annual 13 $\mu g/m^3$; 24-hour 35 $\mu g/m^3$
- Alternative $PM_{2.5}$ standards: annual 12 $\mu g/m^3$; 24-hour 35 $\mu g/m^3$
- Alternative $PM_{2.5}$ standards: annual 13 $\mu g/m^3$; 24-hour 30 $\mu g/m^3$
- Alternative $PM_{2.5}$ standards: annual 12 $\mu g/m^3$; 24-hour 25 $\mu g/m^3$

3 METHODS USED IN URBAN CASE STUDY ANALYSIS

This section provides an overview of the methods used in the risk assessment. Section 3.1 discusses the basic structure of the risk assessment, identifying the modeling elements and related sources of input data needed for the analysis. Section 3.2 discusses air quality considerations. Section 3.3 discusses the selection of health endpoints, urban study areas and C-R functions from key epidemiological studies used in modeling those endpoints. Section 3.4 discusses baseline health effects incidence rates. Finally, section 3.5 describes how uncertainty and variability are addressed in the risk assessment.

3.1 GENERAL APPROACH

3.1.1 Basic Structure of the Risk Assessment

The general approach used in both the prior and the current PM risk assessment relies upon C-R functions which have been estimated in epidemiological studies. Since these studies estimate C-R functions using ambient air quality data from fixed-site, population-oriented monitors, the appropriate application of these functions in a PM risk assessment similarly requires the use of ambient air quality data at fixed-site, population-oriented monitors.

The general PM health risk model, illustrated in Figure 3-1, combines information about $PM_{2.5}$ air quality for specific urban areas with C-R functions derived from epidemiological studies, baseline health incidence data for specific health endpoints, and population estimates to derive estimates of the annual incidence of specified health effects attributable to ambient $PM_{2.5}$ concentrations under different air quality scenarios. The analyses were conducted for recent air quality and for air quality simulated to reflect attainment of current and alternative suites of $PM_{2.5}$ ambient standards.

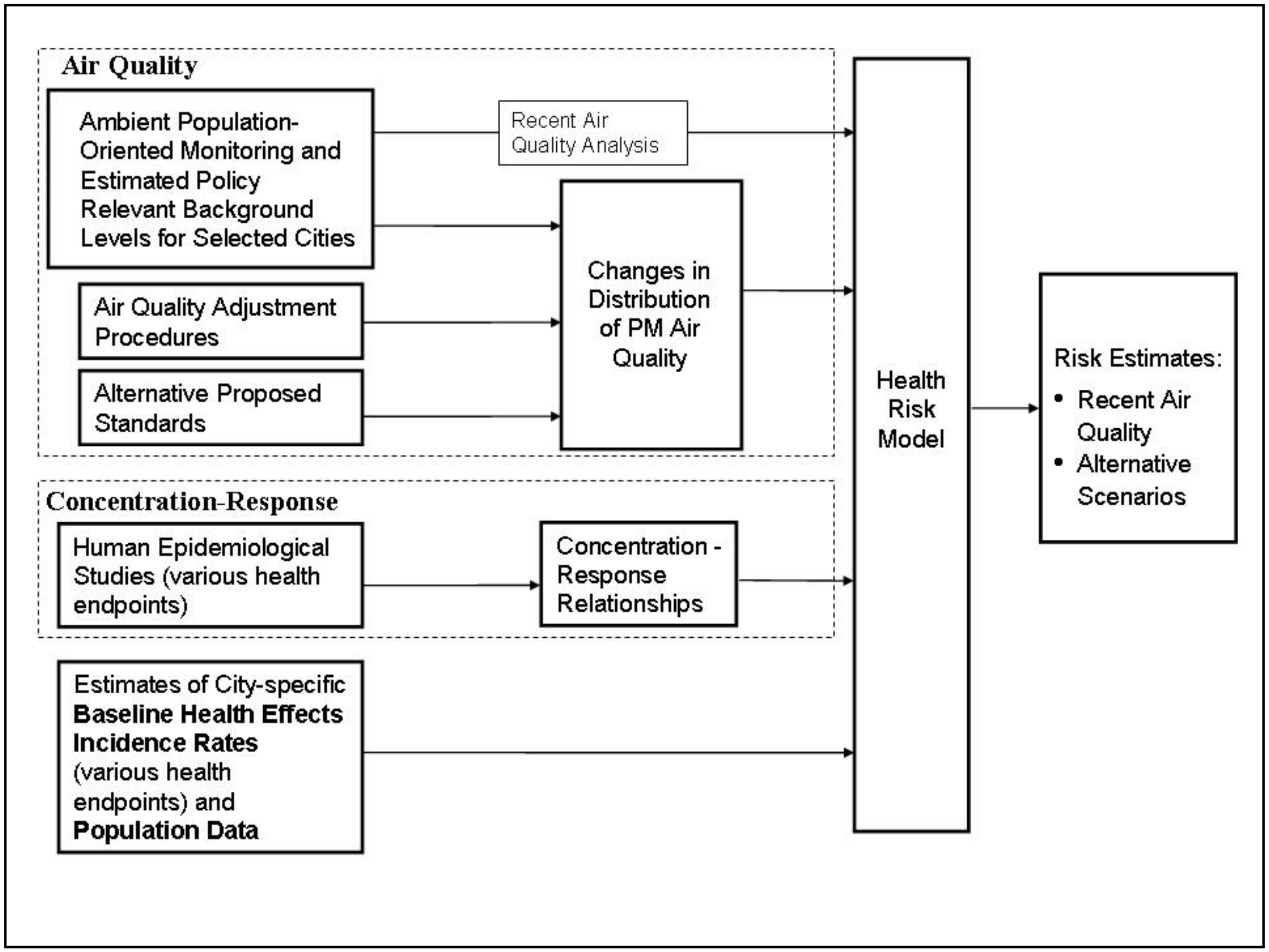
The $PM_{2.5}$ risk assessment was implemented within TRIM.Risk, the component of EPA's Total Risk Integrated Methodology (TRIM) model that estimates human health risks.[14] In the first part of the risk assessment, we estimate health effects incidence associated with recent $PM_{2.5}$ levels. In the second part, we estimate the reduced health effects incidence associated with those $PM_{2.5}$ concentrations that would result if the current or alternative $PM_{2.5}$ standards were just met in the assessment locations, as well as the percent reductions in incidence from incidence under the current suite of standards. Both parts of the risk assessment consider only the incidence of health effects associated with $PM_{2.5}$ concentrations in excess of either policy-relevant background (PRB) for evaluating effects associated with

[14] For more detailed information about TRIM.Risk, go to: http://www.epa.gov/ttn/fera/trim_risk.html

short-term $PM_{2.5}$ concentrations or the lowest measured level (LML) for evaluating effects associated with long-term $PM_{2.5}$ concentrations.

Consistent with past risk assessments for NAAQS reviews, the risk assessment is intended to estimate risks attributable to anthropogenic sources and activities, and thus risks are only estimated for concentrations in excess of PRB levels. For all health endpoints associated with short-term exposure to $PM_{2.5}$, the risk assessment considers only the incidence of health effects associated with $PM_{2.5}$ concentrations in excess of PRB levels. In the studies estimating a relationship between mortality and long-term exposure to $PM_{2.5}$, however, the LMLs in the studies were substantially above PRB. Thus, estimating risk down to PRB would have required substantial extrapolation of the estimated C-R functions below the range of the data on which they were estimated. We therefore estimated risk only down to the LML to avoid extrapolating the estimated C-R functions too far below the range of the $PM_{2.5}$ data on which they were estimated. To provide consistency across the long-term exposure C-R functions, however, and, in particular, to avoid the choice of LML unduly influencing the results of the risk assessment, we selected a single LML – 5.8 $\mu g/m^3$ from the later exposure period used in Krewski et al. (2009) – to be used in all cases involving long-term exposure.

Figure 3-1. Major components of particulate matter health risk assessment.



For each health effect that has been associated with $PM_{2.5}$, the risk assessment may be viewed as assessing the incidence of the health effect associated with $PM_{2.5}$ concentrations under a given air quality scenario (e.g., a scenario in which $PM_{2.5}$ concentrations just meet a specified set of standards) above PRB or the LML . Equivalently, the risk assessment may be viewed as assessing the change in incidence of each health effect associated with a change in $PM_{2.5}$ concentrations from some upper levels (e.g., $PM_{2.5}$ concentrations that just meet a specified set of standards) to specified lower levels (PRB levels or the LML).

To estimate the change in incidence of a given health effect resulting from a given change in ambient $PM_{2.5}$ concentrations in an assessment location, the following analysis inputs are necessary:

- **Air quality information including**: (1) $PM_{2.5}$ air quality data from one or more recent years from population-oriented monitors in the assessment location, (2) estimates of $PM_{2.5}$ PRB concentrations appropriate to this location, and (3) a method for adjusting the air quality data to reflect patterns of air quality change estimated to occur when the area just meets the specified standards. (These air quality inputs are discussed in more detail in section 3.2).
- **C-R function(s)** which provide an estimate of the relationship between the health endpoint of interest and $PM_{2.5}$ concentrations (preferably derived in the assessment location, although functions estimated in other locations can be used at the cost of increased uncertainty -- see section 3.5.3). For $PM_{2.5}$, C-R functions are available from epidemiological studies that assessed $PM_{2.5}$-related health effects associated with either short- or long-term exposures. (Section 3.1.2 describes the role of C-R functions in estimating health risks associated with $PM_{2.5}$).
- **Baseline health effects incidence rate and population**. The baseline incidence rate provides an estimate of the incidence rate (number of cases of the health effect per year, usually per 10,000 or 100,000 general population) in the assessment location corresponding to recent ambient $PM_{2.5}$ levels in that location. To derive the total baseline incidence per year, this rate must be multiplied by the corresponding population number (e.g., if the baseline incidence rate is number of cases per year per 100,000 population, it must be multiplied by the number of 100,000s in the population). (Section 3.4 summarizes considerations related to the baseline incidence rate and population data inputs to the risk assessment).

As noted below (in section 3.2.1), the risk assessment was carried out using three years of recent air quality data –2005, 2006, and 2007. We matched the population data used in the risk assessment to the year of the air quality data. For example, when we used 2005 air quality data, we used 2005 population estimates. Because it was not possible to obtain the necessary data to calculate baseline incidence rates separately for each of the three years for each of the risk assessment locations, we calculated these rates for a single year, under the assumption that these rates are unlikely to have changed significantly from 2005 to 2007. The calculation of baseline incidence rates is described in detail in section 3.4.

The risk assessment procedures described in more detail below are diagramed in Figure 3-2 for analyses based on short-term exposure studies and in Figure 3-3 for analyses based on long-term exposure studies.

For this risk assessment, we have developed a core (primary) set of risk results based on the application of modeling element choices (e.g., C-R functions, lag periods) that we believe have the greatest overall support in the literature (hereafter referred to as the "core" results). While it is not possible at this time to assign quantitative levels of confidence to these core risk estimates, EPA does believe that these estimates are generally based on inputs having higher overall levels of confidence, relative to risk estimates that could have been generated using other inputs identified in the literature. In addition, as discussed above in section 2.1 and later in section 3.5, we have also used single-element and multi-element sensitivity analysis techniques to generate a set of reasonable alternative risk estimates based on the application of alternative modeling element choices that, while not having as much support in the literature as those used in the core analysis, do still represent plausible inputs.

The results of these sensitivity analyses allow us to gain insights into which sources of uncertainty may have the greatest impact on risk estimates when acting alone, or in combination with other sources of uncertainty. In addition, the sensitivity analysis-based risk estimates also provide us with an additional set of reasonable risk results that allow us to place the results of the core analysis in context with regard to uncertainty. The potential utility of the sensitivity analysis-based risk estimates in informing consideration of uncertainty in the core results is discussed in section 4.5.2. A number of modeling elements are used in differentiating core analyses from sensitivity analyses (e.g., C-R function shape, alternative effect estimates, alternative lag structures, different methods used to rollback air quality to simulate attainment to current or alternative standard levels, application of PRB versus LML). Specific choices made in relation to individual modeling elements in differentiating the core analysis from sensitivity analyses are described, as appropriate, in the sections that follow, which cover specific aspects of the risk assessment design.

Figure 3-2. Flow diagram of risk assessment for short-term exposure studies.

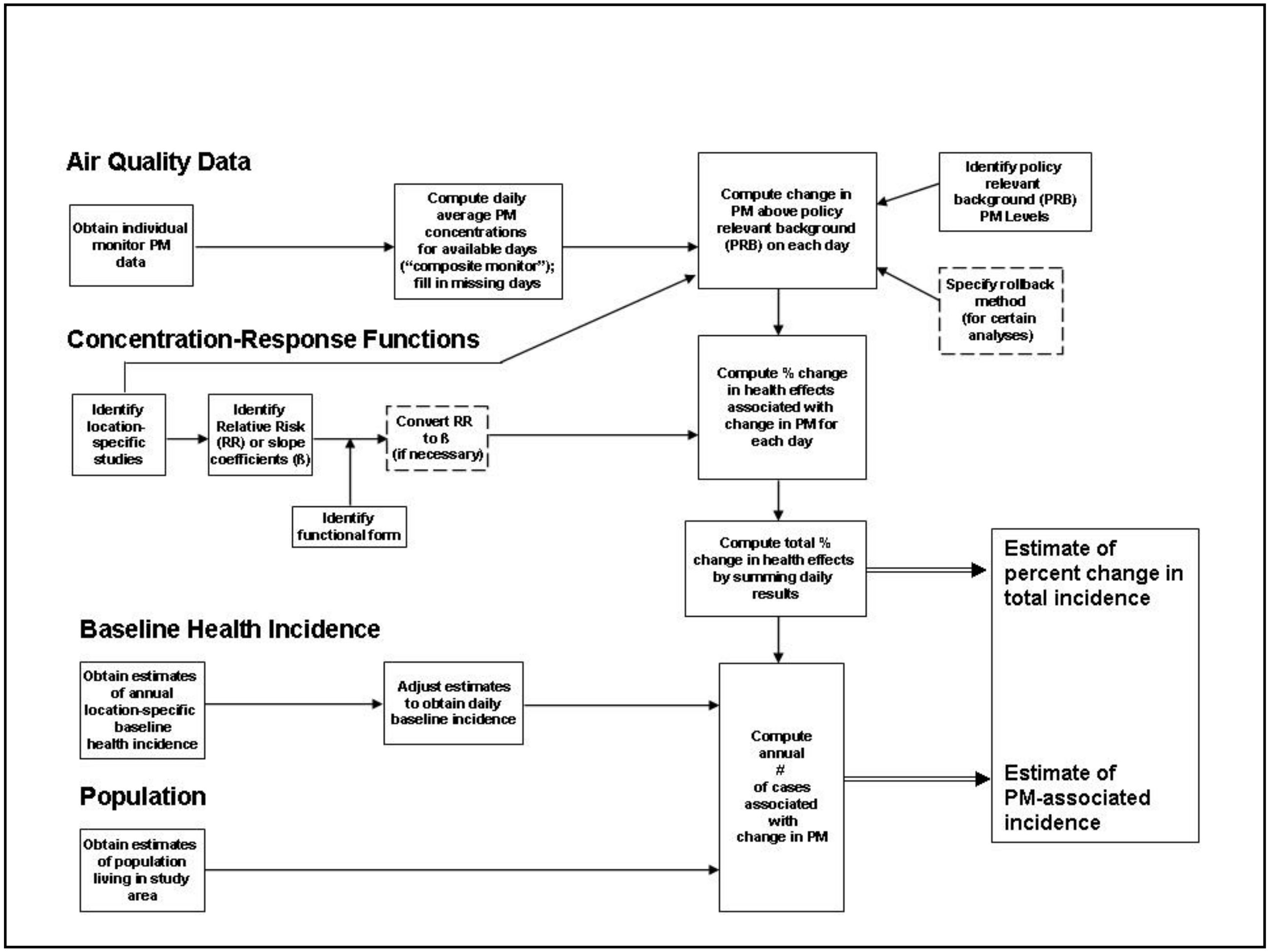
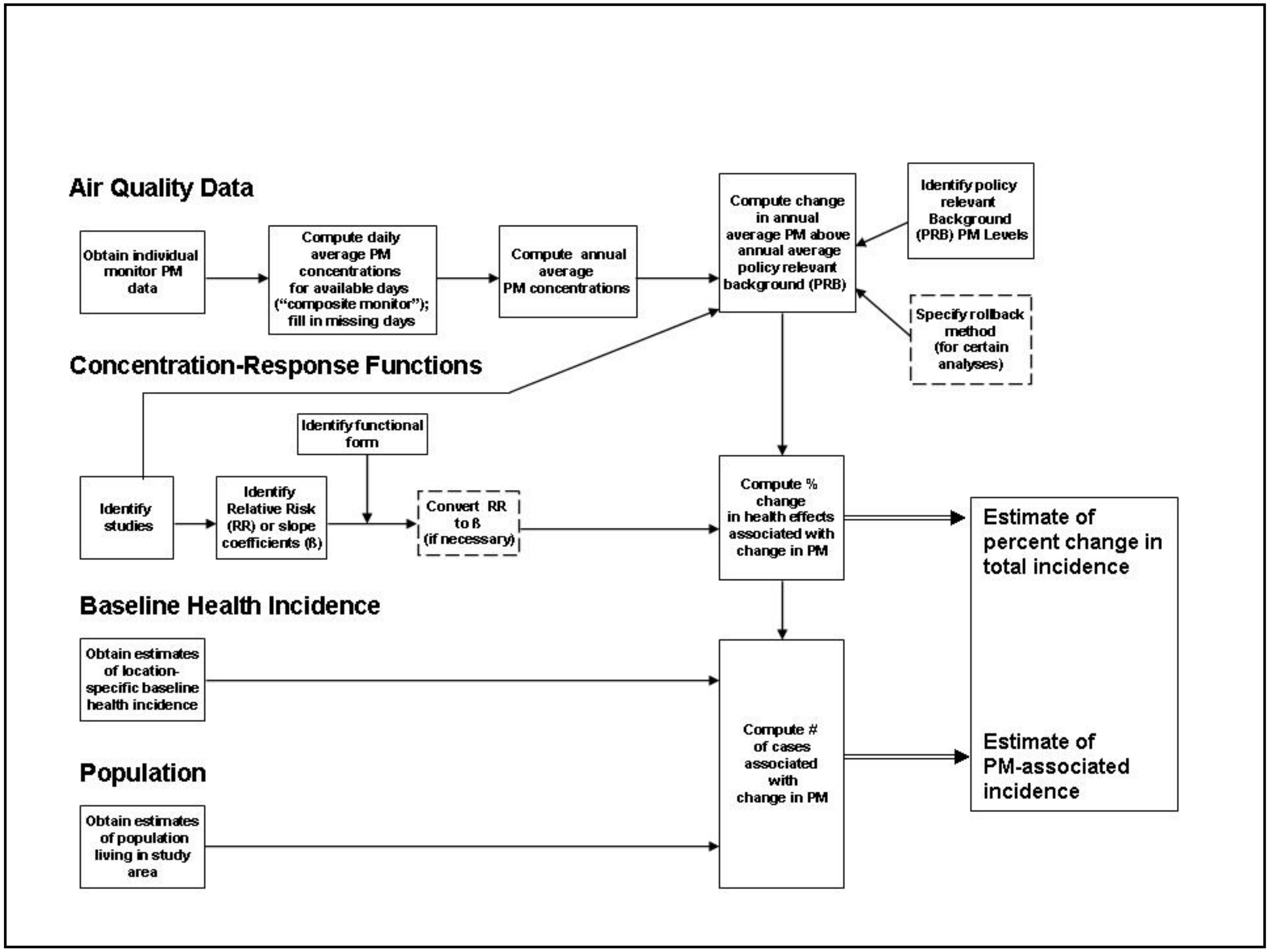


Figure 3-3. Flow diagram of risk assessment for long-term exposure studies.



3.1.2 Calculating PM-Related Health Effects Incidence

3.1.2.1 General approach

The C-R functions used in the risk assessment are empirically estimated relations between average ambient concentrations of $PM_{2.5}$ and the health endpoints of interest (e.g., mortality or hospital admissions associated with short- and long-term exposure to $PM_{2.5}$) reported by epidemiological studies for specific locations. This section describes the basic method used to estimate changes in the incidence of a health endpoint associated with changes in PM, using a "generic" C-R function of the most common functional form.

Although some epidemiological studies have estimated linear C-R functions and some have estimated logistic functions, most of the studies used a method referred to as "Poisson regression" to estimate exponential (or log-linear) C-R functions in which the natural logarithm of the health endpoint is a linear function of $PM_{2.5}$:

$$y = Be^{\beta x} \qquad (1)$$

where x is the ambient $PM_{2.5}$ level, y is the incidence of the health endpoint of interest at $PM_{2.5}$ level x, β is the coefficient of ambient $PM_{2.5}$ concentration, and B is the incidence at x=0, i.e., when there is no ambient $PM_{2.5}$. The relationship between a specified ambient $PM_{2.5}$ level, x_0, for example, and the incidence of a given health endpoint associated with that level (denoted as y_0) is then

$$y_0 = Be^{\beta x_0}. \qquad (2)$$

Because the log-linear form of a C-R function (equation (1)) is by far the most common form, we use this form to illustrate the "health impact function" used in the $PM_{2.5}$ risk assessment.

If we let x_0 denote the baseline (upper) $PM_{2.5}$ level, and x_1 denote the lower $PM_{2.5}$ level, and y_0 and y_1 denote the corresponding incidences of the health effect, we can derive the following relationship between the change in x, $\Delta x = (x_0 - x_1)$, and the corresponding change in y, Δy, from equation (1)[15]:

$$\Delta y = (y_0 - y_1) = y_0[1 - e^{-\beta \Delta x}]. \qquad (3)$$

[15] If $\Delta x < 0$ – i.e., if $\Delta x = (x_1 - x_0)$ – then the relationship between Δx and Δy can be shown to be $\Delta y = (y_1 - y_0) = y_0[e^{\beta \Delta x} - 1]$. If Δx < 0, Δy will similarly be negative. However, the *magnitude* of Δy will be the same whether $\Delta x > 0$ or $\Delta x < 0$ – i.e., the absolute value of Δy does not depend on which equation is used.

Alternatively, the difference in health effects incidence can be calculated indirectly using relative risk. Relative risk (RR) is a measure commonly used by epidemiologists to characterize the comparative health effects associated with a particular air quality comparison. The risk of mortality at ambient $PM_{2.5}$ level x_0 relative to the risk of mortality at ambient $PM_{2.5}$ level x_1, for example, may be characterized by the ratio of the two mortality rates: the mortality rate among individuals when the ambient $PM_{2.5}$ level is x_0 and the mortality rate among (otherwise identical) individuals when the ambient $PM_{2.5}$ level is x_1. This is the RR for mortality associated with the difference between the two ambient $PM_{2.5}$ levels, x_0 and x_1. Given a C-R function of the form shown in equation (1) and a particular difference in ambient $PM_{2.5}$ levels, Δx, the RR associated with that difference in ambient $PM_{2.5}$, denoted as $RR_{\Delta x}$, is equal to $e^{\beta \Delta x}$. The difference in health effects incidence, Δy, corresponding to a given difference in ambient $PM_{2.5}$ levels, Δx, can then be calculated based on this $RR_{\Delta x}$ as:

$$\Delta y = (y_0 - y_1) = y_0[1 - (1/RR_{\Delta x})]. \tag{4}$$

Equations (3) and (4) are simply alternative ways of expressing the relationship between a given difference in ambient $PM_{2.5}$ levels, $\Delta x > 0$, and the corresponding difference in health effects incidence, Δy. These health impact equations are the key equations that combine air quality information, C-R function information, and baseline health effects incidence information to estimate ambient $PM_{2.5}$ health risk.

3.1.2.2 Short-term vs. long-term exposure

C-R functions that use as input annual average $PM_{2.5}$ levels (or some function of these, such as the average over a period of several years) relate these to the annual incidence of the health endpoint – i.e., in such studies x in equation (1) above is the average $PM_{2.5}$ concentration over a period of one or more years, meant to represent long-term exposure, and y is the annual incidence of the health effect associated with that long-term exposure.

C-R functions that use as input 24-hour average $PM_{2.5}$ levels (or some function of these, such as the average over one or more days) relate these to the daily incidence of the health endpoint – i.e., in such studies x in equation (1) above is the average $PM_{2.5}$ concentration over a period of one or a few days (short-term exposure), and y is the daily incidence of the health effect associated with that short-term exposure.

There are several variants of the short-term (daily) C-R function. Some C-R functions were estimated by using moving averages of ambient $PM_{2.5}$ to predict daily health effects incidence. Such a function might, for example, relate the incidence of the health effect on day t to the average of $PM_{2.5}$ concentrations on days t and (t-1). Some C-R functions consider the relationship between daily incidence and daily average $PM_{2.5}$ lagged a certain number of days.

For example, a study might estimate the C-R relationship between mortality on day *t* and average $PM_{2.5}$ on a prior day (*t*-1). A few studies have estimated distributed lag models, in which health effect incidence is a function of $PM_{2.5}$ concentrations on several prior days – that is, the incidence of the health endpoint on day *t* is a function of the $PM_{2.5}$ concentration on day *t*, day (*t*-1), day (*t*-2), and so forth. Such models can be reconfigured so that the sum of the coefficients of the different $PM_{2.5}$ lags in the model can be used to predict the changes in incidence on several days. For example, corresponding to a change in PM on day *t* in a distributed lag model with 0-day, 1-day, and 2- day lags considered, the sum of the coefficients of the 0-day, 1-day, and 2-day lagged $PM_{2.5}$ concentrations can be used to predict the sum of incidence changes on days *t*, (*t*+1) and (*t*+2).

Most daily time-series epidemiological studies estimated C-R functions in which the PM-related incidence on a given day depends only on same-day PM concentration or previous-day PM concentration (or some variant of those, such as a two-day average concentration). Such models necessarily assume that the longer pattern of PM levels preceding the PM concentration on a given day does not affect mortality on that day. To the extent that PM-related mortality on a given day is affected by PM concentrations over a longer period of time, then these models would be mis-specified, and this mis-specification would affect the predictions of daily incidence based on the model.

The extent to which time-series studies using single-day $PM_{2.5}$ concentrations may misrepresent the relationship between short-term $PM_{2.5}$ exposure and mortality is unknown. However, there is some evidence, based on analyses of PM_{10} data, that mortality on a given day is influenced by prior PM exposures up to more than a month before the date of death (Schwartz, 2000). The extent to which short-term exposure studies (including those that consider distributed lags) may not capture the full impact of long-term exposures to $PM_{2.5}$ is similarly not adequately understood, although the current evidence (e.g., Krewski et al., 2009; Krewski et al., 2000) suggests that there is a substantial impact of long-term exposures on health effects that is not picked up in the short-term exposure studies.

3.1.2.3 Calculating annual incidence

The risk assessment estimated health effects incidence, and changes in incidence, on an annual basis, for 2005, 2006, and 2007. For mortality, both short-term and long-term exposure studies have reported estimated C-R functions. As noted above, most short-term exposure C-R functions estimated by daily time-series epidemiological studies relate daily mortality to same-day $PM_{2.5}$ concentration or previous-day $PM_{2.5}$ concentration (or some variant of those).

To estimate the daily health impacts of 24-hour average ambient $PM_{2.5}$ levels above PRB, C-R functions from short-term exposure studies were used together with estimated changes in 24-hour ambient $PM_{2.5}$ concentrations to calculate the daily changes in the incidence of the health endpoint. After daily changes in health effects were calculated, an annual change was calculated by summing the daily changes.

The mortality associated with long-term exposure is likely to include mortality related to short-term exposures as well as mortality related to longer-term exposures. As discussed previously, estimates of daily mortality based on the time-series studies also are likely influenced by prior PM exposures. Therefore, the estimated annual incidences of mortality calculated based on the short- and long-term exposure studies are not likely to be completely independent and should not be added together. While we can characterize the statistical uncertainty surrounding the estimated $PM_{2.5}$ coefficient in a reported C-R function, there are other sources of uncertainty associated with the C-R functions used in the risk assessment that are addressed via sensitivity analyses and/or qualitatively discussed in section 3.5.3.

3.2 AIR QUALITY INPUTS

3.2.1 Characterizing recent conditions

As noted earlier, a major input to the $PM_{2.5}$ risk assessment is ambient $PM_{2.5}$ air quality data for each assessment location. Twenty-four hour $PM_{2.5}$ air quality data for 2005, 2006, and 2007 were obtained for each of the urban study areas from monitors in EPA's Air Quality System (AQS). To characterize $PM_{2.5}$ air quality in each risk assessment location as accurately as possible, we used only those monitors that were located within the county or counties that were analyzed in the epidemiological studies used to select C-R functions.. In a few cases, an urban area was delineated differently by two or more epidemiological studies used in the risk assessment. For example, Birmingham, AL was defined as Blount, Jefferson, Shelby, St. Clair, and Walker Counties in one study and as only Jefferson County in another study. In such cases, we matched our delineation of the urban study area to that used in each study, resulting in two or more different delineations of the urban study area and identified them as, for example, Birmingham 1 and Birmingham 2. The counties and the number of air quality monitors included within each urban area are given in Table 3-1.

In order to be consistent with the approach generally used in the epidemiological studies that estimated $PM_{2.5}$ C-R functions, the average ambient $PM_{2.5}$ concentration on each day for which measured data were available was deemed most appropriate for use in the risk assessment. Consistent with the approach used in the prior PM risk assessment, a composite monitor data set was created for each assessment location based on a composite of all monitors located within each urban study area. Specifically, the value at the composite monitor on a given day was calculated as the average of the values at those monitors in a specific urban study area that reported a measured value for that day.

There were some days on which none of the monitors in a risk assessment location reported $PM_{2.5}$ concentrations. The numbers of missing days at the composite monitors in the risk assessment locations are given in Table 3-1. We used 7-day moving averages to fill in missing values at composite monitors.

To summarize, air quality data inputs for the risk assessment model were developed as follows: first we calculated the composite monitor value for each day. For any day that had a missing value at the composite monitor, we inserted the 7-day moving average centered on that day. We then evaluated the new series of composite monitor values (with missing days filled in as described); if any day still had a missing value, we filled it in with the 7-day moving average centered on the missing day, where the values in the 7-day moving average were calculated from the series created on the previous step. We repeated this process until all missing days were filled in.

Table 3-1. Numbers of Monitors and Numbers of Missing Days at Composite Monitors in Risk Assessment Locations from 2005 Through 2007.

Risk Assessment Location	Counties	Number of Monitors	Number of Missing Days at Composite Monitor Over the 3-Year Period*
Atlanta, GA - 1	Cobb, De Kalb, Fulton, Gwinnett	8	8
Atlanta, GA - 2	Cobb, De Kalb, Fulton	7	8
Atlanta, GA - 3	20-County MSA**	10	7
Baltimore, MD	Baltimore city, Baltimore county	8	2
Birmingham, AL – 1	Blount, Jefferson, Shelby, St. Clair, Walker	10	1
Birmingham, AL – 2	Jefferson	8	1
Dallas, TX	Dallas	6	21
Detroit, MI	Wayne	9	22
Fresno, CA	Fresno	3	40
Houston, TX	Harris	6	59
Los Angeles, CA	Los Angeles	10	0
New York, NY - 1	Kings, New York City (Manhattan), Queens, Richmond, Bronx	12	4
New York, NY - 2	New York City (Manhattan)	5	731***
Philadelphia, PA	Philadelphia	7	14
Phoenix, AZ	Maricopa	5	710
Pittsburgh, PA	Allegheny	12	1
Salt Lake City, UT	Salt Lake	7	4
St. Louis, MO - 1	Jefferson, Madison (IL), St. Louis, St. Louis City, St. Clair (IL)	15	0
St. Louis, MO - 2	Madison (IL), St. Louis, St. Louis City, St. Clair (IL)	14	1
Tacoma, WA	Pierce	1	741***

*The value on a given day at the composite monitor is the average of all monitors reporting on that day.
** Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, and Walton.
*** Note, that the sets of monitors for New York (Manhatten) have 1 in 3 day sampling, with sampling schedules synced across monitors. This means that for the three year simulation period, roughly 2/3 of the days

(i.e., 731) had no monitor coverage for the New York urban study area, resulting in a need to interpolate estimates for these days (for the composite monitor) using the approach described above. Similarly, with Tacoma, the single monitor at that location also has 1 in 3 day sampling, resulting again, in 2/3 of the days not having data with interpolation being used to derive estimates for those days (for the composite monitor).

Appendix A summarizes the $PM_{2.5}$ air quality data that were used in each of the assessment locations, including quarterly and annual counts, quarterly and annual averages, and the 98th percentile of the daily (24-hour) averages.

3.2.2 Estimating policy relevant background

PRB estimates used in the risk assessment model (see Table 3-2 below) were obtained from the draft ISA (Table 3.7-6, draft ISA, EPA, 2009a). These values were generated based on a combination of Community Multiscale Air Quality model (CMAQ) and Goddard Earth Observing System (GEOS)-Chem modeling as described in the draft ISA (see section 3.6.1.2). Annual values presented in Table 3-2 were used in modeling health endpoints associated with long-term exposure (in those sensitivity analysis scenarios where risk was modeled down to PRB – see Section 3.5.4). For health endpoints associated with short-term exposure (which involved modeling down to PRB, exclusively), quarterly values presented in Table 3-2 were used to represent the appropriate block of days within a simulated year.

Table 3-2 Regional Policy-Relevant Background Estimates Used in the Risk Assessment.

U.S. Region	Annual	January-March	April-June	July-September	October-December
Northeast	0.74	0.85	0.78	0.67	0.68
Southeast	1.72	2.43	1.41	1.41	1.64
Industrial Midwest	0.86	0.89	0.89	0.94	0.73
Upper Midwest	0.84	0.79	0.93	0.99	0.66
Southwest	0.62	0.61	0.76	0.70	0.40
Northwest	1.01	0.48	0.81	1.42	1.32
Southern California	0.84	0.54	0.92	1.21	0.67

3.2.3 Simulating air quality to just meet current and alternative standards

This section describes the methodology used to simulate ambient $PM_{2.5}$ levels in an area upon just meeting specified $PM_{2.5}$ standards. The form of the $PM_{2.5}$ standards promulgated in October 2006 requires that the 3-year average (rounded to the nearest 0.1 $\mu g/m^3$) of the annual means *from single monitors or the average of multiple monitors* must be at or below the level of the annual standard and the 3-year average (rounded to the nearest 1 $\mu g/m^3$) of the ninety-eighth percentile values *at each monitor* cannot exceed the level of the

24-hour standard. In determining attainment of the annual average standard, an area may choose to use either the spatially averaged concentrations across all population-oriented monitors, subject to meeting certain criteria detailed in Part 50, Appendix N, of the CFR, or it may use the highest 3-year average based on individual monitors. The most realistic simulation of just meeting both the annual and the 24-hour $PM_{2.5}$ standards in a location would require changing the distribution of 24-hour $PM_{2.5}$ concentrations at each monitor separately, reflecting the specific mix of local and regional controls impacting that particular location. This would require extensive analysis and assumptions about the nature of future control strategies that was considered beyond the scope of the previous risk assessment and is similarly considered beyond the scope of the current risk assessment.

In the previous PM risk assessment, just meeting the current or alternative $PM_{2.5}$ standards was simulated by changing 24-hour $PM_{2.5}$ concentrations at a "composite monitor," which represented the average of the monitors in a location. In the current PM risk assessment, just meeting the current or alternative $PM_{2.5}$ standards was simulated by changing 24-hour $PM_{2.5}$ concentrations at each monitor separately. This change was made because the current PM risk assessment considers two alternative approaches to simulating $PM_{2.5}$ concentrations that just meet a given set of standards. One of these approaches (the "proportional rollback" approach) was used in previous $PM_{2.5}$ risk assessments and involves proportional adjustments to monitor levels, in which $PM_{2.5}$ concentrations are reduced ("rolled back") by the same percentage each day. When this approach is used, it doesn't matter whether (1) $PM_{2.5}$ concentrations are first rolled back by the same percentage each day at each monitor, and then the composite monitor values are calculated from these monitor-specific values or (2) first the composite monitor values are calculated and then these are rolled back by the same percentage each day – the results will be the same.

The second approach (the "hybrid rollback" approach) used in a sensitivity analysis in some of the risk assessment locations (in comparison to the proportional rollback approach), has two steps: (1) first $PM_{2.5}$ concentrations are reduced at a specific monitor location within an urban study area and then additional monitors within that urban study area are adjusted to a lesser extent (with the magnitude of adjustment based on a distance-decay function); then (2) a proportional rollback of the adjusted $PM_{2.5}$ concentrations at all of the different monitors is carried out. This two-step approach is intended to simulate situations in which it is likely that attainment of a set of standards will be achieved by first implementing more localized controls to target a specific monitor (with lesser reductions resulting at other near-by monitors due to the influence of adopting more localized controls) followed by regional controls that result in a more universal (proportional) reduction across all the monitors in a study area. Because the initial step reflecting localized controls is non-proportional, this needs to be completed on the monitor datasets (associated with a particular study area) prior to construction of the composite monitor. However, once those non-proportional reductions have been implemented, a composite monitor can then be constructed (as described earlier) and the second step of conducting proportional adjustment to simulate the current or alternative set of standard levels, can be calculated for the composite monitor.

The percent reduction of 24-hour $PM_{2.5}$ concentrations in the proportional rollback approach (and in the second step of the hybrid rollback approach) at each monitor each day to simulate just meeting current and alternative set of standard levels is determined by the $PM_{2.5}$ annual and 24-hour design values. The annual design value (in µg/m^3) was calculated as follows:

- At each monitor, the annual average $PM_{2.5}$ concentration was calculated for each of the years 2005, 2006, and 2007, and these three annual average concentrations were then averaged.
- The maximum of these monitor-specific 3-year averages of annual averages is the annual design value, denoted dv_{annual};

The 98th percentile design value (in µg/m^3) was similarly calculated as follows:

- At each monitor, the 98th percentile 24-hour $PM_{2.5}$ concentration was calculated for each of the years 2005, 2006, and 2007, and these three 98th percentile concentrations were then averaged.
- The maximum of these monitor-specific 3-year averages of 98th percentile concentrations is the 24-hour design value, denoted $dv_{daily\ 98}$ (note, we will refer to the 98th percentile design value as the 24-hour design value throughout the rest of the document).

The annual and 24-hour design values used in assessing the current and alternative standards for $PM_{2.5}$ are given in Table 3-3. Note, that monitors that were closed in 2005 (and therefore, did not include monitoring data for the majority of the three year simulation period), or which were missing an entire year's worth of monitoring data during any of the three simulation years (2005, 2006 or 2007) were excluded from consideration as design value monitors, although these monitors were still used to construct composite monitors for purposes of estimating risks.

Table 3-3. EPA Design Values for Annual and \24-hour $PM_{2.5}$ Standards for the Period 2005-2007.*

Location	Annual (µg/m^3)	24-hour (µg/m^3)
Atlanta	17	35
Baltimore	16	37
Birmingham	19	44
Dallas	13	26
Detroit	17	43

Location	Annual (µg/m^3)	24-hour (µg/m^3)
Fresno	17	63
Houston	16	31
Los Angeles	20	55
New York	16	42
Philadelphia	15	38
Phoenix	13	32
Pittsburgh	20	60
Salt Lake City	12	55
St. Louis	17	39
Tacoma	10	43

*The calculation of design values is explained in the text above.

The percent reduction required to meet a standard (annual or 24-hour) was determined by comparing the design value for that standard with the level of the standard. Because pollution abatement methods are applied largely to anthropogenic sources of $PM_{2.5}$, rollbacks were applied only to $PM_{2.5}$ above estimated PRB levels. The percent reduction was determined by the controlling standard. For example, suppose both an annual and a 24-hour $PM_{2.5}$ standard are being simulated. Suppose p_a is the percent reduction required to just meet the annual standard (i.e., the percent reduction of daily $PM_{2.5}$ above background necessary to get the annual design value down to the current or alternative annual standard). Suppose p_d is the percent reduction required to just meet the 24-hour standard (i.e., the percent reduction of daily $PM_{2.5}$ above background necessary to get the 24-hour $PM_{2.5}$ design value down to the 24-hour standard). If p_d is greater than p_a, then all 24-hour average $PM_{2.5}$ concentrations above background are reduced by p_d percent. If p_a is greater than p_d, then all 24-hour average $PM_{2.5}$ concentrations are reduced by p_a percent. The method of rollbacks to meet a set of annual and 24-hour $PM_{2.5}$ standards is summarized as follows:

1. The percent by which the above-*PRB* portion of all daily $PM_{2.5}$ concentrations (at the composite monitor) would have to be reduced to just meet the annual standard (denoted std_a) is

$$p_a = 1 - \frac{(std_a - PRB_{avg})}{dv_{annual} - PRB_{avg})} ,$$

where PRB_{avg} is the average of the daily PRB concentrations.[16]

[16] In the previous PM risk assessment, a constant PRB level was assumed for all days, and that constant PRB level was used in the formulas to calculate percent rollbacks necessary to just meet a standard. It can be shown that, if PRB levels vary from day to day, the average PRB level takes the place of the constant PRB level in the previous formula, as shown in the above equation.

2. The percent by which the above-*PRB* portion of all 24-hour $PM_{2.5}$ concentrations (at the composite monitor) would have to be reduced to just meet the current or alternative 24-hour standard (denoted std_{d98}) is:

$$p_{d98} = 1 - \frac{(std_{d98} - PRB_{avg})}{dv_{daily98} - PRB_{avg})}$$

Let p_{max} = maximum of (maximum of p_a and p_{d98}) and zero.[17]

3. Then if PM_o denotes the original PM value on a given day (at the composite monitor), the rolled back PM value on that day, denoted PM_{rb}, is:

$$PM_{rb} = PRB + (PM_o - PRB)*(1 - p_{max}).$$

3.3 SELECTION OF MODEL INPUTS

3.3.1 Health endpoints

As noted in the Scope and Methods Plan, selection of health effect endpoints reflects consideration for a number of factors including: (a) the extent to which a particular health effect endpoint is considered significant from a public health standpoint, (b) the overall weight of evidence from the collective body of epidemiological, controlled human exposure, and toxicological studies and the determination made in the draft ISA as to whether there is a *causal* or likely causal relationship between $PM_{2.5}$ and the more general health effect category, and (c) whether there are well-conducted studies providing estimated C-R functions for specific health effect endpoints within the broader health effects category associated with ambient $PM_{2.5}$ levels (section 3.2.2, EPA, 2009b). An additional factor, not specifically mentioned in the Scope and Methods Plan, that we considered is the availability of baseline health effects incidence data that matches the study population(s) evaluated in the epidemiological study(ies) from which C-R function(s) were selected.

[17] If the percent rollback necessary to just meet the annual standard and the percent rollback necessary to just meet the 24-hour standard were both negative -- i.e., if both standards were already met -- then the percent rollback applied in the risk assessment was zero. That is, PM values were never increased, or "rolled up."

Based on application of the above criteria, as outlined in the Scope and Methods Plan, we identified the following health effects endpoint categories as candidates for inclusion in the risk assessment:

Health effect categories associated with short-term $PM_{2.5}$ exposure:

- Cardiovascular effects (causal relationship)
- Respiratory effects (likely causal relationship)
- Mortality (likely causal relationship)

Health effect categories associated with long-term $PM_{2.5}$ exposure:

- Cardiovascular effects (causal relationship)
- Respiratory effects (likely causal relationship)
- Mortality (likely causal relationship)

In addition, as noted in the Scope and Methods Plan, we considered expanding the focus of the risk assessment to include additional endpoints from health effects categories that had been initially judged in the draft ISA to have evidence from the scientific evidence evaluated that was *suggestive* of a casual relationship between ambient $PM_{2.5}$ measurements and the general category of health effects, if those additional endpoints allowed us to address potentially important policy issues related to the review of the PM NAAQS. In the Scope and Methods Plan, we cited birth outcomes as a potential candidate for inclusion in the $PM_{2.5}$ risk assessment based on this additional criterion, recognizing that, in considering endpoints classified as *suggestive* of a causal relationship, it would be important to appropriately characterize the additional uncertainty associated with the risk estimates (section 3.2.2, EPA, 2009).

In selecting the set of health effect endpoint categories (and associated endpoints) to include in the $PM_{2.5}$ risk assessment, we built upon the health effects evidence presented in the draft ISA (EPA, 2009a), as well as CASAC (Samet, 2009) and public comments received on the Scope and Methods Plan. Comments provided by CASAC regarding the selection of health effects endpoints included providing "a transparent algorithm for selecting endpoints based on the level of certainty and the relative and attributable risks" as well as the suggestion "that weight be given to the level of classification while still considering the Administrator's obligation to set a standard with a "margin of safety" as describe in the Clean Air Act" (Samet 2009, p.1). As an example, several CASAC members did not recommend a risk assessment based on birth outcomes, "in part because the level of evidence is still at a *suggestive* level (Samet 2009, p. 1-2).

In reviewing the draft ISA in relation to $PM_{2.5}$, we focused on the following sections: (a) section 2.3.1.1 (Effects of Short-Term Exposure to $PM_{2.5}$), (b) section 2.3.1.2 (Effects of Long-Term Exposure to $PM_{2.5}$), (c) section 2.3.2 (Integration of $PM_{2.5}$ Health Effects), (d) 6.2.12 (Summary and Causal Determinations [for effects related to short-term $PM_{2.5}$ exposure]), and (e) 7.3.9 (Summary and Causal Determinations [for effects related to long-term $PM_{2.5}$ exposure]). Our overall conclusions regarding the set of health effect endpoint categories to include in the risk assessment for $PM_{2.5}$, based on review of these sections of the draft ISA, did not change from the provisional set provided in the Scope and Methods Plan.

Consideration of information provided in the draft ISA (as referenced above) and CASAC and public comments on the Scope and Methods Plan, as well as review of the available epidemiological studies for deriving C-R functions (see section 3.3.3) as well as availability of baseline health effect incidence data to support risk modeling (see section 3.4), has resulted in the following health effect categories (and associated health effect endpoints) being selected for modeling $PM_{2.5}$ in the risk assessment:

Short-term exposure

- Premature mortality (non-accidental, respiratory, cardiovascular)
- Respiratory effects (respiratory-related hospital admissions and asthma-related ED visits)
- Cardiovascular effects (cardiovascular-related hospital admissions)

Long-term exposure

- Mortality (all-cause, ischemic heart disease (IHD), cardiopulmonary, lung cancer)

In addition to estimating risk for $PM_{2.5}$, in the Scope and Methods Plan, we also outlined plans for modeling risk associated with short-term exposures to thoracic coarse particles ($PM_{10-2.5}$) (section 3.6, EPA, 2009). Specifically, we identified a set of short-term cardiovascular and respiratory morbidity endpoints as potential candidates for inclusion in the risk assessment (cardiovascular and respiratory hospital admissions, asthma-related ED visits and respiratory symptoms), noting that support in the first draft ISA for these endpoints did not rise above being *suggestive* of a causal relationship. We noted in the Scope and Methods Plan that the decision whether to include these thoracic coarse particle-related health endpoints in a quantitative risk assessment would depend on review of the scientific evidence presented in the second draft ISA as well as consideration for public and CASAC comments on the Scope and Methods Plan. During a consultation on the Scope and Methods Plan, CASAC expressed support for a limited risk assessment focusing on exposure to $PM_{10-2.5}$, for appropriate outcomes such as hospitalizations (Samet 2009, p. 2).

In the risk assessment conducted for the last PM NAAQS review, EPA concluded that the nature and magnitude of the uncertainties and concerns associated with this portion of the risk assessment weighed against use of these risk estimates as a basis for recommending specific standard levels (EPA, 2005, p. 5-69). In reviewing the evidence provided in the second draft ISA (US EPA, 2009, ref specific sections or chapters) specifically addressing effects associated with exposure to $PM_{10-2.5}$, we recognize that the ISA concludes that there is suggestive support for an relationship between short-term exposure to $PM_{10-2.5}$ and cardiovascular and respiratory effects, as well as mortality. However, we believe that the underlying epidemiological evidence does not readily support derivation of C-R functions applicable to urban case studies in the U.S without the introduction of significant uncertainty into the risk estimates. Further, we find that research to inform the uncertainties identified in the last review have not fundamentally changed these uncertainties. Therefore, we conclude that additional analyses quantifying $PM_{10-2.5}$-related risks would not provide additional information beyond the assessment done in the last review and, therefore, no quantitative risk assessment has been conducted for $PM_{10-2.5}$ in this document.

3.3.2 Selection and delineation of urban study areas

This section describes the approach used in selecting the 15 urban study areas included in this risk assessment (see Table 3-3 for a listing of the urban study areas). The approach for selecting urban study areas considered criteria from the prior risk assessment and adds two new criteria.

Criteria used in the prior risk assessment include: (a) sufficient air quality data for at least one year for the period 1999 or later (at least 11 observations per quarter for a one year period and at least 122 observations per year), (b) coverage of the location by one of the key epidemiology studies included in the risk assessment (at or close to the location where at least one C-R function for one of the recommended health endpoints has been estimated by a study satisfying the selection criteria used in the risk assessment), and (c) sufficient baseline incidence data for the location (see EPA, 2005, section 3.2 p. 37, for additional detail on these three criteria). Regarding the first criteria (sufficiency of air quality), we assessed prospective study areas by insuring that there was at least one $PM_{2.5}$ monitor within the boundaries of the prospective study area that met completeness criteria for the period 2005 to 2007 (note, that locations with more than one $PM_{2.5}$ monitor meeting completeness criteria were favored, since this provided a better characterization of ambient air levels for that urban location). The two remaining criteria from the prior risk assessment were largely addressed due to new epidemiological studies and baseline incidence data that are now available. Specifically, regarding coverage by key epidemiology studies, because the current risk assessment primarily utilizes multi-city studies to evaluate risk for key short-term and long-term health endpoints (whereas the prior risk assessment used city-specific studies in modeling short-term endpoints), this criterion no longer applies for most prospective areas. Regarding sufficiency of baseline health effects incidence data, an ongoing effort by EPA to collect county-level hospital and emergency department admissions data from states to support this risk assessment (see section 3.5) has resulted in enhanced health effects baseline incidence data, largely addressing this criterion (i.e., most urban areas in the U.S. now have coverage with the updated baseline health effects incidence data).

In addition to these criteria from the prior risk assessment, as noted above, we have also included consideration for two additional factors in selecting urban study areas. First, we focused on those urban areas with $PM_{2.5}$ monitoring levels suggesting the potential for risk reduction under alternative (daily or annual) standards. Specifically, only those urban locations with at least one monitor having an annual average above 12 $\mu g/m^3$ and/or a 24-hour value above 25 $\mu g/m^3$ (the levels in the lowest alternative standard considered in the risk assessment) were considered. Furthermore, locations with ambient $PM_{2.5}$ level significantly higher than these levels were favored (with several urban study areas selected having annual and daily design values exceeding the current standard level, being selected – see Table 3-4). Application of this criterion reflects a desire to include urban case studies that are representative of areas likely to experience some degree of risk reduction under alternative standard levels.

The second criterion we added for study area selection, was the goal of providing coverage for factors believed to play a role in influencing risk heterogeneity at the national-level (e.g., PM source characteristics and composition, demographics, SES status, air conditioner use). We implemented this criterion by using the 7 PM regions originally identified in the 1996 PM Criteria Document (US EPA, 1996), to guide selection of urban study areas. Specifically, we attempted to include several urban locations from each of the PM regions in our suite of 15 urban study areas, to insure that each of the regions was represented by one or more of the urban study areas (see Table 3-4). Note, that ultimately, consideration of the criteria described here resulted in an urban study area not being identified for one of the PM regions (the Upper Midwest). However, the remaining six regions each included at least one of the 15 urban study areas evaluated in the risk assessment. While the 1996 PM regions as defined (see footnote 2), focused primarily on differences in PM composition, size and seasonality, by selecting urban study areas from regions that cover the continental U.S., we also have a better potential for covering regional differences in other factors related to risk heterogeneity (e.g., demographics, SES, and behavior related to PM exposure such as air conditioner use). Note, that the representativeness analysis (which is discussed in section 4.4) specifically assesses the degree to which the 15 urban study areas provide coverage for national trends in key risk-related factors such as those listed here.

Table 3-4 presents the 15 urban study areas selected for the risk assessment, including (a) which state it is located in, (b) whether the urban study area was included in the prior risk assessment, (c) which PM region the urban study area is located in, and (d) the daily and annual design values considered in selected the location. Figure 3-4 identifies each of the 15 urban study areas in relation to the 7 PM regions used to guide the selection of the urban study areas.

Table 3-4. Urban Study Areas Selected for the Risk Assessment.

Urban study area	State	Modeled in last NAAQS review	PM Region*	Annual design value (μg/m^3)	Daily design value (μg/m^3)
Atlanta	GA		SE	16	35
Baltimore	MD		NE	16	37
Birmingham	AL		SE	19	44
Dallas	TX		SE	13	26
Detroit	MI	X	IM	17	43
Fresno	CA		SCA	17	63
Houston	TX		SE	16	31
LA	CA	X	SCA	20	55
New York	NY		NE	16	42
Philadelphia	PA	X	NE	15	38
Phoenix	AZ	X	SW	13	32
Pittsburgh	PA	X	IM	20	60
Salt Lake City	UT		NW	12	55
Tacoma	WA	X	NW	10	43
St. Louis	MO	X	IM	17	39

* SE (Southeast), IM (industrial Midwest), SCA (Southern California), NE (Northeast), NW (Northwest), SW (Southwest) (See, EPA, 1996, section 6.4 for description of these PM regions).

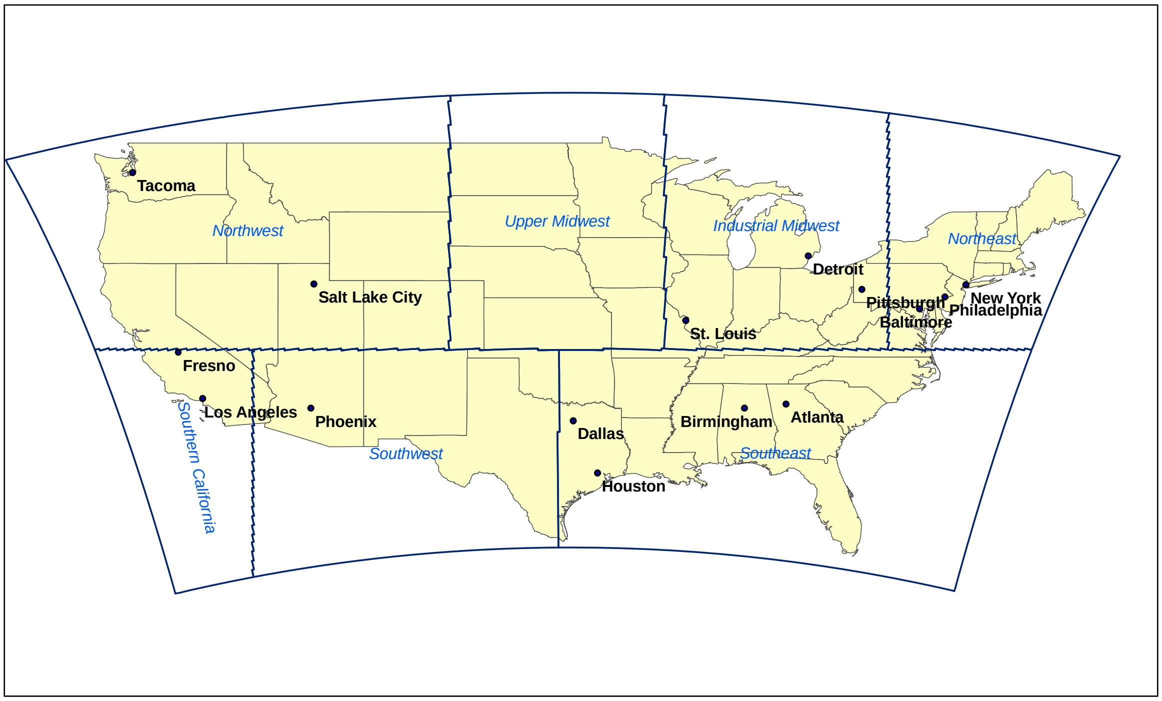


Figure 3-4 15 urban study areas included in the risk assessment (including seven PM regions used to guide selection of study areas).

Once the 15 urban study areas were selected, the next step was to identify the spatial template to use in defining each study area (i.e., the geographical area associated with each study area that would be used in identifying which counties and $PM_{2.5}$ monitors were associated with a particular study area). For 12 of the 15 urban study areas, we either used a combined statistical area (CSA) as the basis for the spatial template, or if that was not available, we used a core-based statistical area (CBSA). The three remaining urban study areas were special cases and were handled as follows: (a) for Baltimore we used counties in the Baltimore CBSA (and not the Baltimore-DC CSA, even though this CSA was available since we felt it unlikely that this entire larger CSA would behave similarly with regard to PM reduction strategies), (b) for Philadelphia, we used the Philadelphia CSA, but excluded Berks County (Reading), and (c) for Tacoma, we only used Pierce County (since we felt it unlikely that efforts to reduce emissions at the "elevated" monitor in Pierce County, would significantly impact monitors in Seattle).

As noted above, in a few instances, two or more epidemiological studies used different geographic boundaries for determining which populations were included in their studies. For example, in one study conducted in Birmingham, AL populations from Blount, Jefferson, Shelby, St. Clair, and Walker Counties were included, while another study included the population residing in only Jefferson County. In such cases, we matched our delineation of the urban area to that of each study, resulting in two or more different delineations of the urban area.

As we discuss below, two of the studies on which we rely for our core analysis – Zanobetti and Schwartz (2009) and Bell et al. (2008) – are multi-location studies. Zanobetti and Schwartz (2009) specified the county or counties included in each of the urban areas they included in their analysis. Bell et al. (2008), however, did not focus on urban areas, but instead focused on counties with populations above a specified threshold number. To limit the number of different "versions" of a risk assessment location, wherever possible we specified the counties in a risk assessment location for Bell et al. (2008) to match the set specified for Zanobetti and Schwartz (2009). This was possible in those cases in which Zanobetti and Schwartz (2009) identified an urban area as a single county, and that county was also included in Bell et al. (2008). This was the case for several of the risk assessment locations. In some cases, however, Zanobetti and Schwartz (2009) used a multi-county delineation of an urban area where at least one of the counties was not among those included in Bell et al. (2008). In those cases, we had to delineate two definitions of the urban area – one corresponding to Zanobetti and Schwartz (2009) and the other corresponding to Bell et al. (2008). This was the case for Atlanta, Birmingham, and St. Louis. In both Atlanta and New York, other delineations by other studies forced additional delineation of these urban areas, as shown in Table 3-1 above.

Finally, we applied the studies of mortality associated with long-term exposure to $PM_{2.5}$ to the urban areas as defined by the short-term exposure mortality study, Zanobetti and Schwartz (2009), to enable meaningful comparisons between estimates of premature morality associated with short-term and long-term exposure to $PM_{2.5}$.

3.3.3 Selection of epidemiological studies and concentration-response (C-R) functions within those studies

As discussed above, we included in the $PM_{2.5}$ risk assessment only the better-understood health effects for which the weight of the evidence supports a likely causal inference. Thus, in cases where the majority of the available studies did not report a statistically significant relationship, the effect endpoint was not included. Once it had been determined that a health endpoint would be included in the analysis, however, inclusion of a study on that health endpoint was not based on statistical significance.

A significant change since the previous PM risk assessment is the addition to the relevant epidemiological literature of several multi-city studies. This type of study has several advantages over single-city studies. First, multi-city studies use the same study design in each of the cities included in the study, so that city-specific results are readily comparable. Second, when they are estimating a single C-R function based on several cities, multi-city studies also tend to have more statistical power and provide effect estimates with relatively greater precision than single city studies due to larger sample sizes, reducing the uncertainty around the estimated coefficient. Moreover, in a multi-city study the statistical power to detect an effect in any given city can be supplemented by drawing statistical power from data across all the cities included in the study (or all the cities in the same region) to adjust city-specific estimates towards the mean across all cities included in the analysis (or in the same region). This is particularly useful in those instances, where a city has relatively less data resulting in a larger standard error for the effect estimate. In this situation, the information on the C-R relationship in all the other cities included in a multi-city study can be used to help inform an assessment of the C-R relationship in the city in question. Finally, multi-city studies tend to avoid the often-noted problem of publication bias that single-city studies confront (in which studies with statistically insignificant or negative results are less likely to get published than those with positive and/or statistically significant results).

For this risk assessment, we selected what we considered to be the best study to assess the C-R relationship between $PM_{2.5}$ and a given health endpoint, and we included other studies for that health endpoint only if they were judged to contribute something above and beyond what we could learn from the primary study selected.

A primary study for a given health endpoint had to satisfy the study selection criteria that we have used in past PM (and other) risk assessments. In particular:

- It had to be a published, peer-reviewed study that has been evaluated in the PM ISA and judged adequate by EPA staff for purposes of inclusion in this risk assessment based on that evaluation.
- It had to directly measure, rather than estimate, $PM_{2.5}$ on a reasonable proportion of the days in the study.
- It had to either not rely on Generalized Additive Models (GAMs) using the S-Plus software to estimate C-R functions or to appropriately have re-estimated these functions using revised methods.[18]

Because of the advantages noted above, we selected multi-city studies as our primary studies for assessing the risks of premature non-accidental, cardiovascular, and respiratory mortality (Zanobetti and Schwartz, 2009) and cardiovascular and respiratory hospital admissions (Bell et al., 2008) associated with short-term exposure to $PM_{2.5}$ in our core analysis. In each of these studies, the 15 urban areas selected for the PM risk assessment were among the locations included in their analysis.

[18] The GAM S-Plus problem was discovered prior to the recent final PM risk assessment carried out as part of the PM NAAQS review completed in 2006. It is discussed in the 2004 PM Criteria Document (EPA, 2004), PM Staff Paper (EPA, 2005c), and PM Health Risk Assessment Technical Support Document (Abt Associates, 2005).

Studies often report more than one estimated C-R function for the same location and health endpoint. Sometimes models including different sets of co-pollutants are estimated in a study; sometimes different lag structures are used. Sometimes different modeling approaches are used to fit weather and temporal variables in the model. Once a study has been selected, the next step is to select one or more C-R functions from among those reported in the study.

Zanobetti and Schwartz (2009) divided the United States into six regions, based on the Köppen climate classification (Kottek 2006; Kottek et al. 2006)(http://koeppen-eiger.vuwien.ac.at/).[19] They estimated the coefficient of $PM_{2.5}$ in single-pollutant log-linear models using Poisson regression for each of 112 cities, as well as in two-pollutant models with coarse PM. They estimated annual models (which assume that the relationship between mortality and $PM_{2.5}$ is the same through the year), as well as four seasonal models per location. They then used a random effects meta-analysis to combine the city-specific results (Berkey et al. 1998). Pooling of city-specific results was done at the national level as well as at the regional level, and separately for each season as well as for the annual functions.

With respect to the multi-city study for short-term exposure mortality, at the request of EPA, the authors produced Empirical Bayes "shrunken" city-specific estimates, adjusted towards the appropriate regional mean, using the approach described in Le Tertre et al. (2005). This was done for the annual estimates as well as for each season-specific estimate.[20] The annual city-specific "shrunken" estimates were used in our core analysis.[21] The seasonal estimates were used in a sensitivity analysis. City-specific estimates have the advantage of relying on city-specific data; however, as noted above, such estimates can have large standard errors (and thus be unreliable); "shrinking" city-specific estimates towards the regional mean estimate is a more efficient use of the data.[22] Such "shrinking" can be thought of as combining the advantages of a single-city study (in which the estimation of a city-specific

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[19] Zanobetti and Schwartz delineate regions as follows: "region 1: humid subtropical climates and maritime temperate climates (Cfa, Cfb), which includes FL, LA TX, GA, AL, MS, AR, OK, KS, MO, TN, SC, NC, VA, WV, KY; region 2: warm summer continental climates (Dfb), including ND, MN, WI, MI, PA, NY, CT, RI, MA, VT, NH, ME; region 3: hot summer continental climates (Dfa) with SD, NE, IA, IL, IN, OH; region 4: dry climates (BSk) (NM, AZ, NV); region 5: dry climates together with continental climate (Dfc, BSk) with MT, ID, WY, UT, CO; region 6: Mediterranean climates which includes CA, OR, WA (Csa, Csb)" (p. 10).

[20] These city-specific "shrunken" estimates were provided to EPA (see Zanobetti, 2009) .

[21] One reason we selected the annual functions over the season-specific functions for the core analysis is that, while we can sum the season-specific mortality estimates across the four seasons, we cannot do the same for the upper and lower bounds of 95% confidence intervals around those estimates. To produce correct confidence bounds around annual mortality estimates based on seasonal functions, we would need the covariance matrix of the season-specific estimates, separately for each location, which we do not have.

[22] The degree to which a city-specific estimate is "shrunken" towards the regional mean depends on the size of the standard error of the city-specific estimate relative to that of the regional mean estimate. The larger the city-specific estimate relative to the regional mean estimate, the less shrinkage toward the regional mean.

coefficient is not influened by data from other locations) with the advantages of a multi-city study (in which there is much greater statistical power to detect small effects).

Since all models with $PM_{2.5}$ in Zanobetti and Schwartz (2009) used the same lag structure (an average of same-day and the previous day's $PM_{2.5}$), there was no selection from among different C-R functions with different lag structures from this study. There were, however, both single-pollutant and two-pollutant models (with coarse PM). We selected the single-pollutant models, in part to avoid collinearity problems, and in part to be consistent with most of the other studies used in the risk assessment, which were single-pollutant studies.

Bell et al. (2008) estimated log-linear models relating short-term exposure to $PM_{2.5}$ and hospital admissions for cardiovascular and respiratory illnesses among people 65 and older, using Poisson regression, for each of 202 counties in the United States. They reported both annual and season-specific results, nationally and regionally (for four regions: Northeast, Southeast, Northwest, and Southwest), but not at the local (city-specific) level. All cardiovascular hospital admissions models were single-pollutant, 0-day lag models; for respiratory hospital admissions, both single-pollutant 0-day models and single-pollutant 2-day models were estimated. We used the regional, annual C-R functions in our core analysis (identifying the appropriate region for each of our 15 risk assessment locations).[23] For respiratory hospital admissions (for the core analysis), we selected the 2-day lag models, based on evidence that for respiratory effects the strongest associations with PM exposure may be associated with longer lag periods (on the order of 2 days or more).[24] We used the regional season-specific functions in a sensitivity analysis.

We identified two studies that estimated C-R relationships between short-term exposure to $PM_{2.5}$ and emergency department (ED) visits for cardiovascular and/or respiratory illnesses. (There were no multi-city studies for this category of health endpoint.) Tolbert et al. (2007) examined both cardiovascular and respiratory ED visits in Atlanta, GA, using single-pollutant log-linear models with a 3-day moving average (0-day, 1-day, and 2-day lags) of $PM_{2.5}$. Ito et al. (2007) estimated the relationship between short-term exposure to $PM_{2.5}$ and ED visits for asthma in New York City (Manhattan). They estimated two single-pollutant models, one for the whole year and one for the period from April through August; in addition, they estimated several two-pollutant models for the period from April through August. We selected the single-pollutant model for the whole year for the core analysis, and we explored

[23] The region into which each of the 202 counties in Bell et al. (2008) falls is given at: http://www.biostat.jhsph.edu/MCAPS/estimates-full.html.

[24] The ISA states that, "Generally, recent studies of respiratory HAs that evaluate multiple lags, have found effect sizes to be larger when using longer moving averages or distributed lag models. For example, when examining HAs for all respiratory diseases among older adults, the strongest associations where observed when using PM concentrations 2 days prior to the HA." (EPA, 2009, section 2.4.2.2).

the impacts of using the annual versus the April-through-August model, as well as the single- versus multi-pollutant models in sensitivity analyses.

For the purpose of conducting a sensitivity analysis to show the impact of different lag structures, different modeling approaches, and single- versus two-pollutant models on estimates of the risks of premature mortality and hospital admissions associated with short-term exposure to $PM_{2.5}$, we selected Moolgavkar (2003). This study reported results for premature non-accidental, cardiovascular, and respiratory mortality and for cardiovascular and respiratory hospital admissions associated with short-term exposures to $PM_{2.5}$ in Los Angeles, using several different lag structures and several different approaches to modeling the effects of weather and temporal variables.

We selected Krewski et al. (2009) as our primary study for assessing the risks of premature mortality associated with long-term exposure to $PM_{2.5}$ in our core analysis. This study is an extension of the ACS prospective cohort study (Pope et al., 2002), used in the previous PM risk assessment, extending the period of observation of the cohort to eighteen years (1982 – 2000). Krewski et al. (2009) considered mortality from all causes, as well as cardiopulmonary mortality, mortality from ischemic heart disease, and lung cancer mortality. They presented a variety of C-R functions, in an effort to show how the results changed with various changes to the method/model used. It was not apparent from review of the HEI report, that the authors of the study recommended any one of these as clearly superior to the others. For our core analysis, we selected what appeared to be two reasonable "standard" options – one corresponding to the earlier exposure period considered in the study, from 1979 – 1983, and the other corresponding to the later exposure period, from 1999 – 2000. Both C-R functions were based on follow-up of the cohort through 2000. Both used the standard Cox proportional hazards model, with 44 individual and 7 ecologic covariates. The relative risks for a 10 $\mu g/m^3$ change in $PM_{2.5}$ from which the $PM_{2.5}$ coefficients were back-calculated were taken from Table 33 of Krewski et al. (2009).[25]

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[25] Note, EPA corresponded with the authors of the Krewski et al., 2009 study to obtain additional clarification regarding specific aspects of the study and associated results as presented in the HEI report (Krewski, 2009). In response to the EPA's question of whether the study authors had a preference for a particular model (in the context of using that model and its hazard ratio(s) in risk assessment), the authors stated that they had "refrained from expressing a preference among the results for their use in quantitative risk assessment," preferring to "explore several plausible statistical models that we have fit to the available data." However, they go on to state that "...if one had to choose a model for use in practical applications involved in air quality management, one could argue that a random effects model (which accounts for apparent spatial autocorrelation in the data) might be preferable. A model that included ecological covariates, which has the effect of reducing the residual variation in mortality, might also be of interest. If forced to pick a single model for risk assessment applications in air quality management, our random effects model with ecological covariates might be selected" (Krewski, 2009). Note, that if the study had provided a random effects model with ecological covariates (for both PM monitoring periods – 1979-1983 and 1999-2000), then we would have used those models in our core analysis. However, a random effects model with ecological covariates was only provided for the more recent PM monitoring period. Therefore, we opted to use the standard Cox model with ecological covariates, since this

We selected several additional C-R functions from Krewski et al. (2009) to use in sensitivity analyses carried out in two risk assessment locations (Los Angeles and Philadelphia). These are described below. In addition, we used Krewski et al. (2000) [reanalysis of the Six Cities Study].

3.3.4 A summary of selected health endpoints, urban areas, studies, and concentration-response (C-R) functions used in the risk assessment

A summary of the selected health endpoints, urban areas, and epidemiological studies used in the risk assessment is given below in Tables 3-5 and 3-6 for short-term and long-term exposure studies, respectively. A more detailed overview of the locations, health endpoints, studies, and C-R functions included in the core analysis is given in Table 3-7. An overview of the locations, health endpoints, studies, and C-R functions included in sensitivity analyses is given in Table 3-8.

model form had been fitted for both PM monitoring periods. Note, however, that we did consider the random effects model form in the sensitivity analysis (see section 3.5.4).

Table 3-5. Locations, Health Endpoints, and Short-Term Exposure Studies Included in the PM2.5 Risk Assessment*

<table>
<tr><th rowspan="2">Urban Area</th><th colspan="3">Premature Mortality</th><th colspan="2">Hospital Admissions</th><th colspan="2">ED Visits</th></tr>
<tr><th>Non-Accidental</th><th>Cardiovascular</th><th>Respiratory</th><th>Cardiovascular</th><th>Respiratory</th><th>Cardiovascular</th><th>Respiratory</th></tr>
<tr><td>Atlanta, GA</td><td rowspan="8">Zanobetti and Schwartz (2009)</td><td rowspan="8">Zanobetti and Schwartz (2009)</td><td rowspan="8">Zanobetti and Schwartz (2009)</td><td rowspan="8">Bell et al. (2008)</td><td rowspan="8">Bell et al. (2008)</td><td>Tolbert et al. (2007)</td><td>Tolbert et al. (2007)</td></tr>
<tr><td>Baltimore, MD</td><td></td><td></td></tr>
<tr><td>Birmingham, AL</td><td></td><td></td></tr>
<tr><td>Dallas, TX</td><td></td><td></td></tr>
<tr><td>Detroit, MI</td><td></td><td></td></tr>
<tr><td>Fresno, CA</td><td></td><td></td></tr>
<tr><td>Houston, TX</td><td></td><td></td></tr>
<tr><td rowspan="2">Los Angeles, CA</td><td></td><td></td></tr>
<tr><td>Moolgavkar (2003)</td><td>Moolgavkar (2003)</td><td></td><td>Moolgavkar (2003)</td><td></td><td></td><td></td></tr>
<tr><td>New York, NY</td><td rowspan="7">Zanobetti and Schwartz (2009)</td><td rowspan="7">Zanobetti and Schwartz (2009)</td><td rowspan="7">Zanobetti and Schwartz (2009)</td><td rowspan="7">Bell et al. (2008)</td><td rowspan="7">Bell et al. (2008)</td><td></td><td>Ito et al. (2007)</td></tr>
<tr><td>Philadelphia, PA</td><td></td><td></td></tr>
<tr><td>Phoenix, AZ</td><td></td><td></td></tr>
<tr><td>Pittsburgh, PA</td><td></td><td></td></tr>
<tr><td>Salt Lake City, UT</td><td></td><td></td></tr>
<tr><td>St. Louis, MO</td><td></td><td></td></tr>
<tr><td>Tacoma, WA</td><td></td><td></td></tr>
</table>

*Studies in italics are used only in sensitivity analyses.

Table 3-6. Locations, Health Endpoints, and Long-Term Exposure Studies Included in the PM2.5 Risk Assessment*

<table>
<tr><th rowspan="2">Urban Area</th><th>Premature Mortality</th><th></th><th></th><th></th></tr>
<tr><th>All-Cause</th><th>Cardiopulmonary</th><th>Ischemic Heart Disease</th><th>Lung Cancer</th></tr>
<tr><td>Atlanta, GA</td><td rowspan="13">Krewski et al. (2009) [extension of the ACS study]</td><td rowspan="13">Krewski et al. (2009) [extension of the ACS study]</td><td rowspan="15">Krewski et al. (2009) [extension of the ACS study]</td><td rowspan="13">Krewski et al. (2009) [extension of the ACS study]</td></tr>
<tr><td>Baltimore, MD</td></tr>
<tr><td>Birmingham, AL</td></tr>
<tr><td>Dallas, TX</td></tr>
<tr><td>Detroit, MI</td></tr>
<tr><td>Fresno, CA</td></tr>
<tr><td>Houston, TX</td></tr>
<tr><td>New York, NY</td></tr>
<tr><td>Phoenix, AZ</td></tr>
<tr><td>Pittsburgh, PA</td></tr>
<tr><td>Salt Lake City, UT</td></tr>
<tr><td>St. Louis, MO</td></tr>
<tr><td>Tacoma, WA</td></tr>
<tr><td>Los Angeles, CA</td><td rowspan="2">Krewski et al. (2009) [extension of the ACS study]

Krewski et al. (2000) [reanalysis of the Six Cities Study]</td><td rowspan="2">Krewski et al. (2009) [extension of the ACS study]

Krewski et al. (2000) [reanalysis of the Six Cities Study]</td><td rowspan="2">Krewski et al. (2009) [extension of the ACS study]

Krewski et al. (2000) [reanalysis of the Six Cities Study]</td></tr>
<tr><td>Philadelphia, PA</td></tr>
</table>

*Studies in italics are used only in sensitivity analyses.

Table 3-7. Summary of Locations, Health Endpoints, Studies and Concentration-Response Functions Included in the Core Analysis.*

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
Atlanta	Cobb, De Kalb, Fulton, Gwinnett	Zanobetti and Schwartz (2009)[1]	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009) [1]	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009) [1]	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009) [2]	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009) [2]	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009) [2]	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009) [2]	Long-term exposure lung cancer mortality	NA
	Cobb, DeKalb, Fulton,	Bell et al. (2008)[3]	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)[3]	Short-term exposure HA (unscheduled), respiratory	2-day lag
	Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, Walton	Tolbert et al. (2007)	Short-term exposure Emergency room (ED) visits, cardiovascular	Avg. of 0-,1-day, and 2-day lags
		Tolbert et al. (2007)	Short-term exposure Emergency room (ED) visits, respiratory	Avg. of 0-,1-day, and 2-day lags
Baltimore	Baltimore city, Baltimore county	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Birmingham	Blount, Jefferson, Shelby, St. Clair, Walker	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
	Jefferson	Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Dallas	Dallas	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Detroit	Wayne	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Fresno	Fresno	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Houston	Harris	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Los Angeles	Los Angeles	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
New York	Kings, New York City (Manhattan), Queens, Richmond, Bronx	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
	New York City (Manhattan)	Ito et al. (2007)	Short-term exposure Emergency room (ED) visits, asthma	Avg. of 0-day and1-day lags
Philadelphia	Philadelphia	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Phoenix	Maricopa	Zanobetti and Schwartz (2009)	Short-term exposure non-accidental mortality	Avg. of 0-day and 1-day lags

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
		Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Pittsburgh	Allegheny	Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Salt Lake City	Salt Lake	Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA

Risk Assessment Location	Counties	Study/C-R Function	Health Endpoint	Lag Structure
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
St. Louis	Jeffferson, Madison (IL), St. Louis, St. Louis city, St. Clair (IL)	Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1-day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
	Madison (IL), St. Louis, St. Louis city, St. Clair (IL)	Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag
Tacoma	Pierce	Zanobetti and Schwartz (2009)	Short-term exposure cardiovascular mortality	Avg. of 0-day and 1 day lags
		Zanobetti and Schwartz (2009)	Short-term exposure respiratory mortality	Avg. of 0-day and 1-day lags
		Krewski et al. (2009)	Long-term exposure all-cause mortality	NA
		Krewski et al. (2009)	Long-term exposure cardiopulmonary mortality	NA
		Krewski et al. (2009)	Long-term exposure ischemic heart disease mortality	NA
		Krewski et al. (2009)	Long-term exposure lung cancer mortality	NA
		Bell et al. (2008)	Short-term exposure HA (unscheduled), cardiovascular	0-day lag
		Bell et al. (2008)	Short-term exposure HA (unscheduled), respiratory	2-day lag

*All C-R functions in the core analysis are single-pollutant, log-linear models; all are for a full year. The exposure metric for all short-term exposure C-R functions is the 24-hr average; the exposure metric for all long-term exposure C-R functions is the annual average.

[1] This is a multi-city study; city-specific estimates "shrunken" towards the mean across all cities in a region were supplied to EPA (Zanobetti, 2009).

[2] Two C-R functions were used for the core analysis – one corresponding to the earlier exposure period, from 1979 – 1983, and the other corresponding to the later exposure period, from 1999 – 2000. Both C-R functions were based on follow-up of the cohort through 2000. Both used the standard Cox proportional

hazards model, with 44 individual and 7 ecologic covariates. The relative risks for a 10 μg/m^3 change in $PM_{2.5}$ from which the $PM_{2.5}$ coefficients were back-calculated were taken from Table 33 of Krewski et al. (2009).
[3] This study estimated four regional C-R functions – for the Northeast, Southeast, Northwest, and Southwest – for each health endpoint. For each risk assessment location, we used the regional C-R function for the region containing the risk assessment location. The designation of counties to each of these four regions can be found at http://www.biostat.jhsph.edu/MCAPS/estimates-full.html .

Table 3-8. Summary of Locations, Health Endpoints, Studies and Concentration-Response Functions Included in Sensitivity Analyses.

Sensitivity Analysis	Study/C-R Function	Health Endpoint**	Risk Assessment Location(s)
Single-Factor Sensitivity Analyses:			
Impact of using different model choices – fixed effects log-linear vs. random effects log-linear vs. random effects log-log C-R function*	random effects log-linear: Krewski et al. (2009) [Table 9, "Autocorrelation at MSA and ZCA levels" group - "MSA & Diff" row] random effects log-log: Krewski et al. (2009) [Table 11, "MSA and DIFF" rows]	All-cause, cardiopulmonary, ischemic heart disease, and lung cancer mortality associated with long-term exposure	Los Angeles and Philadelphia
Impact of estimating risks down to PRB rather than down to LML	Krewski et al. (2009) – C-R functions for each of two exposure periods	Long-term exposure all-cause mortality	All 15 urban areas
Impact of C-R function from alternative long-term exposure study	Krewski et al. (2000) [reanalysis of the Harvard Six Cities study]	All-cause, cardiovascular, respiratory, lung cancer mortality associated with long-term exposure	Los Angeles and Philadelphia
Impact of using alternative hybrid rollback approach	Krewski et al. (2009)	All-cause mortality associated with long-term exposure	Baltimore, Birmingham, Detroit, Los Angeles, New York, Pittsburgh, and St. Louis
Impact of using season-specific C-R functions (vs. an annual C-R function)	Zanobetti and Schwartz (2009) – seasonal functions vs. annual function	Non-accidental mortality, cardiovascular mortality, respiratory mortality associated with short-term exposure	All 15 urban areas
Impact of using season-specific C-R functions (vs. an annual C-R function)	Bell et al. (2008) – seasonal functions vs. annual function	HA (unscheduled), cardiovascular and respiratory, associated with short-term exposure	All 15 urban areas
Impact of using an annual C-R function (applied to the whole year) vs. a seasonal function for April through August (applied only to that period) (using a single pollutant model).	Ito et al. (2007)	Asthma ED visits	New York
Impact of model selection (e.g., log-linear GAM with 30 df; log-linear GAM with 100 df; and log-linear GLM with 100 df)	Moolgavkar (2003)	Non-accidental and cardiovascular mortality; and cardiovascular and COPD+ HA associated with short-term	Los Angeles

Sensitivity Analysis	Study/C-R Function	Health Endpoint**	Risk Assessment Location(s)
		exposure	
Impact of lag structure (0-day, 1-day, 2-day)	Moolgavkar (2003)	Non-accidental and cardiovascular and COPD+ HA associated with short-term exposure	Los Angeles
Impact of single- vs. multi-pollutant models (PM2.5 with CO)	Moolgavkar (2003)	Non-accidental and cardiovascular mortality; and cardiovascular and COPD+ HA associated with short-term exposure	Los Angeles
Impact of using alternative hybrid rollback approach	Zanobetti and Schwartz (2009)	Non-accidental mortality associated with short-term exposure	Baltimore, Birmingham, Detroit, Los Angeles, New York, Pittsburgh, and St. Louis
Multi-Factor Sensitivity Analyses:			
Impact of using a fixed effects log-linear vs. a random effects log-log model, estimating incidence down to the lowest measured level (LML) in the study vs. down to PRB, and using a proportional vs. hybrid rollback to estimate incidence associated with long-term exposure to $PM_{2.5}$ concentrations that just meet the current standards		All-cause and ischemic heart disease mortality associated with long-term exposure	Los Angeles and Philadelphia
Impact of using season-specific vs. all-year C-R functions and proportional vs. hybrid rollbacks to estimate incidence associated with short-term exposure to $PM_{2.5}$ concentrations that just meet the current standards	Zanobetti and Schwartz (2009)	Non-accidental mortality associated with short-term exposure	Baltimore, Birmingham, Detroit, Los Angeles, New York, Pittsburgh, and St. Louis

*This "single-factor" sensitivity analysis is actually two factors – first the change from a fixed effects log-linear model to a random effects log linear model, and then the change from a random effects log-linear model to a random effects log-log model. These were conbined into a single sensitivity analysis because Krewski et al. (2009) did not present the results of a fixed effects log-log model (to compare to the core analysis fixed effects log-linear model).

**"HA" = hospital admissions, "ED" = emergency department visits, "COPD+" = chronic obstructive pulmonary disease.

3.4 BASELINE HEALTH EFFECTS INCIDENCE DATA

As noted in section 3.2.1 above, the form of C-R function most commonly used in epidemiological studies on PM, shown in equation (1), is log-linear. To estimate the change in incidence of a health endpoint associated with a given change in $PM_{2.5}$ concentrations using this form of C-R function requires the baseline incidence (often calculated as the baseline incidence rate times the population) of the health endpoint, that is, the number of cases per unit time (e.g., per year) in the location before a change in $PM_{2.5}$ air quality (denoted y_0 in equations 3 and 4).

Incidence rates express the occurrence of a disease or event (e.g., asthma episode, death, hospital admission) in a specific period of time, usually per year. Rates are expressed either as a value per population group (e.g., the number of cases in Philadelphia County) or a value per number of people (e.g., the number of cases per 10,000 residents in Philadelphia County), and may be age- and sex-specific. Incidence rates vary among geographic areas due to differences in population characteristics (e.g, age distribution) and factors promoting illness (e.g., smoking, air pollution levels).

3.4.1 Data sources

3.4.1.1 Mortality

We obtained individual-level mortality data for 2006 for the whole United States from the Centers for Disease Control (CDC), National Center for Health Statistics (NCHS). The data are compressed into a CD-ROM, which contains death information for each decedent, including residence county FIPS, age at death, month of death, and underlying causes (ICD-10 codes). The detailed mortality data allow us to generate cause-specific death counts at the county level for selected age groups. Below we describe how we generated the county-level death counts.

3.4.1.2 Hospital admission and emergency department visits

For hospital admissions (HA) and emergency department (ED) visits, there are multiple data sources:

- **Healthcare Cost and Utilization Project (HCUP) Central Distributor**. HCUP is a family of health care databases developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). The HCUP databases are based on the data collection efforts of data organizations in participating states. We used two HCUP databases: the State Inpatient Database (SID) and the State Emergency Department Database (SEDD) respectively. SID/SEDD include detailed HA/ED information for each discharge, including patient county FIPS, age, admission type (e.g., emergent, urgent), admission/discharge season, and principle diagnosis (ICD-9 codes). The HCUP databases can be purchased from the HCUP Central Distributor, although not all participant states release the data to the Central Distributor.

- **HCUP State Partners**. For those HCUP participating states that don't release their data to the Central Distributor, we contacted the HCUP state partners to obtain the HA and/or ED data.
- **Communication with the author(s) of selected epidemiological studies**. The ED data for Atlanta in 2004 were sent to EPA by one of the authors of Tolbert et al. (2007).

Table 3-9 shows the states for which we obtained data from the HCUP Central Distributor and the HCUP State Partners. The data are at the discharge level if not otherwise noted, and the data year is 2007 for all the states in the table. The column "PM RA Location" indicates the selected risk assessment location(s) where the incidence rate is applied.

The necessary baseline incidence data were not available for Atlanta, Birmingham, Philadelphia, Pittsburgh and St. Louis. Therefore, for each of these five risk assessment locations EPA instead used the baseline incidence rate for a designated surrogate location. Surrogate locations were chosen if they were deemed to be sufficiently similar to the urban area whose baseline incidence data were not available. Surrogate locations are noted in Table 3-9.

Table 3-9. Sources of Hospital Admissions (HA) and Emergency Department (ED) Visit Data.

States	HCUP Central Distributor	HCUP State Partner	PM RA Location	Notes
Arizona	HA data	--	Phoenix	
California	NA*	HA data	Fresno, Los Angeles	Due to privacy concerns, CA state agency provided county level data.
Illinois	NA	HA data	St. Louis	1. Due to privacy concerns, IL state agency provided county level data. 2. Two IL counties (Madison and St. Clair) serve as the surrogate for the St. Louis metropolitan region.
Maryland	HA data	--	Baltimore, Philadelphia	Baltimore serves as the surrogate for Philadelphia.
Michigan	HA data	--	Detroit	
New York	NA	HA and ED data	New York, Pittsburgh	Buffalo, NY serves as the surrogate for Pittsburgh.
North Carolina	HA data	--	Atlanta and Birmingham	Charlotte, NC serves as the surrogate for both Atlanta and Birmingham.
Texas	NA	HA data	Dallas, Houston	
Utah	HA data	--	Salt Lake	

States	HCUP Central Distributor	HCUP State Partner	PM RA Location	Notes
			City	
Washington	HA data	--	Tacoma	

*NA denotes "not available, or not available with all variables required for our analysis. If data were not available from the HCUP Central Distributor, we contacted the HCUP State Partner.

3.4.1.3 Populations

To calculate baseline incidence rate, in addition to the health baseline incidence data we also need the corresponding population. We obtained population data from the U.S. Census Bureau (http://www.census.gov/popest/counties/asrh/). These data, released on May 14, 2009, are the population estimates of the resident populations by selected age groups and sex for counties in each U.S. state from 2000 to 2008. We used 2007 populations for calculating most incidence rates except for the ED visit rate in Atlanta. Because the ED visit data obtained from the authors of Tolbert et al. (2007) are for 2004, we used 2004 population estimates for the 20-county Metropolitan area used in the Tolbert et al. study for the Atlanta area to calculate the ED incidence rates to be applied when using that study in the risk assessment; we then applied the 2004 rates to the 2007 population, assuming the ED incidence rates in Atlanta didn't change significantly from 2004 to 2007. The sizes of the populations in the assessment locations that are relevant to the risk assessment (i.e., the populations for which the $PM_{2.5}$ C-R functions are estimated and to which the baseline incidences refer) are given in Table 3-10.

Table 3-10. Relevant Population Sizes for PM Risk Assessment Locations.

City	Counties	Population (Year 2006 and 2007)*					
		All Ages		Ages ≥30		Ages ≥ 65	
		2006	2007	2006	2007	2006	2007
Atlanta, GA - 1	Cobb, De Kalb, Fulton, Gwinnett	3,126,000	3,198,000	1,817,000	1,865,000	236,000	245,000
Atlanta, GA - 2	Cobb, De Kalb, Fulton	2,376,000,	2,421,000	1,400,000	1,433,000	191,000	198,000
Atlanta, GA - 3	20-County MSA**	4,975,000	5,123,000	2,831,000	2,918,000	391,000	408,000
Baltimore, MD	Baltimore city, Baltimore county	1,429,000	1,426,000	849,000	848,000	190,000	189,000
Birmingham, AL - 1	Blount, Jefferson, Shelby, St. Clair, Walker	1,037,000	1,044,000	619,000	625,000	131,000	133,000
Birmingham, AL - 2	Jefferson	660,000	659,000	397,000	397,000	88,000	88,000
Dallas, TX	Dallas	2,338,000	2,367,000	1,285,000	1,308,000	195,000	199,000
Detroit, MI	Wayne	2,012,000	1,985,000	1,176,000	1,168,000	236,000	234,000
Fresno, CA	Fresno	886,000	899,000	444,000	452,000	86,000	87,000
Houston, TX	Harris	3,876,000	3,936,000	2,097,000	2,139,000	299,000	307,000
Los Angeles, CA	Los Angeles	9,881,000	9,879,000	5,544,000	5,579,000	1,011,000	1,030,000
New York, NY - 1	Kings, New York City (Manhattan), Queens, Richmond, Bronx	8,251,000	8,275,000	4,940,000	4,975,000	1,004,000	1,013,000
New York, NY - 2	New York city (Manhattan)	1,613,000	1,621,000	1,061,000	1,074,000	201,000	204,000
Philadelphia, PA	Philadelphia	833,000	1,450,000	833,000	833,000	189,000	187,000
Phoenix, AZ	Maricopa	3,779,000	3,880,000	2,103,000	2,167,000	417,000	432,000
Pittsburgh, PA	Allegheny	1,225,000	1,219,000	790,000	786,000	208,000	206,000
Salt Lake City, UT	Salt Lake	991,000	1,010,000	504,000	517,000	83,000	86,000
St. Louis, MO - 1	Jefferson, Madison (IL), St. Louis, St. Louis city, St. Clair (IL)	2,093,000	2,091,000	1,259,000	1,261,000	274,000	275,000

City	Counties	Population (Year 2006 and 2007)*					
		All Ages		Ages ≥30		Ages ≥ 65	
		2006	2007	2006	2007	2006	2007
St. Louis, MO - 2	Madison (IL), St. Louis, St. Louis city, St. Clair (IL)	1,879,000	1,875,000	1,134,000	1,134,000	253,000	252,000
Tacoma, WA	Pierce	764,000	773,000	437,000	444,000	79,000	81,000

* Not all populations listed in the table were used for calculating the incidence rates. As noted above, the population year needs to match the year of the health data and the population age group needs to match what is used in the epidemiological studies. In addition, 2004 population (all ages) is used for ED visits in Atlanta-3, which is 4,663,946. Populations in this table are rounded to the nearest 1,000.

** The 20 counties are Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, and Walton.

3.4.2 Calculation of baseline incidence rates

To calculate a baseline incidence rate to be used with a C-R function from a given study, we matched the counties, age groupings, and ICD codes used in that study. For example, Bell et al. (2008) designated Dallas, TX as Dallas County and estimated a C-R function for ICD-9 codes 490–492, 464–466, and 480–487 (respiratory HA) among ages 65 and up; we therefore selected only those HA records that had corresponding ICD codes for ages 65 and up in Dallas County and also selected the population for the same age group in the same county. The incidence rate is simply the ratio of the selected HA count to the population. The same procedure was used to calculate baseline incidence rates for all of the risk assessment locations.[26]

If a C-R function was estimated for a specific season, we selected only those HA records within that season. The season definitions are: winter (December, January, and February), spring (March, April, and May), summer (June, July, and August) and fall (September, October, and November). Note that the HA data for some states didn't include information about admission season but only discharge season or discharge quarter. The admission season was then approximated using discharge season or discharge quarter.[27]

Some studies (e.g., Bell et al., 2008) look at the unscheduled HAs only, so we excluded scheduled admissions from the analyses to match the study. A HA is unscheduled if the admission type is emergency or urgent.

The baseline mortality rates are given in Table 3-11. The baseline HA and ED visit rates are given in Table 3-12.

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[26] For Atlanta, Birmingham, Philadelphia, Pittsburgh and St. Louis, the HA data are not available. We calculated the hospital admission rates for the surrogates cities. These cities are listed in Table 3-7.
[27] Based on communication with the HCUP state partner in Texas, patients are normally admitted and discharged in the same season.

Table 3-11. Baseline Mortality Rates (Deaths per 100,000 Relevant Population per Year) for 2006 for PM Risk Assessment Locations.*

City	Age Group	Type of Mortality (ICD-10 or ICD-9 Codes)							
		All-Cause	Non-accidental (A00-R99)	Cardiovascular (I01-I59)	Respiratory (J00-J99)	Cardio-pulmonary (401-440, 460-519)	Ischemic Heart Disease (410-414)	Lung Cancer (162)	COPD (490-496)
Atlanta, GA - 1	All ages	---	480	120	41	---	---	---	---
Atlanta, GA - 1	≥ 30	860	---	---	---	330	89	51	---
Atlanta, GA - 2	---	---	---	---	---	---	---	---	---
Atlanta, GA - 3	---	---	---	---	---	---	---	---	---
Baltimore, MD	All ages	---	950	270	85	---	---	---	---
Baltimore, MD	≥ 30	1,700	---	---	---	690	300	110	---
Birmingham, AL - 1	All ages	---	920	260	85	---	---	---	---
Birmingham, AL - 1	≥ 30	1,600	---	---	---	680	190	104	---
Birmingham, AL - 2	---	---	---	---	---	---	---	---	---
Dallas, TX	All ages	---	540	150	48	---	---	---	---
Dallas, TX	≥ 30	1,020	---	---	---	420	170	66	---
Detroit, MI	All ages	---	850	300	67	---	---	---	---
Detroit, MI	≥ 30	1,500	---	---	---	700	360	107	---
Fresno, CA	All ages	---	620	190	67	---	---	---	---
Fresno, CA	≥ 30	1,300	---	---	---	590	260	66	---
Houston, TX	All ages	---	480	130	37	---	---	---	---
Houston, TX	≥ 30	920	---	---	---	370	150	57	---
Los Angeles, CA	All ages	---	560	190	57	---	---	---	29
Los Angeles, CA	≥ 30	1,030	---	---	---	510	250	55	---
New York, NY - 1	All ages	---	630	270	52	---	---	---	---

City	Age Group	Type of Mortality (ICD-10 or ICD-9 Codes)							
		All-Cause	Non-accidental (A00-R99)	Cardiovascular (I01-I59)	Respiratory (J00-J99)	Cardio-pulmonary (401-440, 460-519)	Ischemic Heart Disease (410-414)	Lung Cancer (162)	COPD (490-496)
New York, NY - 1	≥ 30	1,0800	---	---	---	580	380	56	---
New York, NY - 2	---	---	---	---	---	---	---	---	---
Philadelphia, PA	All ages	---	970	280	83	---	---	---	---
Philadelphia, PA	≥ 30	1,700	---	---	---	720	300	120	---
Phoenix, AZ	All ages	---	600	160	67	---	---	---	---
Phoenix, AZ	≥ 30	1,100	---	---	---	470	220	68	---
Pittsburgh, PA	All ages	---	1,090	330	96	---	---	---	---
Pittsburgh, PA	≥ 30	1,800	---	---	---	770	350	120	---
Salt Lake City, UT	All ages	---	480	110	45	---	---	---	---
Salt Lake City, UT	≥ 30	980	---	---	---	350	101	37	---
St. Louis, MO - 1	All ages	---	870	270	83	---	---	---	---
St. Louis, MO - 1	≥ 30	1,500	---	---	---	680	320	106	---
St. Louis, MO - 2	---	---	---	---	---	---	---	---	---
Tacoma, WA	All ages	---	660	190	66	---	---	---	---
Tacoma, WA	≥ 30	1,200	---	---	---	510	240	88	---
National	All ages	810	750	220	76	340	140	53	42
National	≥ 30	1,300	1,300	370	130	580	240	90	71

* Figures in this table are rounded to a two-integer level of precision.

Table 3-12. Baseline Hospital Admission (HA) and Emergency Department (ED) Rates (Admissions/Visits per 100,000 Relevant Population per Year) for 2007 for PM Risk Assessment Locations.*

City	Age Group	Health Endpoints (ICD-9 Codes)						
		HA, cardio-vascular (390-429)	HA (unscheduled), cardiovascular(426–429, 430–438, 410–414, 440–449)	HA, COPD (490-496)	HA (unscheduled), respiratory (490–492, 464–466, 480–487)	ED visits, cardiovascular (410–414, 427, 428, 433–437, 440, 443–445, 451–453)	ED visits, respiratory (460–465, 466.1, 466.11, 466.19, 477, 480–486, 491-493, 496, 786.07, 786.09)	ED visits, asthma (493)
Atlanta, GA - 1	---	---	---	---	---	---	---	---
Atlanta, GA - 2	≥ 65	---	5,700	---	2,020	---	---	---
Atlanta, GA - 3	All ages	---	---	---	---	690**	2600**	---
Baltimore, MD	≥ 65	---	8,600	---	2,600	---	---	---
Birmingham, AL - 1	---	---	---	---	---	---	---	---
Birmingham, AL - 2	≥ 65	---	5,700	---	2,020	---	---	---
Dallas, TX	≥ 65	---	5,000	---	2,000	---	---	---
Detroit, MI	≥ 65	---	8,800	---	3,000	---	---	---
Fresno, CA	≥ 65	---	5,600	---	2,100	---	---	---
Houston, TX	≥ 65	---	5,900	---	2,200	---	---	---
Los Angeles, CA	All ages	---	---	223	---	---	---	---
Los Angeles, CA	≥ 65	5,500	5,500	---	2,000	---	---	---
New York, NY - 1	≥ 65	---	6,400	---	2,030	---	---	---
New York, NY - 2	All ages	---	---	---	---	---	---	1,100
Philadelphia, PA	≥ 65	---	8,600	---	2,600	---	---	---
Phoenix, AZ	≥ 65	---	5,020	---	1,600	---	---	---
Pittsburgh, PA	≥ 65	---	6,100	---	1,900	---	---	---
Salt Lake City, UT	≥ 65	---	3,030	---	1,200	---	---	---
St. Louis, MO - 1	---	---	---	---	---	---	---	---
St. Louis, MO - 2	≥ 65	---	5,600	---	2,600	---	---	---
Tacoma, WA	≥ 65	---	4,500	---	1,600	---	---	---

* Figures in this table are rounded to a two-integer level of precision.
** These are 2004 incidence rates because Tolbert et al. (2007) provided 2004 ED visit data in a 20-county delineation of Atlanta. However, the 2004 rates were applied to the appropriate year population in the risk assessment.

3.5 ADDRESSING UNCERTAINTY AND VARIABILITY

3.5.1 Overview

An important component of a population health risk assessment is the characterization of both uncertainty and variability. *Variability* refers to the heterogeneity of a variable of interest within a population or across different populations. For example, populations in different regions of the country may have different behavior and activity patterns (e.g., air conditioning use, time spent indoors) that affect their exposure to ambient PM and thus the population health response. The composition of populations in different regions of the country may vary in ways that can affect the population response to exposure to PM – e.g., two populations exposed to the same levels of PM might respond differently if one population is older than the other. In addition, the composition of the PM to which different populations are exposed may differ, with different levels of toxicity and thus different population responses. Variability is inherent and cannot be reduced through further research. Refinements in the design of a population risk assessment are often focused on more completely characterizing variability in key factors affecting population risk – e.g., factors affecting population exposure or response – in order to produce risk estimates whose distribution adequately characterizes the distribution in the underlying population(s).

Uncertainty refers to the lack of knowledge regarding the actual values of inputs to an analysis. Models are typically used in analyses, and there is uncertainty about the true values of the parameters of the model (parameter uncertainty) – e.g., the value of the coefficient for $PM_{2.5}$ in a C-R function. There is also uncertainty about the extent to which the model is an accurate representation of the underlying physical systems or relationships being modeled (model uncertainty) – e.g., the shapes of C-R functions. In addition, there may be some uncertainty surrounding other inputs to an analysis due to possible measurement error—e.g., the values of daily $PM_{2.5}$ concentrations in a risk assessment location, or the value of the baseline incidence rate for a health effect in a population. In any risk assessment, uncertainty is, ideally, reduced to the maximum extent possible through improved measurement of key variables and ongoing model refinement. However, significant uncertainty often remains, and emphasis is then placed on characterizing the nature of that uncertainty and its impact on risk estimates. The characterization of uncertainty can be both qualitative and, if a sufficient knowledgebase is available, quantitative.

The selection of urban study areas for the $PM_{2.5}$ risk assessment was designed to cover the range of $PM_{2.5}$-related risk experienced by the U.S. population and, in general, to adequately reflect the inherent variability in those factors affecting the public health impact of $PM_{2.5}$ exposure. Sources of variability reflected in the risk assessment design are discussed in section 3.5.2, along with a discussion of those sources of variability which are not fully reflected in the risk assessment and consequently introduce uncertainty into the analysis.

The characterization of uncertainty associated with risk assessment is often addressed in the regulatory context using a tiered approach in which progressively more sophisticated methods are used to evaluate and characterize sources of uncertainty depending on the overall complexity of the risk assessment (WHO, 2008). Guidance documents developed by EPA for assessing air toxics-related risk and Superfund Site risks (USEPA, 2004b and 2001, respectively) as well as recent guidance from the World Health Organization (WHO, 2008) specify multi-tiered approaches for addressing uncertainty.

The WHO guidance presents a four-tiered approach, where the decision to proceed to the next tier is based on the outcome of the previous tier's assessment. The four tiers described in the WHO guidance include:

- **Tier 0** – recommended for routine screening assessments, uses default uncertainty factors (rather than developing site-specific uncertainty characterizations);
- **Tier 1** – the lowest level of site-specific uncertainty characterization, involves qualitative characterization of sources of uncertainty (e.g., a qualitative assessment of the general magnitude and direction of the effect on risk results);
- **Tier 2** – site-specific deterministic quantitative analysis involving sensitivity analysis, interval-based assessment, and possibly probability bound (high- and low-end) assessment; and
- **Tier 3** – uses probabilistic methods to characterize the effects on risk estimates of sources of uncertainty, individually and combined.

With this four-tiered approach, the WHO framework provides a means for systematically linking the characterization of uncertainty to the sophistication of the underlying risk assessment. Ultimately, the decision as to which tier of uncertainty characterization to include in a risk assessment will depend both on the overall sophistication of the risk assessment and the availability of information for characterizing the various sources of uncertainty. EPA staff has used the WHO guidance as a framework for developing the approach used for characterizing uncertainty in this risk assessment.

The overall analysis in the PM NAAQS risk assessment is relatively complex, thereby warranting consideration of a full probabilistic (WHO Tier 3) uncertainty analysis. However, limitations in available information prevent this level of analysis from being completed at this time. In particular, the incorporation of uncertainty related to key elements of C-R functions (e.g., competing lag structures, alternative functional forms, etc.) into a full probabilistic WHO Tier 3 analysis would require that probabilities be assigned to each competing specification of a given model element (with each probability reflecting a subjective assessment of the probability that the given specification is the "correct" description of reality). However, for many model elements there is insufficient information on which to base these probabilities. One approach that has been taken in such cases is expert elicitation; however, this approach is resource- and time-intensive and consequently, it was not feasible to use this technique in the current PM NAAQS review to support a WHO Tier 3 analysis.[28]

For most elements of this risk assessment, rather than conducting a full probabilistic uncertainty analysis, we have included qualitative discussions of the potential impact of uncertainty on risk results (WHO Tier1) and/or completed sensitivity analyses assessing the potential impact of sources of uncertainty on risk results (WHO Tier 2). Note, however, that in conducting sensitivity analyses, we have used both single- and multi-factor approaches (to look at the individual and combined impacts of sources of uncertainty on risk estimates). Also, as discussed below in section 3.5.4, in conducting sensitivity analyses, we used only those alternative specifications for input parameters or modeling approaches that were deemed to have scientific support in the literature (and so represent alternative reasonable input parameter values or modeling options). This means that the alternative risk results generated in the sensitivity analyses represent reasonable risk estimates that can be used to provide a context, with regard to uncertainty, within which to assess the set of core (base case) risk results (see section 4.5.3).

In addition to the qualitative and quantitative treatment of uncertainty and variability which are described here, we have also completed two additional analyses intended to place the risk results generated for the 15 urban study areas in a broader national context. The first is a representativeness analysis (described in section 4.4) which evaluates the set of urban study areas against national-distributions of key PM risk-related attributes (with the goal of determining the degree to which the study areas are representative of national trends in these parameters). The second is a national-scale assessment of long-term mortality related to $PM_{2.5}$ exposures (discussed in chapter 5). In

[28] Note, that while a full probabilistic uncertainty analysis was not completed for this risk assessment, we were able to use confidence intervals associated with effects estimates (obtained from epidemiological studies) to incorporate statistical uncertainty associated with sample size considerations in the presentation of risk estimates.

addition to providing an estimate of the national impact of $PM_{2.5}$ on long-term mortality, this analysis also evaluates whether the set of 15 urban study areas generally represents the broader distribution of risk across the U.S., or a more focused portion of the national risk distribution (e.g., the higher-end).

The remainder of this section is organized as follows. Key sources of variability which are reflected in the design of the risk assessment, along with sources excluded from the design, are discussed in section 3.5.2. A qualitative discussion of key sources of uncertainty associated with the risk assessment (including the potential direction, magnitude and degree of confidence associated with our understanding of the source of uncertainty – the knowledge base) is presented in section 3.5.3. The methods and results of the single- and multi-factor sensitivity analyses completed for the risk assessment are presented in section 3.5.4. An overall summary of the methods used to address uncertainty and variability for the 15 urban study areas (including the two assessments intended to place the urban study areas in a broader national context) is presented in section 3.5.5.

3.5.2 Key sources of variability

The risk assessment was designed to cover the key sources of variability related to population exposure and exposure response, to the extent supported by available data. However, as with all risk assessments, there are sources of variability which have not been fully reflected in the design of the risk assessment and consequently introduce a degree of uncertainty into the risk estimates. We note, in addition, that while different sources of variability were captured in the risk assessment, it was generally not possible to separate out the impact of each factor on population risk estimates, since many of the sources of variability are reflected collectively in a specific aspect of the risk model. For example, inclusion of urban study areas from different PM regions likely provides some degree of coverage for a variety of factors associated with $PM_{2.5}$ risk (e.g., air conditioner use, $PM_{2.5}$ composition, differences in population commuting and exercise patterns, weather). However, the model is not sufficiently precise or disaggregated to allow the individual impacts of any one of these sources of variability on the risk estimates to be characterized.

Key sources of potential variability that are likely to affect population risks are discussed below, including the degree to which they are (or are not) fully captured in the design of the risk assessment:

- **$PM_{2.5}$ composition**: While the risk assessment did not include modeling of risk associated with different components of $PM_{2.5}$, the assessment did use effect estimates (for a number of the short-term exposure-related health endpoints) differentiated by region of the country, or differentiated for specific urban locations (see section 3.3.3 and 3.3.4). While many factors may contribute to differences in effect estimates (for the same health endpoint) across different locations, compositional differences in $PM_{2.5}$ may be partially responsible. Therefore, while the analysis did not explicitly address compositional differences in generating risk estimates, potential differences in $PM_{2.5}$ composition may be reflected in those effect estimates that are differentiated by region and/or urban study area. The effect estimates for mortality associated with long-term exposure to $PM_{2.5}$ are not regionally differentiated and instead, a single national-scale estimate is used. This means that any differences in risks of mortality associated with long-term exposure to $PM_{2.5}$ that are linked to differences in $PM_{2.5}$ composition (or to any other differences across regions or locations) would not be discernable, since a single national-scale risk estimate is generated for each mortality category. This remains an important limitation of the analysis. In addition to using region- or location-specific effect estimates for health effects associated with short-term exposures, the selection of urban areas to include in the risk assessment was designed in part to ensure that areas in different regions of the country, with different $PM_{2.5}$ composition, were included.

- **Intra-urban variability in ambient $PM_{2.5}$ levels**: Several recent studies (e.g., Jerrett et al., 2005) have addressed the issue of heterogeneity of PM concentrations within urban areas and its potential impact on the estimation of premature mortality associated with long-term exposure to $PM_{2.5}$. Most recently, the HEI Reanalysis II (Krewski et al., 2009), focusing on the ACS dataset, discusses epidemiological analyses completed for Los Angeles and New York City which included more highly-refined (zip code level). characterizations of spatial gradients in population exposure within each urban area based on land-use regression methods and/or kriging. While both analyses provide insights into the issue of intra-urban heterogeneity in $PM_{2.5}$ concentrations and its potential implications for epidemiology-based health assessments, due to the time and resource necessary to integrate them into the risk assessment, we were not able to incorporate these studies quantitatively. The implications of these studies for interpretation of long-term mortality C-R functions and potential exposure error associated with those functions, is discussed below in section 3.5.3.

- **Demographics** (e.g., greater concentrations of susceptible populations in certain locations)**:** We have included multiple urban study areas reflecting differences in demographics in different regions of the country to address this issue.

- **Behavior affecting exposure to $PM_{2.5}$** (e.g., time spent outdoors, air conditioning use): We have incorporated, where available, region- and/or city-specific effect estimates in order to capture behavioral differences across locations that could affect population exposures to $PM_{2.5}$. However, while these location-specific effect estimates may be capturing differences in behavior, they may also be capturing other differences (e.g., differences in the composition of $PM_{2.5}$ to which populations are exposed). As noted above, it was not possible to separate out the impact of these different factors, which may vary across locations and populations, on effect estimates.

- **Baseline incidence of disease**: We collected baseline health effects incidence data (for mortality and morbidity endpoints) from a number of different sources (see section 3.4). Often the data were available at the county-level, providing a relatively high degree of spatial refinement in characterizing baseline incidence given the overall level of spatial refinement reflected in the risk assessment as a whole. Otherwise, for urban study areas without county-level data, either (a) a surrogate urban study area (with its baseline incidence rates) was used, or (b) less refined state-level incidence rate data were used.

- **Longer-term temporal variability in ambient $PM_{2.5}$ levels** (reflecting meteorological trends, as well as future changes in the mix of $PM_{2.5}$ sources and regulations impacting $PM_{2.5}$): Risk estimates for the $PM_{2.5}$ NAAQS review have been generated using recent years of air quality data. In other words, efforts have not been made to simulate potential future changes in either the concentrations or composition of ambient $PM_{2.5}$ in the risk assessment locations based on possible changes in economic activity, demographics or meteorology. Actual risk levels potentially experienced in the future as a result of implementing alternative standard levels may differ from those presented in this report due, in part, to potential changes in these factors related to ambient $PM_{2.5}$.

3.5.3 Qualitative assessment of uncertainty

As noted in section 3.5.1, we have based the design of the uncertainty analysis carried out for this risk assessment on the framework outlined in the WHO guidance document (WHO, 2009). That guidance calls for the completion of a Tier 1 qualitative uncertainty analysis, provided the initial Tier 0 screening analysis suggests there is concern that uncertainty associated with the analysis is sufficient to significantly impact risk results (i.e., to potentially affect decision making based on those risk results). Given previous sensitivity analyses completed for prior PM NAAQS reviews, which have shown various sources of uncertainty to have a potentially significant impact on risk results, we believe that there is justification for conducting a Tier 1 analysis. In fact, as argued earlier, given the complexity of the overall risk assessment, a full Tier 3 uncertainty analysis is warranted for consideration under WHO's guidelines.

For the qualitative uncertainty analysis, We have described each source of uncertainty and qualitatively assessed its potential impact (including both the magnitude and direction of the impact) on risk results, as specified in the WHO guidance. As shown in Table 3-13, for each source of uncertainty, we have (a) provided a description, (b) estimated the direction of influence (*over, under, both, or unknown*) and magnitude (*low,* *medium, high)* of the potential impact of each source of uncertainty on the risk estimates, (c) assessed the degree of uncertainty (*low, medium, or high*) associated with the knowledge-base (i.e., assessed how well we understand each source of uncertainty), and (d) provided comments further clarifying the qualitative assessment presented. Table 3-13 includes all key sources of uncertainty identified for the $PM_{2.5}$ NAAQS risk assessment. A subset of these sources has been included in the Tier 2 quantitative assessment discussed in section 3.5.4.

Table 3-13. Summary of Qualitative Uncertainty Analysis of Key Modeling Elements in the PM NAAQS Risk Assessment.

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
A. Characterizing ambient $PM_{2.5}$ levels for study populations using the existing ambient monitoring network	If the set of monitors used in a particular urban study area to characterize population exposure as part of an ongoing risk assessment do not match the ambient monitoring data used in the original epidemiological study, then uncertainty can be introduced into the risk estimates.	Both	Low-medium	Low-medium	KB and INF: In modeling risk, we focus on those counties that were included in the epidemiological studies supplying the underlying C-R functions. This means that, particularly for those endpoints modeled using C-R functions obtained from more recent studies, there is likely a close association between the monitoring network used in the risk assessment and the network used in the study supplying the C-R function(s). Note, however, that in those instances where the networks are different (e.g., when older studies are used, resulting in an increased potential for networks to have changed), uncertainty may be introduced into the risk assessment and it is challenging to evaluate the nature and magnitude of the impact that that uncertainty would have on risk estimates, given the complex interplay of factors associated with mismatched monitoring networks (i.e., differences in the set of monitors used in modeling risk and those used in the underlying epidemiological study).
B. Characterizing policy-relevant background (PRB)	For this analysis, we have used modeling to estimate PRB levels for each urban study area. Depending on the nature of errors reflected in that modeling, uncertainty (in both directions) may be introduced into the analysis.	Both	Low	Low	INF: Given that the risk assessment focuses primarily on the reduction in risk associated with moving from the current NAAQS to alternative standard levels, the impact of uncertainty in PRB levels on the risk estimates is expected to be low. In addition, for long-term exposure related mortality, we have based the core analysis on modeling risk down to LML rather than PRB, which reduces the significance of the PRB issue in the context of modeling long-term exposure-related mortality.
C. Procedure for adjusting air quality to simulate alternate standard levels	Uncertainty is associated with the manner in which monitor levels are rolled back to simulate just meeting alternative standard levels (e.g., will localized sources be addressed resulting in a geographically focused	Both	Low-medium	Low	INF: There is uncertainty associated with projecting the nature of strategies likely to be used to achieve alternate standard levels, as well as the degree to which localized strategies would disproportionately affect levels at particular (proximate) monitors. However, the sensitivity analysis completed in support of this risk assessment suggests that this source of uncertainty (as represented through the use of proportional vs. hybrid non-proportional rollback modeling) may have a relatively small impact on long-

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
	reduction in ambient levels, or will more generalized regional strategies be used).				term mortality risk in some locations with other areas showing a slightly larger impact (see section 4.3 for results of the sensitivity analysis addressing this source of uncertainty).
D. Characterizing intra-urban population exposure in the context of epidemiology studies linking $PM_{2.5}$ to specific health effects	Exposure misclassification within communities that is associated with the use of generalized population monitors (which may miss important patterns of exposure within urban study areas) introduces uncertainty into the effect estimates obtained from epidemiology studies.	Under (generally)	Medium-high	High	KB and INF: Recent analyses in Los Angeles and New York City based on ACS data (as reported in Krewski et al., 2009) demonstrate the relatively significant effect that this source of uncertainty can have on effect estimates (and therefore on risk results). These analyses also illustrate the complexity and site-specific nature of this source of uncertainty. The results of the Los Angeles analysis suggest that exposure error may result in effects estimates that are biased low and therefore result in the underestimation of risk. Specifically in relation to the zip-code level analysis based on ACS data conducted in Los Angeles (Jerrett et al., 2005), the draft ISA states that, "This [the refined exposure analysis reported in the Jerrett study] resulted in both improved exposure assessment and an increased focus on local sources of fine particle pollution. Significant associations between $PM_{2.5}$ and mortality from all causes and cardiopulmonary diseases were reported with the magnitude of the relative risks being greater than those reported in previous assessments. In general, the associations for $PM_{2.5}$ and mortality using these two methods [kriging and land-use regression] for exposure assessment were similar, though the use of land use regression resulted in somewhat smaller hazard ratios and tighter confidence intervals (see Table 7-9). This indicates that city-to-city confounding was not the cause of the associations found in the earlier ACS Cohort studies. This provides evidence that reducing exposure error can result in stronger associations between $PM_{2.5}$ and mortality than generally observed in broader studies having less exposure detail" (draft ISA, section 7.6.3).
E. Statistical fit of the C-R functions	Exposure measurement error combined with other factors (e.g., size of the effect itself, sample size, control for confounders) can effect the overall level of confidence	Both	• Low-medium (long-term health endpoints) • Medium	Medium	INF: Long-term mortality studies benefit from (a) having larger sample sizes (given that large national datasets are typically used in deriving national-scale models), (b) the fact that the form of the models used appears to be subject to relatively low uncertainty (see next row below) and (c) our not attempting to derive location-specific effects estimates (but instead, relying on national-scale

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
	associated with the fitting of statistical effect-response models in epidemiological studies.		(short-term health endpoints)		estimates). These factors combine to produce effects estimates that tend to be statistically robust (as reflected in results presented in Krewski et al., 2009). In addition, while concerns remain regarding exposure misclassification and potential confounding, generally we do not believe that the effects estimates are consistently biased in a particular direction. In the case of short-term mortality and morbidity health endpoints, there is greater uncertainty associated with the fit of models given the smaller sample sizes often involved, difficulty in identifying the etiologically relevant time period for short-term PM exposure, and the fact that models tend to be fitted to individual counties or urban areas (which introduces the potential for varying degrees of confounding and effects modification across the locations). In contrast to the long-term mortality studies, the short-term mortality and morbidity endpoints occasionally have effects estimates that are not statistically significant. Note, however that for this risk assessment, in modeling both short-term mortality and morbidity endpoints, we are not relying on location-specific models. In the case of short-term mortality, we are using city-specific effects estimates derived using Bayesian techniques (these combine national-scale models with local-scale models) (personal communication with Zanobetti, 2009). For short-term morbidity, we are using regional effects estimates (Bell et al., 2008). In both cases, while effects estimates are at times non-statistically significant, these models do benefit from larger sample sizes compared to city-specific models.
F. Shape of the C-R functions	Uncertainty in predicting the shape of the C-R function, particularly in the lower exposure regions which are often the focus in PM NAAQS regulatory reviews.	Both	Low-medium	Low-medium	INF: Regarding long-term mortality, the ISA suggests that a log-linear non-threshold model is best supported in the literature for modeling both short-term and long-term health endpoints. Although consideration for alternative model forms (Krewski et al., 2009) does suggest that different models can impact risk estimates to a certain extent, generally this appears to be a relatively modest source of overall uncertainty. Particularly if, as is the case in this risk assessment, we are not extrapolating below the lowest measured levels found in the underlying expidemiological studies. With regard to long-term mortality, the

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
					ISA concludes that, "Using a variety of methods and models, most of the studies evaluated support the use of a no-threshold, log-linear model…" (section 2.4.3). Regarding short-term morbidity, the ISA states that, "Overall, the limited evidence from the studies evaluated supports the use of a no-threshold, log-linear model, which is consistent with the observations made in studies that examined the PM-mortality relationship." (section 2.4.3).
G. Addressing co-pollutants	The inclusion or exclusion of co-pollutants which may confound, or in other ways, effect the PM effect, introduces uncertainty into the analysis.	Both	Low-medium	Medium	INF: With regard to long-term health endpoints, the ISA states that, "Given similar sources for multiple pollutants (e.g., traffic), disentangling the health responses of co-pollutants is a challenge in the study of ambient air pollution." (ISA, section 7.5.1). The ISA also notes that in some instances, consideration of copollutants can have a significant impact on risk estimates (i.e., the more refined study of lung cancer mortality in LA as reported in Krewski et al., 2009 – see ISA, section 7.5.1.1). With regard to short-term mortality and morbidity, the ISA generally concludes that observed associations are fairly robust to the inclusion of copollutants (see ISA, sections 6.3.8, 6.3.9, and 6.3.10)
H. Potential variation in effects estimates reflecting compositional differences for PM	The composition of PM can differ across study areas reflecting underlying differences in primary and secondary $PM_{2.5}$ sources (both natural and anthropogenic). If these compositional differences in fact translate into significant differences in public health impact (per unit exposure) for $PM_{2.5}$ then significant uncertainty may be introduced into risk assessments if these compositional differences are not explicitly addressed.	Both	Medium-High	Medium-High	KB and INF: Epidemiology studies examining regional differences in $PM_{2.5}$-related health effects have found differences in the magnitude of those effects (see sections 2.3.1.1 and 2.3.2 in the draft ISA). While these may be the result of factors other than composition (e.g., different degrees of exposure misclassification), composition remains one potential explanatory factor. For short-term exposure morbidity and mortality effects, the inclusion of city-specific and/or regional-specific effect estimates in the risk assessment may well reflect differences in PM composition and, thus consideration of differences in risk due to city-specific differences in composition may already be incorporated in the risk estimates for these endpoints to some extent.
I. Specifying lag structure (short-term	Different lags may have varying degrees of association with a particular health	Both	Medium	Medium	KB and INF: With regard to lag periods, the ISA states, "An attempt has been made to identify whether certain lag periods are more strongly associated with specific health outcomes. The

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
exposure studies)	endpoint and it may be difficult to clearly identify a specific lag as producing the majority of a PM-related effect (recently, distributed lags have been recommended since they allow for a distribution of the impact across multiple days of PM exposure prior to the health outcome). A lack of clarity regarding the specific lag(s) associated with a particular health endpoint adds uncertainty into risk estimates generated for that endpoint.				epidemiologic evidence evaluated in the 2004 PM AQCD supported the use of lags of 0-1 days for cardiovascular effects and longer moving averages or distributed lags for respiratory diseases (U.S. EPA, 2004a). However, currently, little consensus exists as to the most appropriate a priori lag times to use when examining morbidity and mortality outcomes." (ISA, section 2.4.2). This suggests that uncertainty remains concerning the identification of appropriate lags, and thus the etiologically relevant time period for exposure to PM for specific health endpoints.
J. Transferability of C-R functions from study locations to urban study area locations	The use of effects estimates based on data collected in a particular location(s) as part of the underlying epidemiological study in different locations (the focus of the risk assessment) introduces uncertainty into the analysis.	Both	Medium (for long-term exposure mortality) Not applicable (for short-term exposure health effect risk estimates)	Medium (for long-term exposure mortality) Low (for short-term exposure mortality)	INF: This issue has been ameliorated to a great extent in this risk assessment since we are now using multi-city studies for key short-term endpoints with effects estimates generally being applied only to urban study areas matching locations used in the underlying epidemiological study. In the case of long-term exposure mortality studies, these are designed to capture a more generalized national signal and therefore, concerns over the transferability of functions between locations is of greater concern.
K. Impact of historical air quality on estimates of health risk from long-term $PM_{2.5}$	Long-term studies of mortality suggest that different time periods of PM exposure can produce significantly different effects estimates, raising the issue of uncertainty in relation to determining which exposure	Both	Medium	Medium	INF: The latest HEI Reanalysis II study (HEI, 2009) which looked at exposure windows (1979-1983 and 1999-2000) for long-term exposure in relation to mortality, did not draw any conclusions as to which window was more strongly associated with mortality. However, the study did suggest that moderately different effects estimates are associated with the different exposure periods (with the more recent period having larger estimates). Overall, the

Source	Description	Potential influence of uncertainty on risk estimates		Knowledge-Base uncertainty*	Comments (KB: knowledge base, INF: influence of uncertainty on risk estimates)
		Direction	Magnitude		
exposures	window is most strongly associated with mortality.				evidence for determining the window over which the mortality effects of long-term pollution exposures occur suggests a latency period of up to five years, with the strongest results observed in the first two years (Draft ISA, section 7.6.4).
L. Characterizing baseline incidence rates	Uncertainty can be introduced into the characterization of baseline incidence in a number of different ways (e.g., error in reporting incidence for specific endpoints, mismatch between the spatial scale in which the baseline data were captured and the level of the risk assessment).	Both	Low-medium	Low	INF: The degree of influence of this source of uncertainty on the risk estimates likely varies with the health endpoint category under consideration. There is no reason to believe that there are any systematic biases in estimates of the baseline incidence data. The influence on risk estimates that are expressed as incremental risk reductions between alternative standards should be relatively unaffected by this source of uncertainty. KB: The county level baseline incidence and population estimates at the county level were obtained from data bases where the relative degree of uncertainty is low.

* Refers to the degree of uncertainty associated with our understanding of the phenomenon, in the context of assessing and characterizing its uncertainty (specifically in the context of modeling PM risk)

3.5.4 Single and multi-factor sensitivity analyses

We quantitatively examined the impact of several inputs to the risk assessment in a series of single-factor sensitivity analyses summarized above in Table 3-8. Rather than present results for each sensitivity analysis for all of the air quality scenarios considered in the core analysis, we selected a single air quality scenario – $PM_{2.5}$ concentrations that just meet the current standards – to use for the sensitivity analyses. The one exception to this was the sensitivity analyses examining the impact of an alternative approach to simulating just meeting alternative standards (the hybrid rollback).[29]

In discussing the approach used in conducting the sensitivity analysis, we focus first on methods used in assessing long-term exposure related health endpoints followed by the methods used in assessing short-term exposure related health endpoints. Note, that the results of the sensitivity analyses (including both single- and multi-factor analyses) are presented and discussed in section 4.3.

Because Krewski et al. (2009) presented results based on alternative model specifications only for the later exposure period (1999 – 2000), our sensitivity analyses focusing on the estimates of health effects incidence associated with long-term exposure to $PM_{2.5}$ similarly used the C-R functions based on this later exposure period. Krewski et al. (2009) considered several alternative modeling approaches to estimate the relationship between mortality (both all cause and cause-specific) and long-term exposure to $PM_{2.5}$, providing us the opportunity to examine the impact of alternative modeling approaches on the estimate of mortality risk associated with long-term exposure. In particular, we examined the impact of using a random effects log-linear model and of using a random effects log-log model[30] (rather than the standard fixed effects log-linear model used in the core analysis) to estimate the risks of all cause mortality, cardiopulmonary mortality, ischemic heart disease mortality, and lung cancer mortality associated with long-term exposure in Los Angeles and Philadelphia.[31] The coefficient of $PM_{2.5}$ in the random

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[29] Sensitivity analyses focusing on the hybrid rollback approach (relative to the proportional rollback approach used in the core analysis) involved the full set of alternative standard levels, in order to assess potential differences in risk across the range of standard levels.

[30] In the log-log model, the natural logarithm of mortality is a linear function of the natural logarithm of $PM_{2.5}$.

[31] As noted in Table 3-8, we combined both of these alternative modeling approaches in a single sensitivity analysis. In changing from a fixed effects log-linear model to a random effects log-log model, two changes are actually being made – the change from a fixed effects log-linear model to a random effects log-linear model, and the change from a random effects log-linear model to a random effects log-log model. However, because Krewski et al. (2009) did not present results for a fixed effects log-log model, it was not possible to compare the impact of making the single change from a fixed effects log-linear model (our core analysis selection) to a fixed effects log-log model. We thus instead present a two-stage sensitivity analysis incorporating both of the changes.

effects log-linear model was back-calculated from the relative risk reported in Table 9 ("Autocorrelation at MSA and ZCA levels" group – "MSA & DIFF" row) of Krewski et al. (2009). The coefficient of $PM_{2.5}$ in the random effects log-log model was back-calculated from the relative risks reported in Table 11 ("MSA and DIFF" rows) of Krewski et al. (2009).

As noted above, for all health endpoints associated with long-term exposure to $PM_{2.5}$ we estimated risk associated with $PM_{2.5}$ concentrations above 5.8 $\mu g/m^3$ (the LML for the later exposure period used in Krewski et al., 2009). In a sensitivity analysis we examined the impact of that limitation by comparing those mortality risk estimates to the mortality risk estimates obtained when we estimated risk associated with $PM_{2.5}$ concentrations above estimated PRB levels. This sensitivity analysis was carried out for all cause mortality in all 15 risk assessment urban areas.

In addition, we compared the impact of using the primary C-R functions used in the risk assessment, taken from Table 33 of Krewski et al. (2009), versus C-R functions for mortality associated with long-term exposure reported in another study, Krewski et al. (2000), which was based on a reanalysis of the Harvard Six Cities Study. The C-R functions estimated in Krewski et al. (2000) from the Harvard Six Cities cohort were estimated for ages 25 and up, while the C-R functions estimated in Krewski et al. (2009) from the ACS cohort were for ages 30 and up. For purposes of consistency in the comparison, however, we applied the C-R functions from Krewski et al. (2000) to ages 30 and up (and used the baseline incidence rates for that age group as well).[32] This sensitivity analysis was carried out for all cause mortality, cardiopulmonary mortality, and lung cancer mortality in Los Angeles and Philadelphia.

Finally, we compared estimates of all-cause mortality associated with long-term exposure when $PM_{2.5}$ levels just meet the current and alternative standards, using the proportional rollback approach versus the hybrid rollback approach. This sensitivity analysis was carried out in Baltimore, Birmingham, Detroit, Los Angeles, New York, and St. Louis.[33]

In all cases, in addition to calculating the incidence of the health effect when an alternative approach is taken, we calculated the percent difference in estimates from the core analysis resulting from the change in analysis input. So for example, when we calculated the incidence of all cause mortality associated with long-term exposure to

[32] The baseline incidence rates for ages 25 and up and ages 30 and up are likely to be very similar.
[33] As noted earlier in section 2.4.1, an error was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Therefore, while Pittsburgh had initially been included in this sensitivity analysis, these results have been removed since they are based on the set of current standard levels.

$PM_{2.5}$ using a random effects log-log model (instead of the fixed effects log-linear model used in the core analysis), we calculated the percent difference in the result as (incidence estimated using a random effects log-log model - incidence estimated using a fixed effects log-linear model)/(incidence estimated using a fixed effects log-linear model).

The primary studies selected to assess mortality risk and risk of hospitalization associated with short-term exposure to $PM_{2.5}$ (Zanobetti and Schwartz, 2009, and Bell et al., 2008, respectively) both provided all-year C-R functions as well as season-specific C-R functions. We examined the impact of using season-specific functions by applying these functions to each season, as defined by the study authors,[34] and summing the estimated season-specific incidences of mortality and hospitalizations. We compared these estimates to the estimates obtained by applying the corresponding all-year C-R functions to a year of air quality data.[35] This sensitivity analysis was carried out for all 15 of the risk assessment urban areas.

In addition, Ito et al. (2007) estimated an annual C-R function as well as a seasonal function for April through August for asthma ED visits in New York City. We compared the results of applying the annual C-R function to a whole year of air quality data to the results of applying the seasonal function to only those months (April through August) for which it was estimated.

Moolgavkar (2003) estimated C-R functions for several health endpoints – non-accidental and cardiovascular mortality; and cardiovascular and respiratory HAs – associated with short-term exposures to $PM_{2.5}$ in Los Angeles using different lag structures, different modeling approaches to incorporating weather and temporal variables, and single-pollutant versus multi-pollutant models. This study thus provided an opportunity to show the impact of lag structure, modeling approach, and single- vs. multi-pollutant models, individually, for several health endpoints associated with short-term exposures, although it is difficult to generalize to other locations since the study was only conducted in a single urban area.

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[34] Both studies defined each season as three months, beginning with winter defined as December, January, and February. In applying a season-specific function to a year of air quality data, we chose to keep a calendar year together, so that, for example, winter 2005 was defined as December 2005, January 2005, and February 2005.

[35] The mean season-specific incidence estimates can be summed to produce an all-year estimate of incidence. However, the 2.5th and 97.5th percentile season-specific estimates cannot be summed. To calculate the 2.5th and 97.5th percentile estimates of all-year incidence from the season-specific estimates would require the variance-covariance matrix of the season-specific coefficient estimators, which was not available. Therefore our comparison of all-year estimates based on summed season-specific estimates versus estimates based on an all-year C-R function was carried out only using the mean estimates.

Finally, we compared estimates of non-accidental mortality associated with short-term exposures to $PM_{2.5}$ (using Zanobetti and Schwartz, 2009) when $PM_{2.5}$ levels just meet the current and alternative standards, using the proportional rollback approach versus the hybrid rollback approach. This sensitivity analysis was carried out in Baltimore, Birmingham, Detroit, Los Angeles, New York, and St. Louis.

In all cases except the ED visits sensitivity analysis, in addition to calculating the incidence of the health effect when an alternative approach is taken, we calculated the percent difference in estimates from the core analysis resulting from the change in analysis input.[36]

Each single-element sensitivity analysis shows how the estimates of $PM_{2.5}$–related health effects incidence change as we change a single element of the analysis (such as the form of the C-R function or the way we simulate just meeting a set of standards). Because each of the alternative modeling choices is considered to be a reasonable choice, the results of these single-element sensitivity analyses provide a set of reasonable alternative estimates that may similarly be considered plausible (see section 4.3). The results of the single-element sensitivity analysis are presented and discussed in section 4.3.1.

The single-element sensitivity analyses provide insight into which sources of uncertainty may have the greatest impact on risk estimates when acting alone. However, there are several sources of uncertainty in estimating $PM_{2.5}$–related health effects. To provide a more complete picture of the uncertainty surrounding estimates of $PM_{2.5}$–related health effects incidence – and to expand the set of reasonable alternative estimates – we next carried out multi-element sensitivity analyses. The results of the multi-factor sensitivity analysis are presented and discussed in section 4.3.2.

The choice of uncertain analysis elements to include in the multi-element sensitivity analyses was guided by the single-element sensitivity analyses. In particular, we selected those modeling choices that had the greatest impacts on the estimates of health effects incidence in the single-element sensitivity analyses to provide insight into the scope of possible estimates that, while perhaps not based on our first choice of analysis elements, are nevertheless plausible alternative estimates.

We identified three analysis elements that substantially affected the estimates of mortality associated with long-term exposure to $PM_{2.5}$ -- the model choice (fixed effects

[36] We did not calculate percent different for the ED visits sensitivity analysis because the two different C-R functions (all-year in the core analysis vs. April through August in the sensitivity analysis) are also being applied to different portions of the year (all year vs. April through August), so it is something of an "apple to oranges" comparison.

log linear vs. random effects log-log), whether effects are estimated associated with $PM_{2.5}$ concentrations down to the LML in the study (5.8 $\mu g/m^3$) or down to PRB, and whether a proportional or a hybrid rollback is used to simulate $PM_{2.5}$ concentrations that just meet a given set of standards. This resulted in 2 x 2 x 2 = 8 different estimates of mortality, all of which could be considered plausible, based on the fact that the underlying model choices are all considered reasonable.

We identified two analysis elements that substantially affected the estimates of mortality associated with short-term exposure to $PM_{2.5}$ – whether season-specific or all-year C-R functions were used and whether a proportional or a hybrid rollback approach was used to simulate just meeting the current and alternative standards.

3.5.5 Summary of approach to addressing variability and uncertainty

The characterization of uncertainty and variability associated with the risk assessment includes a number of elements, which have been discussed in detail above. These include:

- Identification of key sources of variability associated with $PM_{2.5}$-related population exposure and hazard response and the degree to which they area captured in the risk assessment (see section 3.5.2). When important sources of variability in exposure and/or hazard response are not reflected in a risk assessment, significant uncertainty can be introduced into the risk estimates that are generated. While not explicitly referenced in the WHO guidance, this assessment (focused on coverage for key sources of variability) could be considered part of a Tier 1 analysis (i.e., the qualitative characterization of sources of uncertainty).
- Qualitative assessment of uncertainty, including both an assessment of the magnitude of potential impact of each source on risk estimates (along with the potential direction of that impact) as well as an assessment of overall confidence associated with our understanding of that source of uncertainty (see section 3.5.3). This represents a WHO Tier 1 analysis.
- Single-factor sensitivity analysis intended to evaluate the impact of individual sources of uncertainty on risk estimates (see section 3.5.4). The goal of this assessment is to evaluate the relative importance of these sources of uncertainty in impacting core risk estimates. The single-factor sensitivity analysis represents a WHO Tier 2 analysis. Note, that in conducting these assessments, we have used alternative representations of modeling elements that have support in the literature to ensure that the risk estimates that are generated represent reasonable alternate estimates that can supplement the core risk estimates generated in the analysis (see section 4.5.3).
- Multi-factor sensitivity analysis intended to assess the combined impact of multiple sources of uncertainty on risk estimates (see section 3.5.4). By

considering the combined effect of multiple sources of uncertainty, this analysis has the potential to identify any non-linearities which can magnify the impact of uncertainty on risk estimates, especially if several non-linear factors act in concert. This also represents a WHO Tier 2 analysis. Note, that as with the single-factor sensitivity analysis results, these risk estimates are also generated using modeling inputs which have support in the literature and consequently, they also represent reasonable alternate estimates that supplement the core risk estimates (see section 4.5.2).

It is important to reiterate that, due to our inability to characterize overall levels of confidence in alternative model inputs, the uncertainty characterization completed for this risk assessment did not include a full probabilistic assessment of uncertainty and its impact on core risk estimates (i.e., a WHO Tier 3 analysis was not completed). Furthermore, the risk estimates generated using the single- and multi-factor sensitivity analyses do not represent uncertainty distributions, but rather additional plausible point estimates of risk (i.e., we do not know whether they represent risk estimates near the upper or lower bounds of a true but undefined uncertainty distribution and we do not know the actual population percentiles that they represent). The appropriate use for these reasonable alternate risk estimates in informing consideration of uncertainty in the core risk estimates is discussed in section 4.5.3.

In addition to the specific analyses discussed above, we have also completed two additional analyses intended to place the 15 urban study areas in a broader national context with regard to risk. These include a representativeness analysis which evaluates the way the 15 urban study areas compare to national distributions for key PM-related risk attributes (discussed in section 4.4). We have also completed a national-scale assessment of long-term mortality related to $PM_{2.5}$ exposures (Chapter 5), which, in addition to providing an estimate of the national impact of $PM_{2.5}$ on long-term mortality, also evaluates whether the set of 15 urban study areas generally represents the broader distribution of risk across the U.S., or a more focused portion of the national risk distribution (e.g., the higher-end).

4 RESULTS

As discussed above in section 3.1.1, for this risk assessment, we have developed a core set of risk estimates supplemented by an alternative set of risk results generated using single-factor and multi-factor sensitivity analysis. The core set of risk estimates was developed using model inputs believed to have a relatively greater degree of support in the literature (compared with inputs used in the sensitivity analyses). Therefore, we have emphasized the core set of risk estimates in presenting and discussing risk estimates in this section, with the results of the sensitivity analysis serving to augment the core estimates as discussed below.

The results of the sensitivity analysis allow us to evaluate and rank the potential impact of key sources of uncertainty on the core risk estimates. In addition, as noted in section 3.5.4, because the sensitivity analysis was conducted using alternative modeling inputs having some degree of support in the literature, the results of the sensitivity analysis also represent a set of reasonable alternatives to the core set of risk estimates that can be used in informing characterization of uncertainty in the core results (see section 4.3 below).

As discussed in section 2.2 and 3.2, this risk assessment includes consideration of the following air quality scenarios:

- Recent conditions: based on $PM_{2.5}$ concentrations characterized through monitoring for the period 2005-2007 at each urban case study location;
- Current NAAQS: based on rolling back $PM_{2.5}$ concentrations to just meet the current suite of standards in each urban study area (annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$, denoted 15/35);
- Alternative NAAQS: based on rolling back $PM_{2.5}$ concentrations to just meet an alternative set of standards in each urban study area:
  - annual standard of 13 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$ (denoted 13/35);
  - annual standard of 12 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$ (denoted 12/35);
  - annual standard of 13 $\mu g/m^3$ and a 24-hour standard of 30 $\mu g/m^3$ (denoted 13/30);
  - annual standard of 12 $\mu g/m^3$ and a 24-hour standard of 25 $\mu g/m^3$ (denoted 12/25).

In simulating both current and alternative standard levels, for the core analysis, we used a proportional roll-back approach (see section 3.2.3), while a hybrid roll-back approach reflecting the potential for local source control was used for a subset of urban study areas as part of the sensitivity analysis conducted for this assessment (see section 3.2.3).

As described in section 2.1 and 3.3.2, for this risk assessment, we assessed risk for 15 urban study areas chosen to provide coverage for the diversity of urban settings across the U.S. that reflect areas with elevated annual and/or daily $PM_{2.5}$ concentrations.[9] At a minimum all areas selected had recent air quality levels at or above the most stringent annual and/or 24-hour standard analyzed. In addition, our goal was to select areas reflecting the heterogeneity in PM risk-related attributes such as sources, composition, demographics, and population behavior.

Risk estimates were generated for the following health effects endpoints: (a) long-term exposure-related mortality (all-cause, cardiopulmonary disease-related (CPD), ischemic heart disease-related (IHD) and lung cancer-related), (b) short-term exposure-related mortality (non-accidental, cardiovascular disease-related (CVD), respiratory), and (c) short-term exposure-related morbidity (hospital admissions (HA) for CVD and respiratory illness and emergency department (ED) visits). Risk estimates are presented separately for each of these 15 study areas, although in certain circumstances, risk estimates may be restricted to a subset of these locations if, for example, an endpoint is modeled using a C-R function derived from an epidemiological study that was conducted only in a subset of the urban areas. For the core analysis, long-term exposure mortality risk was modeled down to lowest measured level (LML), because the LML was higher than estimated PRB and because there is substantial uncertainty as to the shape of the concentration-response (C-R) function at concentrations below the LML. For long-term exposure mortality a sensitivity analysis was conducted that estimated risk down to policy-relevant background (PRB). In contrast, all short-term exposure health effects endpoints were modeled down to PRB, since this was higher than the LML across all studies and for purposes of NAAQS decision making, EPA is focused on risks associated with $PM_{2.5}$ levels that are due to anthropogenic sources that can be controlled by U.S. regulations (or through international agreements with neighboring countries).

In modeling long-term exposure mortality, for the core analysis, we have based estimates on the latest reanalysis of the American Cancer Society (ACS) dataset, with two sets of risk estimates being generated; one using a C-R function derived by fitting $PM_{2.5}$ monitoring data from 1979-1983 and a second set based on fitting $PM_{2.5}$ monitoring data from 1999-2000 (Krewski et al., 2009) (see section 3.3.3). In presenting core risk estimates for long-term mortality, both sets of estimates are given equal weight.

In modeling short-term exposure mortality and morbidity for the core analysis, we have used the latest multi-city studies (Zanobetti and Schwartz, 2009; Bell et al., 2008) (see section 3.3.3). In the case of short-term exposure mortality, we obtained and used city-specific effects estimates derived using empirical Bayes methods from the study authors (Zanobetti, 2009). Multi-city studies were favored for the core analysis, since these studies are not subject to publication bias and because they reflect a diverse set of locations with regard to the observed relationship between short-term $PM_{2.5}$ exposure and health affect response in the population. Additional detail on the specific C-R functions and related modeling elements such as effects estimates and lag periods used in the core analysis relative to the sensitivity analysis are presented in sections 3.3 and 3.4 and called out where appropriate below as specific risk estimates are discussed.

Because the recent conditions air quality scenario spans three years (2005-2007), risk estimates are generated for each of these years, reflecting the underlying air quality data for a particular year. Risk metrics generated for the above health effects endpoints include:

- **Annual incidence of the endpoint due to $PM_{2.5}$ exposure (*annual incidence*)**: Generated for the population associated with a given urban study area (for a given simulation year), in most cases, these risk estimates include both a point estimate as well as a 95th percentile confidence interval, the latter reflecting sampling error as characterized in the underlying epidemiological study.
- **Percent of total annual incidence for the health endpoint due to $PM_{2.5}$ exposure (*percent of total incidence attributable to $PM_{2.5}$*):** Again, generated for the population associated with a given urban study area (and simulation year), this metric characterizes the fraction of total incidence that is associated with $PM_{2.5}$ exposure. As with the underlying PM-related incidence estimates, this risk metric also typically includes a 95th percentile confidence interval reflecting sampling error associated with the effects estimate. Compared with the annual incidence metric which reflects underlying population size for each study area, this risk metric has the advantage of not being dependent on the size of the underlying population, thereby allowing direct comparison of the potential impact of $PM_{2.5}$ for the health effect endpoint of interest across urban study area locations. For this reason, in discussing risk estimates in this section, the *percent of total incidence attributable to $PM_{2.5}$* risk metric is given greater emphasis than the absolute measure of *annual incidence attributable to $PM_{2.5}$*.
- **Percent reduction in $PM_{2.5}$-related health effect incidence for an alternative set of standards or the recent conditions scenario, relative to the current standards (*percent change from the current set of standards*)**: Also estimated separately for each urban study area and simulation year, this metric characterizes the degree of risk reduction (for alternative standard levels) or increased risk (for the recent conditions scenario) relative to the current NAAQS. For this metric, a

negative value represents an increase in risk (this is the case for the recent conditions scenario, where risks are actually higher than the current NAAQS). This metric is positive, or zero, for alternative NAAQS since they either produce no risk reduction (if ambient air levels under recent conditions are already at or below that alternative NAAQS level), or a positive risk reduction for alternative standards resulting in a reductions in ambient $PM_{2.5}$ concentrations. We note, that because this metric is incremental, it was not possible to generate the 95th percentile confidence intervals included with the other two "absolute" risk metrics described above. As with the previous risk metric, this metric is not dependent on the underlying population size and therefore, allows direct comparison across urban study areas.

Tables presenting estimates for these risk metrics are included in Appendix E and referenced in the discussion of risk estimates presented in this section (the detailed results tables themselves are not included in this section due to the large number of tables generated). In addition to the above risk metrics, we also generated a series of figures based on the third metric describe above (the percent reduction from the current standards). These figures allow the reader to quickly evaluate trends across air quality scenarios and across the 15 urban study areas in terms of the degree of reduction in $PM_{2.5}$-related risk. A subset of these figures (for 2007) are in this section, with the full set of figures for all three simulation years being included in Appendix E.

Although risk estimates were generated for all three simulation years, in this chapter core risk estimates primarily from 2007 are presented and discussed for both the recent conditions air quality scenario and current and alternative standards. This reflects the observation that generally, 2007 represents a reasonable central year (in terms of the magnitude of risk generated for the three simulated years), when considering results for all modeled health effect endpoints across the 15 study areas. In addition, 2007 is the most recent year of the three simulated. We note, however, that while we do focus on 2007 in presenting and discussing risk estimates, we include an assessment of general trends across the three simulation years to gain perspective on year-to-year variation in $PM_{2.5}$-related risk estimates as assessed here.

In presenting the results of the sensitivity analysis, as with the core risk results, we also focus on 2007. This is done to increase compatibility between the core results and the sensitivity analysis results (i.e., allow the sensitivity analysis results to be used to gain insights into uncertainty associated with the core results, without adding the additional factor of year-to-year variation into the mix). As with the core risk estimates, the full set of sensitivity analysis results for all three simulation years have been generated and are presented in Appendix F.

For a subset of the urban case studies (e.g., Dallas and Phoenix), incremental reductions across alternative standards are initially very low (or even zero) reflecting the fact that recent ambient $PM_{2.5}$ concentrations for these study areas are well below the current annual standard levels. For these study areas, meaningful reductions in risk may not be seen until relatively lower alternative standards are assessed (and results in the percent reduction from the current set of standards tables and figures may be zero for several of the less stringent, alternative sets of standards).

For a number of the urban study areas, confidence intervals (and in some instances, point estimates) for short-term mortality and morbidity incidence and related risk metrics include values that fall below zero. Population incidence estimates with negative lower-confidence bounds (or point estimates) do not imply that additional exposure to $PM_{2.5}$ has a beneficial effect, but only that the estimated $PM_{2.5}$ effect estimate in the C-R function was not statistically significantly different from zero. In the case of short-term exposure mortality, where study area-specific effects estimates were used (see section 3.4), several of the urban locations have non-statistically significant effects estimates; these result in incidence estimates with non-positive lower bounds and/or best estimates (e.g., Birmingham, Detroit, and Los Angeles for non-accidental mortality). In the case of short-term morbidity (e.g., HAs), where regional effects estimates were used, one of the regional coefficients (for the southeast) is not statistically significant, producing incidence estimates including negative values in the confidence interval for urban study areas falling within that region (e.g., Atlanta, Dallas, and Houston, for CV-related HAs). Lack of statistical significance could mean that there is no relationship between $PM_{2.5}$ and the health endpoint or it could mean that there was not sufficient statistical power to detect a relationship that actually exists. In the case of $PM_{2.5}$ and both short-term exposure mortality and morbidity, given the available evidence in the literature, which has resulted in the draft ISA concluding that there is likely to be a causal relationship between short-term $PM_{2.5}$ exposure and adverse health effects (see section 3.3.1), we believe it is reasonable to assume that instances where effects estimates are not-statistically significant are likely to reflect insufficient sample size, rather than the absence of an actual association. We note, however, that (as discussed in section 3.6.3) many factors can potentially result in variations in the magnitude of effect estimates. In addition to sample size, these include: source and compositional differences for $PM_{2.5}$, exposure error associated with the use of ambient monitors as a surrogate for actual exposure, and differences in population susceptibility and vulnerability.

The remainder of this section is organized as follows. Core modeling results for the recent conditions air quality scenario are presented in section 4.1. Core modeling results for just meeting the current NAAQS and just meeting alternative NAAQS are presented in section 4.2. The results of the sensitivity analysis (including single-factor and multi-factor results) are presented in section 4.3. The results of a representativeness analysis involving comparison of counties associated with the 15 urban study area locations against the national distribution of counties with regard to a set of PM-risk related attributes are presented in section 4.4. The chapter concludes in section 4.5 with an overall summary and presentation of key observations drawn from consideration of the core analysis results combined with the results of the sensitivity analysis results. We note that all of the risk estimates discussed in this chapter pertain to the 15 urban study areas. The results of the national-scale health impact analysis are presented separately in chapter 5, although implications for interpretation of risk estimates generated for the 15 urban study areas are discussed in section 4.5.4.

4.1 ASSESSMENT OF HEALTH RISK ASSOCIATED WITH RECENT CONDITIONS (CORE ANALYSIS)

This section discusses core risk estimates generated for the recent conditions air quality scenario, focusing on the 2007 simulation year (although observations related to the three simulated years are also presented). In discussing results for the recent conditions air quality scenario, we have focused on absolute risk (either above PRB or LML, depending on the health effect endpoint). This reflects the fact that this air quality scenario represents recent conditions within the urban study areas and therefore, does not lend itself well to an incremental assessment. The section is organized by health endpoint category, with results discussed in the following order: long-term exposure mortality, short-term exposure mortality and short-term exposure morbidity.

4.1.1 Long-term exposure mortality

This section summarizes core estimates for long-term exposure mortality (all cause, IHD, CPD and lung cancer) generated for the recent conditions air quality scenario for simulation year 2007.

- **Percent of total incidence and $PM_{2.5}$-related incidence (all cause mortality)**: the percent of total long-term exposure mortality incidence associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is estimated to range from 1.7% (Tacoma) to 5.2% (Fresno) based on the C-R function derived using 1979-1983 $PM_{2.5}$ monitoring data (Appendix E, Table E-7). The percent of total incidence for long-term exposure mortality (for all-cause) based on the C-R function derived using 1999-2000 $PM_{2.5}$ monitoring data are somewhat larger, ranging from 2.2% (Tacoma) to 6.7% (Fresno) (Appendix E, Table E-15). Total all-cause mortality incidence associated with long-term exposure to $PM_{2.5}$ ranges from about 90 (Tacoma) to 2,200 (L.A.) (based on the C-R function derived using 1979-1983 $PM_{2.5}$ monitoring data - Appendix E, Table E-3) and from 120 (Tacoma) to 2,900 (L.A.) (based on the C-R function derived using 1999-2000 $PM_{2.5}$ monitoring data - Appendix E, Table E-12).

- **Percent total incidence and $PM_{2.5}$-related incidence (IHD-related mortality)**: the percent of total long-term exposure mortality incidence (IHD) associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is significantly higher than all-cause mortality, ranging from 6.6% (Tacoma) to 17.3% (Birmingham) based on a C-R function derived using 1979-1983 $PM_{2.5}$ data (Appendix E, Table E-24). Percent of total incidence for this mortality endpoint is even higher when a C-R function based on 1999-2000 $PM_{2.5}$ monitoring data is used; ranging from 8.4% (Tacoma) to 23.6% (Fresno) (Appendix E, Table E-33). We note, that while the percent of total incidence is significantly larger for this health endpoint (3-4 times as high as for total all-cause mortality), overall $PM_{2.5}$–associated incidence is significantly less than $PM_{2.5}$-associated incidence for all-cause mortality (on the order of about 50% lower, depending on the city – see results in Appendix E, Table E-12 versus E-30). This reflects the fact that baseline health effect incidence for all-cause mortality is significantly higher than for IHD mortality, which compensates for the greater slope of the IHD mortality effects estimate (see section 3.5). Total IHD-related mortality incidence associated with long-term exposure to $PM_{2.5}$ ranges from about 70 (Tacoma) to 2,000 (L.A.) (based on the C-R function derived using 1979-1983 $PM_{2.5}$ monitoring data - Appendix E, Table E-21) and from about 90 (Tacoma) to 2,600 (L.A.) (based on the C-R function derived using 1999-2000 $PM_{2.5}$ monitoring data - Appendix E, Table E-30).

- **Percent total incidence and $PM_{2.5}$-related incidence (CPD-related mortality)**: overall percent of total incidence results for CPD mortality associated with long-term $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year fall between those for all-cause and ischemic heart disease.[37] Specifically, estimates based on the C-R function derived using 1979-1982 range from 3.6% (Tacoma) to 10.6% (Fresno) (Appendix E, Table E-42), with results based on the 1999-2000 C-R function being somewhat higher (Appendix E, Table E-51). Actual incidence estimates for this mortality endpoint are slightly less than for all-cause mortality, likely reflecting the fact that, while the effect estimates for CPD mortality are significantly larger than for all-cause mortality, the baseline health effects incidence rate is larger for all-cause mortality, again compensating for the smaller effects estimate. Total CPD-related mortality incidence associated with long-term exposure to $PM_{2.5}$ ranges from 81 (Tacoma) to 2,300 (L.A.) (based on the C-R function derived using 1979-1983 $PM_{2.5}$ monitoring data - Appendix E, Table E-39) and from

[37] This is expected, since IHD represents a subset of cardiopulmonary mortality.

120 (Tacoma) to 3,200 (L.A.) (based on the C-R function derived using 1999-2000 $PM_{2.5}$ monitoring data - Appendix E, Table E-48).

- **Percent total incidence and $PM_{2.5}$-related incidence (lung cancer mortality)**: overall percent of total incidence estimates for lung caner mortality associated with long-term $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year are similar to estimates for CPD mortality. Specifically, using a C-R function derived using 1979-1982 $PM_{2.5}$ monitoring data, percent incidence estimates range from 3.5% (Tacoma) to 10.4% (Fresno) (Appendix E, Table E-60). As expected, estimates derived using the C-R function based on 1999-2000 ambient monitoring data are larger (Seep Appendix E, Table E-69). We note, however, that actual $PM_{2.5}$-associated lung cancer mortality incidence estimates are significant lower than those generated for CPD mortality, reflecting the significantly lower baseline health effects incidence rates associated with lung cancer mortality. Total lung cancer-related mortality incidence associated with long-term exposure to $PM_{2.5}$ ranges from about 10 (Salt Lake City) to 240 (L.A.) (based on the C-R function derived using 1979-1983 $PM_{2.5}$ monitoring data - Appendix E, Table E-57) and from 20 (Tacoma) to 340 (L.A.) (based on the C-R function derived using 1999-2000 $PM_{2.5}$ monitoring data - Appendix E, Table E-66).

- **Pattern in percent of total incidence across urban study areas**: Differences across urban study areas for the different long-term mortality categories can be significant (e.g., a factor of over 2 for all cause mortality between Tacoma and Fresno, the two locations with the greatest disparity in estimated incidence – see Appendix E, Table E-3). This spread in incidence estimates likely results primarily from differences in underlying recent conditions ambient air $PM_{2.5}$ levels across the urban study areas (see Appendix A), with differences in baseline health effects incidence data also playing a role (see section 3.5). However, because the C-R functions used to estimate incidence rates for long-term mortality are not differentiated by region or urban study area (see section 3.4 - i.e., the same function is used for all study areas for a given long-term mortality endpoint), differences in incidence estimates generated across the urban study areas do not reflect any underlying differences in the potential response of populations (located in different urban areas) to $PM_{2.5}$ exposure. We note, that as discussed in section 3.6.2 and 3.6.3, there is the potential for regional differences in $PM_{2.5}$ sources and composition, as well as other factors related to long-term PM exposure and risk, that may well produce differences in the response of populations to $PM_{2.5}$ exposure, however, we are not currently able to reflect this factor quantitatively in modeling long-term exposure-related mortality.

- **Pattern of percent of total incidence across the three simulated years (2005-2007)**: A comparison of all-cause mortality incidence estimates (based on the C-R function derived using 1979-1982 monitoring data) across the three years (see Appendix E, Tables E-19 through E-21) shows that, while 2007 does produce incidence estimates between those estimated for 2005 and 2006 for some urban areas (e.g., Tacoma, St. Louis, LA), results for 2007 can be the highest of the three years (e.g., Fresno) or the lowest (e.g., Baltimore) for some locations. Generally, results for the same urban study area across the three years are fairly similar (results for Birmingham vary by less than 3% across the years), although they can vary by as much as 30% or more in some locations (see results for Tacoma in 2005 and 2006). All of this temporal variation results from year-to-year variation in the annual average $PM_{2.5}$ levels for the study areas (see Appendix A). This is because other candidate input parameters, which could also involve temporal variability (e.g., demographics and baseline incidence rates) were not modeled with year-specific values, but rather using one representative year (see section 3.4.1.3 and 3.5 for demographics and baseline health effects incidence rates, respectively).

- **Statistical significance of the effect estimates underlying the risk estimates and implications for interpretation of those risk estimates**: All of the effects estimates used in modeling long-term mortality categories are statistically significant and consequently none of the confidence intervals (or associated best estimates) include negative incidence estimates. We note, that this is in contrast to results for recent air quality generated for short-term mortality and morbidity health effects endpoints, in which case some of the effects estimates were not statistically significant, as noted below.

- **Relationship between all-cause and IHD $PM_{2.5}$-associated incidence estimates for New York City**: The estimated incidence attributable to $PM_{2.5}$ for all cause mortality in New York City (for recent conditions in 2007) is 1,500 (see Appendix E, Table E-3). However, estimated incidence for IHD attributable to $PM_{2.5}$ (for recent conditions in 2007) is 2,000 (Appendix E, Table E-21). This set of estimates is counter to what would be expected, since IHD is a subset of all-cause mortality. This outcome likely results from the fact that we are applying national-scale effects estimates to individual urban study areas, which, in the case of New York City has significantly different baseline incidence rates for all cause and critically, IHD mortality, compared with national estimates.[38] If (a) the fraction of all-cause mortality attributable to IHD is greater in New York City, compared with the national average (which is supported by the data cited here) and (b) the effect estimate for IHD mortality is larger than for all-cause (see section 3.3.4), it would then follow that the estimate for all-cause mortality generated for New York City is biased low. Specifically, the effect estimate for all-cause mortality obtained from Krewski et al., 2009 reflects a fraction of IHD-related deaths that is significantly lower than that seen in New York City, which would result in a downward-bias in the effects estimate for all-cause mortality for New York City. Consequently, if this explanation holds, then the all-cause $PM_{2.5}$-

[38] Specifically, the baseline incidence rates for IHD mortality for New York City are 380 per 100,000 while national rate is 242 per 100,000 (see section 3.5, Table 3-9). This translates into New York City having approximately 1.5 times the rate of IHD deaths relative to the national average. All-cause mortality baseline incidence also differs, although to a lesser extent, with New York City having 1,077 per 100,000 and the national-average being 1,327 per 100,000. This translates into New York City having a baseline incidence rate for all-cause mortality that is 23% lower than the national average.

associated mortality estimate for New York City should be larger than what is presented. It is important to note that many other factors can potentially influence the magnitude of effects estimates for specific locations (e.g., $PM_{2.5}$ sources and composition, differences in population susceptibility and vulnerability).

4.1.2 Short-term exposure mortality

This section summarizes core estimates for short-term exposure mortality (non-accidental, IHD, CVD and respiratory) generated for the recent conditions air quality scenario for simulation year 2007.

- **Percent of total incidence and $PM_{2.5}$-related incidence (non-accidental mortality)**: the percent of total short-term exposure (non-accidental) mortality incidence associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is estimated to range from 0.2% (Los Angeles) to 1.7% (Baltimore) (Appendix E, Table E-78). This estimate is notably lower than that generated for long-term exposure (all cause) mortality (see above). Total $PM_{2.5}$-related incidence estimates for this mortality category, vary greatly across the study areas, ranging from about 50 (Birmingham) to 790 (New York) - see Appendix E., Table E-75). Of the 15 urban study areas modeled for this endpoint, three locations had negative lower bound estimates of incidence, reflecting use of non-statistically significant effects estimates (see section 4.0 for additional discussion).
- **Percent total incidence (CVD mortality)**: the percent of short-term exposure mortality incidence (CVD) associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is similar to non-accidental mortality, with the highest estimate being 2.3% (Philadelphia) (Appendix E, Tables E-87). Total $PM_{2.5}$-related incidence estimates for this mortality category also vary greatly across the study areas (ranging from -50 (Los Angeles) to 510 (New York) - see Appendix E., Table E-84). Of the 15 urban study areas modeled for this endpoint, 12 locations had negative lower bound estimates of incidence (and two of these head negative point estimates), reflecting use of non-statistically significant effects estimates (see section 4.0 for additional discussion).
- **Percent total incidence and $PM_{2.5}$-related incidence (respiratory mortality)**: the percent of short-term exposure mortality incidence (respiratory) associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is also similar to estimates for non-accidental mortality, with the largest estimate being 2.9% (Fresno) (Appendix E, Table E-96). Total $PM_{2.5}$-related incidence estimates for this mortality category, vary greatly across the study areas, ranging from 8 (Tacoma) to 110 (New York) - see Appendix E., Table E-93). Of the 15 urban study areas modeled for this endpoint, six locations had negative lower bound estimates of incidence, reflecting use of non-statistically significant effects estimates (see section 4.0 for additional discussion).

- **Pattern in percent of total incidence across urban study areas**: Differences across urban study areas for the different short-term exposure mortality categories can be large (e.g., a factor of 2 or higher for non-accidental mortality between Detroit and Baltimore, the two locations with the greatest disparity in statistically-significant percent of total incidence estimates – see Appendix E, Table E-78). We note, that differences in this risk metric across urban study areas are substantially higher (up to an order of magnitude) if estimates are compared without consideration for statistical significance (e.g., compare 0.2% for non-accidental mortality in Los Angeles with 1.7% in Baltimore – see Appendix E, Table E-78)). The greater overall difference in this risk metric across urban study areas for short-term mortality categories compared with long-term mortality categories (see last section) is to be expected given that both the effect estimates as well as patterns of daily ambient $PM_{2.5}$ levels differ across the urban locations, while with long-term mortality, only annual-average $PM_{2.5}$ levels differ (as noted earlier, the same effect estimates is used in modeling incidence for all urban study areas for a given long-term exposure mortality category – see section 3.3.4).
- **Pattern of percent of total incidence across the three simulated years (2005-2007)**: A comparison of non-accidental mortality incidence estimates across the three years (see Appendix E, Tables E-76 through E-78) shows that, while 2007 does produce incidence estimates between those estimated for 2005 and 2006 for some urban areas (e.g., Dallas, Houston, Los Angeles, New York, Pittsburgh), results for 2007 can be the highest of the three years (e.g., Atlanta, Fresno) or the lowest (e.g., Detroit, Philadelphia) in some of the 15 urban study areas. Generally, results for the same urban study area across the three years are fairly similar (results for Atlanta vary by less than 2% across the three years), although they can vary by as much as 26% or more (compare results for Detroit in 2005 and 2007). As with the long-term mortality risk metrics, all of this temporal variation results from year-to-year variation in the daily $PM_{2.5}$ levels for the study areas (see Appendix A), given that other candidate input parameters, which could have temporal variability (e.g., demographics and baseline incidence rates) were not modeled with year-specific values, but rather using one representative year (see sections 3.4.1.3 and 3.5 for demographics and baseline health effects incidence rates, respectively).
- **Comparison of long-term exposure and short-term exposure mortality estimates**: The $PM_{2.5}$-related incidence for short-term exposure (non-accidental) mortality is notably smaller than the estimate for long-term exposure (all cause) mortality, with short-term incidence on an aggregate annual basis generally ranging from 25 to 50% of the long-term (annual) estimate for the same city. Furthermore, the maximum value for short-term (non-accidental) mortality is about 790 for New York, while the largest value for long-term (all cause) mortality is 2,900 for Los Angeles (both values are for simulation year 2007). It is interesting to note that maximum estimates for these two mortality endpoints did not occur in the same urban study area.

4.1.3 Short-term exposure morbidity

This section summarizes core estimates for short-term exposure morbidity (HA for CVD and respiratory; ED visits for CV, respiratory and asthma) generated for the recent conditions air quality scenario for simulation year 2007.

- **Percent of total incidence and $PM_{2.5}$-related incidence (CVD HAs):** the percent of total short-term exposure (CV) HAs associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is estimated to range from 0.4% (Atlanta) to 1.65% (Pittsburgh) (Appendix E, Table E-105). Total $PM_{2.5}$-related incidence estimates for this morbidity category, range from 20 (Salt Lake City) to 810 (New York) (see Appendix E., Table E-102). Of the 15 urban study areas modeled for this endpoint, five locations had negative lower bound estimates of incidence, reflecting use of non-statistically significant effects estimates (see section 4.0 for additional discussion).
- **Percent of total incidence and $PM_{2.5}$-related incidence (respiratory HAs):** the percent of total short-term exposure (respiratory) HAs associated with $PM_{2.5}$ exposure under recent conditions for the 2007 simulation year is estimated to range from 0.17% (Tacoma) to 1.6% (Fresno) (Appendix E, Table E-114). This estimate is similar to estimates generated for total short-term (CV) HAs. Total $PM_{2.5}$-related incidence estimates for this morbidity category, range from <10 (Tacoma) to 270 (Los Angeles) (see Appendix E., Table E-110). Of the 15 urban study areas modeled for this endpoint, eleven locations had negative lower bound estimates of incidence, reflecting use of non-statistically significant effects estimates (see section 4.0 for additional discussion).
- **Percent of total incidence and $PM_{2.5}$-related incidence (ED visits for CV, respiratory and asthma illness):** in contrast to the other short-term and long-term exposure endpoints discussed in this section (and included in the core analysis), ED visit endpoints were assessed for specific urban case study locations, using epidemiological studies (and associated effects estimates) derived specifically for those locations. Percent of total incidence estimates for both endpoints for the recent conditions air quality scenario was 0.6% (see Appendix E, Table E-123) with $PM_{2.5}$-related incidence estimates being 220 (CV) and 830 (respiratory) for recent conditions in simulation year 2007. The results for Atlanta both included negative lower bound estimates, reflecting use of non-statistically significant effects estimates (see section 4.1 for additional discussion). Percent of total incidence attributable to $PM_{2.5}$ for ED visits in New York (for asthma) is 6.2% while the related total $PM_{2.5}$-associated incidence estimate is 1,100 (Appendix E, Table E-120). The effect estimates used in evaluating ED visits for New York is statistically significant.
- **Pattern in percent of total incidence across urban study areas**: Differences across urban study areas for the different short-term exposure HAs categories can be significant (e.g., a factor of over 3 for CV HAs between Houston and Pittsburgh, the two locations with the greatest disparity in percent of total incidence estimates – see Appendix E, Table E-105). We note, that variation in

risk estimates across cities for this endpoint category is significantly smaller than that for short-term mortality. This is not unexpected since location-specific effects estimates were not used in modeling short-term exposure HAs (regional estimates were used), while short-term exposure mortality, as noted earlier, was modeled using location-specific effects estimates.

- **Pattern of percent of total incidence across the three simulated years (2005-2007)**: A comparison of CV illness-related HAs incidence estimates across the three years (see Appendix E, Tables E-100 through E-102) shows that, while 2007 does produce incidence estimates between those estimated for 2005 and 2006 for six of the 15 urban study areas, for the remaining locations, estimates for 2007 sometimes represent the highest and sometimes the lowest estimates. Generally, results for the same urban study area across the three years are fairly similar (results for Atlanta vary by less than 2% across the years), although they can vary by as much as 17% or more (compare results for St Louis in 2005 and 2007). As with the long-term and short-term exposure mortality risk metrics, all of this temporal variation results from year-to-year variation in the daily $PM_{2.5}$ levels for the study areas (see Appendix A), given that other candidate input parameters, which could have temporal variability (e.g., demographics and baseline incidence rates) were not modeled with year-specific values, but rather using one representative year (see section 3.4.1.3 and 3.5 for demographics and baseline health effects incidence rates, respectively).

4.2 ASSESSMENT OF HEALTH RISK ASSOCIATED WITH JUST MEETING THE CURRENT AND ALTERNATIVE STANDARDS (CORE ANALYSIS)

This section discusses core (i.e., base case) risk estimates generated for the current set of standards and alternative sets of standard, focusing on the 2007 simulation year (although general trends in observations across the three simulated years are discussed to a limited extent). The results discussed below are based on results from 14 of the 15 study areas, with Pittsburgh being excluded at this time due to an error that was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. As noted earlier in section 2.4.1, there was insufficient time after identifying this error to either generate corrected risk estimates or remove the erroneous risk estimates from the summary tables (presented in Appendix E). We will correct this error and release updated results for the Pittsburgh study area as soon as is practicable and will include the corrected results in the next version of this document.

In discussing risk estimates for the current and alternative standards, we have emphasized the incremental reduction (delta) across sets of standards rather than focusing on the absolute degree of risk (total $PM_{2.5}$-related incidence) for a particular set of standards. This reflects the fact that we have greater confidence in the ability of the risk models to differentiate risk between sets of standards, since this requires the models to estimate risk for ambient air $PM_{2.5}$ levels likely near or within the range of ambient air quality data used in the underlying epidemiology studies. By contrast, estimates of absolute risk (for a given air quality scenario) require the models to perform at the lower boundary of ambient air $PM_{2.5}$ levels reflected in the studies (i.e., down to the LML reflected in the long-term exposure mortality epidemiology studies or down to PRB levels in the short-term exposure morbidity and mortality studies). There is greater overall uncertainty in risk estimates generated based on the contribution to risk of exposures at these lower ambient air $PM_{2.5}$ levels.

This section is organized by health endpoint category, with results discussed in the following order: long-term exposure mortality, short-term exposure mortality and short-term exposure morbidity. We note, that observations presented in the last section regarding the statistical significance of effects estimates used in generating risk estimates and their implications for interpretation of those risk estimates also hold for estimates presented in this section. Consequently, observations regarding risk results with confidence intervals including negative estimates are not presented here and the reader is referred back to the earlier discussion in section 4.1.

An important factor to consider in interpreting the risk estimates for both the current set of standards and sets of alternative standards is whether the annual or 24-hour standard for a given pairing of standards is controlling for a particular area.[39] This factor can have a significant impact on the pattern of risk reductions predicted for a given location under the simulation of just meeting a specific set of standards. A brief overview of which urban study areas are predicted to have risk reductions under the set of current standards and alternative sets of standards included in the risk assessment is presented below.

- **Current set of standards**: Two of the 14 urban study areas (Dallas and Phoenix) have both annual and 24-hr design values that are below the matching current standard levels of 15 and 35 µg/m3, respectively (see Table 3-3).[40] This means that these two urban study areas would not have any reduction in long-term or short-term exposure risk under the current standards, as reflected in the

[39] For a given pairing of standard levels (e.g., 13/35), the controlling standard can be identified by comparing these levels to the design values for a given study area (see Table 3-3 for the annual and 24-hr design values for each of the urban study areas). The controlling standard is the standard (annual or 24 hr) that requires the greatest percent reduction in the matching design value to meet that standard.

[40] As noted earlier, Pittsburgh has been excluded due to an error that was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Consequently, the number of study areas discussed in relation to the current set of standards (as well as alternative sets of standards) is 14, rather than 15.

summaries presented below (note, however, that both areas have predicted risk reductions under some of the alternative sets of standards).

- **Alternative sets of standards focusing on lower annual standard levels (13/35 and 12/35)**: Dallas and Phoenix had annual and 24-hour design values which were lower than the 13/35 set of alternative standards, but annual design values were above the 12/35 set of alternative standards (see Table 3-3). For two of the other study areas (Fresno and Los Angeles), where the 24-hr standard was controlling, simulating just meeting the current standard resulted in significant reductions in the annual $PM_{2.5}$ levels, such that no risk reduction was seen for the 13/35 alternative set of standards (i.e., adjusted annual $PM_{2.5}$ levels for these study areas under the current set of standards were already below 13 $\mu g/m^3$). We note, however, that Los Angeles did show risk reductions under the 12/35 set of standards, while Fresno continued not to have predicted risk reductions under the 12/35 set of alternative standards due to the significant reduction in annual levels associated with just meeting the current set of standards. Because Tacoma and Salt Lake City already had annual design values (10 and 12 $\mu g/m^3$, respectively) at or below the 12 $\mu g/m^3$ associated with the lower of these two alternative sets of standards, neither study area exhibited risk reductions.
- **Alternative sets of standards focusing on combinations of lower annul and lower 24-hour standard levels (13/30, 12/25)**: Because of the combination of lower 24-hr and annual levels, 13 of the 14 urban study areas had risk reductions under the 13/30 standard level (only Dallas continued not to have predicted risk reductions), while all 14 urban study areas exhibited risk reductions under the 12/25 alternative set of standards.

Note, that this pattern of urban areas experiencing risk reductions under various standard levels, is reflected in the detailed discussion of risk estimates provided below in sections 4.2.1 through 4.2.3.

4.2.1 Long-term exposure mortality

This section summarizes core estimates for long-term exposure mortality (all cause, IHD, CPD and lung cancer) generated for the current and alternative sets of standards for simulation year 2007.

- **Comparison of recent conditions risk with risk associated with current standards**: a shift in ambient air $PM_{2.5}$ levels from recent conditions to the current standards is predicted to result in notable reductions in the percent of total incidence (for long-term exposure all cause mortality) attributable to $PM_{2.5}$ across most of the urban case study locations. For example, Fresno is estimated to have a ~60% reduction in percent of total incidence attributable to $PM_{2.5}$ under the current standards for simulation year 2007 using C-R functions based on either ambient monitoring period (relative to recent conditions – see Appendix E, Table E-6 and E-15). However, a subset of urban case studies with recent ambient air $PM_{2.5}$ levels at or below the current standards (e.g., Dallas, Phoenix – see Appendix E, Table E-6 and E-15) are not estimated to experience reductions in long-term exposure mortality-related risk. A similar pattern of risk reduction is seen for the other long-term mortality categories, with most locations having estimated reductions of up to ~60% and a subset of locations not estimated to have any reductions because their recent conditions ambient air $PM_{2.5}$ levels are already at or below the current standards. This pattern of risk changes associated with moving from recent conditions to the current standards is depicted graphically in Figures 4-1 through 4-8. We note, however, that in these plots, risk for each of the long-term mortality categories is expressed in terms of the percent change relative to the current standards, and thus, the values are depicted as negative values reflecting the fact that these figures focus on reductions in risk for alternative sets of standards, relative to the current set of standards.

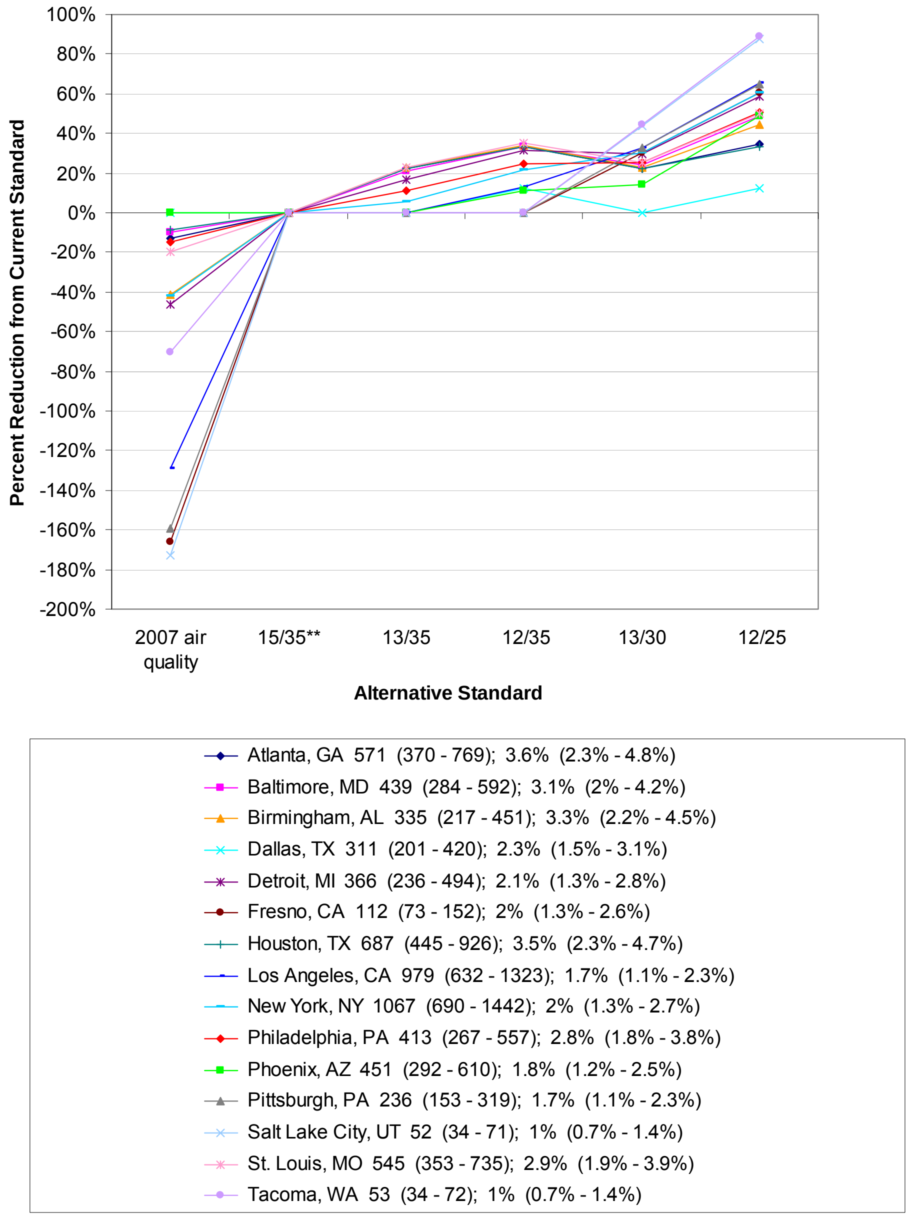
- **Trends in risk reduction across alternative sets of standards focusing on lower annual levels (13/35 and 12/35 combinations)**: reducing ambient $PM_{2.5}$ levels to meet alternative sets of standards with lower annual levels (i.e., 13/35 and 12/35) is estimated to produce a systematic reduction in $PM_{2.5}$-related all cause mortality for roughly half of the urban study areas. Specifically, in simulation year 2007, 8 of the 14 study areas would see estimated reductions in $PM_{2.5}$-related all-cause mortality on the order of 5 to ~25% under a 13/35 standard level combination with this reduction increasing to between 10 and 35% under the 12/35 combination (see Appendix E, Tables E-9 and E-18). These percentage reductions hold for incidence estimates generated using C-R functions based on ambient $PM_{2.5}$ data from both ambient monitoring periods (see Appendix E, Tables E-9 and E-18). The estimated degree of reduction in $PM_{2.5}$-related mortality across these standard combinations with reduced annual levels is similar for the other long-term exposure mortality categories. This pattern of estimated risk reductions associated with moving from the current standards to alternative standard combinations (including lower annual levels) is depicted graphically in Figures 4-1 through 4-8.

- **Trends in risk reduction across alternative sets of standards focusing on lower combinations of 24-hour and annual levels (13/30 and 12/25 combinations)**: Under the 13/30 combination, $PM_{2.5}$-related all cause mortality is reduced by a slightly greater amount than under the 13/35 combination discussed above with estimated percent reductions ranging from 14 to 44% - see Appendix E, Tables E-9 and E-18. With the more stringent 24-hour level (but same alternative annual level of 13), this standard level combination is estimated to reduce long-term exposure mortality risk in 13 of the 14 urban study areas, which is due to the fact that the 24-hour standard level is controlling in most of the urban study area locations for this combination of standards. When the most stringent set of standards (12/25) included in this analysis is modeled, the overall degree of reduction in $PM_{2.5}$-attributable all cause long-term mortality is the largest (relative to the current standards) with estimated percent reductions ranging from 12 to 89% - see Appendix E, Tables E-9 and E-18 (and all of the urban study areas are predicted to experience some degree of risk reduction). We note that estimates for the other long-term exposure mortality categories in terms of risk reductions associated with these two alternative standard combinations are similar to those presented above for all-cause. This pattern of risk reductions associated with moving from the current standards to alternative standard combinations (including lower 24-hour and annual levels) is depicted graphically in Figures 4-1 through 4-8.

- **Pattern of reduction of $PM_{2.5}$-associated long-term mortality incidence across urban study areas under alternative combinations of standards:** Differences in the degree of reduction of $PM_{2.5}$-related long-term exposure mortality risk across the 14 urban study areas can be substantial. For example, considering reductions in all-cause mortality under the most stringent alternative standards combination (12/25), percent reductions in incidence (relative to risk associated with just meeting the current standards) range from 12% (Dallas) to 89% (Tacoma) (Appendix E, Tables E-9 and E-18). In the case of Dallas, reductions are more modest because of relatively low recent conditions ambient air $PM_{2.5}$ levels (relative to the alternative standards considered – see Appendix A). With Tacoma, the greater degree of risk reduction results from having a single monitor with an annual average $PM_{2.5}$ estimate (under recent conditions) that is lower than the alternative standards considered, but 24-hour average levels that are elevated relative to the 24-hour standard. Therefore, for Tacoma, the most stringent alternative standard combination (12/25), with a 24-hour level of 25 $\mu g/m^3$, has a relatively large impact on overall risk, as reflected in the 89% reduction in the risk estimate. Both of these examples illustrate that, with regard to the degree of risk reduction under alternative sets of standards, variation across urban study areas not only reflects variation in baseline incidence rates, but also a number of factors related to ambient air $PM_{2.5}$ levels, including absolute levels in terms of both annual-averaged values and the distribution of 24-hour levels, and how these translate into design values for a given study area. Figures 4-1 through 4-8 provide a ready means for comparing the spread in the relative degree of risk reduction for long-term exposure mortality resulting from alternative sets of standards across the 14 urban study areas.

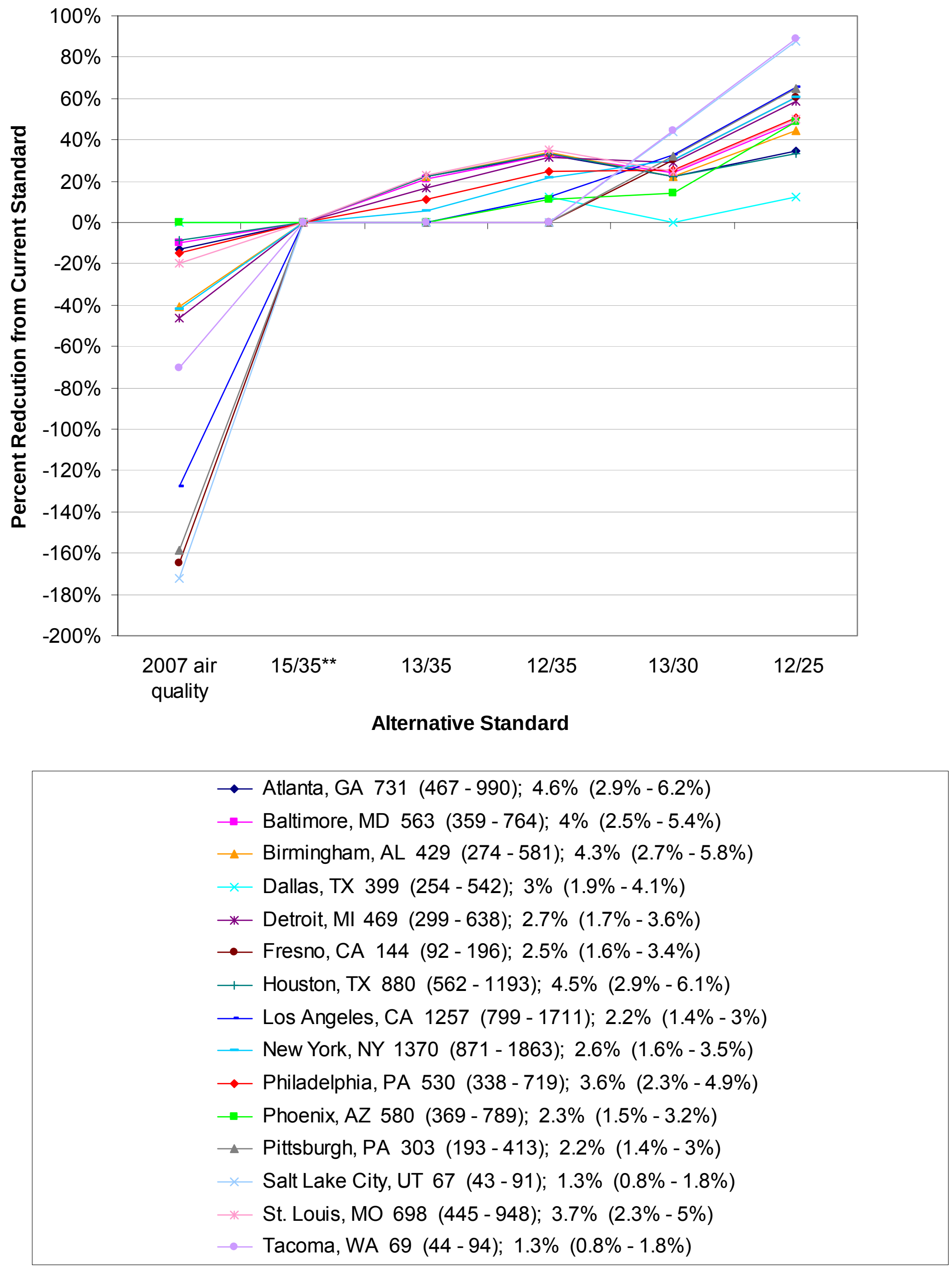
- **Pattern of percent reduction of total incidence across the three simulated years (2005-2007)**: Reductions in $PM_{2.5}$-associated long-term exposure mortality associated with alternative sets of standards across the simulation years (2005-2007) do display significant variation, however, this variation is smaller than the variation in risk reductions <u>across</u> urban study areas <u>for the same simulation year</u> (as discussed in the previous bullet). For example, for long-term $PM_{2.5}$-related all-cause mortality, the two urban study areas with the greatest degree of reduction under the most stringent standard level combination (12/25) (Salt Lake City and Tacoma), retain that status across all three years and have percent reductions that vary by 12 and 32%, respectively, across the three simulation years (based on comparison of results in Appendix E, Tables E-7 through E-9 and Tables E-16 through E-18). Variation across the three simulation years (for the same urban study area) for other long-term mortality categories and for other alternative suite of standards is generally somewhat below this range, with greater variation in degree of risk reduction (across the three years for a given study area) seen with more stringent sets of standards, and with urban study areas modeled using fewer $PM_{2.5}$ monitors. It appears that, as a generality, urban locations with a greater number of monitors, such as Los Angeles, are buffered somewhat from year-to-year variations in annual levels, relative to locations with a smaller number of monitors, such as Tacoma.

Figure 4-1. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in All Cause Mortality Associated with Long- Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data.*



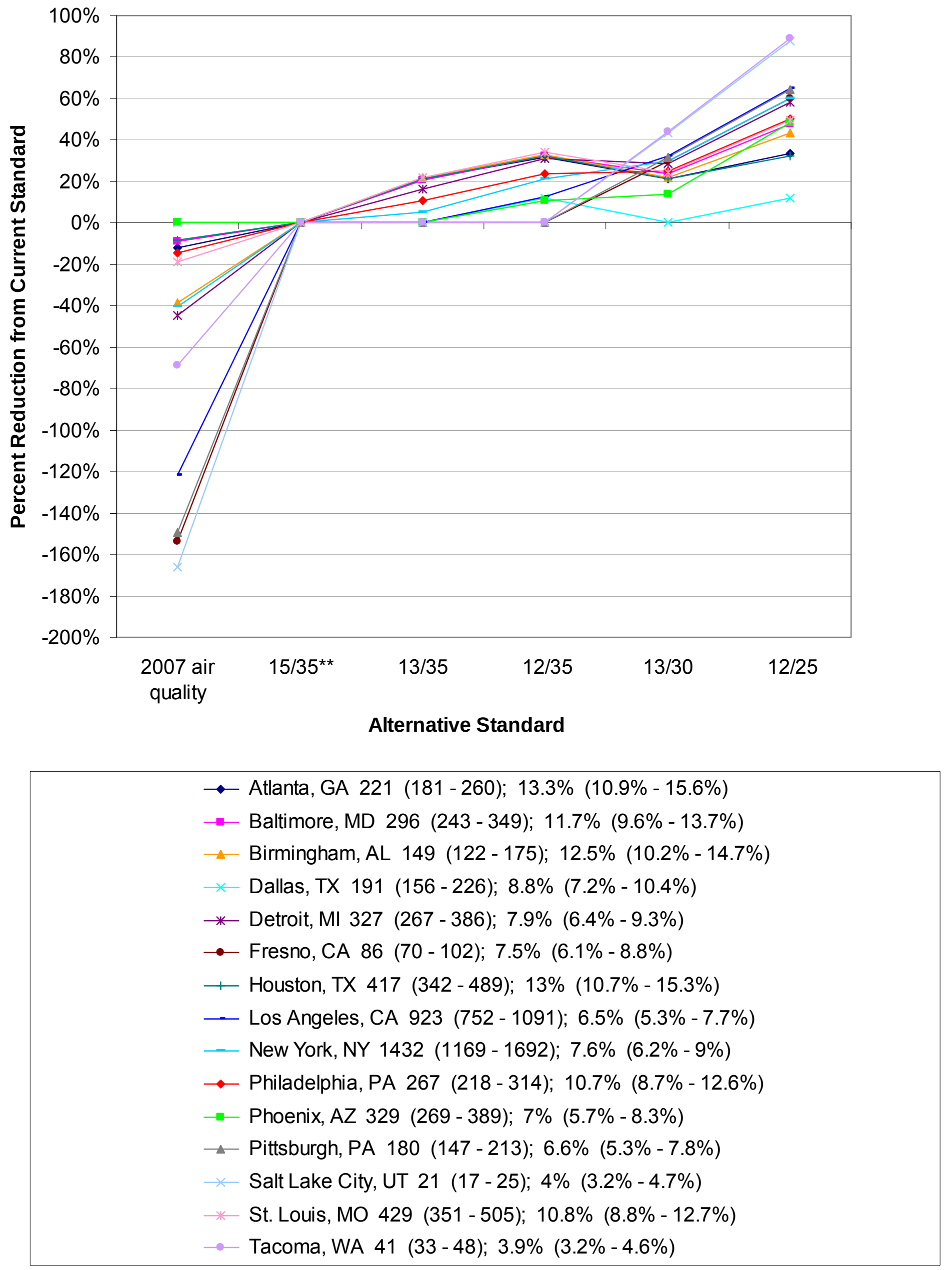
*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-2. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data.*



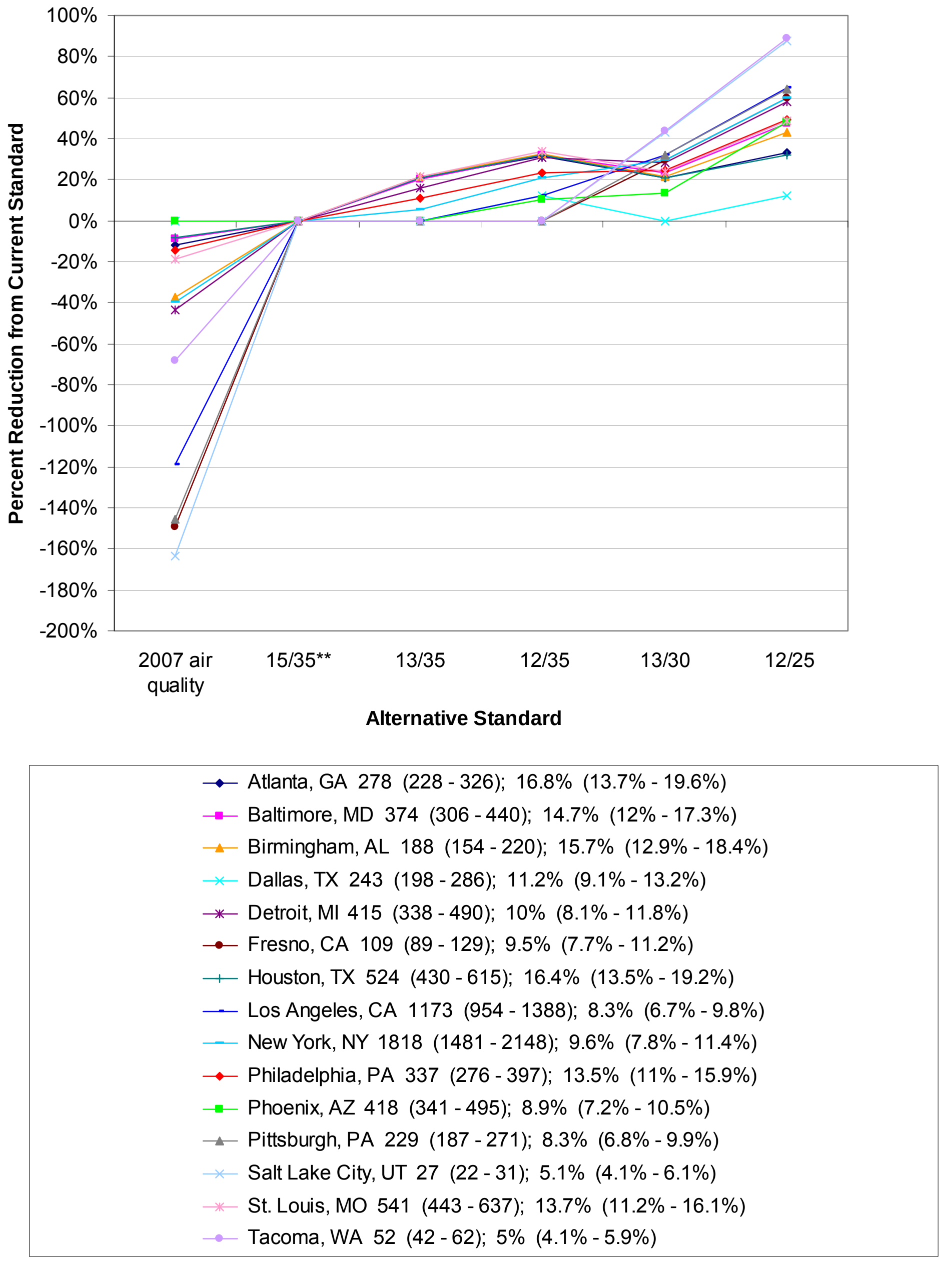
*Based on Krewski et al. (2009), exposure period from 1999 - 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-3. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data.*



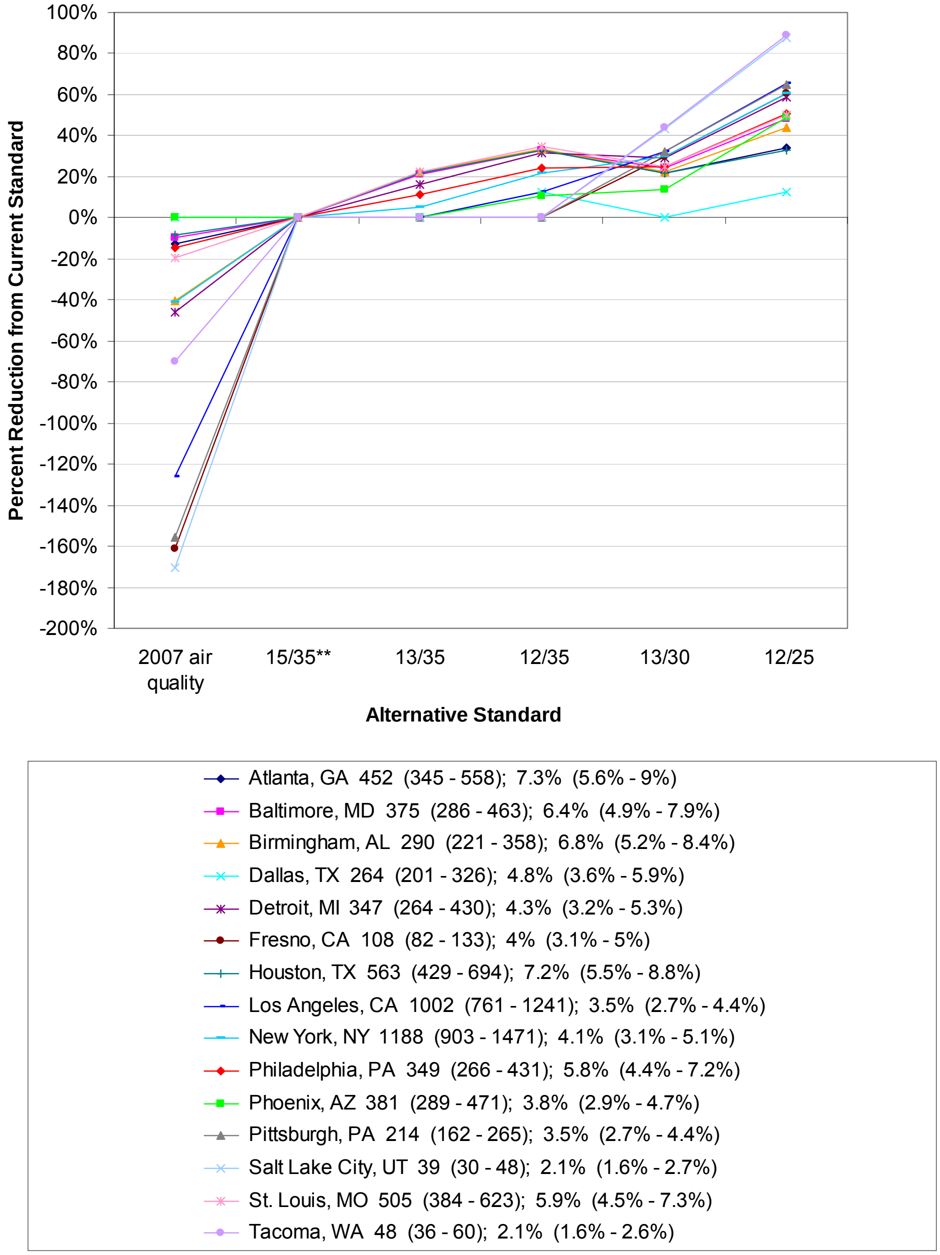
*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 μg/m^3 and a 24-hour standard of 35 μg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-4. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data.*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

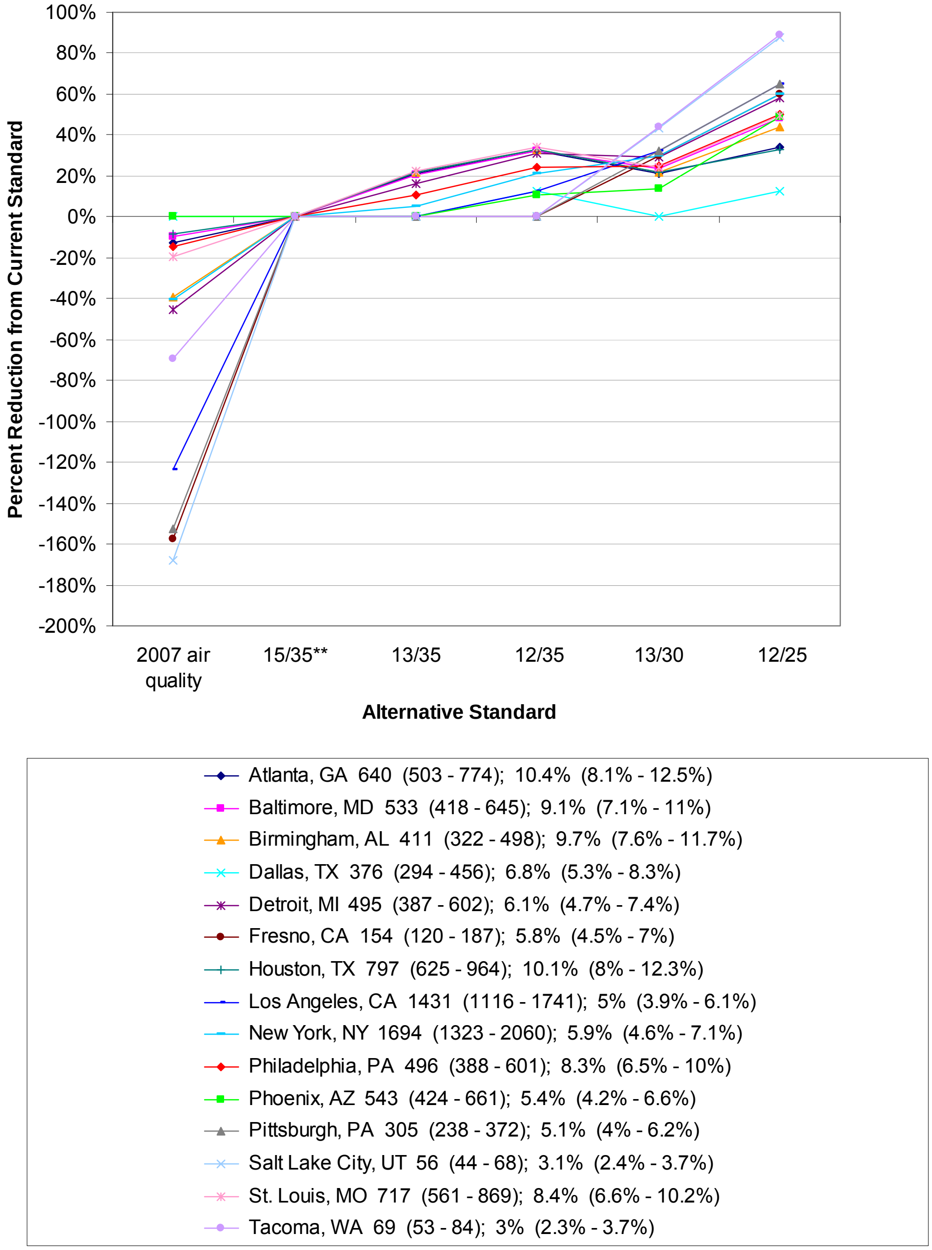
Figure 4-5. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data.*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

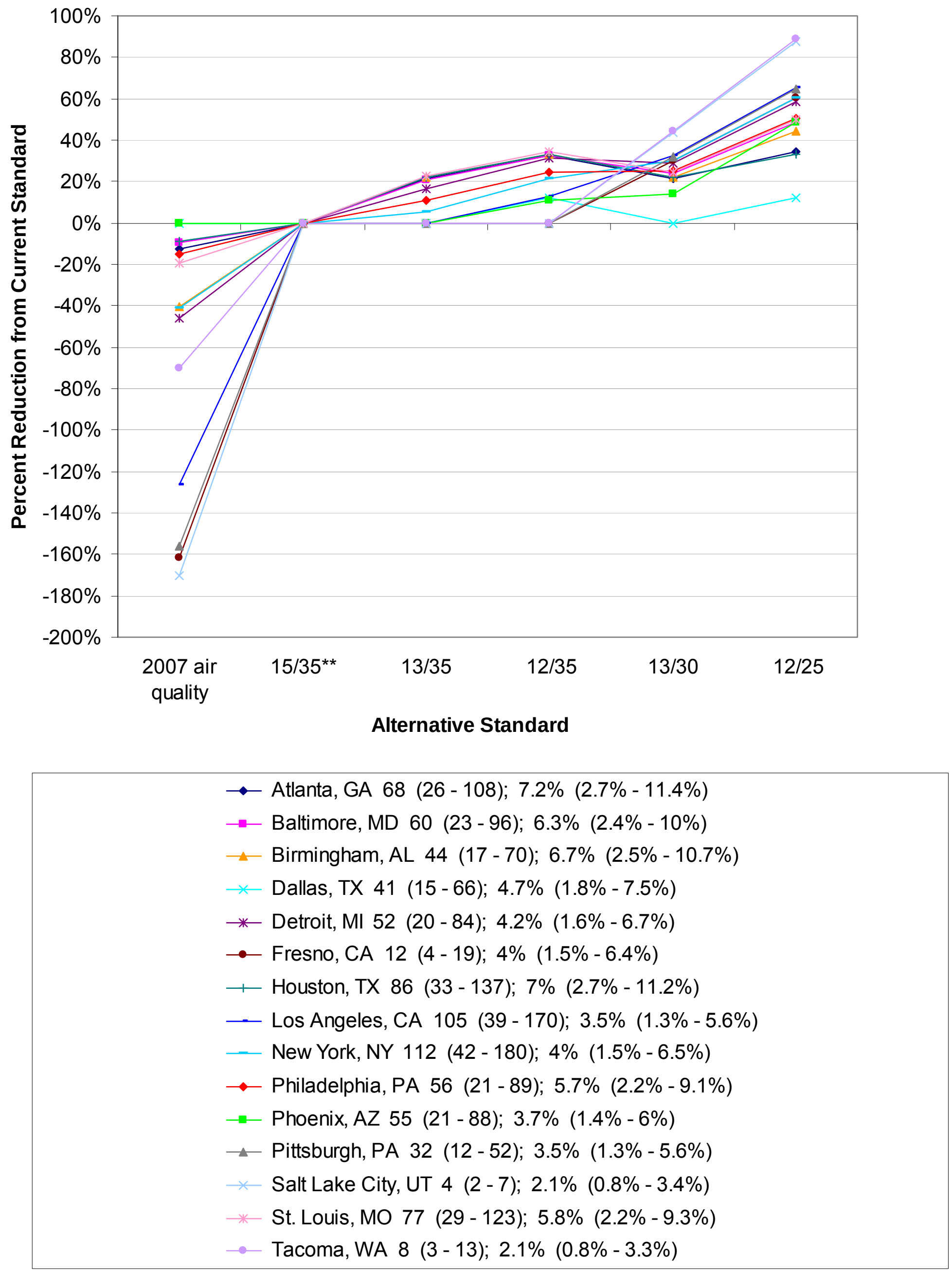
** The current standards consist of an annual standard of 15 µg/m^3 and a 24-hour standard of 35 µg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-6. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data.*



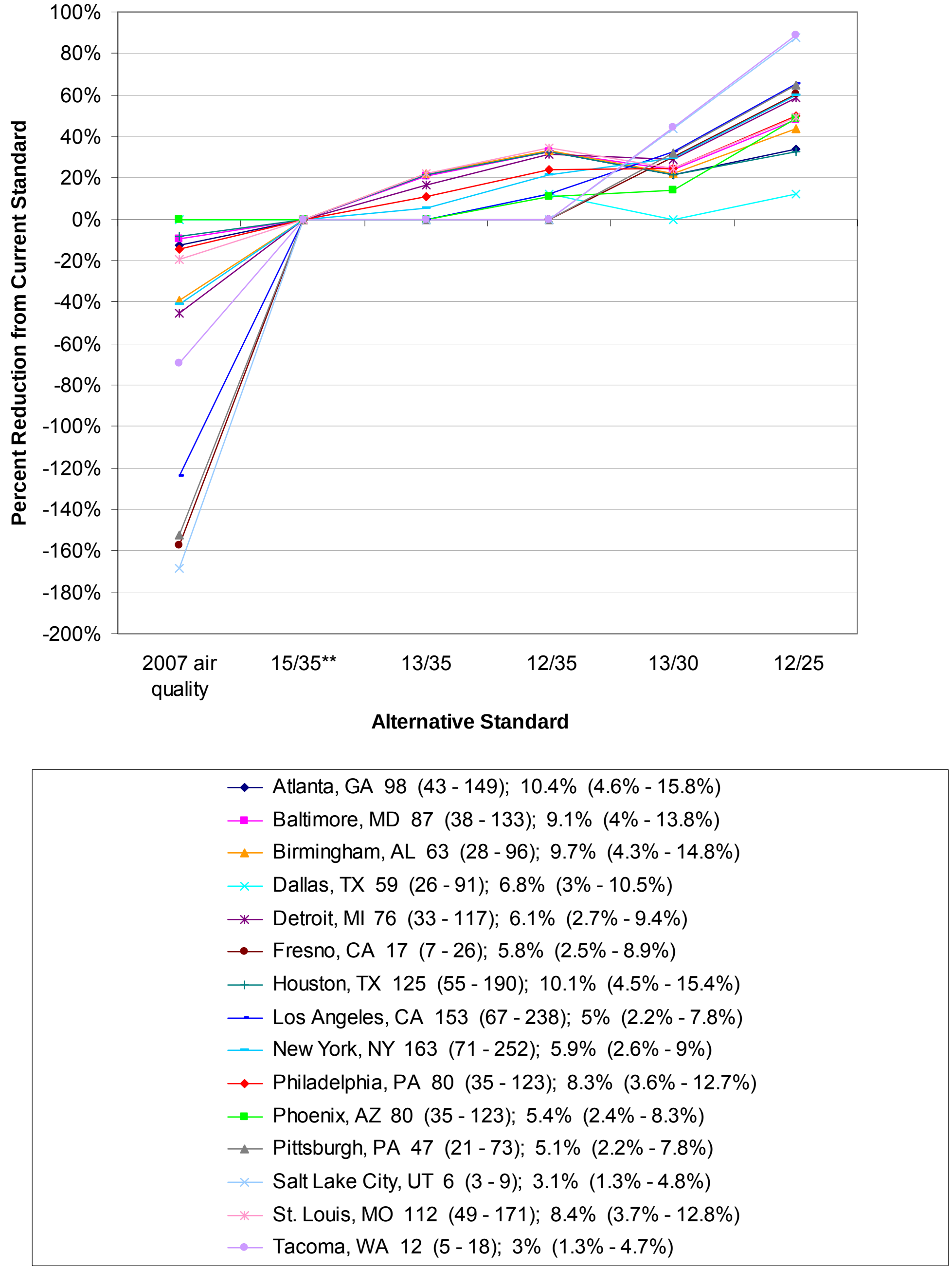
*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 µg/m³ and a 24-hour standard of 35 µg/m³. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-7. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data.*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 µg/m^3 and a 24-hour standard of 35 µg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-8. Estimated Percent Reductions From the Current Standards to Alternative Set of Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data.*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 µg/m^3 and a 24-hour standard of 35 µg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

4.2.2 Short-term exposure mortality

This section summarizes core estimates for short-term exposure mortality (non-accidental, IHD, CVD and respiratory) generated for the current and alternative sets of standards for simulation year 2007.

- **Comparison of recent conditions risk with risk associated with current standards**: A shift in ambient air $PM_{2.5}$ levels from recent conditions to just meeting the current set of standards results in notable reductions in the estimates of percent of total incidence for short-term exposure non-accidental mortality attributable to $PM_{2.5}$ across most of the urban case studies. For example, Fresno, Los Angeles and Salt Lake City are estimated to have reductions in the range of up to 40 to 50% of total incidence attributable to $PM_{2.5}$ under the current standards for simulation year 2007 – see Appendix E, Table E-78). However, a subset of urban case studies with recent ambient air $PM_{2.5}$ levels at or below the current standards (e.g., Dallas, Phoenix – see Appendix E, Table E-78) do not experience any reductions in estimated short-term mortality-related risk, as would be expected. A similar pattern of risk reduction is seen for the other short-term exposure mortality categories, although overall reductions are somewhat lower for these categories compared with non-accidental mortality. As noted earlier, in presenting results for recent conditions, the point estimate for Los Angeles, for CV mortality, is negative. As discussed earlier (see section 4.1), negative point estimates reflect the use of non-statistically significant effects estimates, which can in turn, reflect a number of factors, including insufficient sample size in the epidemiological study that provided the effects estimate. The pattern of risk reductions associated with moving from recent conditions to just meeting the current set of standards is depicted graphically for short-term exposure mortality in Figures 4-9 through 4-11.
- **Trends in risk reduction across alternative sets of standards focusing on lower annual levels (13/35 and 12/35 combinations)**: reducing ambient $PM_{2.5}$ levels to meet alternative sets of standards with lower annual levels (i.e., 13/35 and 12/35) is estimated to produce a systematic reduction in $PM_{2.5}$-related non-accidental mortality in roughly half of the urban study areas. Specifically, for simulation year 2007, 8 of the 14 study areas have estimated reductions in $PM_{2.5}$-related non-accidental mortality on the order of 3 to 15% under a 13/35 set of standards with this reduction increasing to between 5 and 23% under the 12/35 set of standards (see Appendix E, Table E-81). The degree of estimated reduction in $PM_{2.5}$-related short-term exposure mortality across these sets of standards with reduced annual levels is similar for the other short-term exposure mortality categories. The degree of reduction in short-term exposure mortality is somewhat lower than what is estimated for long-term mortality (see section 4.2.1), which is expected since these two alternative standards focus on lower annual levels and consequently would impact long-term exposure mortality risk more than short-term. This pattern of risk reductions associated with moving from just meeting

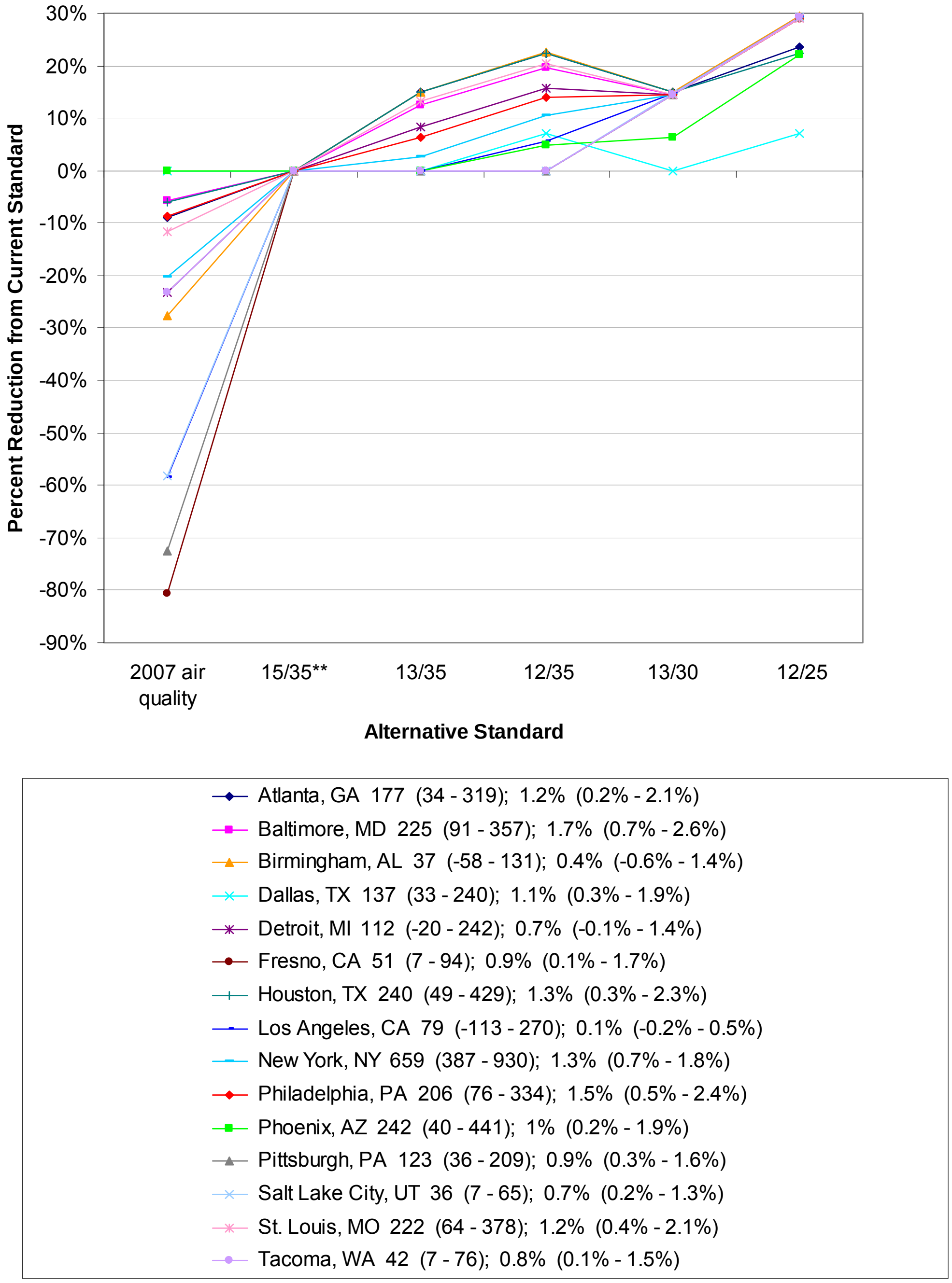
the current set of standards to just meeting alternative sets of standards (including lower annual levels) is depicted graphically in Figures 4-9 through 4-11.

- **Trends in risk reduction across alternative sets of standards focusing on lower combinations of 24-hour and annual levels (13/30 and 12/25 combinations)**: Under the 13/30 standards combination, $PM_{2.5}$-related non-accidental mortality is reduced by a slightly greater amount than under the 13/35 combination discussed above (with percent reductions relative to just meeting the current set of standards ranging from 6 to 15% - see Appendix E, Table E-81). When the most stringent set of standards (12/25) included in this analysis is modeled, the overall degree of reduction in $PM_{2.5}$-attributable non-accidental short-term mortality is increased to between 7 and 29% (and all of the urban study areas are predicted to experience some degree of risk reduction). We note that results for the other short-term mortality categories (in terms of risk reductions associated with these two alternative standard combinations) are similar to those presented above for all non-accidental mortality. This pattern of risk reductions associated with moving from just meeting the current set of standards to just meeting alternative sets of standards (including lower 24-hour and annual levels) is depicted graphically in Figures 4-9 through 4-11.

- **Pattern of reductions of $PM_{2.5}$-associated short-term exposure mortality incidence across urban study areas under alternative sets of standards:** Differences in the degree of reduction of $PM_{2.5}$-related short-term exposure mortality risk across the 14 urban study areas relative to just meeting the current set of standards are moderate for the alternative sets of standards reflecting lower annual standards (i.e., 13/35 and 12/35), with risk reductions ranging from 3 to 15% (for 13/35) and 5 to 23% (for 12/35) (Appendix E, Table E-81). Differences in risk reduction across urban study areas are notably small, for the alternative sets of standards reflecting lower 24-hour standards (i.e., 13/30 and 12/25) (Appendix E, Table E-81). Specifically, for these two alternative standard levels, 12 of the 14 urban study area locations have estimated percent reductions that vary from each other by only 1% (or are the same). In the case of all four sets of alternative standard levels, the range of risk reductions across urban study areas is notably lower for short-term mortality than it is for long-term morality (see section 4.3.1). We believe this reflects, in part, the fact that short-term exposure mortality is modeled down to PRB, which represents a larger span in absolute ambient air levels relative to the annual standard which is modeled to a relatively higher ambient concentration (i.e., the LML). Modeling risk down to PRB for short-term exposure health impacts has a dampening effect on estimates of the percent risk reduction associated with reductions in ambient air levels, since these changes represent a relatively smaller fraction of the total range in ambient air levels being considered. Conversely, for long-term exposure mortality, which is modeled down to LML, incremental reductions in ambient air levels and the associated risk reductions represent a larger relative change, since the overall spread being modeled is less (i.e., only down to LML and not PRB).

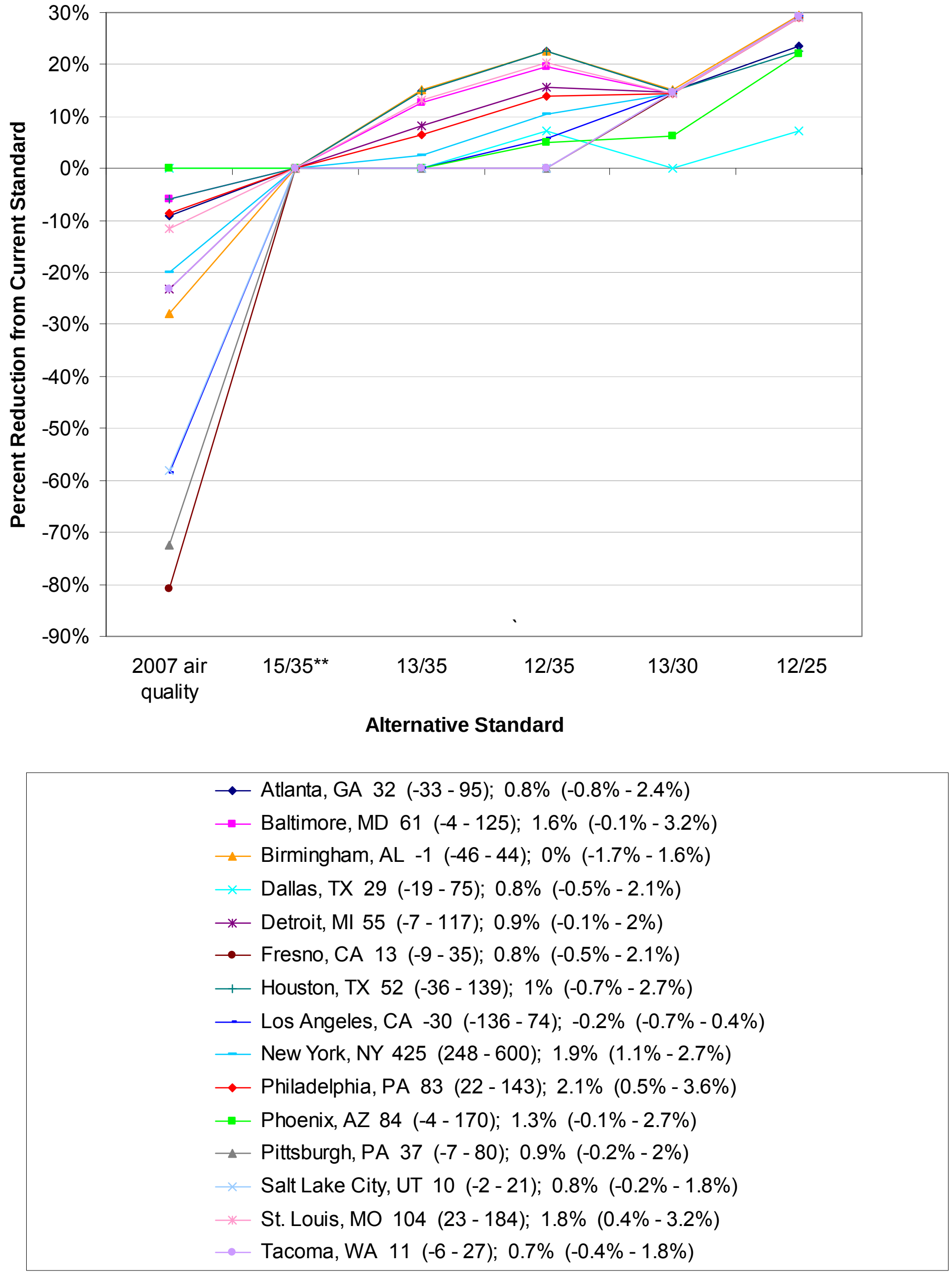
- **Pattern of percent reduction of total incidence across the three simulated years (2005-2007)**: Reductions in $PM_{2.5}$-associated long-term mortality under alternative sets of standards across the simulation years (2005-2007) are also relatively uniform (e.g., for non-accidental mortality, see Appendix F, Tables E-79 through E-81). As with the relatively uniform pattern across urban study areas, we believe this consistency across the simulation years reflects, in part, the fact that short-term exposure endpoints are modeled down to PRB, which can have a dampening effect on the percent reduction risk estimates.

Figure 4-9. Estimated Percent Reductions From the Current Standards to Alternative Sets of Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data.*



*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

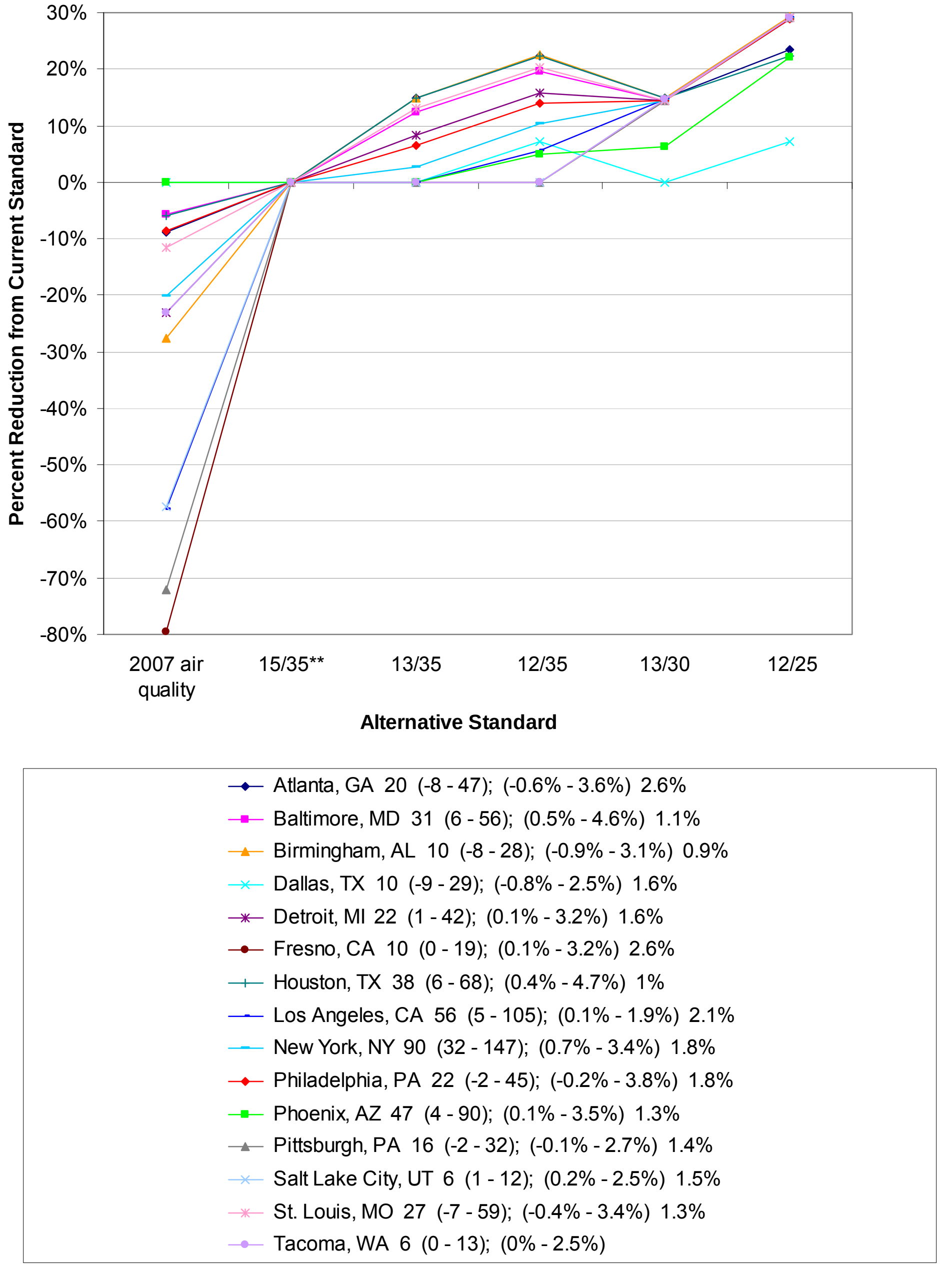
Figure 4-10. Estimated Percent Reductions From the Current Standards to Alternative Sets of Standards in Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data.*



* Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

** The current standards consist of an annual standard of 15 μg/m^3 and a 24-hour standard of 35 μg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-11. Estimated Percent Reductions From the Current Standards to Alternative Sets of Standards in Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data.*



* Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 µg/m^3 and a 24-hour standard of 35 µg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

4.2.3 Short-term exposure morbidity

This section summarizes core estimates for short-term exposure morbidity (HA for CVD and respiratory causes; ED visits for CV, respiratory and asthma) generated for the current and alternative sets of standards for simulation year 2007.

- **Comparison of recent conditions risk with risk associated with current standards**: A shift in ambient air $PM_{2.5}$ levels from recent conditions to just meeting the current set of standards results in notable estimated reductions in the percent of total incidence (for short-term CV HAs) attributable to $PM_{2.5}$ across most of the urban case studies. For example, Fresno and Salt Lake City have estimated reductions in the range of up to 40 to 50% in the percent of total incidence attributable to $PM_{2.5}$ under the current standards for simulation year 2007 – see Appendix E, Table E-105). However, as expected, a subset of urban case studies with recent ambient air $PM_{2.5}$ levels near or below the current standards (e.g., Dallas, Phoenix – see Appendix E, Table E-105) do not show any estimated reductions in short-term mortality-related risk. A similar pattern of risk reduction (in comparing just meeting the current set of standards to recent conditions) is seen for respiratory-related HAs, although overall reductions are somewhat lower for these categories compared with CV HAs for most urban study areas. The pattern of risk reductions associated with moving from recent conditions to just meeting the current set of standards is depicted graphically for short-term exposure morbidity in Figures 4-12 and 4-13. Since these figures show the change in risk for each of the short-term exposure morbidity categories expressed in terms of the percent change relative to just meeting the current set of standards, the change from recent conditions relative to just meeting the current set of standards is often negative, reflecting higher risks under recent conditions.

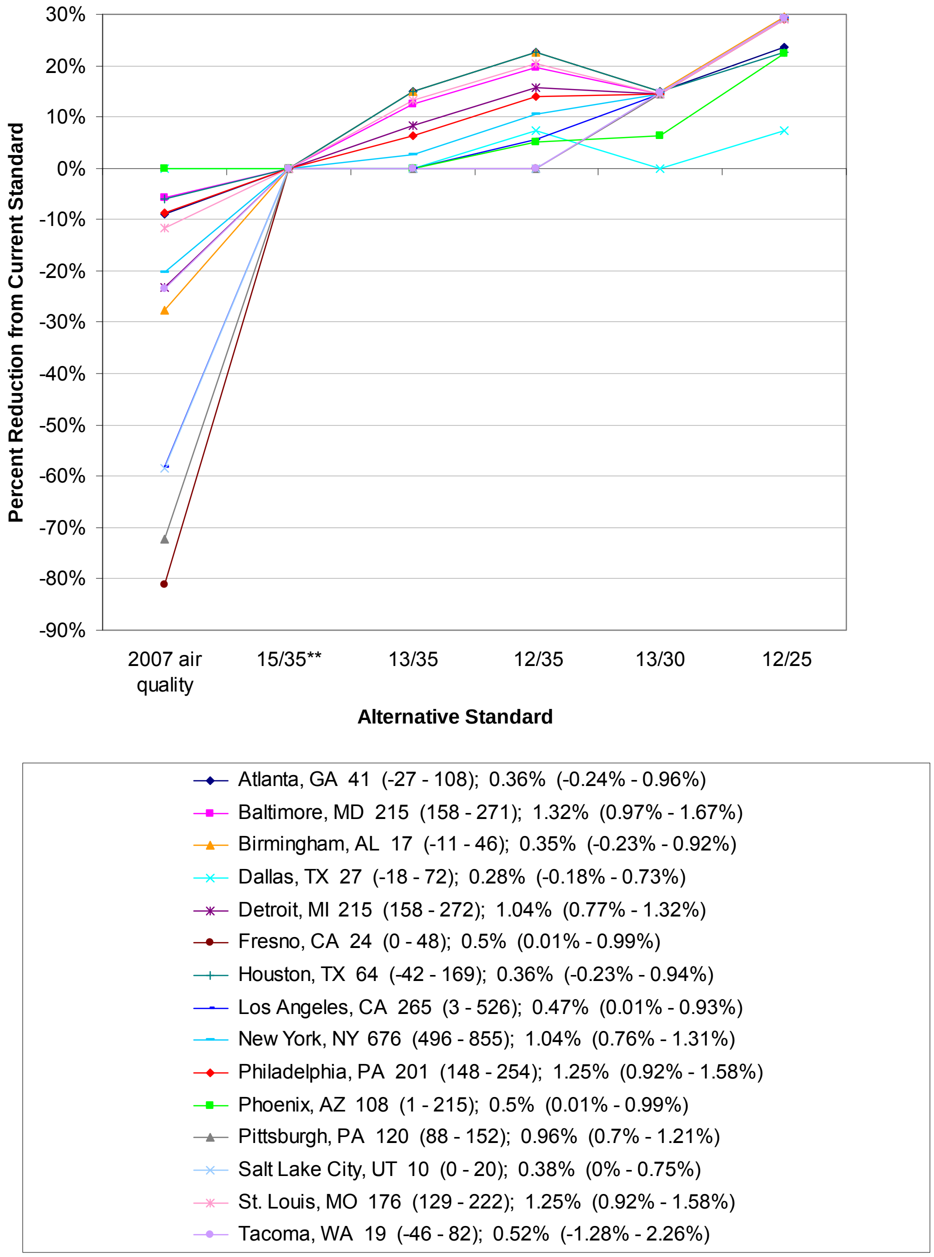
- **Trends in risk reduction across alternative sets of standards focusing on lower annual levels (13/35 and 12/35 combinations)**: reducing ambient $PM_{2.5}$ levels to simulate just meeting alternative suites of standards with lower annual levels (i.e., 13/35 and 12/35) produces a systematic reduction in estimated $PM_{2.5}$-related CV HAs for roughly half of the urban study areas. Specifically, in simulation year 2007, 8 of the 14 study areas are estimated to have reductions in $PM_{2.5}$-related CV HAs on the order of 3% to 15% under a 13/35 suite of standards with this reduction increasing to between 5 and 23% under the 12/35 set of standards (see Appendix E, Table E-107). The degree of reduction in $PM_{2.5}$-related mortality across these sets of standards with reduced annual levels is similar for respiratory-related HAs. This pattern of risk reductions associated with moving from the current set of standards to alternative sets of standards (including lower annual levels) is depicted graphically in Figures 4-12 and 4-13.

- **Trends in risk reduction across alternative sets of standards focusing on lower 24-hour and annual levels (13/30 and 12/25 combinations)**: Under the 13/30 set of standards, $PM_{2.5}$-related CV HAs are reduced by a slightly greater amount than under the 13/35 set discussed above (with percent reductions ranging from 6 to 15% - see Appendix E, Table E-107). When the most stringent set of standards (12/25) included in this analysis is modeled, the overall degree of reduction in $PM_{2.5}$-attributable estimated CV HAs increases to between 7 and 30% (and all of the urban study areas are predicted to experience some degree of risk reduction). We note, that results for respiratory HAs (in terms of estimated risk reductions associated with these two alternative standard combinations) are similar to those presented above for non-accidental mortality. This pattern of risk reductions associated with moving from just meeting the current set of standards to just meeting alternative sets of standards (including lower annual and 24-hour levels) is depicted graphically in Figures 4-12 and 4-13.

- **Pattern of the reduction of $PM_{2.5}$-associated short-term exposure morbidity incidence across urban study areas under alternative sets of standards:** As with short-term exposure mortality, differences in the degree of reduction of $PM_{2.5}$-related short-term morbidity risk across the 14 urban study areas are moderate for those sets of alternative standards focusing on lower annual levels (13/35 and 12/35) and notably smaller for those alternative sets of standards with lower annual and 24-hour levels (13/30 and 12/25) (see Appendix E, Table E-107). We believe the same factors discussed above for short-term exposure mortality are responsible for this trend in estimated incidence for short-term exposure morbidity (see section 4.2.2).

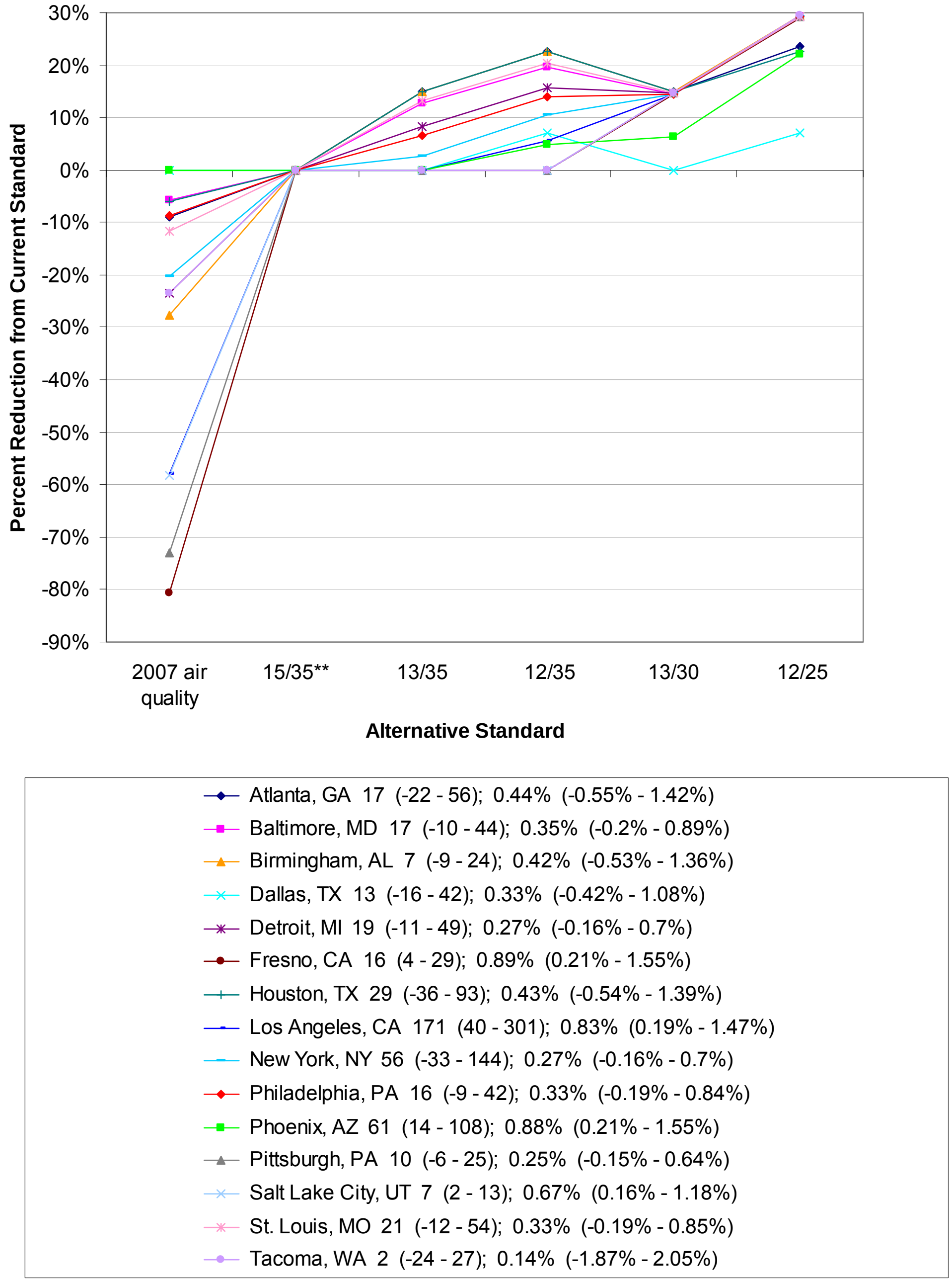
- **Pattern of percent reduction of total incidence across the three simulated years (2005-2007)**: Reductions in $PM_{2.5}$-associated short-term exposure morbidity under alternative sets of standards across the simulation years (2005-2007) are also relatively uniform (see Appendix E, Tables E-106 through E-108). As with the relatively uniform pattern across urban study areas, we believe this consistency across the simulation years reflects the combination of using a proportional reduction approach to simulate alternative 24-hour standard levels, combined with modeling of short-term exposure morbidity.

Figure 4-12. Estimated Percent Reductions From the Current Standards to Alternative Sets of Standards in Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data.*



* Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 μg/m^3 and a 24-hour standard of 35 μg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure.

Figure 4-13. Estimated Percent Reductions From the Current Standards to Alternative Sets of Standards in Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data.*



* Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 µg/m^3 and a 24-hour standard of 35 µg/m^3. Combinations of an annual standard (n) and a 24-hour standard (m) are denoted n/m in this figure. figure.

4.3 SENSITIVITY ANALYSIS RESULTS

As noted in section 3.6.4 and section 4.1 the sensitivity analysis was conducted in order to gain insights into which of the identified sources of uncertainty in the risk assessment model may have significant impacts on risk estimates. A second goal of the sensitivity analysis was to generate an additional set of reasonable risk estimates to supplement the core set of risk estimates and which can be used to inform staff's characterization of uncertainty associated with those core estimates.

The first goal can be achieved by considering the magnitude of the impact of individual modeling elements based on results from the sensitivity analysis and identifying those elements which have the greatest impact on the core risk estimates. Regarding the second goal, given the design of the sensitivity analysis, staff judges that the results of this analysis represent a reasonable set of alternate risk estimates, that fall within an overall set of plausible risk estimates surrounding the core estimates. While not representing a formal uncertainty distribution, the output of the sensitivity analysis, when combined with the core risk estimates, represent a set of plausible risk estimates, which reflect consideration for uncertainty in various elements of the risk assessment model. Therefore, later in section 4.5, when discussing risk estimates for a particular scenario, we focus on the core estimates as representing higher-confidence estimates and then use the output of the sensitivity analysis to provide some perspective on the potential range of uncertainty about the risk estimates given consideration of key sources of uncertainty. While we do not know what confidence interval is captured by this range of estimates, or what specific percentiles of the risk distribution are represented by points within that range, the output of the sensitivity analysis does provide a set of plausible risk estimates and, therefore provides some perspective on the magnitude of potential uncertainty associated with the core estimates.

In conducting the sensitivity analysis we modeled 2 of the 15 urban study areas (Philadelphia and Los Angeles - representing east and west coast urban areas, respectively) for most simulations. We note, however, that for some modeling elements (e.g., the hybrid rollback approach), we included a larger number of the urban study areas that were applicable to the topic being assessed.[41] In conducting the sensitivity analysis, we have also focused on long-term exposure mortality and short-term exposure mortality and have included short-term morbidity to a lesser extent because we expect similar

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[41] As noted earlier in section 2.4.1, an error was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Therefore, while Pittsburgh had initially been included in this sensitivity analysis, these results have been removed since they are based on the set of current standard levels.

patterns with that observed for short-term exposure mortality based on our review of the core estimates.

The results of the sensitivity analysis are summarized in Table 4-1 (detailed results tables are presented in Appendix F). In presenting the results of the sensitivity analysis, we have compared the risk estimates for the particular simulation to the core set of risk estimates generated for the same health effect endpoint/urban study area combination. Specifically, we have calculated a percent difference between the sensitivity analysis result and the associated core risk estimate to foster comparisons of the results of the sensitivity analysis across the different modeling elements that were considered. These *percent difference* results are emphasized in Table 4-1 and in the discussion presented below.

In discussing the results of the sensitivity analysis, we have developed four descriptive categories, based on the general magnitude of the percent difference estimate generated for a particular modeling element:

- **Small contributors to uncertainty in the core risk estimates**: Modeling elements estimated to have percent differences of 20% or smaller (i.e., they produced risk estimates that differed from the core risk estimates by no more than 20%) are classified as having a *small contribution to uncertainty* in the core risk estimates.
- **Moderate contributors to uncertainty in the core risk estimates**: Modeling elements estimated to have percent difference estimates in the range of 20 to 50% are classified as having a *moderate contribution to uncertainty* in the core risk estimates.
- **Moderate-Large contributors to uncertainty in the core risk estimates**: Modeling elements estimated to have percent difference estimates in the range of 50 to 100% are classified as having a *moderate-large contribution to uncertainty* in the core risk estimates.
- **Large contributors to uncertainty in the core risk estimates:** Modeling elements estimated to have percent difference results >100% are classified as having a *large contribution to uncertainty* in the core risk estimates.

These categories are used in discussing the results of the sensitivity analysis, particularly in section 4.5.

In discussing the results of the sensitivity analysis, results of the single-factor simulations are presented first, followed by the results of the multi-factor simulations (within these categories, results are organized by health effect endpoint with results for long-term exposure mortality discussed first and then short-term exposure mortality, followed by short-term exposure morbidity).

The sensitivity analysis based on Moolgavkar's (2003) study in Los Angeles addressing model specifications for both short-term mortality and morbidity (e.g., model selection, lag structure and co-pollutant models) are discussed together as a group, rather than being divided up and discussed with other sensitivity analyses. This reflects the fact that the Moolgavkar-based simulations were all based on the same underlying dataset and focused on Los Angeles. In addition, the discussion of the Moolgavkar-based sensitivity analysis results presented below (and the summary of results presented in Table 4-1) focus on the difference in spread of risk results across the Moolgavkar-based model specifications (for a particular endpoint), rather than the *percent difference* results (based on comparison against the core result) that are emphasized with the other sensitivity analyses.[42]

Although the sensitivity analysis was completed for all three simulation years, we have focused on results for 2007 in this presentation to foster comparability with the core results discussed in sections 4.1 and 4.2.

The discussion provided below for each of the simulations conducted as part of the sensitivity analysis, first gives a brief overview of the purpose of the simulation (i.e., what aspect of the risk assessment model is being evaluated). Next the results of the simulation are discussed in the context of the first goal described above (i.e., the relative impact of a given source of uncertainty on the core risk estimates). An overall conclusion regarding which of the factors included in the sensitivity analysis represent potentially significant sources of uncertainty impacting the core risk estimates is presented at the end of each sub-section. Use of the alternative risk estimates generated through the sensitivity analysis in informing characterization of uncertainty associated with the core risk estimates is discussed in section 4.5.

[42] Comparison of the Moolgavkar-based risk estimates against the core risk estimates consistently produce percent difference estimates that range to levels well above +100%, resulting in a blanket conclusion, based on this metric, that all of the factors considered in the Moolgavkar-based sensitivity analysis are large contributors to uncertainty in the core risk estimates. However, there is significant uncertainty in assuming that the behavior of the Moolgavkar-based risk models (reflecting consideration for alternate design elements) would be representative of how models derived from either of the key short-term studies considered in this risk assessment (Zanobetti and Schwartz., 2009 and Bell et al., 2008) would respond to variations in design. Therefore, while sensitivity analysis results based on comparing Moolgavkar-based risk estimates against the core risk estimates are included in the detailed sensitivity analysis results tables presented in Appendix F (see Tables F-31 through F-33), we do not discuss these results here due to the degree of uncertainty associated with them.

Table 4-1. Overview of Sensitivity Analysis Results.

Sensitivity Analysis[1]	Health Endpoint and Risk Assessment Location	Summary of Results (percent difference in risk estimate relative to the core estimate)	Appendix F Tables with Detailed Results (for 2007)
Single-Factor Sensitivity Analyses (long-term exposure mortality):			
Impact of using different model choices: fixed effects log-linear (the core) vs. random effects <u>log-linear</u> C-R function	• All-cause, CPD, IHD • Los Angeles and Philadelphia	Random effects log-linear C-R model: • all-cause: +23% • IHD: +12%	Table F-3
Impact of using different model choices: fixed effects log-linear (the core) vs. random effects <u>log-log</u> C-R function	• All-cause, CPD, IHD • Los Angeles and Philadelphia	Random effects log-log C-R model: • All-cause: +122 to 155% • CPD: +49 to 71% • IHD: +79 to 107% • Lung Cancer: +68 to 92%	Table F-3
Impact of estimating risks down to PRB rather than down to LML (the core)	• All cause • All 15 urban study areas	• All-cause: +47 to +197%	Table F-6
Impact of using alternative C-R function from another long-term exposure mortality study	• All-cause, CPD, lung cancer • Los Angeles, Philadelphia	• All-cause: -25% • CPD: -55 to -56% • Lung cancer: -192 to - 195%	Table F-9
Impact of using alternative hybrid rollback approach reflecting potential for greater use of localized controls in some study areas(evaluated across current and alternative standard levels)	• All-cause mortality • Baltimore, Birmingham, Detroit, Los Angeles, New York and St. Louis	• 4 urban locations had impacts of <20% across all alternative standard levels (with most of these in the <10% range). • 1 urban locations had impacts of up to +54%	Table F-12
Single-Factor Sensitivity Analyses (short--term exposure mortality):			
Impact of using season-specific C-R functions (vs. an annual C-R function)	• Non-accidental mortality, CV, respiratory • All 15 urban study areas	• Non-accidental: -114 to +186% • CV: -92 to +600% • Respiratory: -47 to +162% (Note, overall incidence estimates, particularly for the locations with higher percent change estimates, is very low, raising concerns over the stability of these sensitivity analysis results)	Table F-15 Table F-18 Table F-21
Impact of using alternative hybrid rollback approach	• Non-accidental mortality	• Results for all seven urban study areas (across the	Table F-36

Sensitivity Analysis[1]	Health Endpoint and Risk Assessment Location	Summary of Results (percent difference in risk estimate relative to the core estimate)	Appendix F Tables with Detailed Results (for 2007)
reflecting potential for greater use of localized controls in some study areas	• Baltimore, Birmingham, Detroit, Los Angeles, New York and St. Louis	current and alternative standard levels) do not exceed +20%, with most <+10%.	
Single-Factor Sensitivity Analyses (short-term morbidity: hospital admissions (HA) and ED visits):			
Impact of using season-specific C-R functions (vs. an annual C-R function)	• HA (unscheduled), CV and respiratory • All 15 urban study areas	• HA (CV): -105 to +10% • HA (respiratory): -54 to +71% (Note, overall incidence estimates, particularly for the locations with higher percent change estimates, is very low, raising concerns over the stability of these sensitivity analysis results)	Table F-24 Table F-27
Impact of using an annual C-R function (applied to the whole year) vs. a seasonal function for April through August (applied only to that period) (using a single pollutant model)	• Asthma ED visits • New York	NA (although incidence estimates were generated for this simulation, "percent difference from the core" were not generated since the alternate simulation focused on a subset of the year).	Table F-30
Single-Factor Sensitivity Analysis (short-term exposure mortality and morbidity in LA based on Moolgavkar, 2003 study model options) (Note, results presented here reflect spread in risk estimates across Moolgavkar-based model specifications and not percent difference from core risk estimates, unless so stated – see text)			
Impact of model selection (e.g., log-linear GAM with 30 df; log-linear GAM with 100 df; and log-linear GLM with 100 df)	• Mortality (non-accidental, CV); HA (CV) • Los Angeles	• Non-accidental mortality: +79% • CV mortality: +49 • CV HA: +36%	Table F-33
Impact of lag structure (0-day, 1-day, 2-day, 3-day, 4-day, 5-day)	• Mortality (non-accidental) • Los Angeles	• Non-accidental mortality: +55%	Table F-33
Impact of single- vs. multi-pollutant models ($PM_{2.5}$ with CO)	• Mortality (CV); HA (CV) • Los Angeles	• CV mortality: +105% • CV HA: +142%	Table F-33
Multi-Factor Sensitivity Analyses (long-term mortality):			
Impact of using a fixed effects log-linear vs. a random effects log-log model, estimating incidence down to the lowest measured level (LML) in the study vs. down to PRB, and using a proportional vs. hybrid	• All-cause, IHD long-term mortality • Los Angeles and Philadelphia	• All-cause: +26 to +1,020% • IHD: +25 to +627%	F-39

Sensitivity Analysis[1]	Health Endpoint and Risk Assessment Location	Summary of Results (percent difference in risk estimate relative to the core estimate)	Appendix F Tables with Detailed Results (for 2007)
rollback to estimate incidence associated with long-term exposure to $PM_{2.5}$ concentrations that just meet the current standards			
Multi-Factor Sensitivity Analyses (short--term mortality):			
Impact of using season-specific vs. all-year C-R functions and proportional vs. hybrid rollbacks to estimate incidence associated with short-term exposure to $PM_{2.5}$ concentrations that just meet the current standards	• Non-accidental • Baltimore, Birmingham, Detroit, Los Angeles, New York and St. Louis	• Non-accidental (four seasons + hybrid): -109 to +119%	F-42

[1] Unless otherwise noted, sensitivity analysis results are based on the scenario reflecting just meeting the current set of $PM_{2.5}$ standards. l

[2] Note: this metric is the percent spread in risk estimates across the Moolgavkar-based model specifications (not the percent difference estimates – see text discussion above).

4.3.1 Single-factor sensitivity analysis results

This section presents the results of the single-factor sensitivity analysis, which involved consideration of alternate model inputs on the core risk estimates, when those alternate inputs are considered one at a time (consideration for the combined effect of several model inputs being varied is covered by the multi-factor sensitivity analysis discussed in section 4.3.2). Note, that the results of the single-factor sensitivity analysis are characterized qualitatively using the four-category approach described above (i.e., low, moderate, moderate-large and large, with each of these representing a defined range of percent difference from the core risk estimates, as detailed above).

4.3.1.1 Sensitivity analysis results associated with long-term exposure mortality

This section summarizes the results of the sensitivity analysis focused on long-term exposure-related mortality endpoints (see Table 5-1 for the specific modeling elements considered in the sensitivity analysis). The results of individual sensitivity analysis simulations are presented below, with overall observations presented at the end of the section.

- **Impact of using different model choices for C-R function - fixed effects log-linear (the core approach) vs. random effects log-linear or random effects log-log models**: This simulation considered two alternative C-R model forms obtained from Krewski et al., 2009 for modeling all-cause, CPD, IHD and lung cancer mortality, including (a) random effects log-linear model and (b) a random effects log-log model (note, the core effect estimate was derived using a fixed effects log-linear model obtained from Krewswki et al., 2009). The results of the simulation suggest that the use of a random effects log-linear model, rather than the core fixed effects model has a relatively small effect on risk, raising it by 12 to 23% across the mortality categories and urban study areas modeled (Appendix F, Table F-3). However, use of a random effects log-log model has a larger impact on risk estimates, raising them by 49 to 155% (Appendix F, Table F-3). The greater impact of the log-log model results from this function having an incrementally steeper slope at lower PM levels, which quickly increases incidence estimates compared with the core log-linear model (whose slope has a much more gradual incremental increase in slope at lower PM levels).

- **Impact of estimating risks down to PRB rather than down to LML**: This simulation compared long-term exposure mortality incidence associated with modeling risk down to PRB (which varies by region – see section 3.2.1) with the core approach of modeling down to LML (5.8 $\mu g/m^3$ for long-term mortality – see section 3.1). This simulation involved all 15 urban study areas, given that PRB is stratified by region and therefore, results of the simulation could differ significantly across the 15 urban study areas (or at least across the six PM regions represented by those study areas). The results of this simulation suggest that modeling risk down to PRB could have a moderate to large impact on long-term exposure mortality incidence, with estimates ranging from 47 to 197% higher than the core estimates (for matching urban locations) (Appendix F, Table F-6). Note, however, that risk metrics based on considering the incremental reduction in risk between two standard levels would not be impacted by this source of uncertainty, since it only effects estimates of absolute risk (for a particular standard level).

- **Impact of C-R function from alternative long-term exposure mortality study**: This simulation considered use of alternative C-R functions (and effect estimates) based on the reanalysis of the Six Cities study (Krewski et al., 2000). The results suggest that use of the alternative C-R function could have a moderate to moderate-large effect on all cause and CPD mortality (-25% for all-cause and about -55% for CPD) (Appendix F, Table F-9). The effect of using the alternative function on risk estimates for lung cancer mortality was much larger (-192 to -195%) (Appendix F, Table F-9). The results of this simulation suggest that (at least with regard to application of C-R functions obtained from the Six Cities study), the potential impact of functions from alternative studies on long-term exposure mortality depends on the mortality category being considered. In this analysis, use of the alternative C-R functions was shown to have a significant impact on lung cancer mortality, but a much smaller impact on the other long-term exposure mortality categories.

- **Impact of using alternative hybrid rollback approach to simulate just meeting the current and alternative suite of standards**: This simulation evaluated the potential impact of simulating just meeting the current and alternative sets of standards using a hybrid rollback approach that employs a combination of localized controls (resulting in non-proportional rollbacks of monitored $PM_{2.5}$ concentrations) with a second phase of proportional adjustments (see section 3.3.3). We note that the core analysis utilized proportional adjustment exclusively in simulating conditions for the current and alternative sets of standards. In discussing these results, we focus on risk estimates generated for the most stringent alternative set of standards (12/25) since this is the level where the greatest differences between the core and hybrid rollback approach were seen (for all relevant urban study areas). The results of this simulation suggest that the use of the hybrid rollback strategy can have widely varying impacts on long-term mortality incidence. For five of the seven urban study areas for which this procedure was evaluated, the results were relatively small (e.g., percent differences ranged from +2% to +17%) (Appendix F, Table F-12). For the urban study area demonstrating the greatest impact (Los Angeles), percent differences were moderate-large (+54%) (Appendix F, Table F-12). The results of this simulation suggest that for many of the urban study areas, the use of an alternative rollback strategy employing non-proportional adjustment, did not produce a very large impact on long-term mortality risk estimates. However, for a subset of the study areas, the use of this rollback approach was shown to have moderate impact.

Based on the simulations discussed above covering potential sources of uncertainty impacting long-term mortality, we conclude that the following factors contribute potentially large sources of uncertainty to the core risk estimates (i.e., they produce risk estimates that are at least 100% different from the core risk estimate): (a) use of alternative form of the C-R function, specifically use of a random-effects log-log model form obtained from the updated ACS study (Krewski et al., 2009) (b) use of an alternative C-R function with effects estimates obtained from the reanalysis of the Six Cities study (Krewski et al. 2000) (specifically in modeling lung-cancer risk), and (c) estimation of risk down to PRB. We note, that the use of the hybrid (non-proportional adjustment) approach for simulating conditions for alternative suites of standards was shown to have a moderate-large impact (+90%) in one of the urban study areas. Other factors considered in the sensitivity analysis had smaller impacts on core risk estimates.

4.3.1.2 Sensitivity analysis results associated with short-term exposure mortality

This section summarizes the results of the sensitivity analysis focused on short-term exposure-related mortality endpoints (see Table 5-1 for the specific modeling elements considered in the sensitivity analysis). The results of individual sensitivity analysis simulations are presented below, with overall observations presented at the end of the section.

- **Impact of using season-specific C-R functions (vs. an annual C-R function)**: This simulation considered the impact on short-term exposure mortality risk of using seasonally-differentiated effects estimates rather than the core approach of using a single C-R function for the whole year (note, that the seasonal models were based on the same study as the model used in the core analysis – Zanobetti and Schwartz, 2009). The results of the simulation suggest that this source of uncertainty can have a wide range of effects across urban study areas (including not only variation in the magnitude of effect, but also in the direction). Percent changes compared with the core risk estimate were large, ranging from -114% (Los Angeles) to +186% (Birmingham) (these results are for non-accidental mortality – see Appendix F, Table F-15). We note that these two locations also have relatively low overall incidence estimates, which does raise concerns over the degree of stability in the sensitivity analysis estimates. Furthermore, for 9 of the 15 urban study areas (for non-accidental morality), percent changes from the core were small, with absolute values of 12% or less (Appendix F, Tables F-15). The results for CV and respiratory mortality also demonstrate considerable variation across locations, but are generally smaller than results cited above for non-accidental, with one exception. Birmingham is estimated to have short-term CV mortality that is +600% higher using seasonal effects estimates compared with the core results (We note, however, that this endpoint category also has very small incidence, again raising concerns over the stability of the sensitivity analysis results) (see Table F-18). The results for respiratory-related mortality also demonstrate considerable variability with results that could suggest a moderate to large impact (i.e., -47 to +162% - see Appendix F, Table F-21). We note, however, that small incidence estimates again raise concerns regarding the stability of these percent difference results.

- **Impact of using alternative hybrid rollback approach**: This simulation evaluates the potential impact of using the hybrid (non-proportional) approach for simulating just meeting current and alternative sets of standards to reflect the potential greater use of more localized controls in some urban study areas (see section 3.3.3), in place of the proportional approach used in the core analysis. The results of this simulation (as contrasted with the impact of using the hybrid approach on long-term exposure mortality) suggest that use of the hybrid rollback approach has relatively little effect on short-term mortality risk (e.g., percentage differences relative to the core risk estimates were in the low single digits for most locations, with one location having a difference of +20% - see Appendix F, Table F-36). These results suggest that the issue of how alternative standard levels are simulated appears to introduce relatively little uncertainty into the modeling of short-term exposure mortality.

The sensitivity analysis results discussed above, result in a number of overall observations regarding sources of uncertainty potentially impacting short-term exposure morality endpoints. The results of using the seasonally-differentiated effect estimates in modeling short-term exposure mortality appear to generally have a relatively small impact (e.g., <15%) in most study areas. For some study areas, the impact does appear to be much larger, with results including both substantial negative and positive percent differences from the core estimates. However, in all of these cases, the total incidence estimates involved are very small, raising concerns over the stability of the risk estimates generated as part of this particular sensitivity analysis (in many of these instances, the estimates include negative lower bounds, reflecting the use of non-statistically significant effects estimates). For these reasons, the results of this sensitivity analysis, while initially appearing to be notable in terms of magnitude in some study areas, need to be interpreted with care. At this point, we are not able to reach a definitive conclusion as to how important this source of uncertainty is in the context of short-term exposure mortality estimation (due to the limitations regarding small incidence estimates and the stability of the relative differences in percent incidence estimates). Regarding the use of the alternative hybrid (non-proportional) approach for simulating conditions under alternative standard levels, the results suggest that this factor has a modest impact on short-term exposure mortality (significantly less impact than with the use of the hybrid approach in estimating long-term exposure mortality). With the exception of factors examined using the Moolgavkar et al., (2003) study in Los Angeles (see section 4.3.1.4), it would appear that the factors examined here do not have a large impact on risk estimates generated for short-term exposure mortality.

4.3.1.3 Sensitivity analysis results associated with short-term exposure morbidity

This section summarizes the results of the sensitivity analysis focused on short-term exposure-related morbidity endpoints (see Table 5-1 for the specific modeling elements considered in the sensitivity analysis). The results of individual sensitivity analysis simulations are presented below, with overall observations presented at the end of the section.

- **Impact of using season-specific C-R functions (vs. an annual C-R function):** This simulation considered the impact on short-term exposure morbidity (HAs) of using seasonally-differentiated effects estimates rather than the core approach of using a single C-R function for the whole year (we note that the seasonal models were obtained from the same study as the model used in the core analysis – Bell et al, 2008). The results of the simulation suggest that, as with short-term exposure mortality this source of uncertainty can have a wide range of impacts on the risk estimates across urban study areas (including not only variation in the magnitude of risk, but also in the direction) depending on the specific health endpoint examined. We note, however, that the magnitude of impact appears to be less for short-term morbidity than for short-term mortality. Percent changes for most of the 15 urban study areas were small for CV HAs (generally less than a 20% difference in either direction, although there was a large impact for Tacoma (-105%)) (see Appendix F, Table F-24). This source of uncertainty has a moderate to moderate-large impact for respiratory-related HAs with most locations having greater than a 40% to 70% absolute effect (see Appendix F, Table F-27).

- **Impact of using a seasonal function for April through August (applied only to that period) in modeling asthma-related ED visits in New York, relative to the core approach of using a single annual effect estimate (and applying that to the whole year):** This sensitivity analysis compared the core approach of using a single effect estimate to model asthma-related ED visits in New York (based on Ito et al., 2007) to the approach of using a season-specific estimate to model incidence for the period April through August (also obtained from Ito et al., 2007). Because the simulation periods used with the two approaches do not match (i.e., a seasonal estimate versus annual estimate), we have not directly compared the two to generate a percent difference estimate (as is done with the other sensitivity analysis simulations). While we do not draw a conclusion regarding the importance of this factor, the results do argue for further research to more fully characterize the impact of using seasonally-differentiated estimates in modeling this endpoint). As part of ongoing efforts to refine the sensitivity analysis, we are considering compare risk estimates (for April-August) generated using the single (annual) effect estimates, to estimates generated for this same time period using the seasonally-differentiated effect estimates.

Given the results of the set of simulations completed for short-term exposure morbidity (both of which focused on the use of seasonally-differentiated effects estimates), it would appear that this factor does not have a substantial impact on risk estimates. Additional factors potentially impacting short-term exposure morbidity are addressed below in relation to the sensitivity analysis based on alternative models from Moolgavkar et al. (2003).

4.3.1.4 Single-factor sensitivity analysis addressing model selection, lags, and co-pollutant models

As noted earlier in the introduction to section 4.3, the results of sensitivity analysis based on Moolgavkar et al., (2003) include percent difference estimates based on considering the range of risk estimates generated using alternative model specifications from this study for a given health endpoint and it is these results that are discussed below. However, sensitivity analysis results reflecting comparison of Moolgavkar-based risk estimates against the core risk estimates, while included in the detailed results tables in Appendix F, are not discussed here due to their high degree of uncertainty.

- **Impact of model selection (e.g., log-linear GAM with 30df, log-linear GAM with 100df, and log-linear GLM with 100df) on estimating short-term exposure mortality and morbidity**: Application of models obtained from Moolgavkar et al., (2003) with various formulations related to model selection (degrees of freedom, GLM vs. GAM) to the Los Angeles urban case study location results in a range of short-term exposure mortality estimates (for non-accidental and CV) that differ by 79% and 49%, respectively (see Appendix F, Table F-33). In the case of short-term exposure morbidity (specifically, CV-related HAs), incidence estimates differ by 36% (see Appendix F, Table F-33). These results suggest that these elements of model specification represent a moderate source of uncertainty in estimating short-term mortality and morbidity.

- **Impact of lag structure (0-day through 5-day) on estimating short-term exposure mortality:** Consideration of the range of risk estimates for non-accidental mortality generated using different lag structures (and associated effect estimates) provided in Moolgavkar et al., (2003), suggest that this factor could have a moderate impact on risk (in the range of 55% when comparing the lowest and highest positive incidence estimates generated). (see Appendix F, Table F-33).
- **Impact of considering multi-pollutant models on estimating short-term exposure mortality and morbidity**: The results of the Moolgavkar-based simulations (when considering the spread in risk estimates specifically across these simulations) suggest that the multi-pollutant versus single-pollutant model issue (i.e., including CO in addition to $PM_{2.5}$), could have a large impact on the estimation of short-term exposure mortality (105% for all-cause) and morbidity (142% for CV-related HAs).

Overall observations regarding key sources of uncertainty impacting short-term exposure mortality and morbidity risk estimates (based on the Moolgavkar et al., 2003 study) include the following. The spread in risk estimates generated across the Moolgavkar-based model specifications (for a particular endpoint), suggests that C-R model selection factors may have a moderate to large impact. More specifically, specification of lag structure has a moderate impact on risk and use of single versus multi-pollutant models could have a potentially large impact on risk. Note, however, that as discussed earlier, the relevance of these sensitivity analysis results to the interpretation of risk estimates generated using C-R functions derived from alternative epidemiology studies that used different underlying datasets and analytical approaches (i.e., Bell et al., 2008 and Zannobetti and Schwartz et al., 2009) is not clear and may be relatively low.

4.3.2 Multi-Factor Sensitivity Analysis

The results of the multi-factor sensitivity analyses are intended to support both goals of the sensitivity analysis: (a) identify which factors (now in combination), appear to have a significant impact on uncertainty in the core estimates and (b) to derive a set of reasonable alternative risk estimates for use in considering uncertainty associated with the core risk estimates. Regarding the second goal, given that these sensitivity analysis results reflect the combined impact of multiple uncertainty factors, they will likely provide high- and low-bounds on the range of reasonable alternative risk estimates, thereby providing key information in the consideration of uncertainty associated with the core risk estimates. Consequently, in providing an overall observations section here, we emphasize the potential reasonableness of each of the multi-element combinations included in the sensitivity analysis, since this factor is key to determining the degree to which these risk estimates can inform consideration of uncertainty related to the core risk estimates.

Note, that as discussed in section 4.4.3, while we have included sensitivity analyses involving estimation of risk down to PRB for long-term exposure mortality, overall uncertainty associated with these estimates is considered higher than other estimates (due to the need to extrapolate the behavior of the C-R function below the LML). Consequently, results of the simulations involving estimation of risk down to PRB will not be included in the set of reasonable alternative risk estimates used in supporting consideration of uncertainty in the core risk estimates, although these results are discussed below in the context of understanding key sources of uncertainty associated with the core risk estimates.

4.3.2.1 Multi-factor sensitivity analyses – long-term exposure mortality

This section summarizes the results of the sensitivity analysis focused on long-term exposure-related mortality endpoints (see Table 4-1 for the specific modeling elements considered in the sensitivity analysis). The results of individual sensitivity analysis simulations are presented below, with overall observations presented at the end of the section.

- **Impact of using log-linear vs. log-log C-R model with fixed or random effects, estimating incidence down to the LML vs. PRB, and using proportional vs. hybrid rollback to estimate long-term exposure mortality**: This multi-factor sensitivity analysis focused on a number of model design choices related to modeling long-term exposure mortality (all-cause and IHD). Modeling elements reflected in the simulations included: model form (log-linear vs log-log and random vs fixed effects), modeling risk down to PRB (vs LML), and use of an alternative hybrid rollback approach (vs proportional rollback) to simulate just meeting the current and alternative sets of standards. Various permutations of these various design elements choices (relative to the elements selected for the core analysis) were considered. Percent difference estimates (for all-cause mortality) ranged from 147% (for a model estimating risk down to PRB and use of the hybrid rollback approach) to 1,020% (for a model with random effects log-log model, risk estimated down to PRB, and use of the hybrid rollback approach).

We believe that application of a log-log model with random effects is a reasonable alternative to the core model (fixed-effects log-linear model), based on our review of the discussion in Krewski et al. (2009). Similarly, the use of a hybrid rollback approach involving non-proportional adjustment where there is the potential for greater use of local control strategies to address local-sources, is a reasonable alternative to solely using a proportional rollback approach in all study areas. Therefore, we believe that the combinations of modeling elements including these alternative choices are reasonable. However, there is more concern in predicting risk down to PRB. This is not because there is evidence for a threshold, but rather because we do not have data to support characterization of the nature of the C-R function in the vicinity of PRB. Specifically, there is increasing uncertainty in predicting the nature of the C-R function as you move below the LML. So, while we believe it is reasonable conceptually to estimate risk down to PRB, the quantitative process of doing this requires use of a function with very high uncertainty. Therefore, we concluded that those alternative risk estimates generated using risk estimated down to PRB should not be used in creating the reasonable alternative set of risk estimates in considering uncertainty associated with the core risk estimates.

4.3.2.2 Multi-factor sensitivity analyses – short-term exposure mortality

This section summarizes the results of the sensitivity analysis focused on short-term exposure-related mortality endpoints (see Table 4-1 for the specific modeling elements considered in the sensitivity analysis). The results of individual sensitivity analysis simulations are presented below, with overall observations presented at the end of the section.

- **Impact of using season-specific vs. annual effect estimates and proportional vs. hybrid rollback approaches in modeling short -term exposure mortality**: This multi-factor sensitivity analysis focused on a number of model design choices related to modeling short-term mortality (non-accidental). Modeling elements included in this sensitivity analysis were use of seasonal vs. annual effects estimates and use of hybrid vs proportional rollback to simulate just meeting current and alternative standard levels. Percent difference estimates (for non-accidental mortality) across the 7 urban study areas included in the simulation ranged from -109% (LA) to +119% (Birmingham) (see Appendix F, Table F-42). However, we note that the total incidence estimates associated with these higher-impact locations were relatively low, again raising the concern for the stability in relative differences with the core estimates.

We believe that the application of both alternative model formulations reflected in this multi-factor sensitivity analysis (seasonally-differentiated C-R functions and the hybrid rollback approach) are reasonable, and consequently the risk estimates that are generated do represent reasonable alternatives to the core estimates.

4.4 EVALUATING THE REPRESENTATIVENESS OF THE URBAN STUDY AREAS IN THE NATIONAL CONTEXT

The goal in selecting the 15 urban study areas included in this risk assessment was two fold: (a) to choose urban locations with relatively elevated ambient PM levels (in order to evaluate risk for locations likely to experience some degree of risk reduction under alternative standards) and (b) to include a range of urban areas reflecting heterogeneity in other PM risk-related attributes across the country. To further support interpretation of risk estimates generated in this analysis, we are assessing the degree to which urban study areas represent the range of key $PM_{2.5}$ risk-related attributes that spatially vary across the nation. We have partially addressed this issue by selecting urban study areas that provide coverage for different PM regions of the country (see section 3.3.2). In addition, we are considering how well the selected urban areas represent the overall U.S. for a set of spatially-distributed $PM_{2.5}$ risk related variables (e.g., $PM_{2.5}$ composition, weather, demographics including SES, baseline health incidence rates). This analysis will help to inform how well the urban study areas reflect national-level variability in these key PM risk-related variables. Based on generally available data (e.g. from the 2000 Census, Centers for Disease Control (CDC), or other sources), distributions for risk-related variables across U.S. counties and for the specific counties represented in the urban study areas are generated. The specific values of these variables for the selected urban study areas are then plotted on these distributions, and an evaluation is conducted of how representative the selected study areas are with respect to these individual variables, relative to the national distributions.

Estimates of risk (either relative or absolute, e.g. number of cases) within our risk assessment framework are based on four elements: population, baseline incidence rates, air quality, and the coefficient relating air quality and the health outcome (i.e., the $PM_{2.5}$ effect estimates). Each of these elements can contribute to heterogeneity in risk across urban locations, and each is variable across locations. In addition, there may be additional identifiable factors that contribute to the variability of the four elements across locations. In this assessment, we examine the representativeness of the selected urban area locations for the four main elements, and also provide additional assessment of factors that have been identified as influential in determining the magnitude of the C-R function across locations.

The specific choice of variables which may affect the $PM_{2.5}$ effect estimates for which we will examine urban study area representativeness is informed by an assessment of the epidemiology literature. We particularly focused on meta-analyses and multi-city studies which identified variables that influence heterogeneity in $PM_{2.5}$ effect estimates, and exposure studies which explored determinants of differences in personal exposures to ambient $PM_{2.5}$. While personal exposure is not incorporated directly into PM epidemiology studies, differences in the $PM_{2.5}$ effect estimates between cities clearly is impacted by differing levels of exposure and differences in exposure are clearly related to a number of exposure determinants. Broadly speaking, determinants of $PM_{2.5}$ effect estimates can be grouped into three areas: demographics, baseline health conditions, and climate and air quality. Based on a review of these studies, we identified the following variables within each group as potentially determining the $PM_{2.5}$ effect estimates:

- Demographics: education (see Zeka et al, 2006; Ostro et al, 2006), age and gender (see Zeka et al, 2006), population density (see Zeka et al, 2005), unemployment rates (see Bell and Dominici, 2008), race (see Bell and Dominici, 2008), public transportation use (see Bell and Dominici, 2008),
- Baseline health conditions: disease prevalence (diabetes – Bateson and Schwartz, 2004; Ostro et al, 2006; Zeka et al, 2006; pneumonia – Zeka et al, 2006; stroke – Zeka et al, 2006; heart and lung disease – Bateson and Schwartz, 2004; acute myocardial infarction – Bateson and Schwartz, 2004).
- Climate and air quality: $PM_{2.5}$ levels (average, 98^{th} percentiles, and numbers of days over the level of the 24-hour standard, e.g. 35 $\mu g/m^3$), co-pollutant levels, PM composition (see Bell et al, 2009; Dominici et al, 2007; Samet, 2008; Tolbert, 2007), temperatures (temp) (days above 90 degrees, variance of summer temp, mean summer temp, 98^{th} percentile temp, mean winter temp -- see Roberts, 2004; Medina-Ramon et al, 2006; Zeka et al., 2005), air conditioning prevalence (see Zanobetti and Schwartz, 2009; Franklin et al, 2007; Medina-Ramon et al, 2006), ventilation (see Sarnat et al, 2006), percent of primary PM from traffic (see Zeka et al., 2005),

Based on these identified potential risk determinants, we identified possible datasets that could be used to generate nationally representative distributions for each parameter. We were not able to identify readily available national datasets for all variables. In these cases, if we were able to identify a broad enough dataset covering a large enough portion of the U.S., we used that dataset to generate the parameter distribution. In addition, we were not able to find exact matches for all of the variables identified through our review of the literature. In cases where an exact match was not available, we identified proxy variables to serve as surrogates. For each parameter, we report the source of the dataset, its degree of coverage, and whether it is a direct measure of the parameter or a proxy measure. The target variables and sources for the data are provided in Table 4-2. Summary statistics for the most relevant variables are provided in Table D-3.

Table 4-2. Data Sources for PM NAAQS Risk Assessment Risk Distribution Analysis.

Potential Risk Determinant	Metric	Year	Source	Degree of National Coverage
Demographics				
Age	Median Age	2005	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Age	Percent over 65	2005	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Age	Percent under 15	2005	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Education	Population with less than HS diploma	2000	USDA/ERS, http://www.ers.usda.gov/Data/Education/	All counties
Unemployment	Percent unemployed	2005	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Income	Per Capita Personal Income	2005	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Race	Percent nonwhite	2006	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Population	Total population	2008	Cumulative Estimates of Resident Population Change for the United States, States, Counties, Puerto Rico, and Puerto Rico Municipios: April 1, 2000 to July 1, 2008, Source: Population Division, U.S. Census Bureau	All counties
Population density	Population/square mile	2008	Cumulative Estimates of Resident Population Change for the United States, States, Counties, Puerto Rico, and Puerto Rico Municipios: April 1, 2000 to July 1, 2008, Source: Population Division, U.S. Census Bureau	All counties
Urbanicity	ERS Classification Code	2003	County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Climate and Air Quality				
$PM_{2.5}$ Levels	$PM_{2.5}$ Levels -- Monitored Ann Mean	2007	AQS	617 Monitored counties
$PM_{2.5}$ Levels	$PM_{2.5}$ Levels --	2007	AQS	617 Monitored

Potential Risk Determinant	Metric	Year	Source	Degree of National Coverage
	Monitored 98th %ile			counties
$PM_{2.5}$ Levels	Average MCAPS		MCAPS website 204 counties	204 MCAPS counties
$PM_{2.5}$ Levels	% days exceeding 35 $\mu g/m^3$		MCAPS website 204 counties	204 MCAPS counties
Copollutant Levels	Ozone		AQS	725 Monitored counties
Roadway emissions/Exposure	% of primary emissions from traffic	1999	NEI	All counties
Temperature	Annual Average		MCAPS website 204 counties	204 MCAPS counties
Temperature	Mean July Temp 1941-1970		County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Relative Humidity	Mean July RH 1941-1970		County Characteristics, 2000-2007 Inter-university Consortium for Political and Social Research	All counties
Ventilation	Air conditioning prevalence	2005	American Housing Survey, with additional processing as in Reid et al (2009)	83 urban areas
Baseline Health Conditions				
Baseline Mortality	All Cause		CDC Wonder 1999-2005	All counties
Baseline Mortality	Non Accidental		CDC Wonder 1999-2006	All counties
Baseline Mortality	Cardiovascular		CDC Wonder 1999-2007	All counties
Baseline Mortality	Respiratory		CDC Wonder 1999-2008	All counties
Baseline Morbidity	AMI prevelence	2007	BRFSS MSA estimates	184 BRFSS MSA
Baseline Morbidity	Diabetes Prevalence	2007	BRFSS MSA estimates	184 BRFSS MSA
Baseline Morbidity	Pneumonia Prevalence			
Baseline Morbidity	Stroke Prevalence	2007	BRFSS MSA estimates	184 BRFSS MSA
Baseline Morbidity	CHD Prevelence	2007	BRFSS MSA estimates	184 BRFSS MSA
Baseline Morbidity	COPD Prevalence			
Obsesity	BMI	2007	BRFSS MSA estimates	184 BRFSS MSA
Level of exercise	vigorous activity 20 minutes	2007	BRFSS MSA estimates	184 BRFSS MSA
Level of exercise	moderate activity 30 minutes or vigorous activity 20 minutes	2007	BRFSS MSA estimates	184 BRFSS MSA
Respiratory Risk Factors	Current Asthma	2007	BRFSS MSA estimates	184 BRFSS MSA
Smoking	Ever Smoked	2007	BRFSS MSA estimates	184 BRFSS MSA
C-R Estimates				
Mortality Risk	All Cause	2009	Zanobetti and Schwartz (2009) 212 cities	212 cities
Mortality Risk	Respiratory	2009	Zanobetti and Schwartz (2009) 212 cities	212 cities

Potential Risk Determinant	Metric	Year	Source	Degree of National Coverage
Mortality Risk	Cardiovascular	2009	Zanobetti and Schwartz (2009) 212 cities	212 cities

Table 4-3. Summary Statistics for Selected PM Risk Attributes.

Risk Attributes	Average		Standard Deviation		Maximum		Minimum		Sample Size	
	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas (number of counties)	U.S. (number of counties)
Demographics										
Population	1,410,331	97,020	1,870,237	312,348	9,862,049	9,862,049	57,441	42	31	3143
Population Density (Pop/sq mile)	7,212	258	14,960	1,757	71,758	71,758	87	0	31	3143
Median Age (years)	35.5	38.6	2.6	4.4	41.5	55.3	30.2	20.1	31	3141
% Age 65 Plus	11.3	14.9	2.6	4.1	17.2	34.7	5.8	2.3	31	3141
Unemployment rate (%)	5.4	5.4	1.5	1.8	9.0	20.9	2.7	1.9	31	3133
% with Less than High School Diploma	21.8	22.6	7.7	8.8	37.7	65.3	11.2	3.0	31	3141
Income ($2005)	35691	27367	12605	6604	93377	93377	23492	5148	31	3086
Air conditioning prevalence (%)	85.8	83.3	13.3	21.5	99.4	100.0	58.6	9.9	10	70
% Non-white	29.5	13.0	18.2	16.2	68.3	95.3	2.7	0.0	31	3141
Health Conditions										
Prevalence of CHD (%)	3.9	4.3	0.9	1.3	5.2	8.7	1.8	1.8	14	184
Prevalence of Obesity (%)	26.4	26.0	3.0	4.1	32.7	35.7	22.2	14.0	14	182
Prevalence of Stroke (%)	2.7	2.7	0.8	1.0	4.1	6.5	1.1	0.7	14	184
Prevalence of Smoking (ever) (%)	18.4	19.6	3.1	4.0	23.1	34.4	14.2	6.5	14	184
Prevalence of Exercise (20 minutes) (%)	28.4	28.0	3.6	4.8	33.9	44.1	20.5	15.4	14	183
All Cause Mortality (per 100,000 population)	833.7	1022.3	241.1	258.6	1342.9	2064.2	402.5	176.8	31	3142
Non-accidental Mortality (per 100,000 population)	774.1	950.6	227.3	249.6	1242.0	1958.4	361.6	117.7	31	3142
Cardiovascular Mortality (per 100,000 population)	317.5	392.1	100.6	121.0	535.7	970.4	122.4	37.5	31	3142
Respiratory Mortality (per 100,000 population)	70.8	97.3	23.0	32.3	130.3	351.0	34.8	13.3	31	3136
Air Quality and Climate										
AQ - PM25 Annual Mean ($\mu g/m^3$)	15.1	11.7	2.2	3.1	19.6	22.5	9.7	3.4	29	617
AQ - PM25 98th %ile 24-hour Average ($\mu g/m^3$)	38.7	30.7	11.6	9.3	79.2	81.1	26.8	9.1	29	617
AQ - O_3 4th High Maximum 8-hour Average (ppm)	0.087	0.077	0.009	0.010	0.105	0.126	0.064	0.033	27	725
% Mobile Source PM Emissions	34.0	44.4	11.2	21.9	56.6	97.6	13.7	0.3	31	3141

Risk Attributes	Average		Standard Deviation		Maximum		Minimum		Sample Size	
	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas	U.S. counties	Urban study areas (number of counties)	U.S. (number of counties)
July Temperature Long Term Average (°F)	78.1	75.9	4.5	5.4	91.2	93.7	64.8	55.5	31	3104
July Relative Humidity Long Term Average (°F)	58.2	56.2	14.0	14.6	70.0	80.0	19.0	14.0	31	3104
C-R Estimates										
All Cause Mortality $PM_{2.5}$ Risk Estimate	0.000971	0.000974	0.000340	0.000216	0.001349	0.001508	0.000159	-0.000099	15	112
Respiratory Mortality $PM_{2.5}$ Risk Estimate	0.001606	0.001670	0.000419	0.000305	0.002157	0.002221	0.000931	-0.000346	15	112
Cardiovascular Mortality $PM_{2.5}$ Risk Estimate	0.001013	0.000842	0.000586	0.000324	0.001958	0.001958	-0.000180	-0.000180	15	112

Formal comparisons of parameter distributions for the set of urban study areas and the national parameter distributions are conducted using standard statistical tests, e.g. the Kolmogorov-Smirnov non-parametric test for equality of distributions. In addition, visual comparisons are made using cumulative distribution functions, and boxplots.

The formal Kolmogorov-Smirnov test results are provided in Table 4-4. The K-S tests the hypotheses that two distributions are not significantly different. A high p-value indicates a failure to reject the null hypotheses that the case-study and national distributions are the same. We used a rejection criterion of $p \leq 0.05$, which is a standard rejection criteria. It should be noted that the K-S test provides a good overall measure of fit, but will not provide a test of how well specific percentiles of the distributions are matched. As such, the K-S test results will not be sufficient to determine whether the urban study areas adequately capture the tails of the distributions of specific risk related variables. Additional visual analyses are used to assess representativeness for the tails of the distributions. Overall, the K-S test results show that for many of the important risk variables such as population, air quality, age, and baseline mortality rates, the urban study areas are not representative of the distributions of these variables for the U.S. as a whole. However, for some important potential risk determinants, such as prevalence of underlying hear and lung diseases, the case study areas are representative of the national distributions. However, for these specific variables, the national distribution is represented primarily by large urban areas, so it is more accurate in these cases to suggest that the urban study areas are representative of the overall distribution across urban areas.

Figures 4-14 through 4-17 show for the four critical risk function elements (population, air quality, baseline incidence, and the $PM_{2.5}$ effect estimate) the cumulative distribution functions plotted for the nation, as well as for the urban study areas. These four figures focus on critical variables representing each type of risk determinant, e.g. we focus on all-cause mortality rates, but we also have conducted analyses for cardiovascular and respiratory mortality separately. The complete set of analyses is provided in Appendix D. The vertical black lines in each graph show the values of the variables for the individual urban study areas. These figures show that the selected urban study areas represent the upper percentiles of the distributions of population and air quality, while not representing lower population locations with lower 24-hour $PM_{2.5}$ levels. This is consistent with the objectives of our case study selection process, e.g. we are characterizing risk in areas that are likely to be experiencing excess risk due to PM levels above alternative standards. The urban case study locations represent the full distribution of $PM_{2.5}$ risk coefficients, but do not capture the upper end of the distribution of baseline all-cause mortality. The interpretation of this is that the case study risk estimates may not capture the additional risk that may exist in locations that have the highest baseline mortality rates.

Figures 4-18 through 4-21 shows for several selected potential risk attributes the CDF plotted for the nation as well as for the urban study areas. These potential risk attributes do not directly enter the risk equations, but have been identified in the literature as potentially affecting the magnitude of the $PM_{2.5}$ C-R functions reported in the epidemiological literature. The selected urban study areas do not capture the higher end percentiles of several risk characteristics, including populations over 65, income, and baseline cardiovascular disease prevalence. Comparison graphs for other risk attributes are provided in Appendix D. Summarizing the analyses of the other risk attributes, we conclude that the urban study areas provide adequate coverage across population, population density, annual and 24-hour PM2.5 levels, ozone co-pollutant levels, temperature and relative humidity, unemployment rates, percent non-white population, asthma prevalence, obesity prevalence, stroke prevalence, exercise prevalence, and less than high school education. We also conclude that while the urban study areas cover a wide portion of the distributions, they do not provide coverage for the upper end of the distributions of age (all case study locations are below the 85th %ile), % of population 65 and older (below 85th %ile), percent of primary PM emissions from mobile sources (below 8oth %ile), prevalence of angina/coronary heart disease (below 85th %ile), prevalence of diabetes (below 85th %ile), prevalence of heart attack (below 80th %ile), prevalence of smoking (below 85th %ile), all-cause mortality rates (below 90th %ile), cardiovascular mortality rates (below 90th %ile) and respiratory mortality rates (below 90th %ile). In addition, all of the case study locations were above the 25th percentile of the distribution of personal income.

Based on the above analyses, we can draw several inferences regarding the representativeness of the urban case studies. First, the case studies represent urban areas that are among the most populated and most densely population in the U.S. Second, they represent areas with relatively higher levels of annual mean and 24-hour 98th percentile $PM_{2.5}$. Third, they capture well the range of effect estimates represented in the Zanobetti and Schwartz (2009) study. These three factors would suggest that the urban study areas should capture well overall risk for the nation, with a potential for better characterization of the high end of the risk distribution. However, there are several other factors that suggest that the urban study areas may not be representing areas that may have a high risk per microgram of $PM_{2.5}$. The analysis suggests that the urban study areas are not capturing areas with the highest baseline mortality risks, nor those with the oldest populations. These areas may have higher risks per microgram of $PM_{2.5}$, and thus the high end of the risk distribution may not be captured, although the impact on characterization of overall PM risk may not be as large, for the following reasons.

It should be noted that several of the factors with underrepresented tails, including age and baseline mortality (R=0.81) are spatially correlated, so that certain counties which have high proportions of older adults also have high baseline mortality and high prevalence of underlying chronic health conditions. Because of this, omission of certain urban areas with higher percentages of older populations, for example, cities in Florida, may lead to underrepresentation of high risk populations. However, with the exception of areas in Florida, most locations with high percentages of older populations have low overall populations, less than 50,000 people in a county. And even in Florida, the counties with the highest $PM_{2.5}$ levels do not have a high percent of older populations. This suggests that while the risk per exposed person per microgram of $PM_{2.5}$ may be higher in these locations, the overall risk to the population is likely to be within the range of risks represented by the urban case study locations.

Table 4-4 Results of Kolomogrov-Smirnoff Tests for Equality Between National and Urban Study Area Distributions for Selected National Risk Characteristic Variables

(null hypothesis is no difference between the distributions)

Risk Attributes	Reject H0?	p-value
Demographics		
Population	Y	0.0001
Population Density (Pop/sq mile)	Y	0.0001
Median Age	Y	0.0001
% Age 65 Plus	Y	0.0001
Unemployment rate	N	0.5850
% with Less than High School Diploma	N	0.8535
Income	Y	0.0001
Air Conditioning Prevalence (%)	N	0.9592
% Non-white	Y	0.0001
Health Conditions		
Prevalence of CHD	N	0.7705
Prevalence of Obesity	N	0.9180
Prevalence of Stroke	N	0.7064
Prevalence of Smoking (ever)	N	0.5748
Prevalence of Exercise (20 minutes)	N	0.7649
All Cause Mortality	Y	0.0001
Non-accidental Mortality	Y	0.0002
Cardiovascular Mortality	Y	0.0060
Respiratory Mortality	Y	0.0001

Risk Attributes	Reject H0?	p-value
Air Quality and Climate		
AQ - PM25 Annual Mean	Y	0.0001
AQ - PM25 98th %ile 24-hour Average	Y	0.0001
AQ - PM25 % of days above 35 ug/m3	Y	0.0248
AQ - O3 4th High Maximum 8-hour Average	Y	0.0003
% Mobile Source PM Emissions	Y	0.0133
July Temperature Long Term Average	Y	0.0003
July Relative Humidity Long Term Average	N	0.0614
C-R Estimates		
All Cause Mortality $PM_{2.5}$ Risk	N	0.1585
Respiratory Mortality $PM_{2.5}$ Risk	N	0.2864
Cardiovascular Mortality $PM_{2.5}$ Risk	N	0.1161

Figure 4-14. Comparison of distributions for key elements of the risk equation: total population.

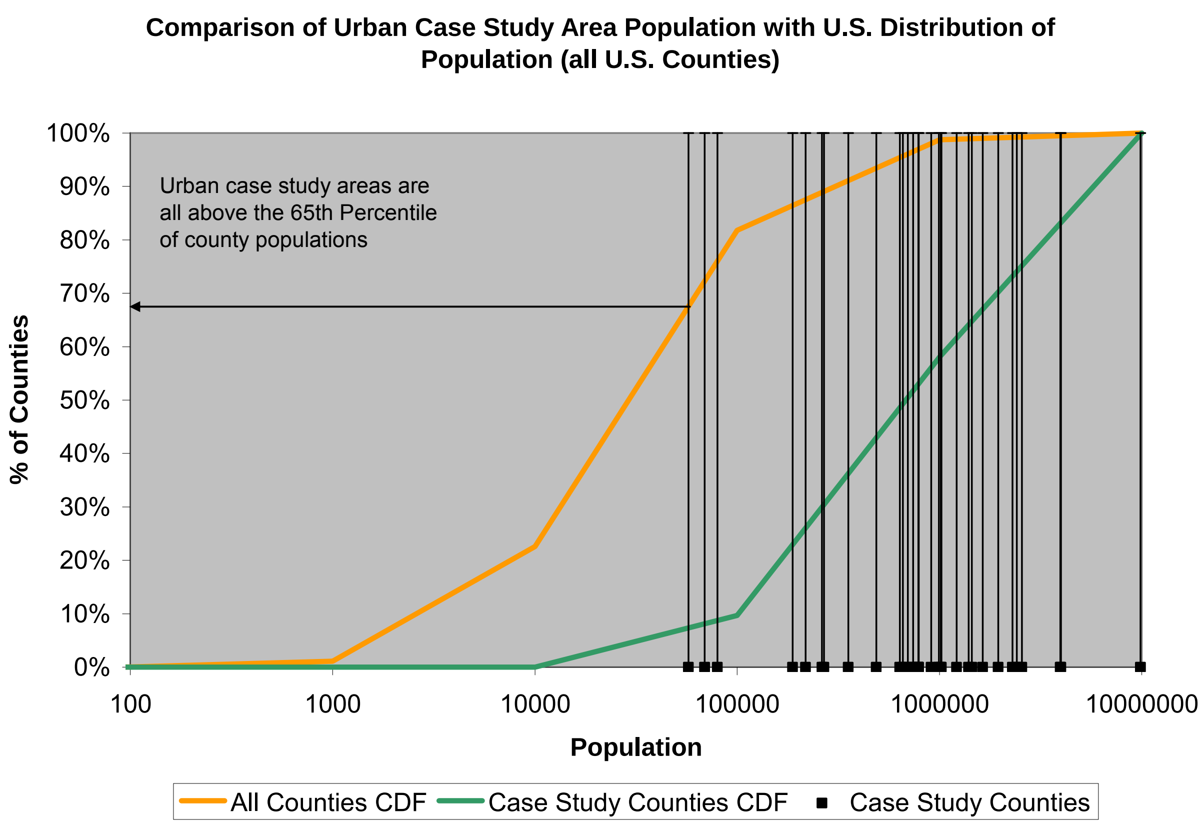


Figure 4-15 Comparison of distributions for key elements of the risk equation: 98th percentile 24-hour average $PM_{2.5}$

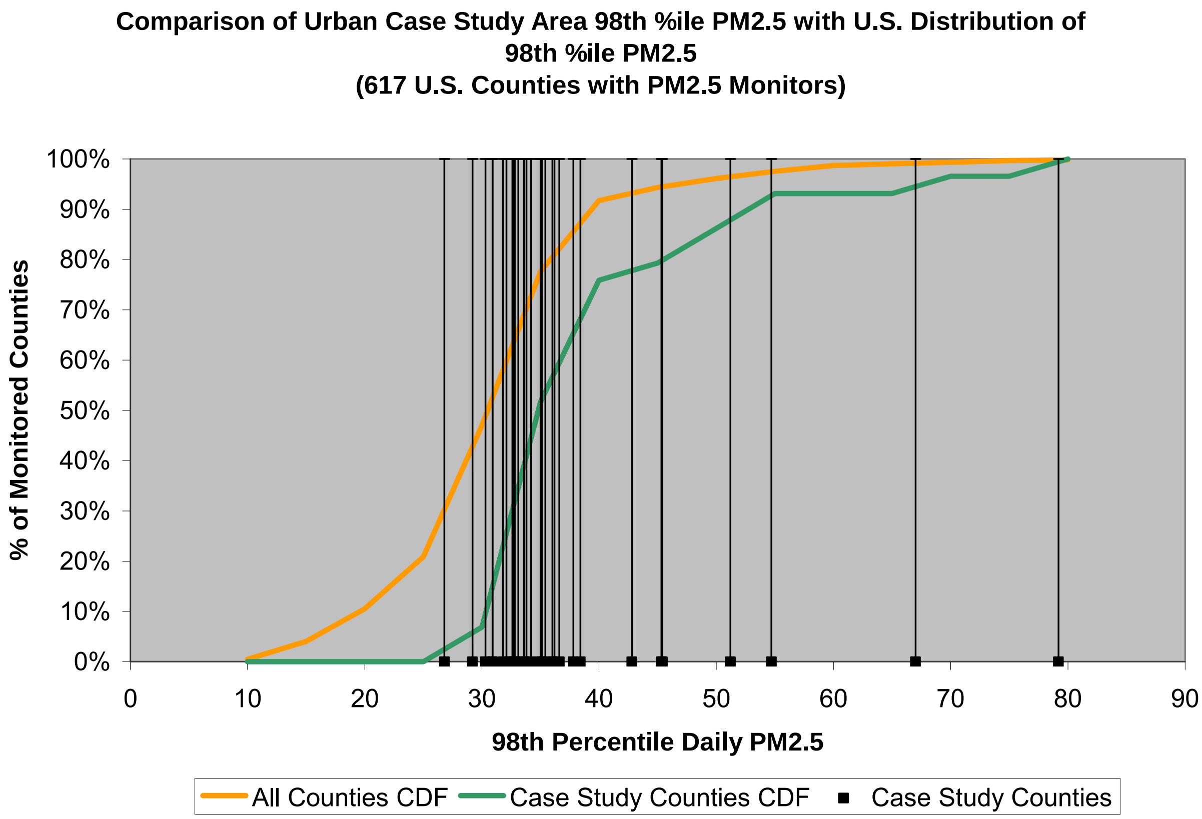


Figure 4-16. Comparison of distributions for key elements of the risk equation: all cause mortality rate.

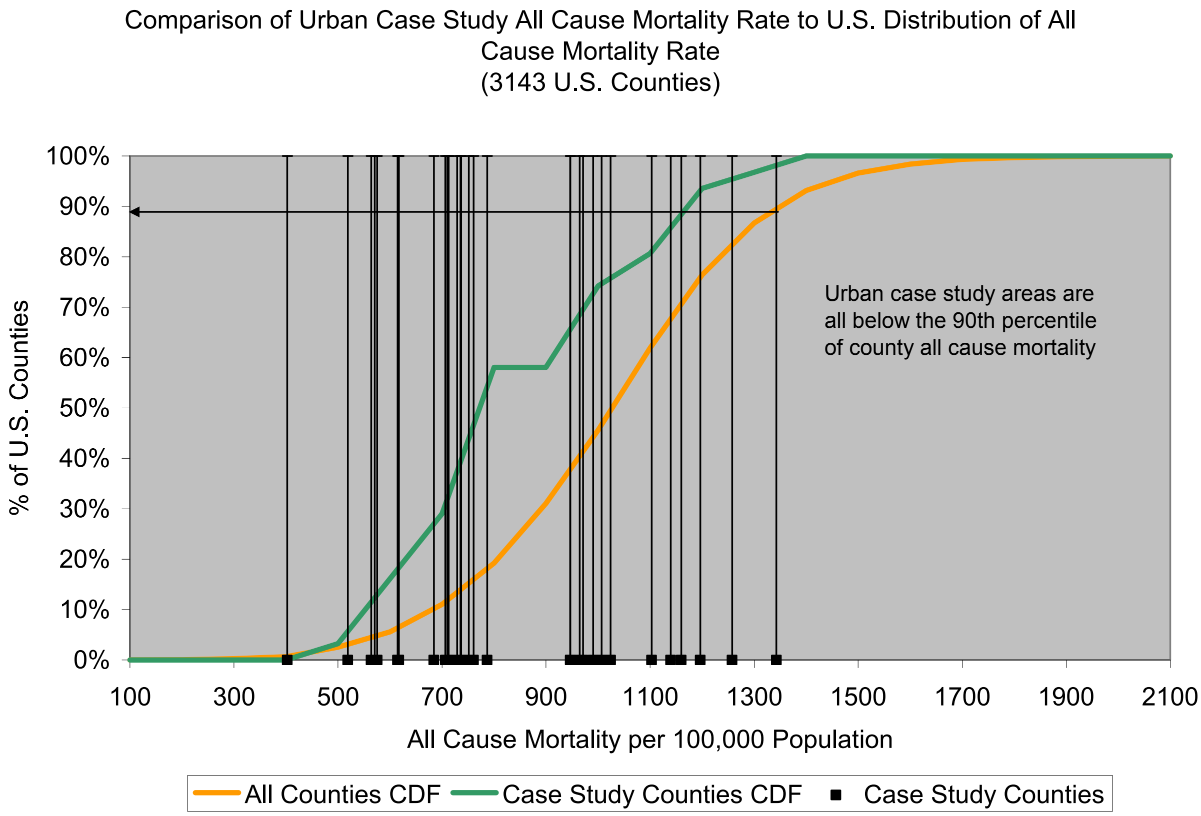


Figure 4-17. Comparison of distributions for key elements of the risk equation: mortality risk effect estimate from Zanobetti and Schwartz (2008).

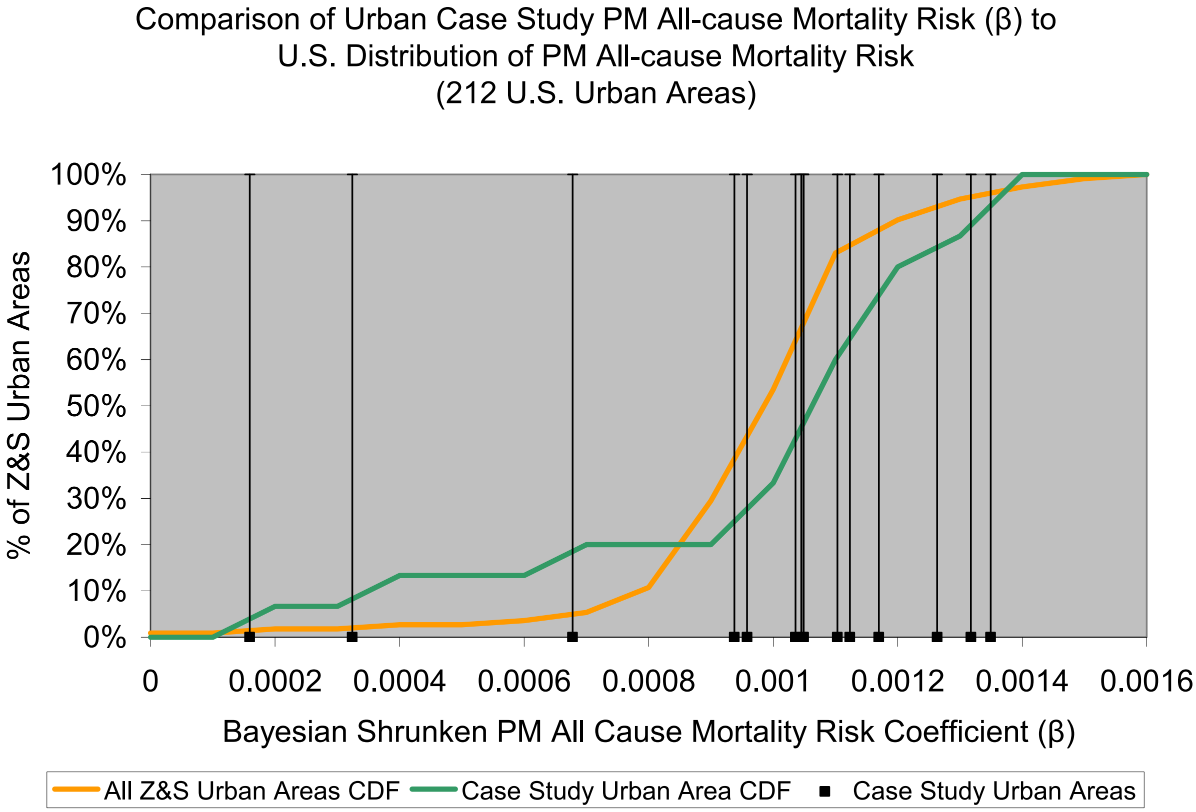


Figure 4-18. Comparison of distributions for selected variables expected to influence the relative risk from $PM_{2.5}$: long term average July temperature.

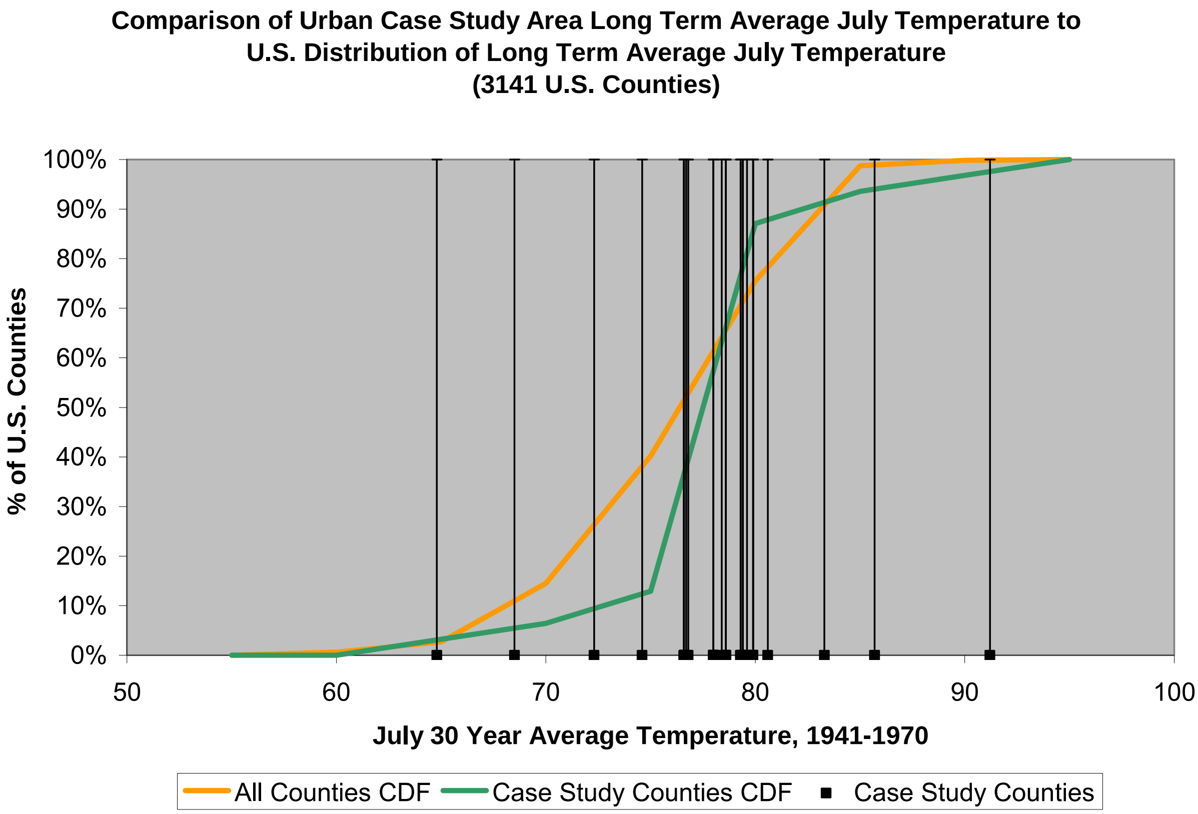


Figure 4-19. Comparison of distributions for selected variables expected to influence the relative risk from $PM_{2.5}$: percent of population 65 and older.

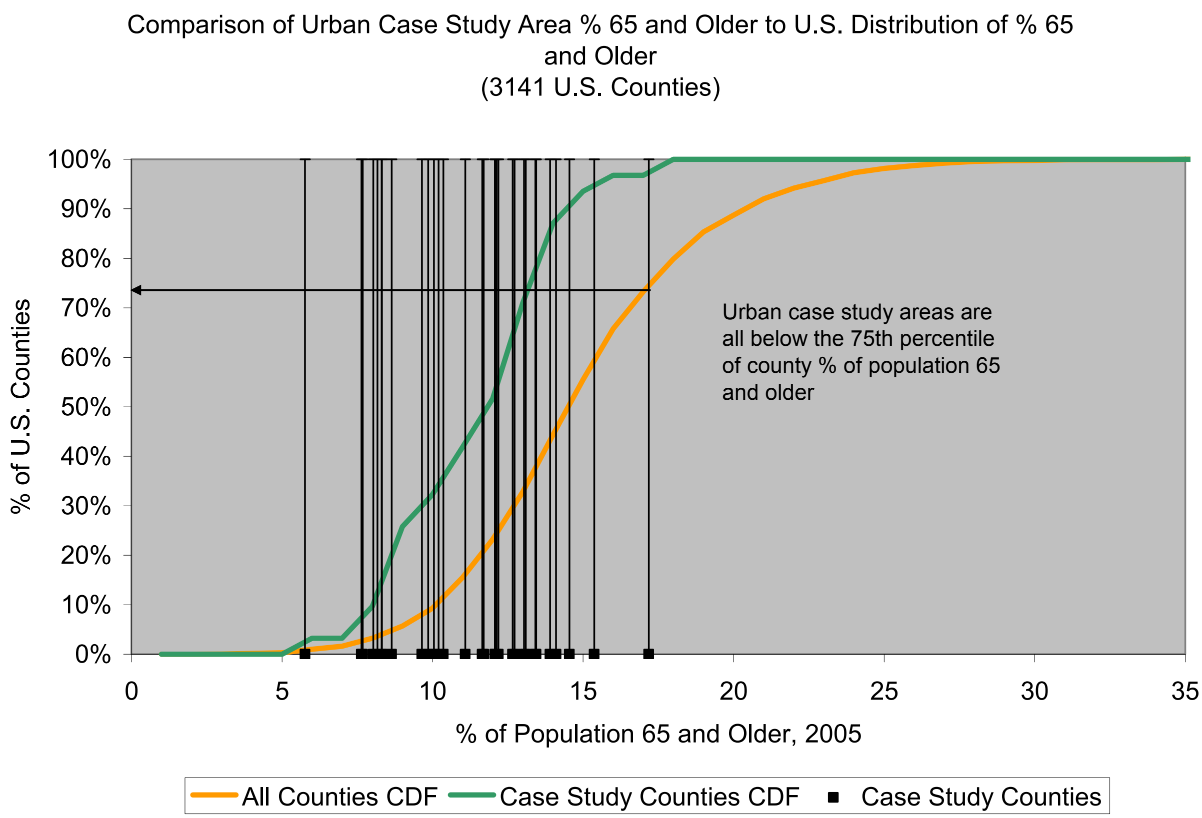


Figure 4-20. Comparison of distributions for selected variables expected to influence the relative risk from $PM_{2.5}$: per capita annual personal income.

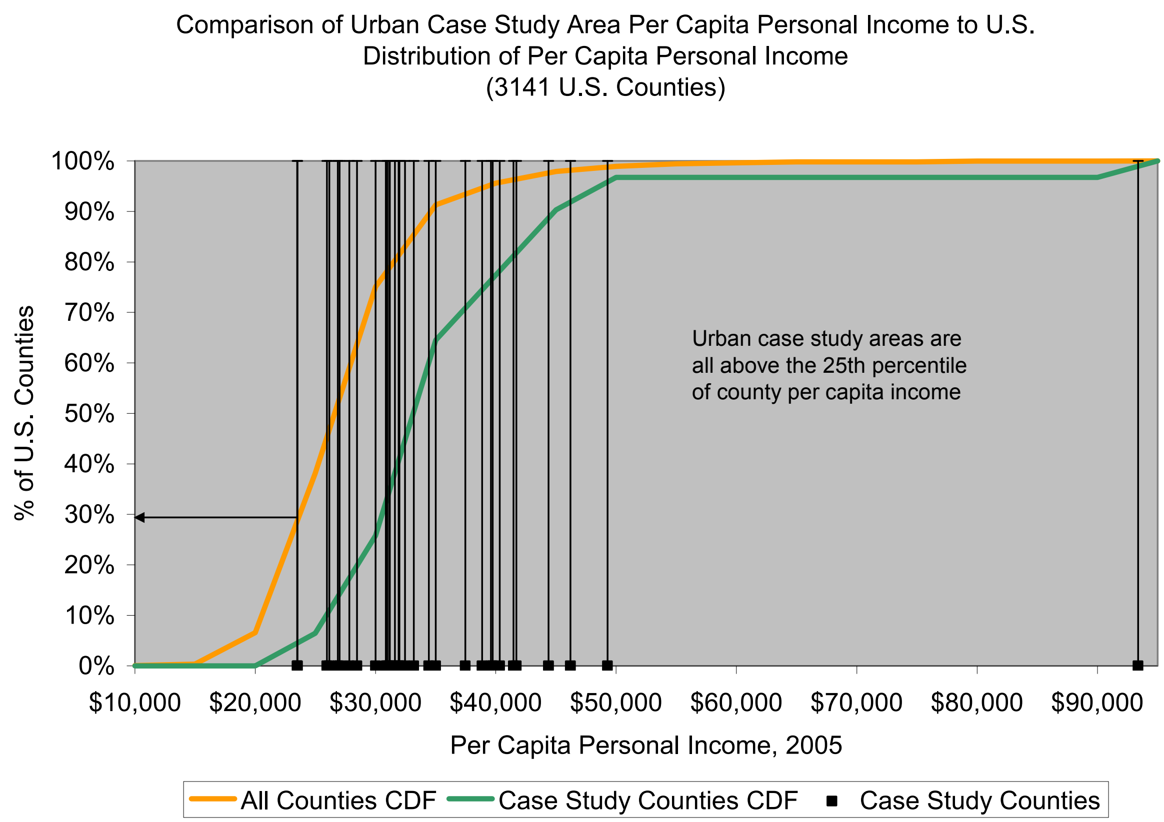
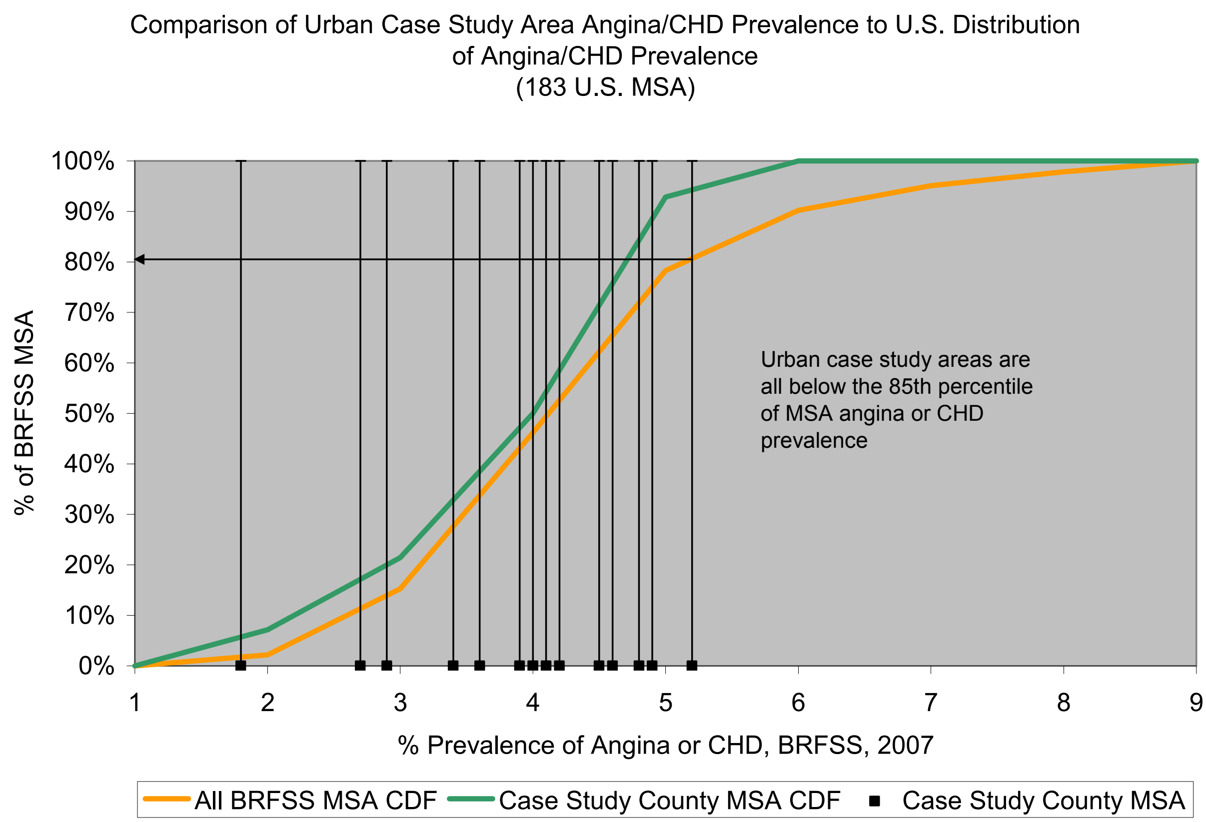


Figure 4-21. Comparison of distributions for selected variables expected to influence the relative risk from $PM_{2.5}$: cardiovascular disease prevalence days.



4.5 OVERALL SUMMARY AND KEY OBSERVATIONS

This section provides a summary of the key observations related to the core risk results, including both the recent conditions analysis results and estimates generated for the current and alternative sets of standards (section 4.5.1). Next, observations resulting from the sensitivity analyses related to the first goal for the analyses (what they tell us about the key sources of uncertainty potentially impacting the core risk estimates) are presented (section 4.5.2). Then, observations related to the second goal of the sensitivity analysis (how the output of the sensitivity analysis can be used to gain some perspective on the magnitude of uncertainty related to the core risk estimates) are presented (section 4.5.3). The final two subsections end by discussing the results of two national-scale assessments designed to evaluate the representativeness of the 15 urban study areas (and the 31 counties comprising those urban areas) in the national context with regard to PM-related risk. Specifically, section 4.5.4 discuses observations from an assessment of how the 15 urban study areas (and their 31 counties) compare against a set of national distributions for key PM risk-related attributes. Section 4.5.5 discusses observations resulting from seeing how the set of 15 urban study areas (and their 31 counties) are distributed across a cumulative plot of national-scale long-term $PM_{2.5}$-related mortality generated for all counties in the U.S.

4.5.1 Core risk results from the recent conditions, current NAAQS, and alternative NAAQS analyses

This section provides an overall summary and key observations related to the core risk estimates (see section 4.1 and 4.2 for a detailed discussion of these results). As discussed in section 4.1, the core risk estimates are generated using model inputs believed to have the greatest support in the literature and therefore, they have received greater focus in the discussions of risk estimates generated for the urban study areas. The results discussed below related to just meeting the current and alternative sets of standards are based on results from 14 of the 15 study areas, with Pittsburgh being excluded at this time due to an error that was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. As noted earlier in sections 2.4.1 and 4.2, there was insufficient time after identifying this error to either generate corrected risk estimates or remove the erroneous risk estimates from the summary tables (presented in Appendix E). We will correct this error and release updated results for the Pittsburgh study area as soon as is practicable and will include the corrected results in the next version of this document.

This overview of risk results is organized by air quality scenario, beginning with recent conditions followed by just meeting the current set of standards and each of the four sets of alternative standards considered. An important factor to consider in interpreting the risk estimates for both the current set of standards and set of alternative standards is whether the annual or 24-hour standard for a given pairing of standards is controlling for a particular area.[43] This factor can have a significant impact on the pattern of risk reductions predicted for a given location under the simulation of just meeting a specific set of standards. As such, particular attention is given to this factor when discussing risk reductions associated with the current and alternative sets of standards.

[43] For a given pairing of standard levels (e.g., 13/35), the controlling standard can be identified by comparing these levels to the design values for a given study area (see Table 3-3 for the annual and 24-hr design values for each of the urban study areas). The controlling standard is the standard (annual or 24 hr) that requires the greatest percent reduction in the matching design value to meet that standard.

Recent conditions analysis: Because this air quality scenario represents recent conditions, risk estimates are described in absolute terms, not in terms of a change or reduction relative to another air quality scenario.

- **Long-term exposure mortality:** The recent conditions analysis for long-term exposure mortality suggests that across the 15 urban study areas, for the simulation year 2007, from 1.7 to 6.7% of all cause mortality incidence is estimated to be associated with $PM_{2.5}$ exposure. Risk estimates are notably higher for specific mortality categories, with IHD having the highest percent contribution from $PM_{2.5}$, ranging from 6.7 to 23.5% across the 15 urban study areas. We note that a significant portion of these ranges results from application of two sets of C-R functions – one based on monitoring data from 1979-1983 and a second set derived using monitoring data from 1999-2000 from the same cohort study (i.e., the extended analysis of the ACS).
- **Short-term exposure mortality and morbidity:** Recent conditions estimates for short-term exposure mortality suggest that from 0.2 to 1.7 percent of all non-accidental mortality is associated with $PM_{2.5}$. As with long-term mortality, estimates for individual short-term exposure mortality categories (e.g., respiratory) are higher, ranging up to 2.9%. Estimates for short-term exposure morbidity (HAs) are similar in magnitude to short-term mortality. The analysis of emergency department visits in New York and Los Angeles produced estimates nearer the lower end of this range (e.g., 0.6% of incidence attributable to $PM_{2.5}$).

Simulating just meeting the current standards: Risk estimates for this air quality scenario in 14 study areas are described by comparing estimates of risk attributable to $PM_{2.5}$ under the current set of standards to risk estimates under recent conditions.[44] Note that two of the 14 urban study areas (Dallas and Phoenix) have both annual and 24-hr design values that are below the matching current standard levels of 15 and 35 $\mu g/m^3$, respectively (see Table 3-3). This means that these two urban study areas would not have any reduction in long-term or short-term risk under the current standards, as reflected in the summaries presented below (note, however, that both areas have predicted risk reductions under some of the alternative sets of standards).

- **Long-term exposure mortality:** Of the 12 urban study areas with at least one design value exceeding the current standard levels, we estimated that the percent of total all-cause mortality (associated with $PM_{2.5}$) would be reduced by 5 to 15% (for 5 urban study areas), by 30 to 40% (for 4 urban study areas), and by ~60% (for 3 urban study areas) relative to risk estimated under recent conditions. The magnitude of risk reductions is similar for the other long-term cause-specific mortality categories.

[44] As noted earlier, Pittsburgh has been excluded due to an error that was identified in the approach used to simulate ambient $PM_{2.5}$ levels just for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Consequently, the number of study areas discussed in relation to the current standard (as well as alternative standards) is 14, rather than 15.

- **Short-term exposure mortality and morbidity**: Short-term exposure non-accidental mortality is estimated to have a slightly smaller overall degree of risk reduction under the current set of standards compared with reductions estimated for long-term exposure mortality. With regard to the 12 urban study areas predicted to have risk reductions under the current standards, we estimated that total non-accidental mortality associated with $PM_{2.5}$ would be reduced by less than 10% (for 4 areas), by 10 to 30% (for 5 areas), and by 40 to ~70% (for 4 areas) relative to risk estimated under recent conditions. Other short-term exposure mortality categories, as well as short-term exposure morbidity categories (HAs), display a similar distribution of risk reduction across the urban study areas for the current set of standards.

Simulating just meeting alternative sets of standards focusing on lower annual standard levels (13/35, 12/35): Risk reductions for alternative sets of standards were calculated relative to risk estimated under the current set of standards.[44] We note that Dallas and Phoenix had annual and 24-hour design values which were lower than the 13/35 set of alternative standards , but the annual design values were above the 12/35 set of alternative standards (see Table 3-3). For two of the other study areas (Fresno and Los Angeles), where the 24-hr standard was controlling, simulating just meeting the current standard resulted in significant reductions in the annual $PM_{2.5}$ levels, such that no risk reduction was seen for the 13/35 alternative set of standards (i.e., adjusted annual $PM_{2.5}$ levels for these study areas under the current set of standards were already below 13 $\mu g/m^3$). We note, however, that Los Angeles did show risk reductions under the 12/35 set of standards , while Fresno continued not to have predicted risk reductions under the 12/35 set of alternative standards due to the significant reduction in annual levels associated with just meeting the current set of standards. Because Tacoma and Salt Lake City already had annual design values (10 and 12 $\mu g/m^3$, respectively) at or below the 12 $\mu g/m^3$ associated with the lower of these two alternative sets of standards, neither study area exhibited risk reductions. Specific ranges of risk reductions for those urban study areas predicted to have reductions under these two alternative sets of standards are summarized below:

- **Long-term exposure mortality:** For the 8 study areas predicted to have risk reductions under the 13/35 set of standards, one area had reductions in all-cause mortality (attributable to $PM_{2.5}$) of about 5%, while the remaining 7 had reductions from over 10 to ~25% relative to risk estimated under the current set of standards. Under the 12/35 set of standards, 11 of the urban study areas were predicted to have risk reductions, with 4 areas having 10 to 22% reductions and 7 locations having 25 to 35% reductions relative to risk estimated under the current set of standards. The magnitude of risk reductions is similar for the other long-term exposure cause-specific mortality categories.

Short-term exposure mortality and morbidity: For the 8 study areas predicted to have risk reductions for short-term exposure mortality and morbidity endpoints under the 13/35 set of standards, reductions range from 3 to 15% across all endpoints relative to risk estimated under the current set of standards. For the 11 urban study areas predicted to have risk reductions for short-term exposure mortality and morbidity endpoints under the 12/35 set of standards, reductions range from 5 to 23% across all endpoints.

Simulating just meeting alternative sets of standards focusing on combinations of lower annul and lower 24-hour levels (13/30, 12/25): Because of the combination of lower 24-hr and annual levels, 13 of the 14 urban study areas had risk reductions under the 13/30 standard level (only Dallas continued not to have predicted risk reductions), while all 14 urban study areas exhibited risk reductions under the 12/25 alternative set of standards.

- **Long-term exposure mortality:** Under the 13/30 set of standards, reductions in all-cause mortality attributable to $PM_{2.5}$ ranged from 14 and 44% relative to risk under the current set of standards across 13 study areas. Under the 12/25 set of standards, the degree of risk reduction in all-cause mortality was between 12 and 89% across all 14 study areas . The magnitude of risk reductions was **similar for the other long-term cause-specific mortality categories.**
- **Short-term exposure mortality and morbidity: Under the 13/30 se**t of standards, reductions in non-accidental mortality attributable to $PM_{2.5}$ ranged from 6 to 15% relative to the current set of standards. Under the 12/25 set of standards, risk reductions ranged from 7 to 29%. Other short-term exposure mortality categories, as well as short-term exposure morbidity categories (HAs), display a similar distribution of risk reduction across the urban study areas.

4.5.2 Use of the reasonable set of alternative risk estimates generated through the sensitivity analysis

As discussed in the introduction to this chapter, the use of alternative inputs to the risk assessment model that have some degree of support in the literature (for the single and multi-element sensitivity analyses) results in a set of reasonable risk estimates that supplement the core risk estimates (the full set of sensitivity analysis-related risk estimates are presented in the detailed tables presented in Appendix F and summarized in section 4.3). Specifically, these additional risk estimates represent a set of alternative realizations around the core set of risk results and while these results collectively do not represent a formal uncertainty distribution, they can be used to gain some perspective regarding the range of uncertainty around the core risk results.

After careful consideration of the results of the sensitivity analysis completed for the three categories of health endpoints included in the risk assessment (long-term exposure mortality, short-term exposure mortality, and short-term exposure morbidity), we have concluded that only the sensitivity analysis results generated for long-term exposure mortality are robust enough to support using those estimates to inform consideration of uncertainty associated with the core risk estimates.[45] In the case of both

[45] Note, however, that as discussed earlier in section 4.3.1, uncertainty associated with modeling risk down to PRB is such that we have not included these risk estimates as part of the reasonable set of risk estimates and therefore they are not discussed here. However, the PRB-based risk estimates can be used generally, to

short-term exposure mortality and morbidity, the sensitivity analyses were not as comprehensive (the number of modeling elements considered was smaller), reflecting information readily available in the underlying epidemiological studies. As noted above (sections 4.3.1 and 4.3.2), the results of the sensitivity analysis conducted for these two short-term health impact categories, resulted in a combination of inconclusive results (in the case of seasonally-differentiated effects estimates) and fairly small impacts on risk (for the application of the hybrid rollback approach for simulating just meeting alternative suites of standards). Therefore, there would be little utility in using these sensitivity analysis results to generate an additional set of risk estimates to inform consideration of uncertainty associated with the core risk results.[46]

We also considered the use of the Moolgavakar-based sensitivity analysis results, reflecting the range of risk across alternative model choices based on this single study. However, use of this study to generate alternative sets of risk estimates to supplement the core estimates is problematic given the questionable relevance of the Moolgavkar-based sensitivity analysis findings to the core risk results (i.e., core risk estimates are based on large multi-location studies with different design elements relative to the Moolgavkar et al., 2003 study conducted only for Los Angeles). Therefore, we concluded that the Moolgavkar-based results should not be used to generate an additional set of risk estimates to supplement the core estimates in considering uncertainty. This means that only the long-term mortality endpoints have been included in this effort to use the results of the sensitivity analysis to inform consideration of uncertainty related to the core risk estimates.

For purposes of illustrating how the results of the sensitivity analysis (specifically the multi-factor analysis) can be used to inform consideration of the range of uncertainty associated with the core risk estimates involving long-term mortality, we have provided one example below, focusing on Los Angeles for long-term (all cause) mortality. We

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gain perspective for the overall magnitude of uncertainty that modeling risk down to PRB (rather than LML) might produce and for that reason they are discussed in the context of identifying key sources of uncertainty impacting the core risk estimates.

[46] As part of ongoing refinements to the risk assessment, we may consider additional sensitivity analyses focused on short-term exposure mortality and morbidity endpoints. One potential area of exploration is the C-R functions used, although in the case of short-term exposure mortality, it may not be possible to gain further insights into alternate model specifications (from a quantitative standpoint) since we obtained a set of location-specific effects estimates from the authors and various model designs provided in the original study would have little applicability to assessing sensitivity of the location-specific effect estimates.

note that the approach illustrated here for this urban study area location/health endpoint combination can be readily repeated for other combinations (based on application of data in Appendices E and F). We also note that the sensitivity analyses were conducted based exclusively for the scenario where the current set of standards is just met, so our observations here are limited to that scenario. However, we believe that observations made based on these results can be extrapolated with care to other air quality scenarios, for the same health endpoint/urban study area location.

The process of generating the additional set of reasonable risk estimates based on the sensitivity analysis results involves using the results of the sensitivity analysis (which are in the form of percent difference compared to the core estimates) to adjust the core risk estimates. This procedure results in the additional set of reasonable risk estimates which can be used to inform consideration of uncertainty in the underlying core results. Table 4-5 provides the underlying core risk estimates, the percent difference results (from the sensitivity analysis) and the resulting adjusted risk estimates that represent the additional set of reasonable risk results (for Los Angeles/all-cause mortality combination for simulation year 2007).

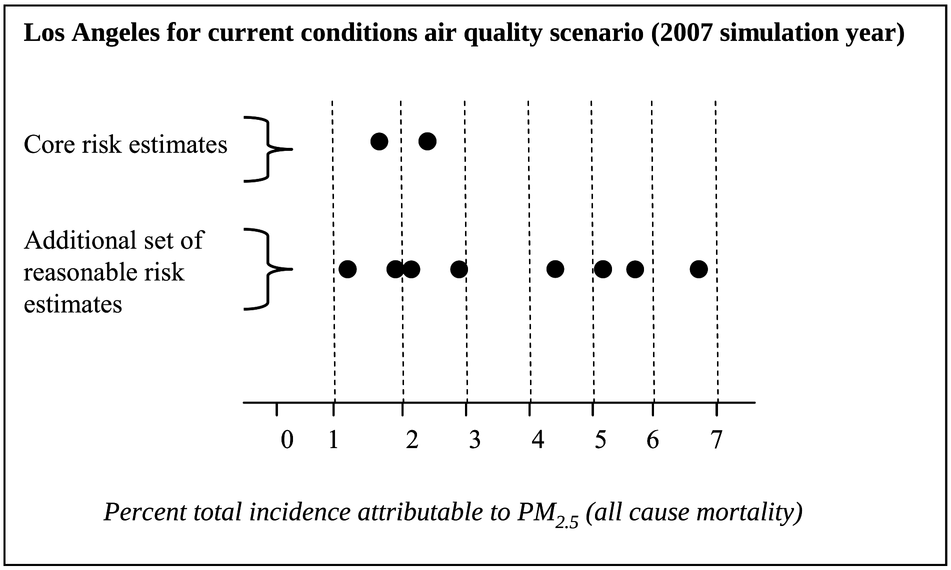
Table 4-5 Derivation of a set of reasonable alternative risk estimates to supplement the core risk estimates (Los Angeles, current standards, for long-term all cause mortality).

	Sensitivity analysis		
Core risk estimate	**Description simulation**	**Results (percent difference: sensitivity analysis versus core estimate)**	**Adjusted set of risk estimate to supplement core risk estimates[1]**
Percent of total incidence for all cause mortality (current suite of standards): **1.7 to 2.2%** (range reflects two C-R functions based on different periods of ambient data - see Appendix F, Tables F-6 and F-15)	*Single-element sensitivity analysis results*		
	Impact of using different model choices: random effects log-linear model	+23%	2.1 to 2.7%
	Impact of using different model choices: random effects log-log model	+155%	4.3 to 5.6%
	Impact of C-R function from alternative long-term exposure study (Krewski et al., 2000)	-25%	1.3 to 1.7%
	Impact of using alternative hybrid roll-back approach to simulate just meeting alternative standards	+24%	2.1 to 2.7%
	Multi-element sensitivity analysis results		
	Random effects log-log & hybrid non-proportional rollback	+203%	5.2 to 6.7%

[1] Percent of total incidence that is $PM_{2.5}$- related.

The reasonable set of alternative risk estimates is presented along with the core set of risk estimates for the example scenario in Figure 4-22. As noted earlier in discussing the results of the single-factor sensitivity analysis (and in Table 4-5), we consider estimates based on modeling risk down to PRB to be less reasonable than the other scenarios included in the sensitivity analysis, since there is substantial uncertainty associated with the C-R function shape below the LML (i.e., for long-term ambient $PM_{2.5}$ levels below the levels for any of the urban areas included in the underlying epidemiological studies). Therefore, results of modeling risk down to PRB are not included in Figure 4-22.

Figure 4-22. Comparison of core risk estimates with reasonable alternative set of risk estimates generated as part of sensitivity analyses.



The additional sets of risk estimates presented in Table 4-5 (and illustrated in Figure 4-22) can be used to inform consideration for the range of uncertainty associated with the core risk estimates. Given consideration for alternative model specifications that have some degree of support in the literature, the range of risk estimates around the core estimates of 1.7 to 2.2% extends from 1.3 to 6.7% for total all cause mortality attributable to $PM_{2.5}$. It is important to reiterate that this set of alternative realizations presented in Table 4-5 and depicted in Figure 4-22, does not represent an uncertainty distribution. Therefore, we can not assign percentiles to the individual data points presented and (importantly), we do not draw any conclusions based on any clustering of the alternative risk estimates see in Figure 4-22. Furthermore, we do not know whether any of the higher-end estimates generated actually represent true bounding risk estimates given overall uncertainty associated with the core risk estimates. Despite these key caveats, having a range of risk estimates reflecting the impact of modeling element uncertainties does provide information that helps to inform our characterization of uncertainty related to the core risk estimates.

4.5.3 Representativeness of the urban study areas in the national context based on consideration for coverage of $PM_{2.5}$ risk-related parameters

The representativeness analysis (discussed in detail in section 4.4) considered how well the 15 urban study areas represent the overall U.S. for a set of spatially-distributed $PM_{2.5}$ risk related variables (e.g., $PM_{2.5}$ composition, weather, demographics including SES, baseline health incidence rates). In doing so, this analysis helps inform how well the urban study areas reflect national-level variability in these key PM risk-related variables.

The results of the representativeness analysis suggest that, in relation to three of the factors considered (coverage for: more heavily populated urban areas, urban areas with higher ambient $PM_{2.5}$ levels, and the range of effects estimates for short-term mortality from Zannobetti and Schwartz., 2009), the 15 urban study areas would appear to capture well the overall risk for the nation, with a potential for better characterization of the higher end of the national risk distribution. However, consideration for other factors (coverage for areas with higher baseline mortality rates and with the oldest populations) suggests that the 15 urban study areas may not capture areas having the highest risk per microgram of $PM_{2.5}$ (i.e., they may not be capturing the high-end of the national risk distribution). The limitations in coverage for high baseline mortality rates and older populations, are tempered by the fact that many locations with these types of "at risk" populations do not have elevated $PM_{2.5}$ levels (e.g., urban locations in Florida).

4.5.4 Use of the results of the national-scale long-term mortality analysis to evaluate degree of coverage of the 15 urban study areas for national-distribution of risk

As part of the national-scale long-term mortality analysis related to $PM_{2.5}$ exposure, which is discussed in detail in chapter 5, we developed a cumulative distribution of county-level long-term exposure mortality risk for the U.S. (see Figure 5-4). This then allowed us to determine where along this cumulative distribution the 31 counties associated with the 15 urban study areas modeled in the risk assessment fell (note, the location of the 31 counties along the cumulative distribution is also shown in 5-4).

Comparison of the 31 counties (from the 15 urban study areas) against the national county-level distribution of long-term exposure mortality risk results in the observation that most of the 31 counties fall towards the upper end of the national distribution with 23 of the 31 counties falling within the upper 5th percentile of the distribution. These observations suggest that the 15 urban study areas included in the PM NAAQS risk assessment capture well the upper-end of the national distribution of long-term $PM_{2.5}$ exposure-related risk.

5 NATIONAL-SCALE ASSESSMENT OF LONG-TERM MORTALITY RELATED TO $PM_{2.5}$ EXPOSURE

5.1 OVERVIEW

In this section we present the estimated nationwide premature mortality resulting from recent exposures to ambient $PM_{2.5}$. The goal of this assessment is twofold: (1) estimate the incidence of premature mortality within the U.S. related to long-term $PM_{2.5}$ exposure; and (2) identify where the subset of counties assessed in the urban case study areas analysis fall along the distribution of national county-level risk.[47] To perform this assessment we use 2005 $PM_{2.5}$ fused air quality estimates from the Community Model for Air Quality (CMAQ) (Byun and Schere, 2006) in conjunction with the environmental Benefits Mapping and Analysis Program (BenMAP) to estimate long-term $PM_{2.5}$-related premature mortality nationwide.

To address the first goal of the assessment, we estimate excess $PM_{2.5}$-related long-term mortality by applying two estimates of all-cause mortality risk found in the Krewski et al. (2009) $PM_{2.5}$ mortality extended analysis of the American Cancer Society (ACS) cohort, and an estimate of all-cause mortality risk found in the Laden et al. (2006) $PM_{2.5}$ mortality extended analysis of the Six-Cities cohort. We estimate that total $PM_{2.5}$-related premature mortality ranges from 63,000 (39,000—87,000) (95^{th} percentile confidence interval) and 88,000 (49,000—130,000), respectively; in each case we estimated deaths per year down to the lowest measured levels (LMLs) in each epidemiological study.

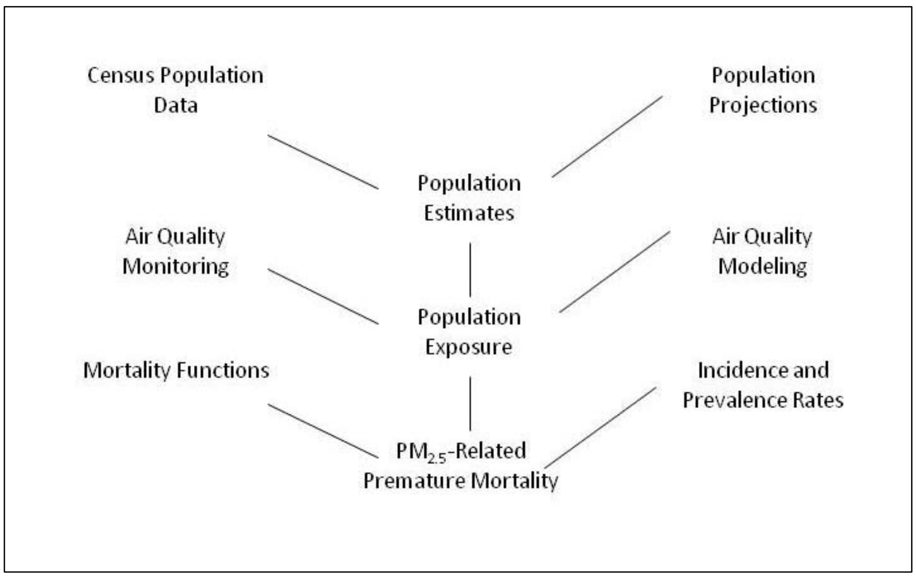
In addressing the second goal of this assessment, we observe that the subset of 31 counties for the 15 urban study areas considered in the urban case study fall toward the upper end of the national distribution. Specifically, all of the 31 counties were above the median of the national risk distribution and 23 of the 31 fell within the upper 5^{th} percentile of the national distribution. Therefore, according to this analysis, we appear to be capturing high-end percentiles of the national risk distribution with the set of urban case study areas we are evaluating in the $PM_{2.5}$ NAAQS risk assessment.

[47] We do not directly compare the estimated county-level risks generated in the urban case study assessment and the county-level risks generated in the national-scale analysis. Rather, we identify where the 31 counties modeled for urban case study fell along the national risk distribution. This assessment revealed whether the baseline $PM_{2.5}$ mortality risks in the 31counties modeled in the urban case study areas represented more typical or higher-end risk relative to the national risk distribution.

5.2 METHODS

This assessment combines information regarding estimated $PM_{2.5}$ air quality levels, population projections, baseline mortality rates, and mortality risk coefficients to estimate $PM_{2.5}$-related premature mortality. Figure 5-1 below provides a conceptual diagram, detailing each of the key steps involved in performing this BenMAP-based health impact assessment. Appendix G contains additional information regarding the data inputs to this analysis.

Figure 5-1 Conceptual diagram of data inputs and outputs for national long-term mortality risk assessment



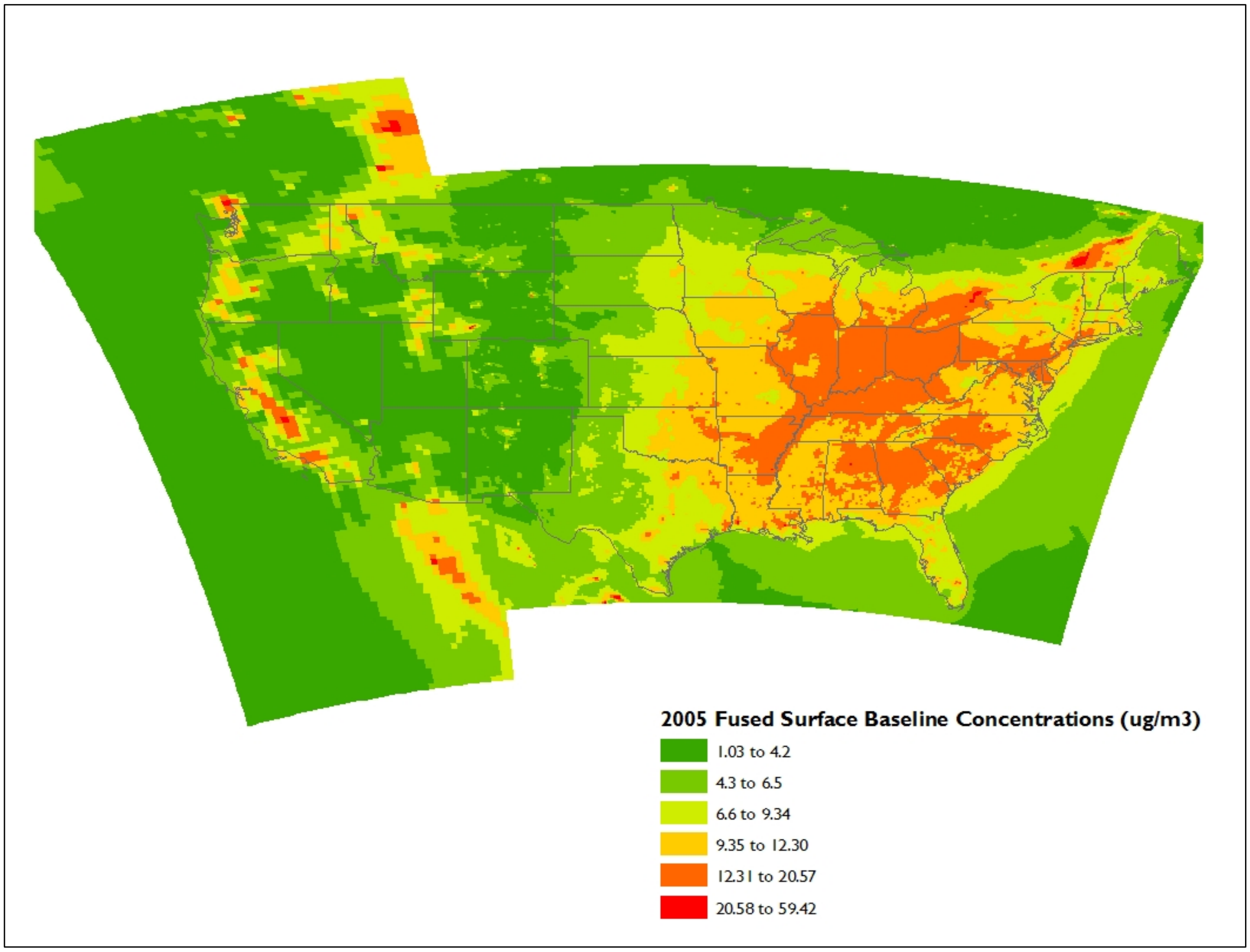
5.2.1 Population Estimates

The starting point for estimating the size and demographics of the potentially exposed population is the 2000 census-block level population, which BenMAP aggregates up to the same grid resolution as the air quality model. Using county-level growth factors based on economic projections (Woods and Poole Inc., 2001), BenMAP projects this 2000 population to the analysis year of 2005; we selected this population year because it matches both the year in which the emissions inventory was developed for the air quality modeling and the year to which the baseline mortality rates were projected (see below).

5.2.2 Population Exposure

Having first estimated the size and geographic distribution of the potentially exposed population, BenMAP then matches these population projections with estimates of the ambient levels of $PM_{2.5}$. In contrast to the urban study areas analysis, the national-scale analysis employed a data fusion approach, which joined 2005 monitored $PM_{2.5}$ concentrations with 2005 CMAQ-modeled air quality levels using the Voronoi Neighbor Averaging (VNA) technique (Abt, 2003). CMAQ was run at a horizontal grid resolution of 12km for the east and 36km in the west using 2005 estimated emission levels and meteorology. More information on this model run can be found in Appendix G of this document. Figure 5-2 shows the geographic distribution of baseline annual mean $PM_{2.5}$ concentrations across the continental U.S. The maximum predicted value within the U.S. is 31 $\mu g/m^3$, the mean $PM_{2.5}$ value is 8.7 $\mu g/m^3$, median is 8.8 $\mu g/m^3$ and the 95th percentile value is about 14 $\mu g/m^3$.

Figure 5-2 2005 fused surface baseline $PM_{2.5}$ concentrations



This assessment applies $PM_{2.5}$ mortality risk coefficients drawn from long-term cohort studies which estimate changes in risk based on annual mean changes in $PM_{2.5}$ concentration. For this reason, EPA used the CMAQ model to estimate annual mean concentrations at each grid cell. These grid-level annual average concentrations were then input to BenMAP.

5.2.3 Premature Mortality Estimates

In this assessment of $PM_{2.5}$-related premature mortality we considered risk estimates drawn from studies based on two prospective cohorts. The first study is the recently published Krewski et al. (2009) extended reanalysis of the ACS cohort. To remain consistent with the urban study areas analysis, we applied the two log-linear all-cause mortality risk coefficients based on the 1979-1983 and the 1999-2000 time periods that control for 44 individual and 7 ecologic covariates. We also applied a log-linear all-cause mortality risk coefficient drawn from the extended analysis of the Six Cities cohort as reported by Laden et al. (2006). When estimating premature mortality using these functions we considered air quality levels down to the lowest measured levels (LML) in each study; for the Krewski et al. (2009) study this is 5.8 $\mu g/m^3$ and for the Laden et al. (2006) study this is 10 $\mu g/m^3$. In general, we place a higher degree of confidence in health impacts estimated at air quality levels at or above the LML because the portion of the concentration-response curve below this point is extrapolated beyond the observed data. We also estimated health impacts down to Policy Relevant Background (PRB) levels (EPA, 2008). The second draft ISA presents estimates of annual mean PRB for each of 7 Health Effects Institute PM regions; this value ranges from 0.62 $\mu g/m^3$ in the southwest to 1.72 $\mu g/m^3$ in the southeast.

BenMAP contains baseline age-, cause- and county-specific mortality rates drawn from the CDC-WONDER. Current baseline mortality estimates are an average of a three year period from 1996-1998. EPA is in the process of updating these rates with 2006-2008 data; a sensitivity analysis suggests that the results reported here are largely insensitive to the use of more current mortality rates.

5.3 RESULTS

Table 5-1 and figures 5-3 through 5-4 below summarize the results of the national-scale analysis. Table 5-1 summarizes the total $PM_{2.5}$-related premature mortality associated with modeled 2005 $PM_{2.5}$ levels.

Estimated PM2.5-Related Premature Mortality Associated with Incremental Air Quality Differences Between 2005 Ambient Mean PM2.5 Levels and LML from the Epidemiology Studies or PRB (90th percentile confidence interval)

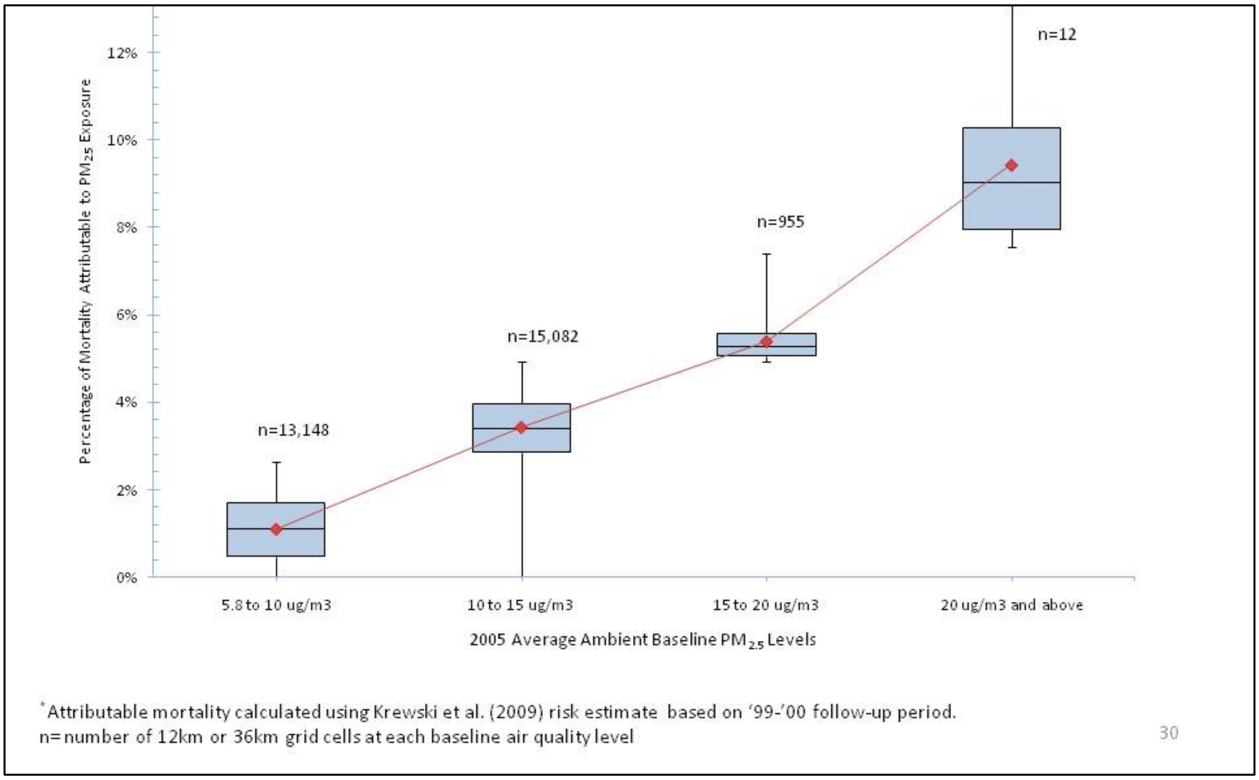
Table 5-1 Estimated $PM_{2.5}$-related premature mortality associated with incremental air quality differences between 2005 ambient mean pm2.5 levels and lowest measured level from the epidemiology studies or policy relevant background (90th percentile confidence interval)

Air Quality Level	Estimates Based on Krewski et al. (2009)		Estimates Based on Laden et al. (2006) *(90th percentile confidence interval)*
	'79-'83 estimate (90th percentile confidence interval)	***'99-'00 estimate (90th percentile confidence interval)***	
10 µg/m^3 (LML for Laden et al., 2006)	26,000 (16,000—36,000)	33,000 (22,000—44,000)	**88,000 (49,000—130,000)**
5.8 µg/m^3 (LML for Krewski et al., 2009)	**63,000 (39,000—87,000)**	**80,000 (54,000—110,000)**	210,000 (120,000—300,000)
Policy-Relevant Background	110,000 (68,000—150,000)	140,000 (94,000—180,000)	360,000 (200,000—500,000)
Bold indicates that the minimum air quality level used to calculate this estimate corresponds to the lowest measured level identified in the epidemiological study			

In this table, the bold figures indicate the estimate that corresponds with the LML identified in the epidemiological study. The bold estimates in the column Krewski et al. (2009) were calculated using the same risk coefficients as the urban case study analysis. We place a greater emphasis on those results calculated using the LML reported in the epidemiological studies.[48] Figure 3 illustrates the percentage of baseline mortality attributable to $PM_{2.5}$ exposure in each of the grid cells according to the 2005 $PM_{2.5}$ air quality levels, using the Krewski et al. (2009) estimate based on 1999-2000 air quality levels.

[48] Note, that as stated in Section 4.3.2, modeling of risk down to PRB is subject to considerable uncertainty. While there is no evidence for a threshold (which conceptually supports estimation of risk below LML), we do not have information characterizing the nature of the C-R function for long-term mortality below the LML and consequently estimates of mortality based on incremental exposure below LML (and down to PRB) is subject to greater uncertainty.

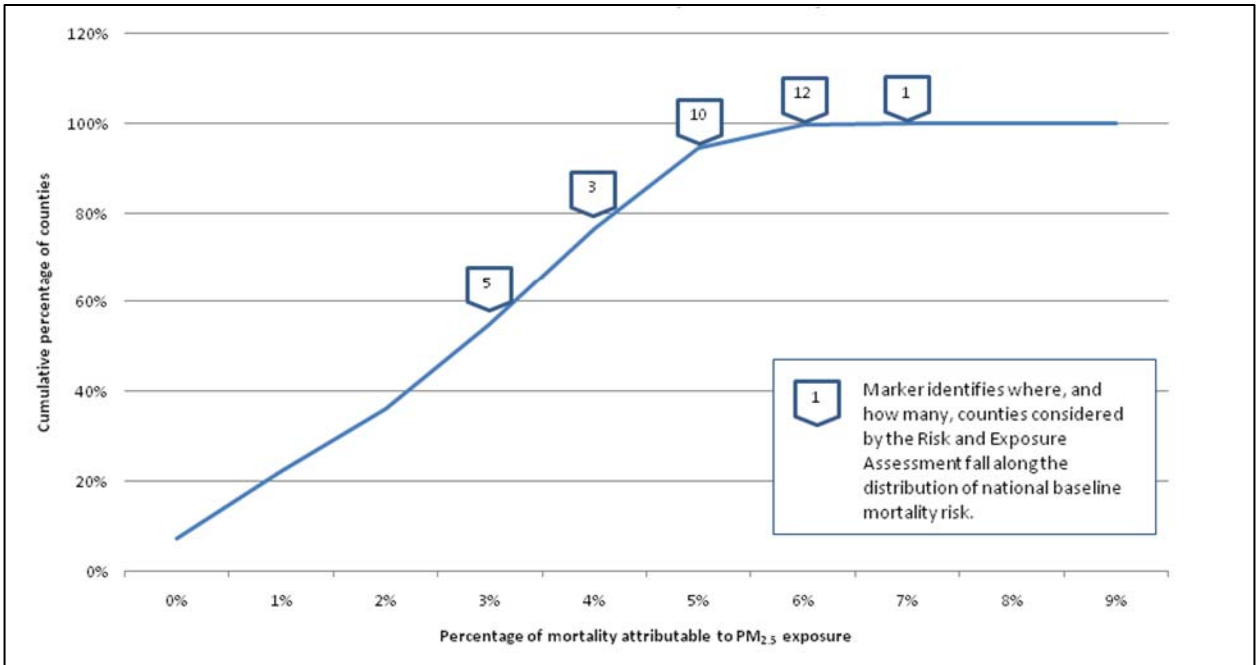
Figure 5-3 Percentage of premature mortality attributable to $PM_{2.5}$ exposure at various 2005 annual average $PM_{2.5}$ levels*



This figure illustrates the number of deaths attributable to $PM_{2.5}$ according to the baseline level of ambient average $PM_{2.5}$ levels down to 5.8 µg/m^3 (the LML for the Krewski et al. (2009) analysis). Each of four box plots characterizes the range of premature mortality attributable to $PM_{2.5}$ according to the baseline level of annual mean $PM_{2.5}$ levels in that model grid cell. Note that while the lower whisker of the box plots for the baseline air quality values of 5.8 µg/m^3 to 10 µg/m^3 appear to extend to zero, the minimum value is greater than zero. The number above each box plot indicates the number of grid cells summarized by that plot.

Figure 5-4 displays the cumulative distribution of total mortality attributable to $PM_{2.5}$ exposure at the county level developed as part of the national-scale analysis. The location of the 31 counties included in the urban case study analysis is then superimposed on top of the cumulative distribution.

Figure 5-4 Cumulative distribution of county-level percentage of total mortality attributable to $PM_{2.5}$ for the U.S. with markers identifying where along that distribution the urban case study area analysis fall*



*Attributable mortality calculated using Krewski et al. (2009) risk estimate based on 99-'00 follow-up period.

Counties considered in the urban scale analysis that are located toward the lower end of the distribution of all counties nationwide include Maricopa County, Arizona and Salt Lake City, Utah. Counties assessed in the urban scale analysis that are located toward the upper end of the distribution of all counties include Jefferson County, Alabama and Los Angeles County, California. The results of this analysis indicate that most of the 31 counties included in the urban case study counties fall toward the upper end of the national risk distribution and that 23 of these counties fall within the upper 5th percentile of the risk distribution—suggesting that the $PM_{2.5}$ mortality risk estimates included in the urban case study analysis generally represent the upper end of urban area mortality risks within the nation.

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APPENDIX A: AIR QUALITY ASSESSMENT

Appendix A. Air Quality Assessment

This Appendix describes the PM data for the 15 urban study areas evaluated in the risk assessment, including summaries of $PM_{2.5}$ monitoring data associated with each study area as well as the composite monitor estimates generated for each study area based on that monitoring data (see section 3.2 for additional detail regarding selection of monitors and derivation of composite monitor values).

Table A-1. Air Quality Data for Atlanta

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
130630091 [3]	27	30	25	30	112	12.63	16.83	21.22	15.92	16.65	36.09
130670003 [1,2,3]	27	30	29	29	115	13.75	17.39	18.57	15.62	16.33	34.94
130670004 [1,2,3]	30	28	26	27	111	12.98	17.17	18.03	13.98	15.54	30.28
130890002 [1,2,3]	82	84	81	88	335	12.72	15.72	18.81	14.56	15.45	32.82
130892001 [1,2,3]	80	75	67	85	307	12.84	15.10	20.44	14.83	15.80	36.72
131210032 [1,2,3]	84	89	76	80	329	13.64	16.00	19.43	14.38	15.86	33.40
131210039 [1,2,3]	27	30	23	29	109	15.03	18.35	17.97	16.56	16.98	30.29
131210048 [1,2,3]	0	0	0	0	0	---	---	---	---	---	---
131350002 [1,3]	13	14	12	14	53	14.35	14.62	20.39	15.16	16.13	31.66
132230003 [3]	28	29	26	26	109	11.41	15.52	18.62	12.99	14.63	34.52
Composite monitor for Atlanta - 1	90	91	92	92	365	13.30	16.01	19.86	14.62	15.95	35.80
Composite monitor for Atlanta - 2	90	91	92	92	365	13.28	16.05	19.85	14.60	15.95	35.80
Composite monitor for Atlanta - 3	90	91	92	92	365	13.15	15.93	19.95	14.57	15.90	35.80
2006											
130630091 [3]	29	29	31	30	119	12.94	17.91	21.32	14.49	16.67	30.84
130670003 [1,2,3]	28	29	31	30	118	12.22	17.88	21.52	14.20	16.46	32.66
130670004 [1,2,3]	28	29	27	28	112	12.09	17.75	21.04	12.39	15.82	33.34
130890002 [1,2,3]	85	86	81	81	333	12.25	16.09	19.86	13.43	15.41	31.65
130892001 [1,2,3]	86	84	77	81	328	11.94	15.75	18.31	12.18	14.54	28.89
131210032 [1,2,3]	88	86	84	90	348	12.46	15.99	19.28	13.74	15.37	31.44
131210039 [1,2,3]	29	28	26	0	83	15.12	19.15	20.88	---	---	---
131210048 [1,2,3]	0	0	2	30	32	---	---	15.25	15.00	---	---
131350002 [1,3]	12	14	13	15	54	15.21	18.98	20.31	12.93	16.86	30.64
132230003 [3]	29	27	31	29	116	10.91	15.20	18.90	10.77	13.95	32.28
Composite monitor for Atlanta - 1	90	91	92	92	365	12.30	16.33	19.29	13.26	15.30	30.62
Composite monitor for Atlanta - 2	90	91	92	92	365	12.30	16.33	19.27	13.27	15.29	30.62
Composite monitor for Atlanta - 3	90	91	92	92	365	12.19	16.28	19.38	13.17	15.26	30.74

Table A-1 cont'd. Air Quality Data for Atlanta

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2007											
130630091 (3)	29	30	30	29	118	13.87	16.51	18.83	13.02	15.56	36.04
130670003 (1,2,3)	29	30	29	29	117	13.49	17.03	19.49	13.41	15.85	35.51
130670004 (1,2,3)	26	27	30	30	113	12.50	17.47	18.77	11.39	15.03	33.54
130890002 (1,2,3)	85	83	90	85	343	12.78	15.54	19.38	12.15	14.96	34.22
130892001 (1,2,3)	69	79	76	75	299	12.48	17.11	20.04	12.38	15.50	37.42
131210032 (1,2,3)	87	88	91	85	351	12.99	17.95	19.64	13.08	15.91	35.10
131210039 (1,2,3)	0	0	0	0	0	---	---	---	---	---	---
131210048 (1,2,3)	28	28	31	28	115	13.45	18.97	18.24	12.83	15.87	37.52
131350002 (1,3)	27	27	29	29	112	13.05	14.03	17.97	11.68	14.18	30.19
132230003 (3)	29	30	29	30	118	12.21	17.12	18.95	10.64	14.73	33.82
Composite monitor for Atlanta - 1	90	91	92	92	365	12.60	17.23	19.32	12.38	15.38	35.07
Composite monitor for Atlanta - 2	90	91	92	92	365	12.58	17.34	19.40	12.44	15.44	35.04
Composite monitor for Atlanta - 3	90	91	92	92	365	12.60	17.22	19.29	12.32	15.36	35.07

Note 1: Different definitions of Atlanta include different monitors. The number(s) shown in the parenthesis next to the monitor indicates the location(s) in which it is included. For example, monitor 130630091 is used in Atlanta - 3 only while 130670003 is used for all definitions of Atlanta.

Note 2: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-2. Air Quality Data for Baltimore

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
240051007	30	28	27	27	112	14.78	11.86	20.66	12.34	14.91	33.76
240053001	75	80	85	92	332	16.09	12.60	18.27	13.44	15.10	35.77
245100006	28	31	27	28	114	15.76	12.47	20.18	11.67	15.02	33.17
245100007	27	27	30	30	114	16.09	12.50	20.05	13.00	15.41	35.27
245100008	24	30	30	29	113	18.85	14.16	20.99	14.80	17.20	39.16
245100035	79	75	78	70	302	17.58	13.59	20.24	14.12	16.38	37.49
245100040	79	81	90	76	326	18.47	14.68	19.40	13.42	16.49	39.45
245100049	26	30	25	27	108	17.72	13.19	20.62	12.77	16.07	36.43
Composite Monitor for Baltimore	90	91	92	92	365	16.76	13.58	19.19	13.41	15.74	35.38
2006											
240051007	29	29	28	30	116	12.03	11.37	15.73	11.09	12.55	32.06
240053001	90	85	90	92	357	12.81	11.79	18.51	13.90	14.25	34.25
245100006	27	30	27	30	114	13.20	11.62	16.24	11.61	13.17	32.67
245100007	30	29	29	31	119	12.64	11.59	15.19	12.03	12.86	32.27
245100008	30	28	31	30	119	14.80	13.34	16.88	12.97	14.50	35.21
245100035	74	90	83	82	329	13.31	12.57	19.27	14.14	14.82	36.74
245100040	85	86	87	86	344	13.83	12.58	18.64	14.73	14.94	35.93
245100049	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Baltimore	90	91	92	92	365	13.14	12.28	18.41	13.74	14.39	34.89
2007											
240051007	29	29	31	30	119	12.09	13.54	15.53	12.04	13.30	31.46
240053001	74	87	83	89	333	12.53	12.95	16.93	13.70	14.03	34.01
245100006	30	29	31	27	117	12.10	12.83	16.28	11.16	13.09	31.55
245100007	29	30	30	28	117	12.07	13.20	15.84	12.44	13.39	33.31
245100008	30	30	31	27	118	13.53	14.68	16.90	14.79	14.97	35.25
245100035	79	85	74	76	314	12.11	14.03	17.23	13.23	14.15	33.77
245100040	82	85	89	76	332	13.42	13.66	16.32	13.35	14.19	34.39
245100049	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Baltimore	90	91	92	92	365	12.33	13.39	16.42	13.28	13.85	33.41

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-3. Air Quality Data for Birmingham

Monitor	Quarterly Counts Q1	Quarterly Counts Q2	Quarterly Counts Q3	Quarterly Counts Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Quarterly Averages (ug/m^3) Q2	Quarterly Averages (ug/m^3) Q3	Quarterly Averages (ug/m^3) Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
10730023*	90	90	89	92	361	14.35	20.49	26.42	17.27	19.63	49.68
10731005*	30	31	29	31	121	11.62	16.70	22.61	14.33	16.32	35.06
10731009*	30	31	29	31	121	9.82	16.12	20.26	11.87	14.52	37.68
10731010*	15	15	15	16	61	11.71	16.91	22.77	15.51	16.73	36.46
10732003*	88	90	91	91	360	14.49	18.48	23.75	15.03	17.94	44.41
10732006*	30	30	30	31	121	11.53	16.46	21.11	13.79	15.72	33.98
10735002*	30	31	30	31	122	10.84	16.33	21.08	12.61	15.21	36.23
10735003*	30	30	30	31	121	10.60	16.42	21.94	12.74	15.43	39.20
11170006	30	31	30	28	119	11.23	15.67	19.60	12.92	14.85	32.86
11270002	27	31	28	30	116	10.37	15.31	18.86	12.17	14.18	33.17
Composite Monitor for Birmingham - 1	90	91	92	92	365	13.25	18.28	23.98	15.50	17.75	45.90
Composite Monitor for Birmingham - 2	90	91	92	92	365	13.34	18.44	24.19	15.56	17.88	45.90
2006											
10730023*	89	91	92	92	364	13.61	20.57	22.35	17.02	18.39	39.55
10731005*	30	30	31	31	122	10.51	18.84	19.59	13.38	15.58	33.14
10731009*	30	29	30	30	119	8.81	17.16	17.78	10.02	13.44	31.69
10731010*	15	15	15	16	61	11.57	18.63	18.71	12.37	15.32	32.28
10732003*	89	90	90	92	361	14.41	20.48	21.62	15.67	18.05	40.18
10732006*	30	30	31	31	122	10.76	18.08	20.02	12.33	15.30	31.69
10735002*	30	30	31	31	122	9.87	17.15	19.61	10.60	14.31	33.16
10735003*	29	30	30	30	119	10.37	17.42	18.84	11.31	14.48	33.22
11170006	30	30	31	31	122	9.95	16.37	18.38	11.65	14.09	29.79
11270002	29	30	30	29	118	9.85	17.49	17.38	11.83	14.14	34.53
Composite Monitor for Birmingham - 1	90	91	92	92	365	13.13	19.64	21.07	15.07	17.23	38.03
Composite Monitor for Birmingham - 2	90	91	92	92	365	13.21	19.75	21.22	15.15	17.33	38.35

Table A-3 cont'd. Air Quality Data for Birmingham

Monitor	Quarterly Counts Q1	Q2	Q3	Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Q2	Q3	Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2007											
10731010*	15	15	15	15	60	14.53	18.69	19.31	13.63	16.54	37.92
10732003*	89	90	89	90	358	15.40	21.38	19.18	12.42	17.10	44.02
10732006*	30	30	31	30	121	12.24	19.29	18.53	10.93	15.25	39.92
10735002*	30	28	31	30	119	12.15	19.16	18.41	10.40	15.03	37.90
10735003*	29	30	31	30	120	11.79	18.99	17.83	10.38	14.75	38.56
11170006	29	30	31	30	120	12.97	18.27	17.52	10.84	14.90	38.52
11270002	28	29	31	29	117	11.97	17.81	17.72	10.95	14.61	34.91
Composite Monitor for Birmingham - 1	90	91	92	92	365	14.47	21.23	19.97	12.40	17.02	44.24
Composite Monitor for Birmingham - 2	90	91	92	92	365	14.52	21.40	20.06	12.45	17.11	44.30

Note 1: The monitors marked with * are used for Birmingham - 2. All monitors shown in this table are used for Birmingham - 1.

Note 2: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-4. Air Quality Data for Dallas

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
481130035	30	31	20	0	81	11.78	15.16	13.90	---	---	---
481130050	15	30	27	31	103	11.95	15.01	15.64	12.47	13.77	28.55
481130057	27	21	22	0	70	12.00	16.07	14.41	---	---	---
481130069	78	88	90	91	347	11.07	13.80	14.03	11.11	12.50	27.44
481130087	27	31	30	30	118	9.87	13.32	13.45	10.18	11.70	24.55
481133004	88	89	61	0	238	10.86	13.58	12.82	---	---	---
Composite Monitor for Dallas	90	91	92	92	365	11.05	13.87	14.07	11.07	12.51	26.25
2006											
481130035	0	0	0	0	0	---	---	---	---	---	---
481130050	28	30	31	31	120	10.99	12.53	12.98	10.68	11.79	22.16
481130057	0	0	0	0	0	---	---	---	---	---	---
481130069	84	90	92	90	356	9.97	12.15	11.73	9.26	10.78	21.99
481130087	30	30	30	28	118	9.22	11.66	10.89	8.45	10.05	19.55
481133004	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Dallas	90	91	92	92	365	10.05	12.19	11.77	9.27	10.82	21.97
2007											
481130035	0	0	0	0	0	---	---	---	---	---	---
481130050	29	28	30	0	87	11.54	11.76	15.42	---	---	---
481130057	0	0	0	0	0	---	---	---	---	---	---
481130069	88	91	91	79	349	10.13	10.91	13.78	10.14	11.24	23.24
481130087	28	21	29	30	108	9.96	11.16	12.70	9.30	10.78	20.03
481133004	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Dallas	90	91	92	92	365	10.43	11.04	13.91	9.66	11.26	23.82

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-5. Air Quality Data for Detroit

Monitor	Quarterly Counts Q1	Quarterly Counts Q2	Quarterly Counts Q3	Quarterly Counts Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Quarterly Averages (ug/m^3) Q2	Quarterly Averages (ug/m^3) Q3	Quarterly Averages (ug/m^3) Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
261630001	88	87	89	86	350	18.45	13.87	17.15	14.38	15.96	42.31
261630015	27	27	30	30	114	20.20	14.73	18.73	15.18	17.21	48.27
261630016	87	79	84	88	338	18.92	14.78	16.62	13.70	16.01	47.80
261630019	28	31	29	29	117	19.82	14.48	17.43	14.20	16.48	51.37
261630025	26	28	30	30	114	17.86	11.74	17.45	12.68	14.94	39.50
261630033	28	31	28	28	115	21.50	16.57	18.22	17.90	18.55	48.69
261630036	29	28	29	27	113	16.96	14.92	18.58	15.19	16.41	46.22
261630038	28	25	22	0	75	16.98	14.60	17.66	---	---	---
261630039	0	0	7	28	35	---	---	18.20	14.25	---	---
Composite Monitor for Detroit	90	91	92	92	365	18.25	13.86	16.58	13.87	15.64	43.36
2006											
261630001	82	85	88	90	345	13.66	11.89	13.68	13.65	13.22	32.82
261630015	29	26	28	31	114	16.98	12.26	14.93	14.56	14.68	35.89
261630016	79	14	13	17	123	13.04	11.58	12.58	14.97	13.04	35.49
261630019	30	15	14	16	75	15.20	10.39	11.78	13.46	12.71	35.67
261630025	27	14	15	17	73	13.49	11.23	10.01	12.70	11.86	30.00
261630033	28	29	27	31	115	18.79	12.85	15.56	17.30	16.13	42.43
261630036	29	26	29	29	113	15.10	10.95	13.69	11.94	12.92	32.91
261630038	0	29	27	28	84	---	11.10	14.34	11.98	---	---
261630039	29	30	31	30	120	14.78	11.71	14.20	11.84	13.13	32.32
Composite Monitor for Detroit	90	91	92	92	365	13.61	11.85	13.69	13.67	13.20	32.74
2007											
261630001	86	89	87	92	354	12.92	10.28	14.00	14.08	12.82	31.19
261630015	28	30	27	29	114	15.15	13.06	15.12	14.82	14.54	32.73
261630016	26	26	30	29	111	13.98	12.12	14.74	14.61	13.86	33.72
261630019	30	28	31	27	116	13.20	11.16	14.36	13.31	13.01	31.09
261630025	26	30	31	27	114	12.23	10.59	13.76	14.42	12.75	32.49
261630033	29	29	29	27	114	18.84	15.20	16.02	17.49	16.89	36.60
261630036	29	28	30	29	116	13.75	11.96	14.60	13.47	13.45	28.48
261630038	27	27	28	30	112	13.63	12.85	15.35	14.23	14.01	33.38
261630039	29	30	30	28	117	13.83	12.98	14.65	13.86	13.83	33.97
Composite Monitor for Detroit	90	91	92	92	365	13.00	10.28	13.78	14.00	12.76	31.04

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-6. Air Quality Data for Fresno

Monitor	Quarterly Counts Q1	Q2	Q3	Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Q2	Q3	Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
60190008	85	78	89	91	343	19.53	7.19	11.42	28.65	16.70	67.64
60195001	30	15	15	22	82	17.11	7.55	10.78	29.95	16.35	64.56
60195025	30	15	13	31	89	20.24	8.29	11.24	27.92	16.92	71.90
Composite Monitor for Fresno	90	91	92	92	365	18.97	7.24	11.34	28.07	16.41	65.72
2006											
60190008	89	87	87	85	348	21.82	9.10	12.39	23.85	16.79	50.06
60195001	30	15	14	29	88	18.38	9.47	12.99	24.96	16.45	53.69
60195025	30	15	12	31	88	20.13	9.81	13.66	26.87	17.62	57.60
Composite Monitor for Fresno	90	91	92	92	365	21.04	9.27	12.49	24.95	16.94	49.72
2007											
60190008	87	90	88	91	356	27.61	8.32	10.70	28.71	18.84	66.95
60195001	29	13	14	27	83	23.70	7.16	9.91	24.91	16.42	61.01
60195025	29	14	15	30	88	24.91	8.73	9.65	24.10	16.85	57.53
Composite Monitor for Fresno	90	91	92	92	365	26.39	8.37	10.41	27.80	18.24	66.00

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-7. Air Quality Data for Houston

Monitor	Quarterly Counts Q1	Q2	Q3	Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Q2	Q3	Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
482010024	26	31	22	15	94	11.77	14.39	17.17	11.83	13.79	26.00
482010026	23	31	20	0	74	10.47	13.10	14.47	---	---	---
482010055	25	28	19	0	72	9.12	12.31	12.97	---	---	---
482010058	20	28	23	26	97	11.95	12.99	14.40	12.19	12.88	24.61
482011034	10	15	10	0	35	11.79	15.36	14.49	---	---	---
482011035	84	68	78	87	317	13.09	16.59	18.41	15.47	15.89	30.10
Composite Monitor for Houston	90	91	92	92	365	12.25	14.97	17.69	14.90	14.95	29.99
2006											
482010024	15	13	13	13	54	10.92	11.66	15.97	12.58	12.78	23.80
482010026	0	0	0	0	0	---	---	---	---	---	---
482010055	0	0	0	0	0	---	---	---	---	---	---
482010058	26	29	29	29	113	9.74	12.34	9.04	9.82	10.24	21.93
482011034	0	0	0	0	0	---	---	---	---	---	---
482011035	85	87	88	88	348	13.98	18.15	17.38	14.48	16.00	32.01
Composite Monitor for Houston	90	91	92	92	365	13.65	17.32	16.15	13.56	15.17	29.12
2007											
482010024	15	14	13	0	42	11.01	12.82	14.64	---	---	---
482010026	0	0	0	0	0	---	---	---	---	---	---
482010055	0	0	0	0	0	---	---	---	---	---	---
482010058	26	30	30	30	116	9.40	10.96	11.84	11.75	10.99	25.48
482011034	0	0	0	0	0	---	---	---	---	---	---
482011035	87	91	91	82	351	14.42	17.02	16.62	14.50	15.64	32.00
Composite Monitor for Houston	90	91	92	92	365	13.59	15.87	15.95	13.79	14.80	28.87

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-8. Air Quality Data for Los Angeles

Monitor	Quarterly Counts Q1	Quarterly Counts Q2	Quarterly Counts Q3	Quarterly Counts Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Quarterly Averages (ug/m^3) Q2	Quarterly Averages (ug/m^3) Q3	Quarterly Averages (ug/m^3) Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
60370002	65	78	87	62	292	11.37	13.97	20.71	21.78	16.96	51.56
60371002	29	25	30	22	106	17.01	13.75	18.55	21.95	17.82	50.47
60371103	90	84	87	89	350	15.26	13.78	19.62	22.48	17.79	52.91
60371201	25	29	28	22	104	12.27	11.97	15.01	16.18	13.86	35.69
60371301	29	26	28	31	114	16.68	13.28	18.15	21.75	17.46	47.18
60371602	29	9	9	29	76	16.90	11.63	17.13	22.31	16.99	52.65
60372005	30	26	26	31	113	12.98	12.95	17.15	17.28	15.09	42.71
60374002	87	82	88	67	324	13.39	11.54	16.21	22.56	15.93	40.11
60374004	90	84	87	83	344	12.64	10.83	15.63	19.59	14.67	37.44
60379033	28	30	27	18	103	8.18	8.27	9.96	9.00	8.85	15.96
Composite Monitor for Los Angeles	90	91	92	92	365	13.24	12.20	17.68	20.44	15.89	43.30
2006											
60370002	66	73	84	55	278	12.62	16.17	16.95	15.87	15.40	36.83
60371002	25	24	30	25	104	15.33	18.34	15.87	16.66	16.55	43.21
60371103	89	82	85	74	330	14.49	14.69	16.34	16.80	15.58	38.55
60371201	20	27	28	17	92	11.19	14.21	12.95	13.00	12.84	30.42
60371301	28	28	27	24	107	17.62	14.76	15.11	19.26	16.69	43.98
60371602	29	28	31	28	116	16.82	13.92	17.19	18.57	16.63	42.34
60372005	29	27	28	29	113	12.85	14.64	13.46	12.51	13.37	31.95
60374002	73	81	73	63	290	15.19	12.27	13.53	15.57	14.14	33.89
60374004	89	86	79	66	320	14.35	11.99	14.21	17.22	14.44	34.17
60379033	15	15	14	14	58	6.13	7.27	8.36	8.00	7.44	12.86
Composite Monitor for Los Angeles	90	91	92	92	365	13.72	13.56	15.52	16.32	14.78	34.90

Table A-8 cont'd. Air Quality Data for Los Angeles

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2007											
60370002	64	77	74	77	292	13.57	17.11	14.68	17.47	15.71	48.71
60371002	23	26	27	22	98	13.64	15.96	15.36	22.47	16.86	45.32
60371103	67	83	90	84	324	16.25	16.05	14.62	20.19	16.78	49.41
60371201	22	26	28	19	95	9.50	13.24	12.55	17.72	13.25	28.90
60371301	25	27	29	25	106	16.98	14.05	13.00	19.99	16.00	45.22
60371602	27	27	21	26	101	16.75	14.01	15.18	20.45	16.60	49.40
60372005	28	23	30	27	108	12.62	15.60	14.02	15.24	14.37	43.62
60374002	76	86	88	82	332	15.45	12.42	11.50	19.04	14.60	39.96
60374004	65	81	90	90	326	13.84	12.26	11.30	17.31	13.68	33.25
60379033	15	15	15	15	60	6.73	7.67	9.00	8.67	8.02	19.28
Composite Monitor for Los Angeles	90	91	92	92	365	14.33	14.37	13.01	17.99	14.93	40.34

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-9. Air Quality Data for New York

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
360050080	28	31	29	27	115	18.59	14.78	18.42	15.68	16.87	37.50
360050083	30	31	30	31	122	13.77	12.21	16.90	12.71	13.90	36.05
360050110	90	91	91	91	363	14.93	12.17	15.38	12.30	13.69	36.58
360470122	28	30	28	27	113	16.04	13.74	17.31	14.13	15.31	35.94
360610056*	30	31	30	31	122	18.44	15.51	19.16	15.17	17.07	39.93
360610062*	27	31	30	31	119	17.14	13.84	18.34	13.54	15.71	38.96
360610079*	30	31	30	31	122	14.60	13.12	17.03	12.56	14.33	36.18
360610128*	25	31	30	31	117	17.74	14.11	18.37	15.21	16.36	37.66
360610134*	0	0	0	0	0	---	---	---	---	---	---
360810124	89	79	62	74	304	13.02	10.44	15.21	10.84	12.38	34.28
360850055	28	25	28	27	108	14.92	12.49	17.81	12.91	14.53	33.37
360850067	24	28	28	30	110	12.60	10.75	16.17	10.41	12.48	33.00
Composite Monitor for New York City - 1	90	91	92	92	365	14.46	11.94	15.44	12.29	13.53	35.73
Composite Monitor for New York City - 2	90	91	92	92	365	16.89	14.02	18.11	14.20	15.80	32.81
2006											
360050080	29	30	27	29	115	16.57	13.17	13.95	11.88	13.89	38.89
360050083	30	30	29	29	118	13.44	11.06	13.34	10.33	12.04	34.80
360050110	86	91	84	86	347	13.10	11.15	14.49	11.40	12.53	36.51
360470122	28	30	29	25	112	15.00	12.49	14.75	9.00	12.81	37.06
360610056*	30	30	27	30	117	16.61	14.03	14.41	12.59	14.41	40.60
360610062*	30	28	28	27	113	14.33	13.00	13.82	9.86	12.75	35.73
360610079*	30	30	31	29	120	14.12	12.08	13.32	10.59	12.53	36.92
360610128*	26	30	29	29	114	15.79	13.07	14.39	12.64	13.97	37.84
360610134*	0	0	0	0	0	---	---	---	---	---	---
360810124	69	86	84	76	315	11.17	10.67	13.68	10.91	11.61	33.10
360850055	25	27	29	29	110	12.27	12.07	14.06	10.56	12.24	35.89
360850067	30	26	31	29	116	10.01	10.49	12.60	8.54	10.41	31.85
Composite Monitor for New York City - 1	90	91	92	92	365	12.67	11.11	14.33	11.45	12.39	35.91
Composite Monitor for New York City - 2	90	91	92	92	365	15.09	13.22	14.00	11.70	13.50	33.78

Table A-9 cont'd. Air Quality Data for New York

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2007											
360050080	30	30	30	29	119	17.45	13.49	16.20	15.43	15.64	36.16
360050083	30	30	30	29	119	14.14	11.72	13.91	12.87	13.16	32.50
360050110	89	84	85	91	349	12.90	11.64	14.22	12.31	12.77	33.92
360470122	29	30	28	30	117	13.67	12.82	15.92	13.00	13.85	33.38
360610056*	30	27	31	30	118	18.43	14.73	15.99	15.29	16.11	36.12
360610062*	27	0	0	0	27	15.84	---	---	---	---	---
360610079*	30	30	31	30	121	14.11	12.48	14.92	12.89	13.60	33.86
360610128*	30	30	29	21	110	19.10	13.83	14.63	14.76	15.58	37.01
360610134*	3	30	31	30	94	8.53	14.12	16.43	14.08	13.29	33.66
360810124	74	86	80	92	332	11.34	10.66	12.30	11.35	11.41	30.81
360850055	30	28	31	30	119	13.04	12.37	14.55	11.91	12.97	31.58
360850067	27	30	26	26	109	10.60	10.49	14.29	10.54	11.48	28.56
Composite Monitor for New York City - 1	90	91	92	92	365	12.70	11.26	13.64	12.22	12.46	33.41
Composite Monitor for New York City - 2	90	91	92	92	365	16.77	13.55	15.67	14.10	15.02	30.59

Note 1: The monitors marked with * are used for New York City - 2. All monitors in the table are used for New York City - 1.
Note 2: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-10. Air Quality Data for Philadelphia

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
421010003	0	0	0	62	62	---	---	---	14.35	---	---
421010004	55	61	78	74	268	13.23	13.06	17.26	13.28	14.21	35.83
421010020	19	0	0	0	19	15.51	---	---	---	---	---
421010024	37	54	67	71	229	12.68	10.76	16.26	12.02	12.93	34.57
421010047	19	28	26	12	85	16.99	12.04	18.91	12.31	15.06	37.70
421010057	0	0	0	0	0	---	---	---	---	---	---
421010136	86	89	29	33	237	13.57	11.40	19.06	12.91	14.23	31.13
Composite Monitor for Philadelphia	90	91	92	92	365	14.09	11.81	16.76	12.33	13.75	33.58
2006											
421010003	85	26	0	0	111	12.21	8.74	---	---	---	---
421010004	81	70	53	84	288	12.74	11.85	17.23	12.41	13.56	38.08
421010020	0	0	0	0	0	---	---	---	---	---	---
421010024	34	70	71	80	255	11.52	10.56	16.17	11.34	12.40	34.60
421010047	40	67	45	47	199	14.44	14.57	18.04	15.04	15.52	35.91
421010057	0	0	0	0	0	---	---	---	---	---	---
421010136	47	50	79	73	249	11.97	12.06	16.29	12.25	13.14	36.36
Composite Monitor for Philadelphia	90	91	92	92	365	12.35	12.32	16.95	12.76	13.59	36.39
2007											
421010003	0	0	0	0	0	---	---	---	---	---	---
421010004	87	71	86	90	334	13.61	13.19	15.15	12.96	13.73	34.61
421010020	0	0	0	0	0	---	---	---	---	---	---
421010024	87	58	86	90	321	12.05	12.76	14.88	11.73	12.85	33.42
421010047	71	59	90	92	312	14.49	13.05	16.33	13.43	14.32	35.07
421010057	0	0	18	90	108	---	---	10.96	13.13	---	---
421010136	75	65	72	82	294	12.60	13.38	14.36	12.99	13.33	31.53
Composite Monitor for Philadelphia	90	91	92	92	365	12.98	12.93	15.32	12.82	13.51	33.43

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-11. Air Quality Data for Phoenix

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
40130019	32	32	30	31	125	11.04	10.78	11.11	18.37	12.83	39.88
40131003	0	22	30	29	81	---	8.77	8.26	9.72	---	---
40134003	29	31	27	31	118	10.94	13.04	10.40	16.98	12.84	34.73
40137020	0	30	29	31	90	---	8.08	7.72	9.46	---	---
40139997	29	31	30	31	121	9.04	8.69	7.58	13.56	9.72	27.48
Composite Monitor for Phoenix	90	91	92	92	365	9.69	10.00	9.03	13.82	10.64	26.03
2006											
40130019	30	30	31	31	122	14.17	13.58	8.07	17.82	13.41	28.51
40131003	26	28	31	31	116	8.87	9.52	8.92	11.33	9.66	20.07
40134003	28	28	31	29	116	13.53	10.34	9.31	17.58	12.69	28.38
40137020	29	30	31	30	120	8.09	7.98	7.14	9.12	8.08	15.35
40139997	29	29	30	30	118	10.74	8.66	7.46	14.04	10.22	24.29
Composite Monitor for Phoenix	90	91	92	92	365	11.38	10.03	8.28	13.92	10.90	21.92
2007											
40130019	32	30	31	30	123	10.26	8.85	8.63	15.42	10.79	26.63
40131003	29	28	30	30	117	7.66	10.45	9.50	11.27	9.72	18.20
40134003	30	29	30	29	118	10.54	11.76	11.32	15.45	12.27	27.33
40137020	30	30	31	20	111	5.85	7.81	7.35	8.21	7.31	13.44
40139997	30	29	32	30	121	8.85	8.12	8.21	12.75	9.48	22.02
Composite Monitor for Phoenix	90	91	92	92	365	8.95	9.30	9.01	13.05	10.08	19.69

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-12. Air Quality Data for Pittsburgh

Monitor	Quarterly Counts Q1	Q2	Q3	Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Q2	Q3	Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
420030008	89	90	92	89	360	13.80	15.29	20.72	13.40	15.80	42.23
420030021	28	27	30	27	112	12.91	14.99	22.00	11.49	15.35	35.01
420030064	88	90	92	86	356	16.28	22.26	25.94	21.10	21.40	69.46
420030067	26	28	29	27	110	12.32	13.95	20.35	10.26	14.22	33.87
420030093	13	11	12	13	49	10.66	13.83	23.66	9.63	14.44	41.68
420030095	14	13	14	15	56	12.79	14.49	21.55	9.83	14.67	36.09
420030116	23	29	28	26	106	13.82	16.42	21.68	12.66	16.15	38.72
420030133	14	13	13	9	49	13.54	12.62	20.51	9.51	14.04	27.32
420031008	30	29	30	29	118	12.79	15.60	21.90	13.52	15.95	40.11
420031301	29	29	29	26	113	14.39	16.86	23.90	13.37	17.13	38.22
420033007	15	13	14	15	57	14.13	14.25	24.36	12.71	16.36	30.68
420039002	13	13	14	15	55	12.95	14.01	21.32	11.25	14.88	37.93
Composite Monitor for Pittsburgh	90	91	92	92	365	14.68	17.81	22.54	15.91	17.73	51.14
2006											
420030008	85	89	91	92	357	11.60	13.28	20.19	12.54	14.40	37.44
420030021	0	0	0	0	0	---	---	---	---	---	---
420030064	85	90	87	89	351	14.86	17.89	22.78	20.97	19.13	55.70
420030067	23	26	28	21	98	9.61	9.52	16.39	9.06	11.14	28.04
420030093	14	6	13	13	46	10.37	9.85	16.38	9.41	11.50	29.46
420030095	13	13	13	14	53	10.02	10.97	18.22	10.31	12.38	36.70
420030116	0	0	0	0	0	---	---	---	---	---	---
420030133	0	0	0	0	0	---	---	---	---	---	---
420031008	27	23	28	25	103	11.87	14.30	18.32	11.63	14.03	37.54
420031301	26	28	29	29	112	12.56	14.55	19.89	13.11	15.03	37.73
420033007	15	15	14	15	59	12.93	13.51	19.16	12.36	14.49	34.73
420039002	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Pittsburgh	90	91	92	92	365	12.54	15.10	21.11	15.93	16.17	45.21

Table A-12. Air Quality Data for Pittsburgh

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2007											
420030008	85	86	86	89	346	11.80	14.72	20.30	12.74	14.89	39.35
420030021	0	0	0	0	0	---	---	---	---	---	---
420030064	88	90	91	90	359	14.16	18.64	25.16	17.57	18.88	54.67
420030067	19	25	28	26	98	10.28	13.40	19.46	10.73	13.47	40.80
420030093	15	12	14	14	55	9.67	10.50	19.35	12.57	13.02	32.56
420030095	14	13	15	14	56	10.96	9.89	20.79	12.90	13.64	32.40
420030116	0	0	0	0	0	---	---	---	---	---	---
420030133	0	0	0	0	0	---	---	---	---	---	---
420031008	27	27	30	27	111	12.79	14.55	19.68	13.23	15.06	39.60
420031301	28	27	31	26	112	14.02	15.18	21.90	15.16	16.56	43.57
420033007	14	14	14	13	55	12.36	13.03	21.19	13.85	15.11	34.74
420039002	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Pittsburgh	90	91	92	92	365	12.36	16.25	22.33	14.49	16.36	47.20

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-13. Air Quality Data for Salt Lake City

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
490350003	30	29	30	31	120	14.16	6.58	8.98	14.49	11.06	41.66
490350012	82	89	85	85	341	16.73	9.59	12.68	17.24	14.06	43.36
490351001	29	30	28	30	117	11.85	5.47	8.61	11.35	9.32	36.25
490353006	88	90	90	85	353	13.95	6.27	9.56	14.17	10.99	43.23
490353007	28	27	29	28	112	13.64	7.40	10.57	16.36	11.99	39.37
490353008	30	31	24	31	116	9.90	6.03	7.76	7.45	7.79	26.61
490353010	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Salt Lake City	90	91	92	92	365	14.77	7.43	10.47	14.93	11.90	41.98
2006											
490350003	28	28	29	30	115	10.76	6.98	9.41	13.58	10.18	38.67
490350012	76	87	82	90	335	11.80	11.22	14.19	14.91	13.03	37.93
490351001	27	28	29	27	111	7.95	5.65	8.65	9.29	7.88	27.72
490353006	88	90	90	88	356	10.59	7.21	8.54	12.37	9.68	37.54
490353007	30	30	31	29	120	10.11	7.18	11.56	13.61	10.61	35.69
490353008	29	26	30	30	115	6.14	6.85	9.26	7.09	7.33	21.97
490353010	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for Salt Lake City	90	91	92	92	365	10.54	8.60	10.80	12.72	10.67	36.89
2007											
490350003	30	30	29	28	117	18.12	6.97	10.99	13.89	12.49	55.65
490350012	80	86	0	0	166	20.84	11.45	---	---	---	---
490351001	24	30	31	26	111	11.42	6.44	10.08	9.71	9.41	29.84
490353006	89	85	78	89	341	18.17	6.11	9.42	12.05	11.44	54.28
490353007	29	29	29	31	118	17.72	7.17	11.53	13.42	12.46	50.13
490353008	23	28	28	30	109	10.03	6.06	9.66	7.09	8.21	23.02
490353010	0	80	83	92	255	---	7.68	11.62	13.00	---	---
Composite Monitor for Salt Lake City	90	91	92	92	365	18.77	8.06	10.72	12.35	12.48	50.64

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-14. Air Quality Data for St. Louis

Monitor	Quarterly Counts Q1	Q2	Q3	Q4	Annual Total	Quarterly Averages (ug/m^3) Q1	Q2	Q3	Q4	Annual Average (ug/m^3)	98th Percentile (ug/m^3)
2005											
171190023*	28	28	29	29	114	18.01	19.10	21.49	16.95	18.89	41.17
171190024*	0	0	0	0	0	---	---	---	---	---	---
171191007*	26	31	29	30	116	18.40	16.49	21.47	16.27	18.16	43.68
171192009*	12	12	13	12	49	14.94	16.35	20.82	11.98	16.02	39.63
171193007*	29	31	27	29	116	16.42	15.20	19.99	12.49	16.02	41.08
171630010*	13	15	14	15	57	17.31	16.81	19.97	14.47	17.14	39.59
171634001*	30	30	29	28	117	17.86	14.17	17.20	14.69	15.98	37.61
290990012	90	87	90	91	358	15.22	14.69	19.26	12.42	15.40	39.86
291890004*	29	29	28	31	117	16.01	12.64	17.80	11.87	14.58	37.57
291892003*	57	30	29	31	147	16.73	14.15	18.44	12.65	15.49	40.00
295100007*	88	88	83	81	340	16.99	14.67	18.92	12.87	15.86	38.44
295100085*	90	86	78	88	342	16.78	14.46	19.67	13.33	16.06	39.81
295100086*	84	26	30	29	169	15.11	14.34	18.43	13.14	15.26	39.57
295100087*	90	87	82	81	340	17.02	14.80	18.74	12.94	15.88	40.80
295100093*	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for St Louis - 1	90	91	92	92	365	16.24	14.64	19.17	12.97	15.76	39.59
Composite Monitor for St Louis - 2	90	91	92	92	365	16.44	14.59	18.95	13.10	15.77	39.83
2006											
171190023*	30	26	31	29	116	15.21	17.34	19.40	12.11	16.02	32.81
171190024*	0	0	0	0	0	---	---	---	---	---	---
171191007*	27	24	24	27	102	14.95	16.12	20.18	14.05	16.32	36.24
171192009*	15	15	14	16	60	12.59	13.35	13.49	12.92	13.08	27.28
171193007*	28	30	31	31	120	13.08	12.00	16.47	10.87	13.11	27.54
171630010*	12	14	15	14	55	14.18	13.75	15.72	14.48	14.53	29.18
171634001*	28	28	31	29	116	13.43	12.87	15.20	12.00	13.38	27.92
290990012	82	81	91	89	343	11.62	11.79	15.46	11.49	12.59	30.20
291890004*	30	29	0	0	59	10.56	10.49	---	---	---	---
291892003*	29	29	28	26	112	11.36	10.69	13.87	11.00	11.73	27.61
295100007*	78	88	91	90	347	12.27	11.82	15.89	12.51	13.12	29.39
295100085*	86	77	84	92	339	13.04	12.46	15.26	12.68	13.36	28.52
295100086*	30	30	31	29	120	11.94	11.55	15.48	10.90	12.47	30.46
295100087*	85	90	86	91	352	12.92	12.32	16.17	13.18	13.65	29.60
295100093*	0	0	0	0	0	---	---	---	---	---	---
Composite Monitor for St Louis - 1	90	91	92	92	365	12.77	12.21	16.20	12.56	13.44	28.60
Composite Monitor for St Louis - 2	90	91	92	92	365	12.97	12.27	16.28	12.82	13.58	28.87

Table A-14 cont'd. Air Quality Data for St. Louis

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2007											
171190023*	0	0	0	0	0	---	---	---	---	---	---
171190024*	0	0	6	29	35	---	---	15.07	14.94	---	---
171191007*	29	27	29	26	111	14.28	15.31	17.61	13.23	15.11	35.86
171192009*	15	12	14	13	54	14.31	16.02	15.66	13.51	14.88	34.98
171193007*	29	28	26	30	113	12.42	14.84	17.39	12.32	14.24	34.45
171630010*	13	13	14	14	54	14.94	17.65	15.94	13.79	15.58	33.08
171634001*	26	30	31	29	116	13.35	13.95	14.83	10.90	13.26	32.27
290990012	82	81	90	86	339	11.94	14.44	16.23	12.13	13.68	31.92
291890004*	0	0	0	0	0	---	---	---	---	---	---
291892003*	89	90	91	90	360	11.63	12.96	15.25	12.49	13.09	30.28
295100007*	88	91	91	92	362	12.56	14.50	16.13	12.97	14.04	31.61
295100085*	90	88	89	90	357	12.59	13.79	16.09	13.30	13.94	32.06
295100086*	27	30	0	0	57	11.79	14.50	---	---	---	---
295100087*	90	86	92	86	354	13.24	14.43	16.61	13.10	14.34	33.72
295100093*	0	0	24	29	53	---	---	17.26	13.82	---	---
Composite Monitor for St Louis - 1	90	91	92	92	365	12.42	14.15	16.22	12.96	13.94	31.94
Composite Monitor for St Louis - 2	90	91	92	92	365	12.58	14.13	16.14	13.09	13.98	31.90

Note 1: The monitors marked with * are used for St Louis - 2. All monitors shown in the table are used for St Louis - 1.
Note 2: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

Table A-15. Air Quality Data for Tacoma

Monitor	Quarterly Counts				Annual Total	Quarterly Averages (ug/m^3)				Annual Average (ug/m^3)	98th Percentile (ug/m^3)
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		
2005											
530530029	29	30	30	31	120	16.46	5.34	7.13	17.07	11.50	40.42
Composite Monitor for Tacoma	90	91	92	92	365	16.01	5.38	7.07	17.21	11.42	39.61
2006											
530530029	30	30	31	26	117	8.92	5.89	7.45	15.93	9.55	39.82
Composite Monitor for Tacoma	90	91	92	92	365	8.91	5.94	7.40	15.13	9.35	37.05
2007											
530530029	29	28	31	29	117	13.76	5.94	5.23	13.76	9.67	45.11
Composite Monitor for Tacoma	90	91	92	92	365	14.74	6.00	5.25	13.47	9.87	44.07

Note: The information on the composite monitors in this table is based on the composite monitors after missing values have been filled in.

APPENDIX B: HYBRID (NON-PROPORTIONAL) ROLLBACK APPROACH

Appendix B. Methodology for Rolling Back PM2.5 Concentrations Due to Local Source Impacts (hybrid non-proportional approach)

During the last review of the Particulate Matter National Ambient Air Quality Standards (NAAQS), a technique was employed to simulate fine particulate concentrations under a series of attainment scenarios to determine the risk associated with each. The "rolling back" of the concentrations consisted of simply using a proportional rollback calculation where every measured concentration value was multiplied by a constant to obtain a set of concentrations which would meet alternative standard levels. This technique was reviewed by the Clean Air Scientific Advisory Committee (CASAC) and was considered to be a satisfactory way to simulating alternative PM2.5 distributions. The rolled back values, however, only constituted a regional reduction in PM concentrations without accounting for in any way emission reductions at local point sources.

For the current review, an alternative rollback approach reflecting the combined effect of both local and regional reduction strategies was considered (this alternative approach is referred to as the *hybrid non-proportional approach* in the risk assessment). In addition to utilizing a traditional proportional rollback to represent the regional PM reductions, a distance weighted rollback was conducted on a subset of the 15 study areas which contain source oriented monitors measuring concentrations higher than those observed at other sites within a particular area.[1]

Unique sites with high design values exceeding the NAAQS were further investigated to determine if they were in close proximity to a large source of PM2.5 (Figure 1). The presence of possible source oriented sites in each area was visually determined using satellite photographs provided by Google Earth. Areas where source oriented adjustments were made include Detroit MI, Pittsburgh PA, St. Louis MO-IL, Baltimore MD, New York NY, Los Angeles CA and Birmingham AL.

[1] In the risk assessment, as outlined in Section 3.1, the proportional rollback approach was used in generating the core risk estimates, while the hybrid non-proportional approach described here, was considered as part of the sensitivity analysis.

Figure B-1. Example of a PM2.5 source oriented monitoring site

For those sites that were within proximity to a large emitter, the site's measured concentrations were reduced using a proportional rollback depending on the magnitude of the reduction needed to either the highest 24-hour or annual design value of a non-source oriented site within the area whose design values were close to those of the source oriented site (Figure 2).

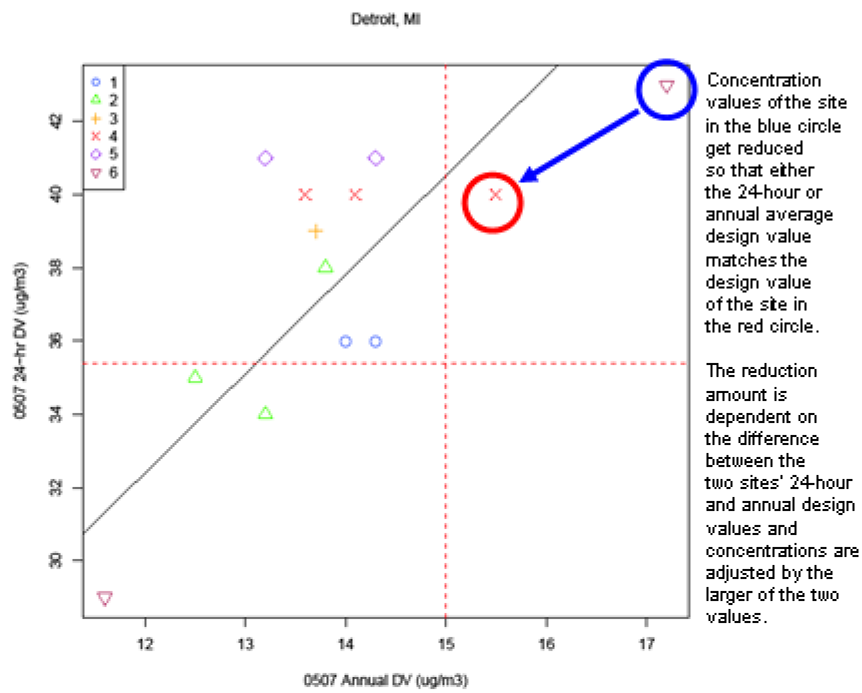


Figure B-2. Plot of the 24-hour versus the annual average PM2.5 design values for individual sites in Detroit MI

The fractional reduction made to the site near the point source was then weighted by the inverse distance in kilometers between the source oriented site and all of the other individual sites in the area to determine their fractional reductions in relation to the source oriented site. If more than one source oriented site was reduced, a distance weighted average fractional reduction was calculated and implemented across the non-source oriented sites. Sites within one kilometer of the source oriented site received the same amount of reduction as the source oriented site. An example of the effect of this reduction technique for Detroit is presented in Table I. For Detroit, adjustments were based on the difference between the two sites' annual design values.

Table B-1. Comparison of the original and adjusted design values for Detroit, MI

Site ID	Original Annual Design Value (2005-2007)	Adjusted Annual Design Value (2005-2007)	Original 24-hour Design Value (2005-2007)	Adjusted 24-hour Design Value (2005-2007)
260490021	11.6	11.5	29	29
260990009	12.5	12.4	35	35
261150005	13.8	13.7	38	38
261250001	13.6	13.5	40	40

Site ID	Original Annual Design Value (2005-2007)	Adjusted Annual Design Value (2005-2007)	Original 24-hour Design Value (2005-2007)	Adjusted 24-hour Design Value (2005-2007)
261470005	13.2	13.1	41	40
261610005	13.2	13.1	39	39
261610008	13.7	13.6	39	39
261630001	14	13.9	36	36
261630015	**15.5**	**15.2**	**40**	**39**
261630016	14.3	14.2	41	41
261630019	14.1	14	40	40
261630025	13.2	13.1	34	34
261630033	**17.2**	**15.4**	**43**	**39**
261630036	14.3	14.2	36	36
261630038	14.3	14.1	40	39
261630039	14.4	14.3	37	37

Site in blue represents source oriented site

Site in red represents reference site used for reduction

Reduction of the concentrations of the source oriented site reduced either the 24-hour or annual design value of the site to either the maximum non-source oriented site's 24-hour or annual design value. This did not necessarily mean that the adjusted values at the source oriented site met either the 24-hour or annual standard after the reduction. Since, the adjusted design values were calculated using the same data handling rules as contained within 40 CFR Part 50 Appendix N, truncation or rounding of the adjusted concentrations could sometimes give adjusted design values at the source oriented site that were not exactly the same value as the original design value at the reference site. However, they were usually within 1 ug/m^3 for the 24-hour standard and a few tenths of a microgram per cubic meter for the annual standard.

APPENDIX C: EPIDEMIOLOGY STUDY-SPECIFIC INFORMATION FOR PM RISK ASSESSMENT

Appendix C. Epidemiology Study-Specific Information for $PM_{2.5}$ Risk Assessment

This Appendix provides detailed summary information for the epidemiological studies used to obtain the concentration-response (C-R) functions used in the risk assessment. For additional details on selection of epidemiological studies and specification of the C-R functions, see section 3.3.3.

Table C-1. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Health Effects Associated with Long-Term Exposure to $PM_{2.5}$:											
Krewski et al. (2009) - exposure period 1979-1983	Mortality, all-cause	All	30+	log-linear	none	n/a	annual mean	National	0.00431	0.00276	0.00583
	Mortality, cardiopulmonary	401-440, 460-519							0.00898	0.00677	0.01115
	Mortality, ischemic heart disease	410-414							0.01689	0.01363	0.02005
	Mortality, lung cancer	162							0.00880	0.00325	0.01432
Krewski et al. (2009) - exposure period 1999-2000	Mortality, all-cause	All	30+	log-linear	none	n/a	annual mean	National	0.00554	0.00354	0.00760
	Mortality, cardiopulmonary	401-440, 460-519							0.01293	0.01007	0.01587
	Mortality, ischemic heart disease	410-414							0.02167	0.01748	0.02585
	Mortality, lung cancer	162							0.01293	0.00554	0.02029
	Mortality, all-cause	All	30+	log-linear (random effects)	none	n/a	annual mean		0.00686	0.00315	0.01053
	Mortality, ischemic heart disease	410-414							0.02437	0.01450	0.03429
	Mortality, all-cause	All	30+	log-log	none	n/a	annual mean		0.10966	0.06758	0.15306
	Mortality, cardiopulmonary	401-440, 460-519							0.17225	0.11261	0.23161
	Mortality, ischemic heart disease	410-414							0.35942	0.24629	0.47210
	Mortality, lung cancer	162							0.19284	0.09861	0.28797
Krewski et al. (2000) [reanalysis of Six Cities Study]	Mortality, all-cause	All	25+	log-linear	none	n/a	annual mean	Six U.S. Cities	0.00414	0.00414	0.02071
	Mortality, cardiopulmonary	400-440, 485-495							0.00561	0.00561	0.02789
	Mortality, lung cancer	162							-0.01133	-0.01133	0.04525

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Health Effects Associated with Short-Term Exposure to $PM_{2.5}$:											
Bell et al. (2008)	HA (unscheduled), cardiovascular	426–427, 428, 430–438; 410–414, 429; 440–449	65+	log-linear	none	0-day	24-hr avg.	Northeast	0.00107	0.00079	0.00136
								Northwest	0.00074	-0.00176	0.00324
								Southeast	0.00029	-0.00019	0.00077
								Southwest	0.00053	0.00000	0.00104
	HA (unscheduled), respiratory	490–492; 464–466, 480–487	65+	log-linear	none	2-day	24-hr avg.	Northeast	0.00028	-0.00017	0.00072
								Northwest	0.00019	-0.00255	0.00294
								Southeast	0.00035	-0.00044	0.00113
								Southwest	0.00094	0.00022	0.00166
Ito et al. (2007)	ER visits, asthma	493	all ages	log-linear	none	avg of 0- and 1-day	24-hr avg.	New York	0.00453	0.00286	0.00621
Moolgavkar (2003) [reanalysis of Moolgavkar (2000a)]	Mortality, cardiovascular	390-429	all ages	log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.	Los Angeles	0.00099	0.00010	0.00188
				log-linear, GAM (stringent), 100 df					0.00097	0.00014	0.00180
				log-linear, GLM, 100 df					0.00097	-0.00002	0.00196
				log-linear, GAM (stringent), 100 df	CO				0.00178	0.00075	0.00281
				log-linear, GLM, 100 df					0.00188	0.00067	0.00309
				log-linear, GAM (stringent), 30 df	none	1 day			0.00103	0.00015	0.00191
				log-linear, GAM (stringent), 100 df					0.00080	-0.00003	0.00163
				log-linear, GLM, 100 df					0.00069	-0.00032	0.00170
				log-linear, GAM (stringent), 100 df	CO				0.00091	-0.00013	0.00195
				log-linear, GLM, 100 df					0.00091	-0.00035	0.00217

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Moolgavkar (2003) [reanalysis of Moolgavkar (2000a)]	Mortality, non-accidental	<800	all ages	log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.	Los Angeles	0.00054	-0.00007	0.00115
				log-linear, GLM, 30 df					0.00040	-0.00034	0.00114
				log-linear, GAM (stringent), 100 df					0.00032	-0.00023	0.00087
				log-linear, GLM, 100 df					0.00030	-0.00043	0.00103
				log-linear, GAM (stringent), 30 df	none	1 day	24-hr avg.		0.00059	0.00000	0.00118
				log-linear, GLM, 30 df					0.00055	-0.00017	0.00127
				log-linear, GAM (stringent), 100 df					0.00010	-0.00046	0.00066
				log-linear, GLM, 100 df					-0.00001	-0.00099	0.00097
				log-linear, GAM (stringent), 30 df	CO	1 day	24-hr avg.		-0.00053	-0.00131	0.00025
				log-linear, GAM (stringent), 100 df					-0.00033	-0.00105	0.00039
				log-linear, GLM, 100 df					-0.00033	-0.00117	0.00051
				log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.		0.00054	-0.00007	0.00115
						1 day			0.00059	0.00000	0.00118
						2 day			0.00038	-0.00019	0.00095
						3 day			-0.00015	-0.00073	0.00043
						4 day			-0.00009	-0.00064	0.00046
						5 day			-0.00056	-0.00115	0.00003

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Moolgavkar (2003) [reanalysis of Moolgavkar (2000a)]	Mortality, respiratory (COPD+)	490-496	all ages	log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.	Los Angeles	-0.00056	-0.00300	0.00188
				log-linear, GAM (stringent), 100 df					-0.00142	-0.00380	0.00096
				log-linear, GLM, 100 df					-0.00121	-0.00407	0.00165
				log-linear, GAM (stringent), 30 df	none	1 day	24-hr avg.		0.00038	-0.00210	0.00286
				log-linear, GAM (stringent), 100 df					0.00086	-0.00158	0.00330
				log-linear, GLM, 100 df					0.00020	-0.00282	0.00322
Moolgavkar (2003) [reanalysis of Moolgavkar (2000b)]	HA, cardiovascular	390-429	65+	log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.	Los Angeles	0.00158	0.00091	0.00225
				log-linear, GAM (stringent), 100 df					0.00116	0.00050	0.00182
				log-linear, GLM, 100 df					0.00126	0.00045	0.00207
				log-linear, GAM (stringent), 100 df	CO	0 day	24-hr avg.		0.00039	-0.00044	0.00122
				log-linear, GLM, 100 df					0.00058	-0.00041	0.00157
				log-linear, GAM (stringent), 30 df	none	1 day	24-hr avg.		0.00139	0.00069	0.00209
				log-linear, GAM (stringent), 100 df					0.00113	0.00046	0.00180
				log-linear, GLM, 100 df					0.00120	0.00038	0.00202
				log-linear, GAM (stringent), 100 df	CO	1 day	24-hr avg.		0.00024	-0.00065	0.00113
				log-linear, GLM, 100 df					0.00027	-0.00075	0.00129

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Moolgavkar (2003) [reanalysis of Moolgavkar (2000c)]	HA, respiratory (COPD+)	490-496	all ages	log-linear, GAM (stringent), 30 df	none	0 day	24-hr avg.	Los Angeles	0.00167	0.00068	0.00266
				log-linear, GAM (stringent), 100 df					0.00138	0.00052	0.00224
				log-linear, GLM, 100 df					0.00149	0.00041	0.00257
				log-linear, GAM (stringent), 30 df	none	1 day	24-hr avg.		0.00119	0.00022	0.00216
				log-linear, GAM (stringent), 100 df					0.00075	-0.00011	0.00161
				log-linear, GLM, 100 df					0.00077	-0.00027	0.00181
				log-linear, GAM (stringent), 30 df	none	2 day	24-hr avg.		0.00185	0.00082	0.00288
				log-linear, GAM (stringent), 100 df					0.00114	0.00021	0.00207
				log-linear, GLM, 100 df					0.00103	-0.00012	0.00218
				log-linear, GAM (stringent), 100 df	NO2	0 day	24-hr avg.		0.00042	-0.00091	0.00175
						1 day			-0.00004	-0.00161	0.00153
						2 day			0.00035	-0.00102	0.00172
						3 day			-0.00109	-0.00238	0.00020
Tolbert et al. (2007)	ER visits, cardiovascular	410–414, 427, 428, 433–437, 440, 443–445, 451–453	all ages	log-linear	none	avg of 0-,1-day, and 2-day	24-hr avg.	Atlanta	0.00046	-0.00064	0.00154
	ER visits, respiratory	493, 786.07, 786.09; 491, 492, and 496; 460–465, 460.0, and 477; 480–486; 466.1, 466.11, and 466.19	all ages	log-linear	none	avg of 0-,1-day, and 2-day	24-hr avg.	Atlanta	0.00046	-0.00046	0.00136

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, cardiovascular	I01-I59	all ages	log-linear	none	avg of 0- and 1-day	24-hr avg.	Atlanta	0.00066	-0.00066	0.00198
								Baltimore	0.00128	-0.00009	0.00265
								Birmingham	-0.00002	-0.00140	0.00135
								Dallas	0.00086	-0.00056	0.00228
								Detroit	0.00097	-0.00012	0.00205
								Fresno	0.00082	-0.00056	0.00219
								Houston	0.00084	-0.00056	0.00223
								Los Angeles	-0.00018	-0.00080	0.00044
								New York	0.00196	0.00114	0.00278
								Philadelphia	0.00179	0.00046	0.00313
								Phoenix	0.00142	-0.00006	0.00291
								Pittsburgh	0.00102	-0.00020	0.00225
								Salt Lake City	0.00117	-0.00027	0.00260
								St. Louis	0.00158	0.00035	0.00282
								Tacoma	0.00104	-0.00055	0.00262

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, non-accidental	A00-R99	all ages	log-linear	none	avg of 0- and 1-day	24-hr avg.	Atlanta	0.00094	0.00018	0.00170
								Baltimore	0.00135	0.00054	0.00215
								Birmingham	0.00032	-0.00050	0.00115
								Dallas	0.00112	0.00027	0.00198
								Detroit	0.00068	-0.00012	0.00147
								Fresno	0.00096	0.00014	0.00178
								Houston	0.00104	0.00021	0.00188
								Los Angeles	0.00016	-0.00023	0.00055
								New York	0.00132	0.00077	0.00186
								Philadelphia	0.00126	0.00046	0.00206
								Phoenix	0.00110	0.00018	0.00202
								Pittsburgh	0.00104	0.00030	0.00177
								Salt Lake City	0.00105	0.00021	0.00188
								St. Louis	0.00105	0.00030	0.00180
								Tacoma	0.00117	0.00020	0.00214

Table C-1 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: All-Year Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Model	Other Pollutants in Model	Lag	Metric	Region Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, respiratory	J00-J99	all ages	log-linear	none	avg of 0- and 1-day	24-hr avg.	Atlanta	0.00121	-0.00048	0.00290
								Baltimore	0.00211	0.00039	0.00384
								Birmingham	0.00096	-0.00076	0.00268
								Dallas	0.00093	-0.00084	0.00270
								Detroit	0.00169	0.00008	0.00330
								Fresno	0.00175	0.00006	0.00344
								Houston	0.00211	0.00033	0.00388
								Los Angeles	0.00112	0.00011	0.00213
								New York	0.00216	0.00075	0.00356
								Philadelphia	0.00157	-0.00015	0.00329
								Phoenix	0.00194	0.00015	0.00374
								Pittsburgh	0.00149	-0.00014	0.00313
								Salt Lake City	0.00194	0.00024	0.00364
								St. Louis	0.00132	-0.00034	0.00298
								Tacoma	0.00179	-0.00005	0.00363

Table C-2. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Bell et al. (2008)	HA (unscheduled), cardiovascular	426–427, 428, 430–438; 410–414, 429; 440–449	65+	none	0-day	Northeast	Winter	0.00199	0.00138	0.00260
							Spring	0.00095	0.00032	0.00157
							Summer	0.00055	0.00008	0.00101
							Fall	0.00102	0.00048	0.00157
						Northwest	Winter	0.00085	-0.00420	0.00589
							Spring	-0.00007	-0.01324	0.01309
							Summer	-0.00156	-0.01651	0.01337
							Fall	-0.00067	-0.00721	0.00587
						Southeast	Winter	0.00105	-0.00007	0.00219
							Spring	0.00075	-0.00026	0.00176
							Summer	-0.00067	-0.00161	0.00026
							Fall	0.00017	-0.00072	0.00106
						Southwest	Winter	0.00076	-0.00025	0.00177
							Spring	0.00176	-0.00087	0.00441
							Summer	-0.00121	-0.00502	0.00262
							Fall	0.00030	-0.00098	0.00158
	HA (unscheduled), respiratory	490–492; 464–466, 480–487	65+		2-day	Northeast	Winter	0.00079	-0.00021	0.00178
							Spring	0.00004	-0.00088	0.00097
							Summer	0.00077	-0.00001	0.00155
							Fall	0.00012	-0.00082	0.00106
						Northwest	Winter	-0.00006	-0.00674	0.00663
							Spring	0.00226	-0.01539	0.01991
							Summer	0.00074	-0.02074	0.02220
							Fall	-0.00074	-0.01062	0.00915
						Southeast	Winter	0.00040	-0.00146	0.00224
							Spring	0.00075	-0.00082	0.00231
							Summer	-0.00052	-0.00209	0.00105
							Fall	0.00014	-0.00130	0.00158
						Southwest	Winter	0.00119	-0.00010	0.00249
							Spring	0.00104	-0.00220	0.00430
							Summer	0.00238	-0.00264	0.00741
							Fall	0.00097	-0.00137	0.00330
Ito et al. (2007)	ER visits, asthma	493	all ages	none	avg of 0- and 1-day	New York	April-August	0.00759	0.00486	0.01032
				O3		New York	April-August	0.00602	0.00322	0.00883
				NO2		New York	April-August	0.00334	0.00029	0.00640
				CO		New York	April-August	0.00647	0.00356	0.00939
				SO2		New York	April-August	0.00469	0.00163	0.00775

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term cardiovascular	I01-I59	all ages	none	avg of 0- and 1-day	Atlanta	Winter	0.00135	-0.00193	0.00462
						Atlanta	Spring	0.00076	-0.00273	0.00425
						Atlanta	Summer	0.00062	-0.00222	0.00347
						Atlanta	Fall	-0.00018	-0.00293	0.00257
						Baltimore	Winter	0.00104	-0.00196	0.00405
						Baltimore	Spring	0.00085	-0.00269	0.00438
						Baltimore	Summer	0.00067	-0.00251	0.00384
						Baltimore	Fall	0.00296	-0.00017	0.00609
						Birmingham	Winter	0.00080	-0.00283	0.00443
						Birmingham	Spring	0.00016	-0.00333	0.00365
						Birmingham	Summer	-0.00004	-0.00301	0.00293
						Birmingham	Fall	-0.00189	-0.00485	0.00106
						Dallas	Winter	0.00120	-0.00214	0.00454
						Dallas	Spring	0.00125	-0.00222	0.00472
						Dallas	Summer	0.00115	-0.00223	0.00453
						Dallas	Fall	-0.00022	-0.00349	0.00306
						Detroit	Winter	-0.00006	-0.00203	0.00191
						Detroit	Spring	0.00166	-0.00045	0.00378
						Detroit	Summer	0.00136	-0.00099	0.00371
						Detroit	Fall	0.00226	-0.00001	0.00452
						Fresno	Winter	-0.00033	-0.00201	0.00135
						Fresno	Spring	0.00050	-0.00138	0.00238
						Fresno	Summer	0.00019	-0.00173	0.00211
						Fresno	Fall	0.00071	-0.00105	0.00248
						Houston	Winter	0.00070	-0.00285	0.00425
						Houston	Spring	0.00013	-0.00347	0.00373
						Houston	Summer	0.00183	-0.00142	0.00509
						Houston	Fall	0.00046	-0.00246	0.00337
						Los Angeles	Winter	-0.00014	-0.00109	0.00080
						Los Angeles	Spring	0.00007	-0.00113	0.00127
						Los Angeles	Summer	-0.00106	-0.00253	0.00042
						Los Angeles	Fall	0.00000	-0.00099	0.00099

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term cardiovascular	I01-I59	all ages	none	avg of 0- and 1-day	New York	Winter	0.00204	0.00048	0.00360
						New York	Spring	0.00231	0.00050	0.00412
						New York	Summer	0.00202	0.00038	0.00366
						New York	Fall	0.00205	0.00047	0.00363
						Philadelphia	Winter	0.00214	-0.00042	0.00470
						Philadelphia	Spring	0.00153	-0.00135	0.00441
						Philadelphia	Summer	0.00178	-0.00082	0.00438
						Philadelphia	Fall	0.00300	0.00044	0.00555
						Phoenix	Winter	--- [1]	---	---
						Phoenix	Spring	---	---	---
						Phoenix	Summer	---	---	---
						Phoenix	Fall	---	---	---
						Pittsburgh	Winter	0.00150	-0.00102	0.00401
						Pittsburgh	Spring	0.00284	0.00026	0.00543
						Pittsburgh	Summer	0.00085	-0.00148	0.00318
						Pittsburgh	Fall	0.00047	-0.00185	0.00279
						Salt Lake City	Winter	---	---	---
						Salt Lake City	Spring	---	---	---
						Salt Lake City	Summer	---	---	---
						Salt Lake City	Fall	---	---	---
						St. Louis	Winter	-0.00013	-0.00297	0.00270
						St. Louis	Spring	0.00278	-0.00013	0.00568
						St. Louis	Summer	0.00188	-0.00084	0.00459
						St. Louis	Fall	0.00253	-0.00022	0.00527
						Tacoma	Winter	0.00006	-0.00182	0.00193
						Tacoma	Spring	0.00020	-0.00173	0.00212
						Tacoma	Summer	0.00025	-0.00168	0.00219
						Tacoma	Fall	0.00053	-0.00136	0.00242

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term non-accidental	A00-R99	all ages	none	avg of 0- and 1-day	Atlanta	Winter	0.00133	0.00020	0.00246
						Atlanta	Spring	0.00123	0.00007	0.00238
						Atlanta	Summer	0.00078	-0.00027	0.00184
						Atlanta	Fall	0.00069	-0.00035	0.00172
						Baltimore	Winter	0.00126	0.00016	0.00236
						Baltimore	Spring	0.00119	0.00002	0.00236
						Baltimore	Summer	0.00100	-0.00011	0.00212
						Baltimore	Fall	0.00129	0.00017	0.00240
						Birmingham	Winter	0.00097	-0.00022	0.00216
						Birmingham	Spring	0.00105	-0.00012	0.00222
						Birmingham	Summer	0.00049	-0.00061	0.00160
						Birmingham	Fall	0.00035	-0.00074	0.00144
						Dallas	Winter	0.00099	-0.00017	0.00215
						Dallas	Spring	0.00090	-0.00027	0.00208
						Dallas	Summer	0.00106	-0.00008	0.00221
						Dallas	Fall	0.00132	0.00018	0.00247
						Detroit	Winter	-0.00009	-0.00125	0.00107
						Detroit	Spring	0.00174	0.00043	0.00304
						Detroit	Summer	0.00090	-0.00053	0.00233
						Detroit	Fall	0.00072	-0.00066	0.00210
						Fresno	Winter	0.00002	-0.00159	0.00163
						Fresno	Spring	0.00225	-0.00021	0.00471
						Fresno	Summer	0.00054	-0.00217	0.00325
						Fresno	Fall	0.00088	-0.00090	0.00266
						Houston	Winter	0.00106	-0.00011	0.00223
						Houston	Spring	0.00129	0.00010	0.00248
						Houston	Summer	0.00092	-0.00023	0.00207
						Houston	Fall	0.00092	-0.00015	0.00199
						Los Angeles	Winter	0.00012	-0.00059	0.00083
						Los Angeles	Spring	0.00059	-0.00031	0.00149
						Los Angeles	Summer	-0.00084	-0.00208	0.00039
						Los Angeles	Fall	-0.00002	-0.00067	0.00064

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term non-accidental	A00-R99	all ages	none	avg of 0- and 1-day	New York	Winter	0.00168	0.00061	0.00275
						New York	Spring	0.00123	0.00001	0.00245
						New York	Summer	0.00074	-0.00029	0.00177
						New York	Fall	0.00181	0.00078	0.00285
						Philadelphia	Winter	0.00195	0.00041	0.00350
						Philadelphia	Spring	0.00078	-0.00090	0.00247
						Philadelphia	Summer	0.00064	-0.00089	0.00217
						Philadelphia	Fall	0.00200	0.00050	0.00350
						Phoenix	Winter	---	---	---
						Phoenix	Spring	---	---	---
						Phoenix	Summer	---	---	---
						Phoenix	Fall	---	---	---
						Pittsburgh	Winter	0.00135	-0.00013	0.00283
						Pittsburgh	Spring	0.00193	0.00034	0.00352
						Pittsburgh	Summer	0.00090	-0.00047	0.00227
						Pittsburgh	Fall	0.00062	-0.00073	0.00197
						Salt Lake City	Winter	0.00113	-0.00013	0.00240
						Salt Lake City	Spring	0.00152	-0.00047	0.00352
						Salt Lake City	Summer	0.00106	-0.00095	0.00308
						Salt Lake City	Fall	0.00131	-0.00051	0.00314
						St. Louis	Winter	0.00054	-0.00055	0.00164
						St. Louis	Spring	0.00136	0.00025	0.00247
						St. Louis	Summer	0.00097	-0.00009	0.00203
						St. Louis	Fall	0.00129	0.00022	0.00236
						Tacoma	Winter	0.00006	-0.00236	0.00249
						Tacoma	Spring	0.00154	-0.00123	0.00431
						Tacoma	Summer	0.00088	-0.00203	0.00378
						Tacoma	Fall	0.00145	-0.00099	0.00389

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term respiratory	J00-J99	all ages	none	avg of 0- and 1-day	Atlanta	Winter	0.00093	-0.00144	0.00329
						Atlanta	Spring	0.00035	-0.00205	0.00275
						Atlanta	Summer	0.00077	-0.00155	0.00310
						Atlanta	Fall	0.00096	-0.00134	0.00325
						Baltimore	Winter	0.00107	-0.00127	0.00340
						Baltimore	Spring	0.00144	-0.00097	0.00384
						Baltimore	Summer	0.00116	-0.00120	0.00353
						Baltimore	Fall	0.00103	-0.00134	0.00340
						Birmingham	Winter	0.00043	-0.00197	0.00282
						Birmingham	Spring	0.00079	-0.00160	0.00318
						Birmingham	Summer	-0.00018	-0.00252	0.00217
						Birmingham	Fall	0.00145	-0.00087	0.00377
						Dallas	Winter	0.00040	-0.00198	0.00278
						Dallas	Spring	0.00106	-0.00135	0.00347
						Dallas	Summer	0.00060	-0.00180	0.00300
						Dallas	Fall	0.00038	-0.00202	0.00278
						Detroit	Winter	0.00104	-0.00128	0.00335
						Detroit	Spring	0.00226	-0.00015	0.00467
						Detroit	Summer	0.00253	0.00009	0.00498
						Detroit	Fall	0.00247	0.00001	0.00492
						Fresno	Winter	-0.00022	-0.00423	0.00380
						Fresno	Spring	0.00496	-0.00093	0.01085
						Fresno	Summer	0.00263	-0.00375	0.00900
						Fresno	Fall	0.00099	-0.00383	0.00580
						Houston	Winter	0.00138	-0.00102	0.00377
						Houston	Spring	0.00129	-0.00114	0.00372
						Houston	Summer	0.00100	-0.00140	0.00341
						Houston	Fall	0.00092	-0.00143	0.00327
						Los Angeles	Winter	0.00165	-0.00016	0.00345
						Los Angeles	Spring	0.00237	-0.00018	0.00493
						Los Angeles	Summer	-0.00134	-0.00500	0.00233
						Los Angeles	Fall	-0.00003	-0.00190	0.00183

Table C-2 cont'd. Information about the Concentration-Response Functions Used in the $PM_{2.5}$ Risk Assessment: Season-Specific Functions

Study	Health Endpoint	ICD-9 or 10 Codes	Ages Covered	Other Pollutants in Model	Lag	Region Covered	Season Covered	Coefficient	Lower Bound	Upper Bound
Zanobetti and Schwartz (2009)	Mortality, short-term respiratory	J00-J99	all ages	none	avg of 0- and 1-day	New York	Winter	0.00334	0.00122	0.00547
						New York	Spring	0.00172	-0.00058	0.00403
						New York	Summer	0.00157	-0.00066	0.00381
						New York	Fall	0.00235	0.00013	0.00457
						Philadelphia	Winter	0.00217	-0.00030	0.00463
						Philadelphia	Spring	0.00219	-0.00033	0.00471
						Philadelphia	Summer	0.00182	-0.00068	0.00432
						Philadelphia	Fall	0.00186	-0.00062	0.00435
						Phoenix	Winter	0.00251	-0.00253	0.00755
						Phoenix	Spring	0.00538	-0.00140	0.01215
						Phoenix	Summer	0.00577	-0.00083	0.01238
						Phoenix	Fall	0.00887	0.00285	0.01489
						Pittsburgh	Winter	0.00134	-0.00110	0.00377
						Pittsburgh	Spring	0.00223	-0.00024	0.00470
						Pittsburgh	Summer	0.00188	-0.00052	0.00428
						Pittsburgh	Fall	0.00231	-0.00009	0.00472
						Salt Lake City	Winter	0.00301	-0.00088	0.00690
						Salt Lake City	Spring	0.00438	-0.00459	0.01336
						Salt Lake City	Summer	-0.00353	-0.01304	0.00598
						Salt Lake City	Fall	-0.00138	-0.00915	0.00639
						St. Louis	Winter	0.00019	-0.00212	0.00250
						St. Louis	Spring	0.00123	-0.00112	0.00357
						St. Louis	Summer	0.00060	-0.00171	0.00292
						St. Louis	Fall	0.00127	-0.00106	0.00360
						Tacoma	Winter	0.00011	-0.00563	0.00585
						Tacoma	Spring	0.00287	-0.00349	0.00924
						Tacoma	Summer	0.00190	-0.00467	0.00848
						Tacoma	Fall	0.00138	-0.00458	0.00733

1 --- indicates that results were not available.

APPENDIX D: SUPPLEMENT TO THE REPRESENTATIVENESS ANALYSIS OF THE 15 URBAN STUDY AREAS

Appendix D. Supplement to the Representativeness of the 15 Urban Study Areas (additional graphical comparisons of distributions for key contributors to $PM_{2.5}$ risk)

Following the analysis discussed in Section 4.4, this appendix provides graphical comparisons of the empirical distributions of components of the risk function, and additional variables that have been identified as potentially influencing the risk associated with PM exposures.

In each graph, the orange line represents the empirical cumulative distribution function (CDF) for the complete set of data available for the variable. In some cases, this may encompass all counties in the U.S., while in others, it may be based on a subset of the U.S., usually for large urban areas. The green line in each graph represents the empirical cumulative distribution function for the variable based only on the data available for the set of urban case study locations. The black squares at the bottom of each graph represents the specific value of the variable for one of the case study locations, with the line showing where that value intersects the two empirical CDFs.

D.1 Elements of the Risk Equation

Figure D-1. Comparison of Distributions for Key Elements of the Risk Equation: Total Population

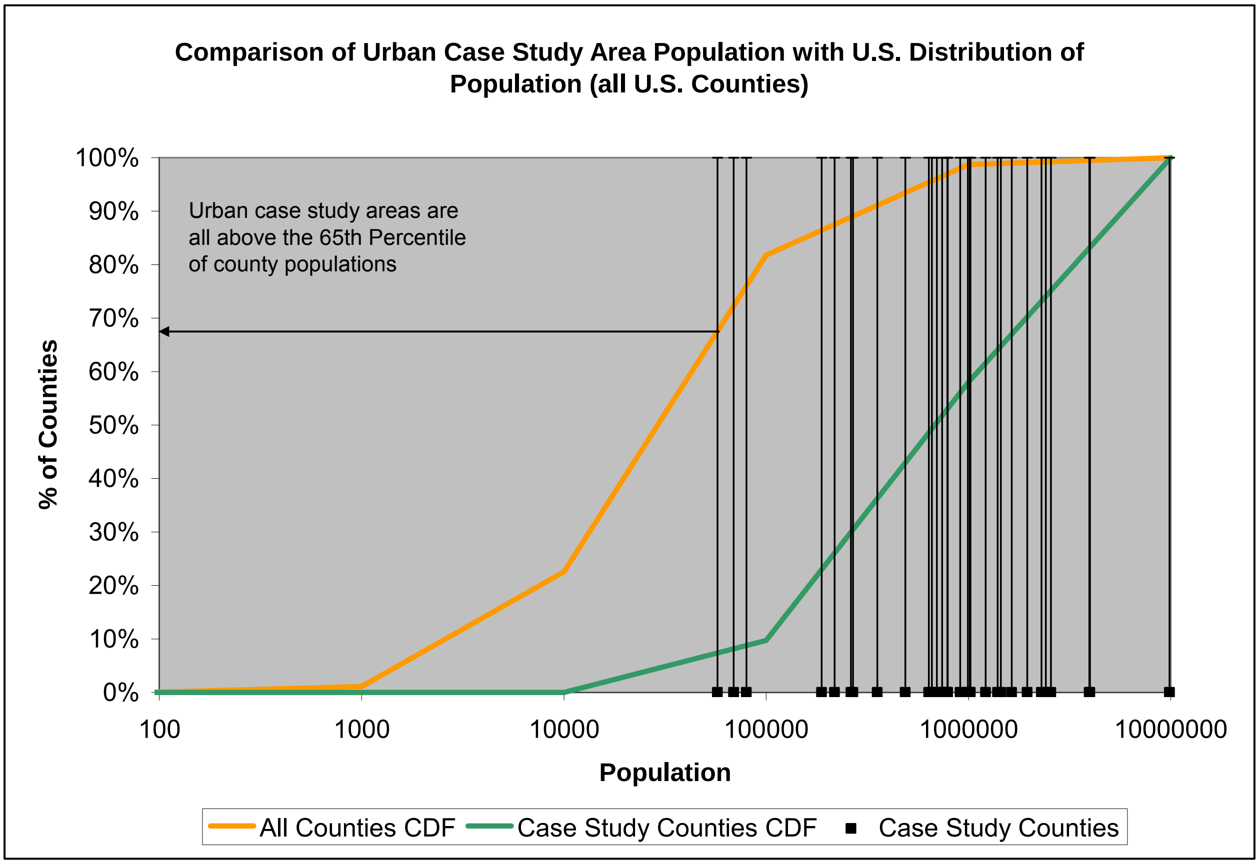


Figure D-2. Comparison of Distributions for Key Elements of the Risk Equation: Percent of Population Under 15 Years of Age

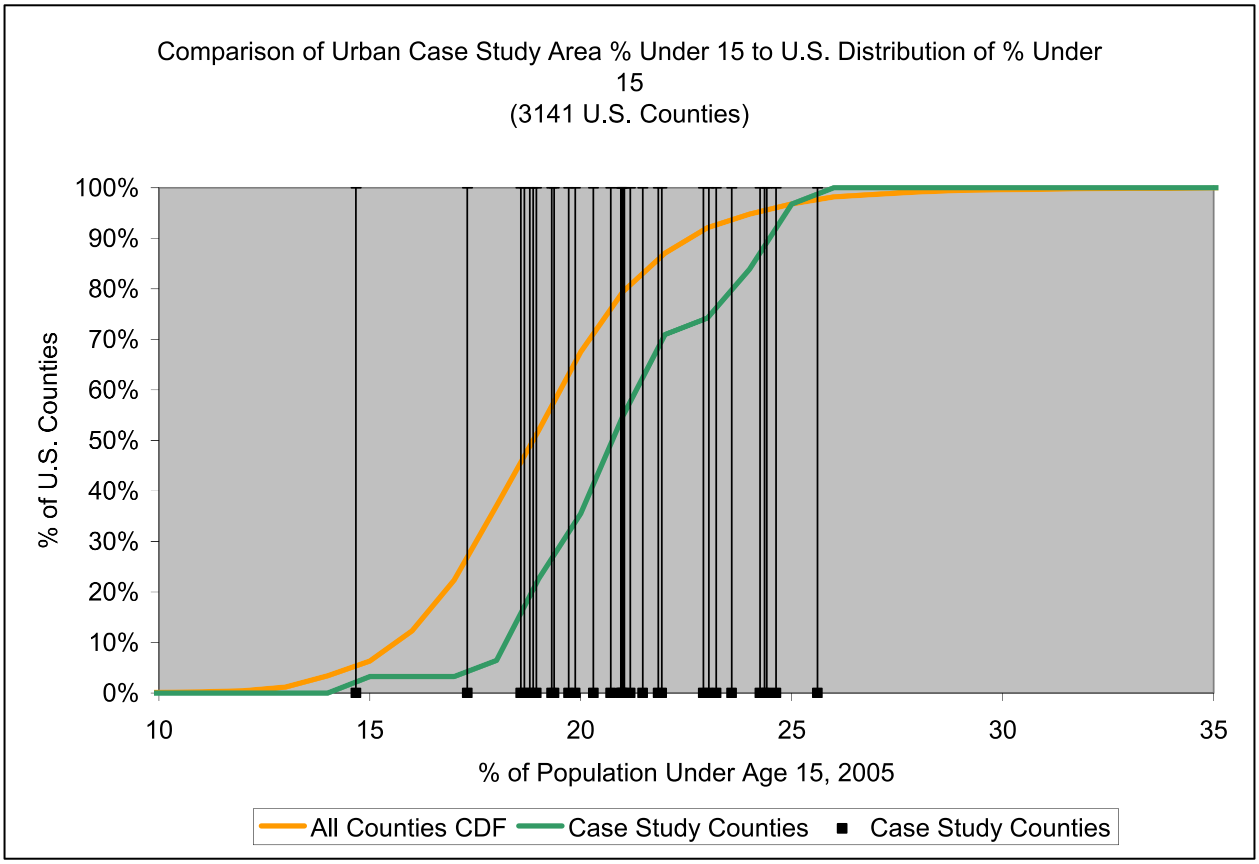


Figure D-3. Comparison of Distributions for Key Elements of the Risk Equation: Percent of Population 65 Years of Age and Older

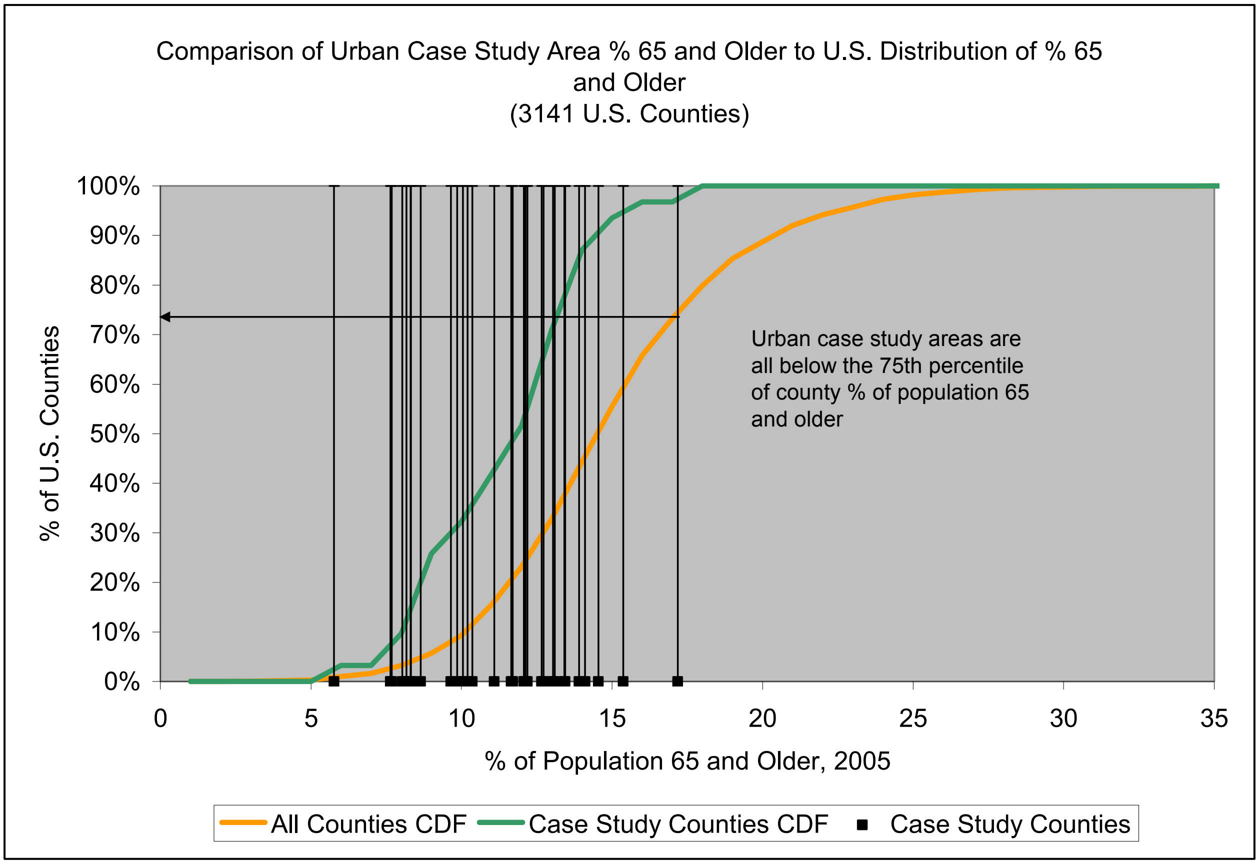


Figure D-4. Comparison of Distributions for Key Elements of the Risk Equation: Percent of Population 85 Years of Age and Older

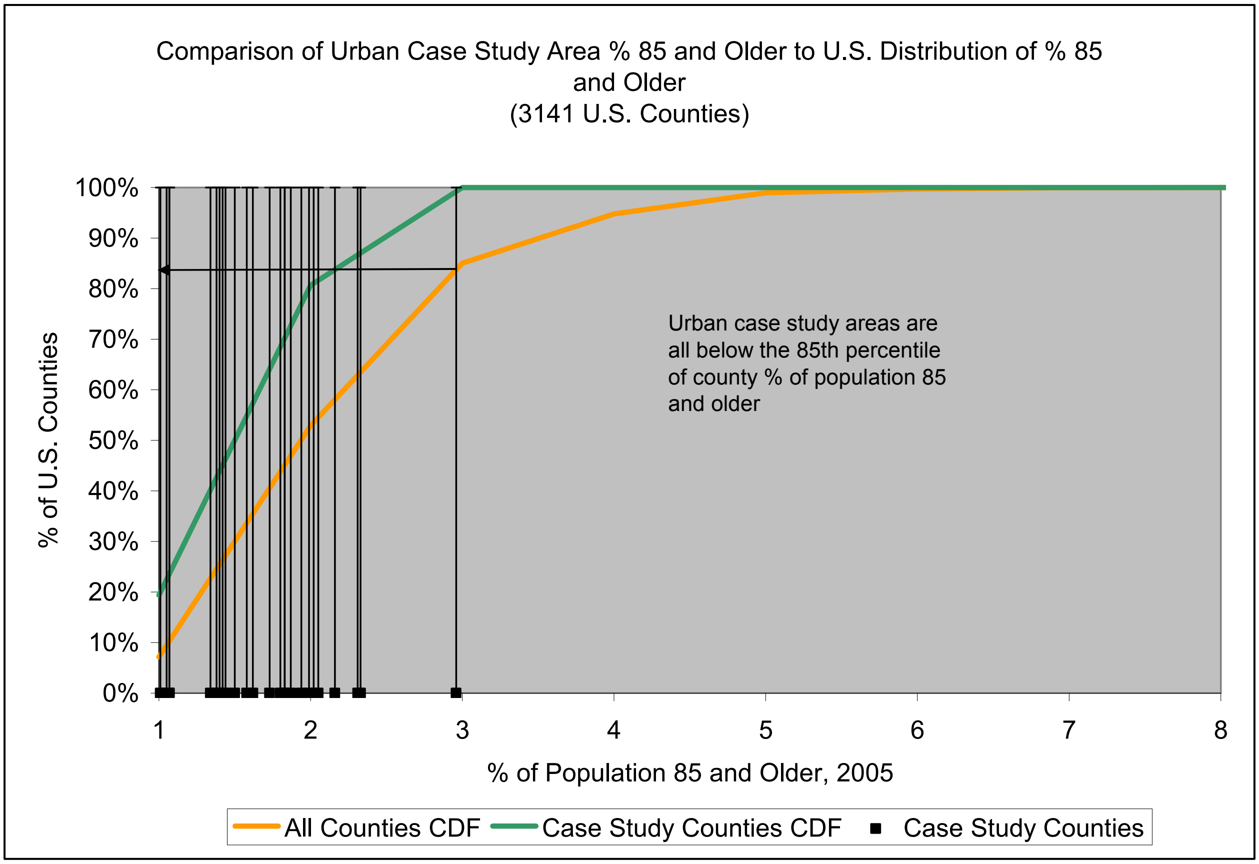


Figure D-5. Comparison of Distributions for Key Elements of the Risk Equation: Annual Mean PM2.5

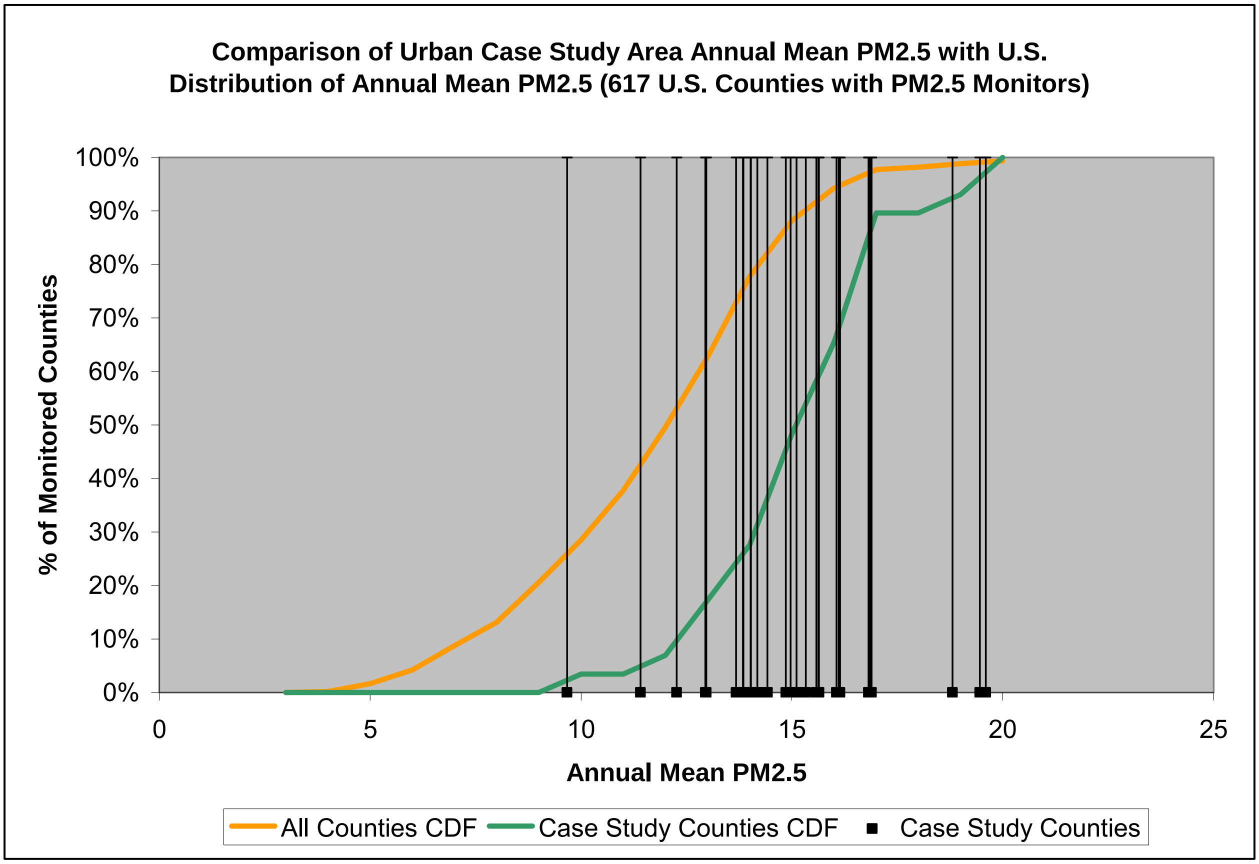


Figure D-6. Comparison of Distributions for Key Elements of the Risk Equation: 98th %ile Daily Average PM2.5

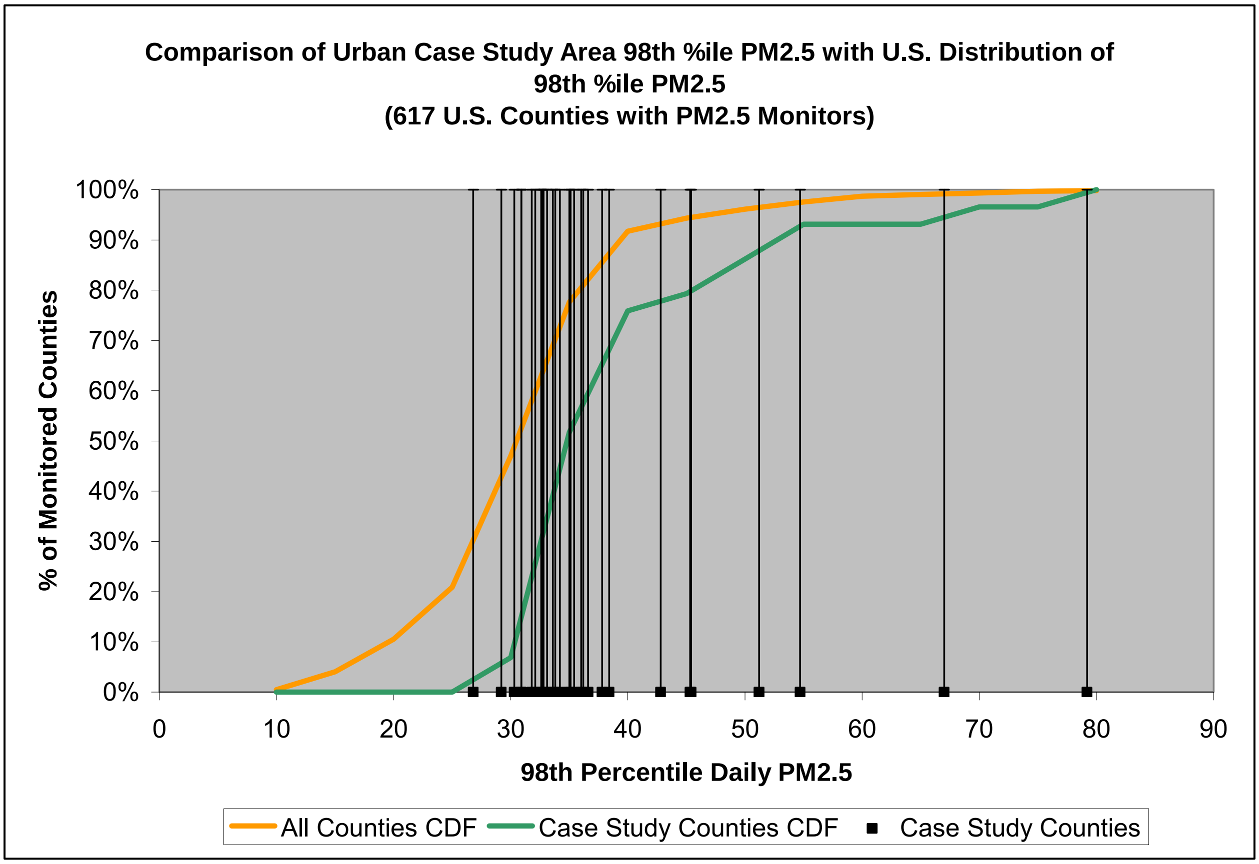


Figure D-7. Comparison of Distributions for Key Elements of the Risk Equation: % of Days with PM2.5>35 μg/m^3

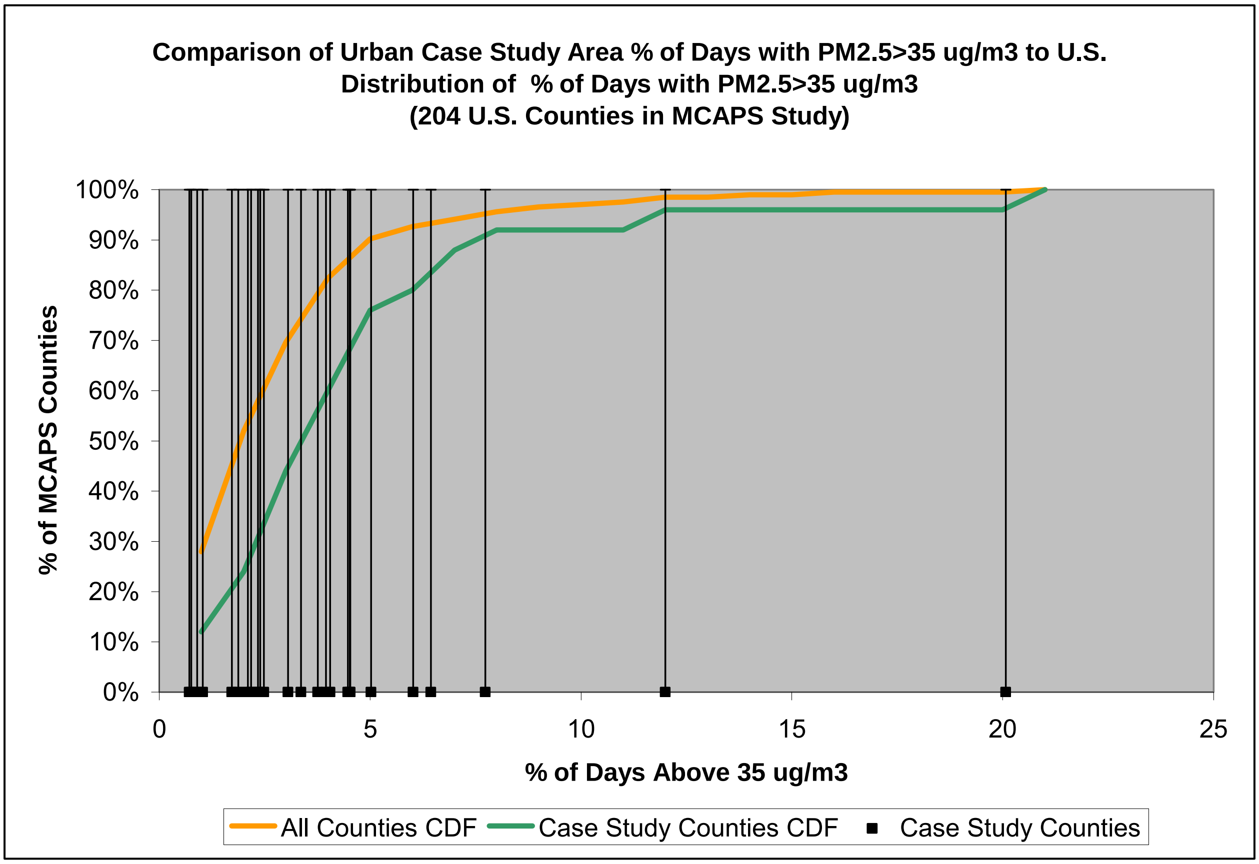


Figure D-8. Comparison of Distributions for Key Elements of the Risk Equation: All Cause Mortality Rate

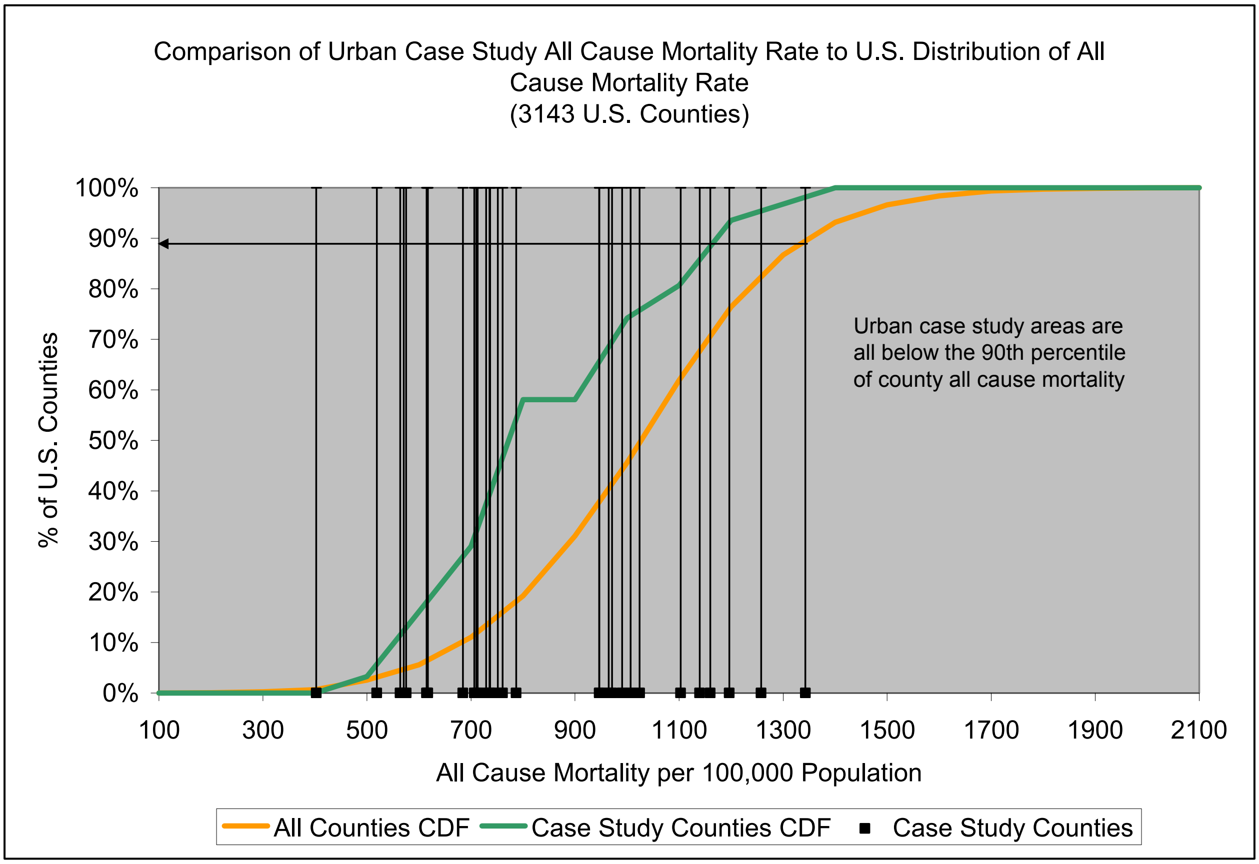


Figure D-9. Comparison of Distributions for Key Elements of the Risk Equation: Non-accidental Mortality Rate

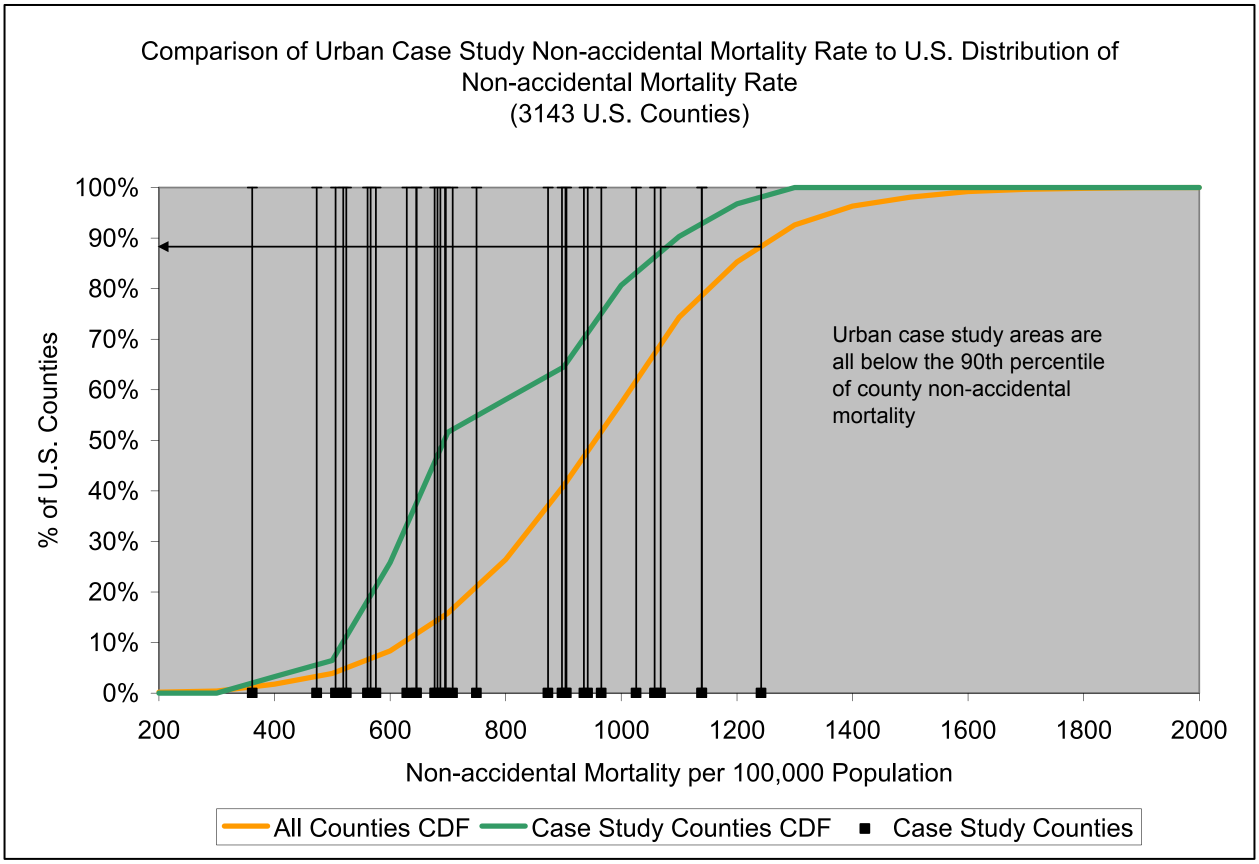


Figure D-10. Comparison of Distributions for Key Elements of the Risk Equation: Cardiovascular Mortality Rate

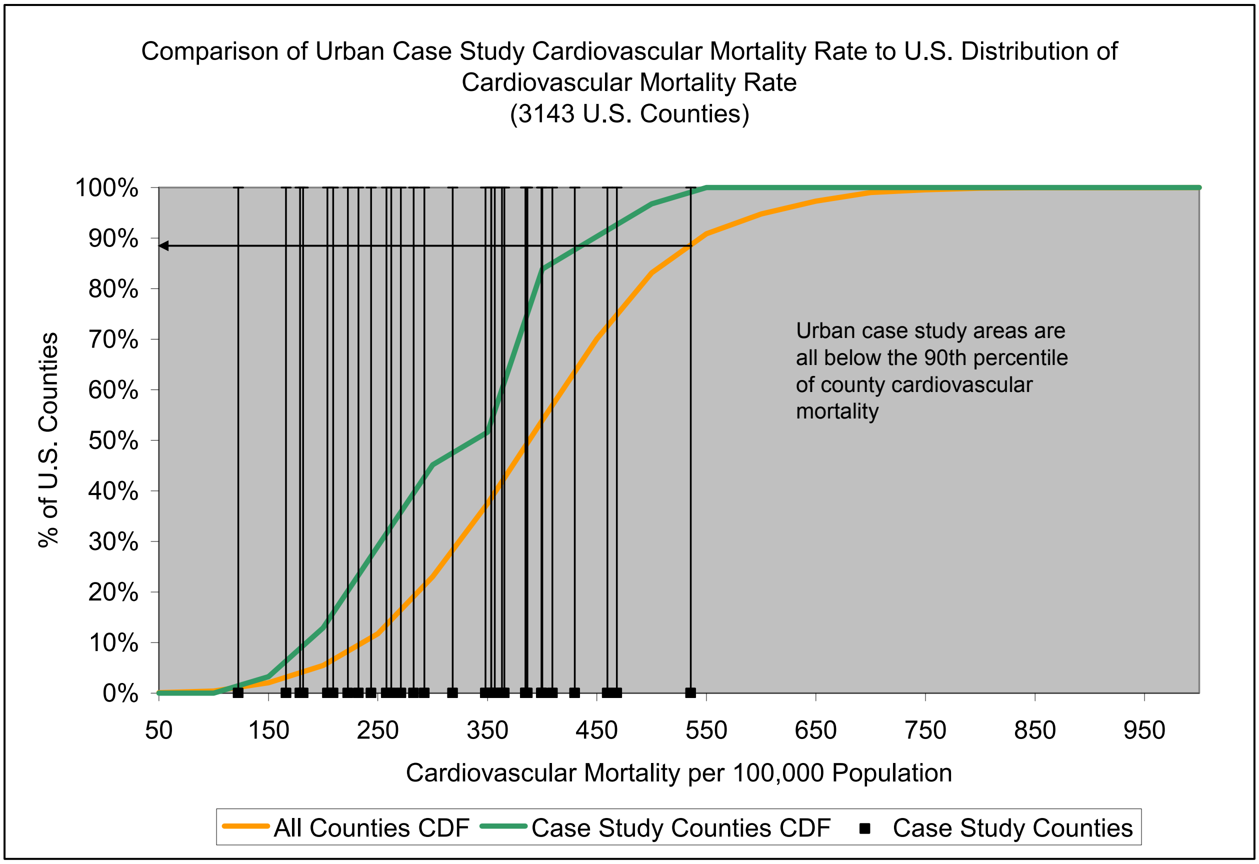


Figure D-11. Comparison of Distributions for Key Elements of the Risk Equation: Respiratory Mortality Rate

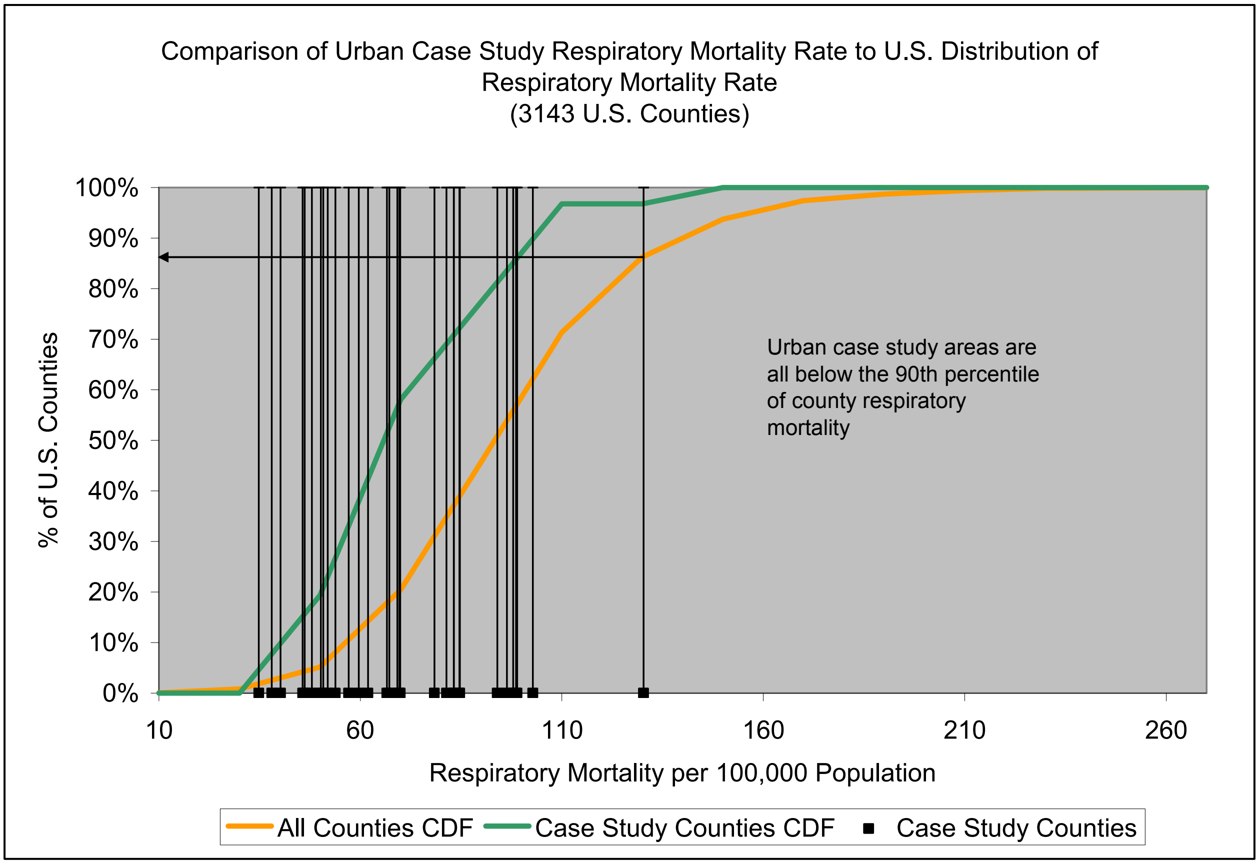


Figure D-12. Comparison of Distributions for Key Elements of the Risk Equation: All Cause Mortality Risk Effect Estimate from Zanobetti and Schwartz (2008)

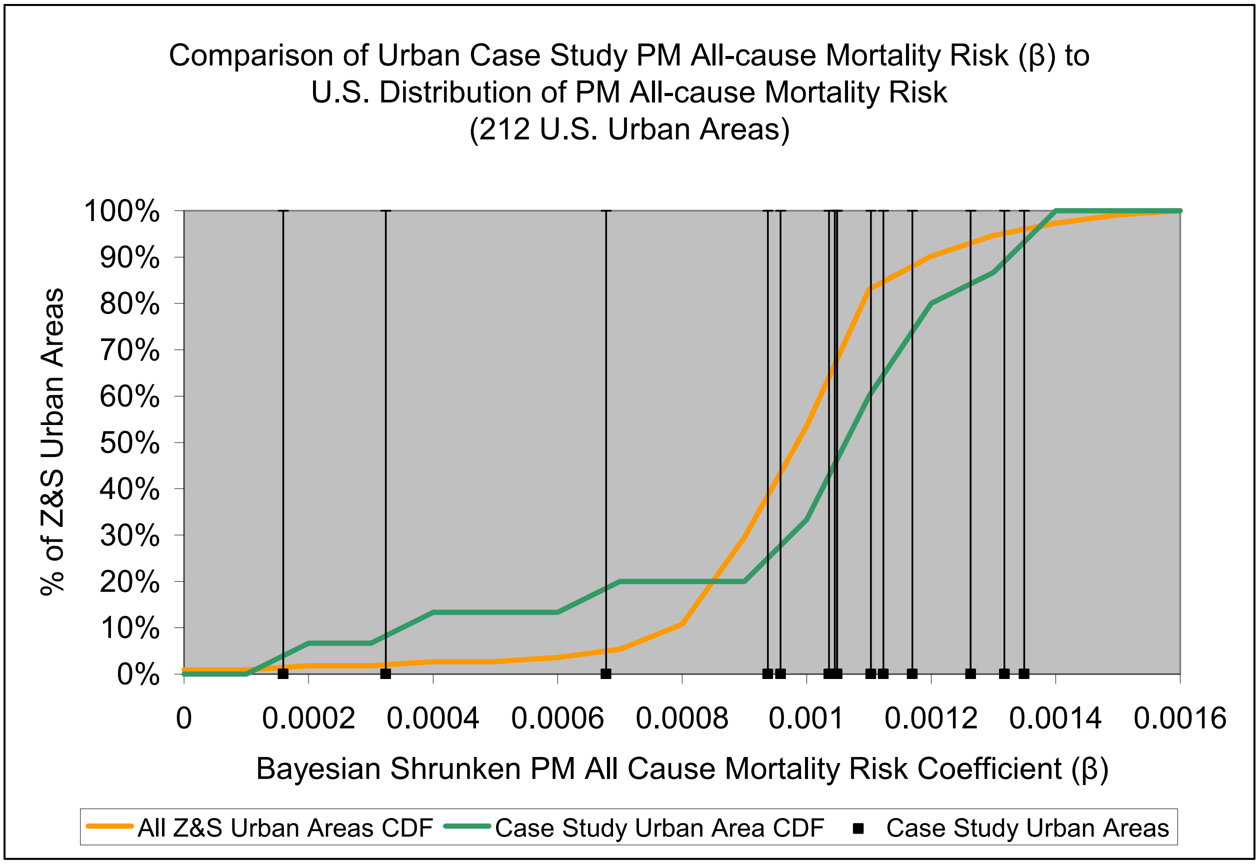


Figure D-13. Comparison of Distributions for Key Elements of the Risk Equation: Cardiovascular Mortality Risk Effect Estimate from Zanobetti and Schwartz (2008)

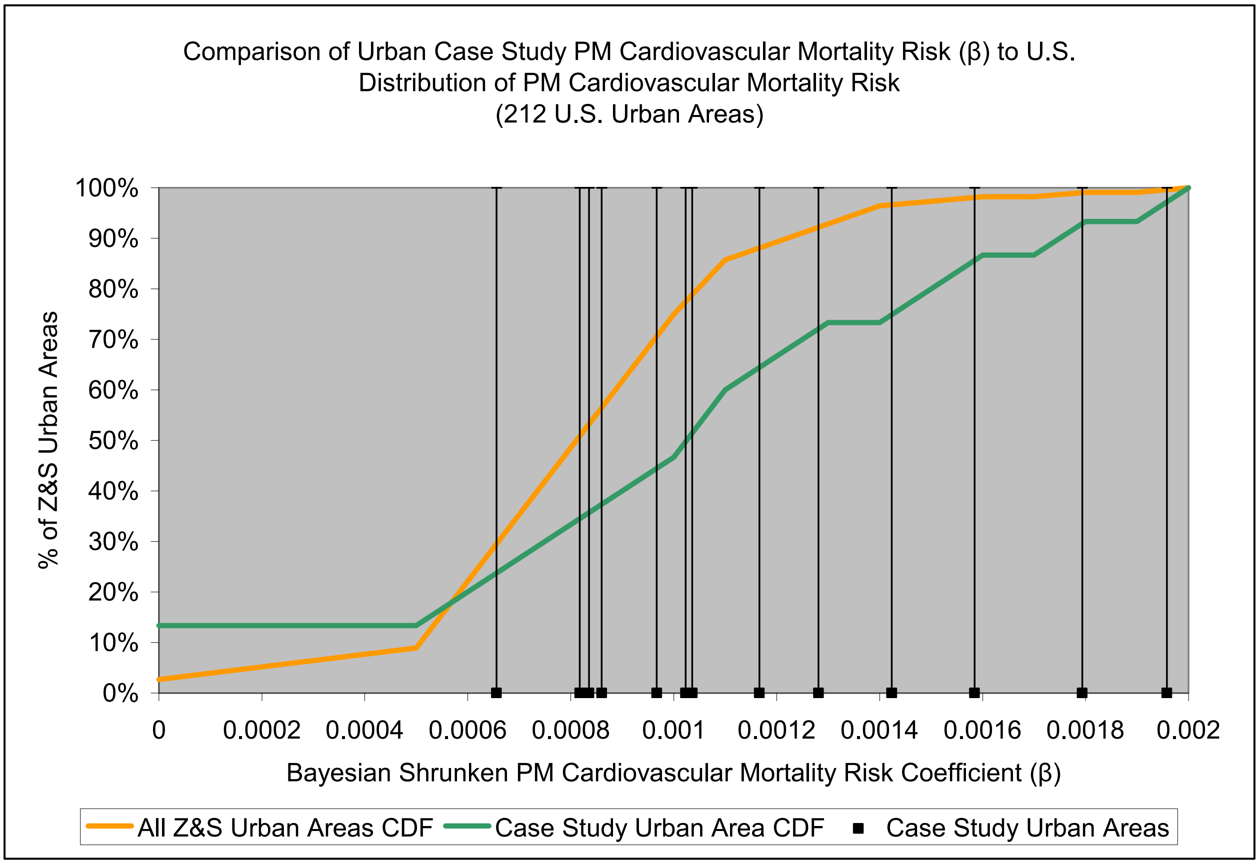
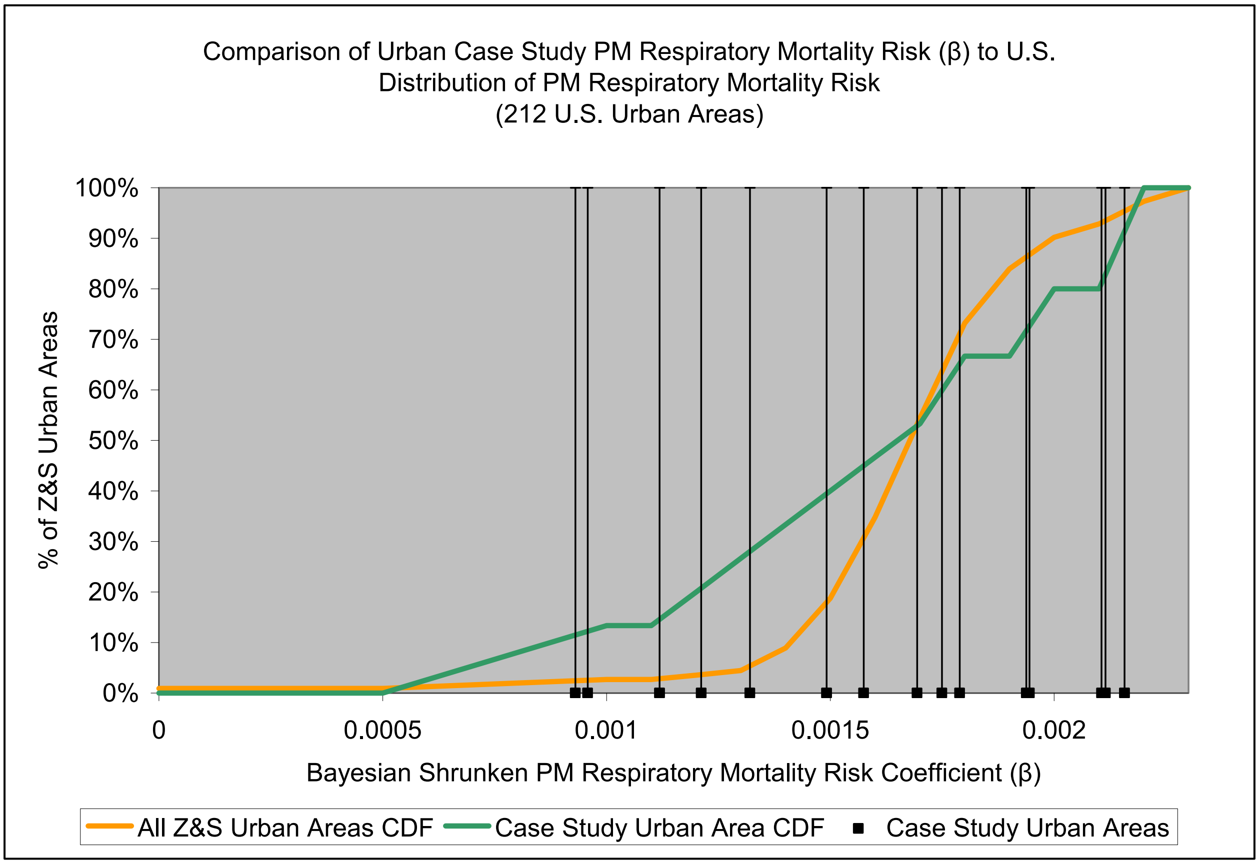


Figure D-14. Comparison of Distributions for Key Elements of the Risk Equation: Respiratory Mortality Risk Effect Estimate from Zanobetti and Schwartz (2008)



D.2. Variables Expected to Influence the Relative Risk from PM2.5

D.2.1. Demographic Variables

Figure D-15. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Population Density

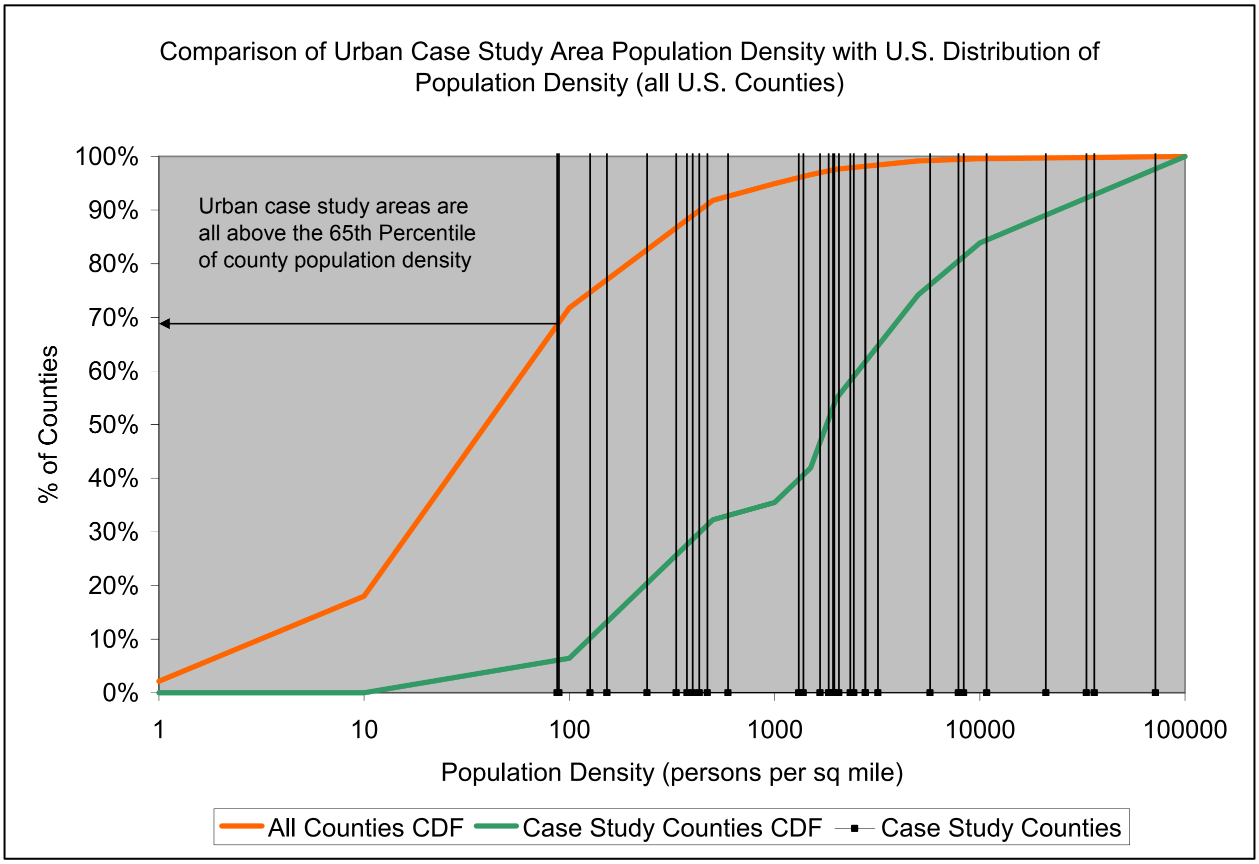


Figure D-16. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Unemployment Rate

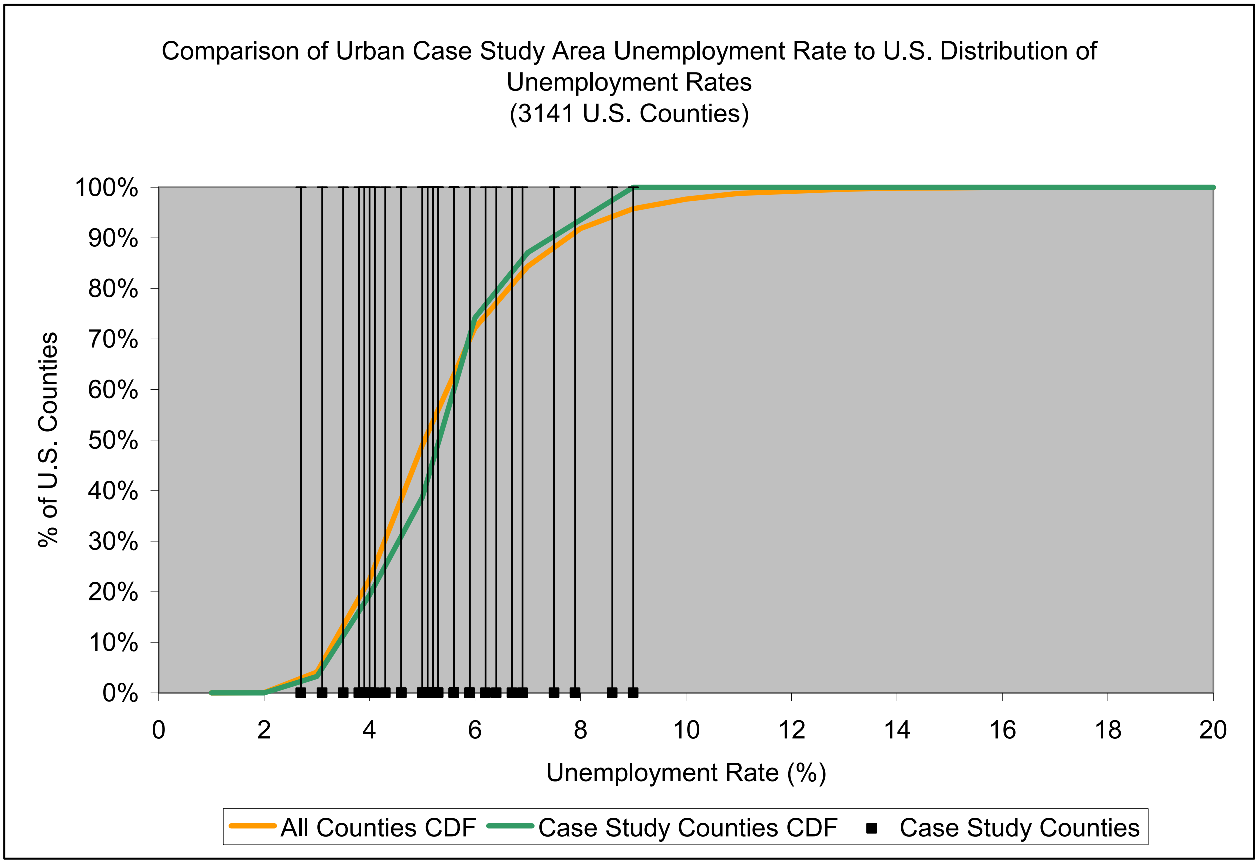


Figure D-17. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: % with Less than a High School Education

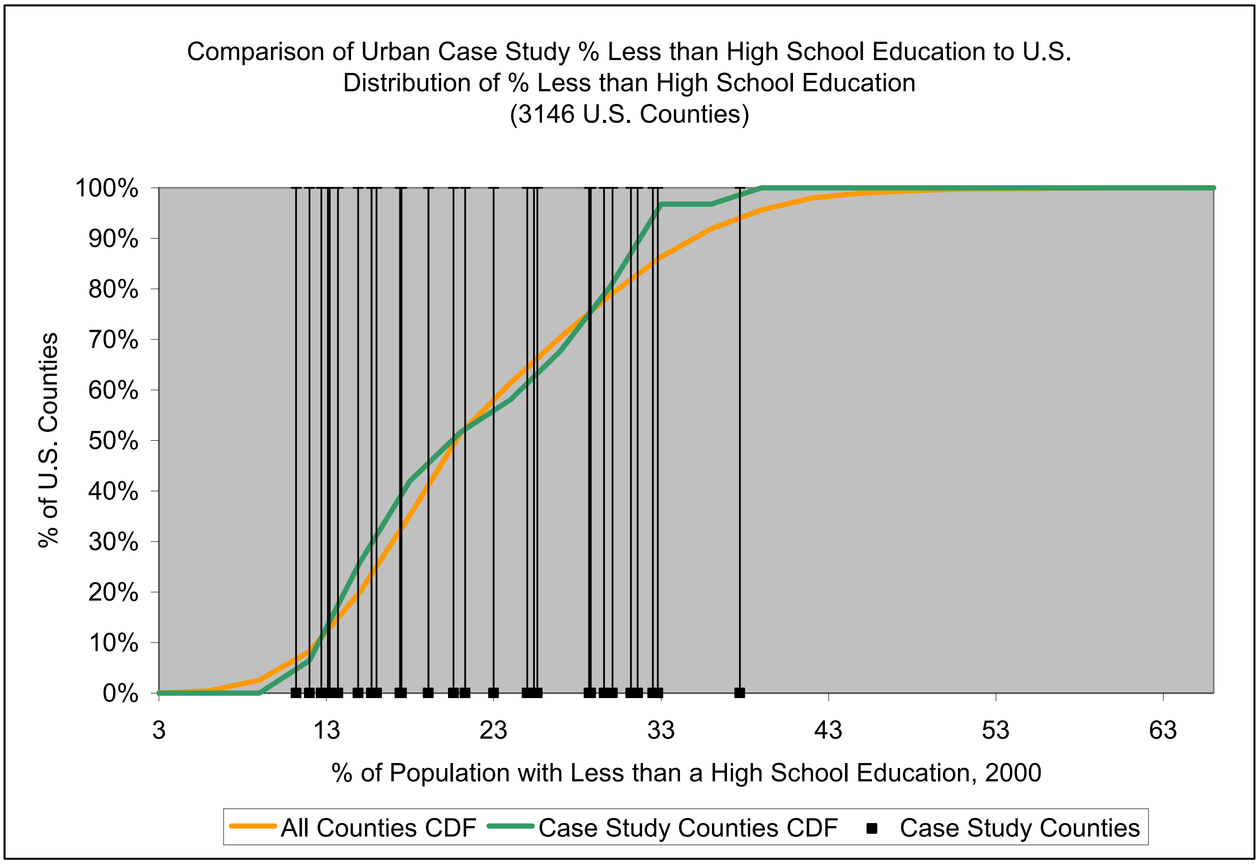


Figure D-18. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Per Capita Personal Income

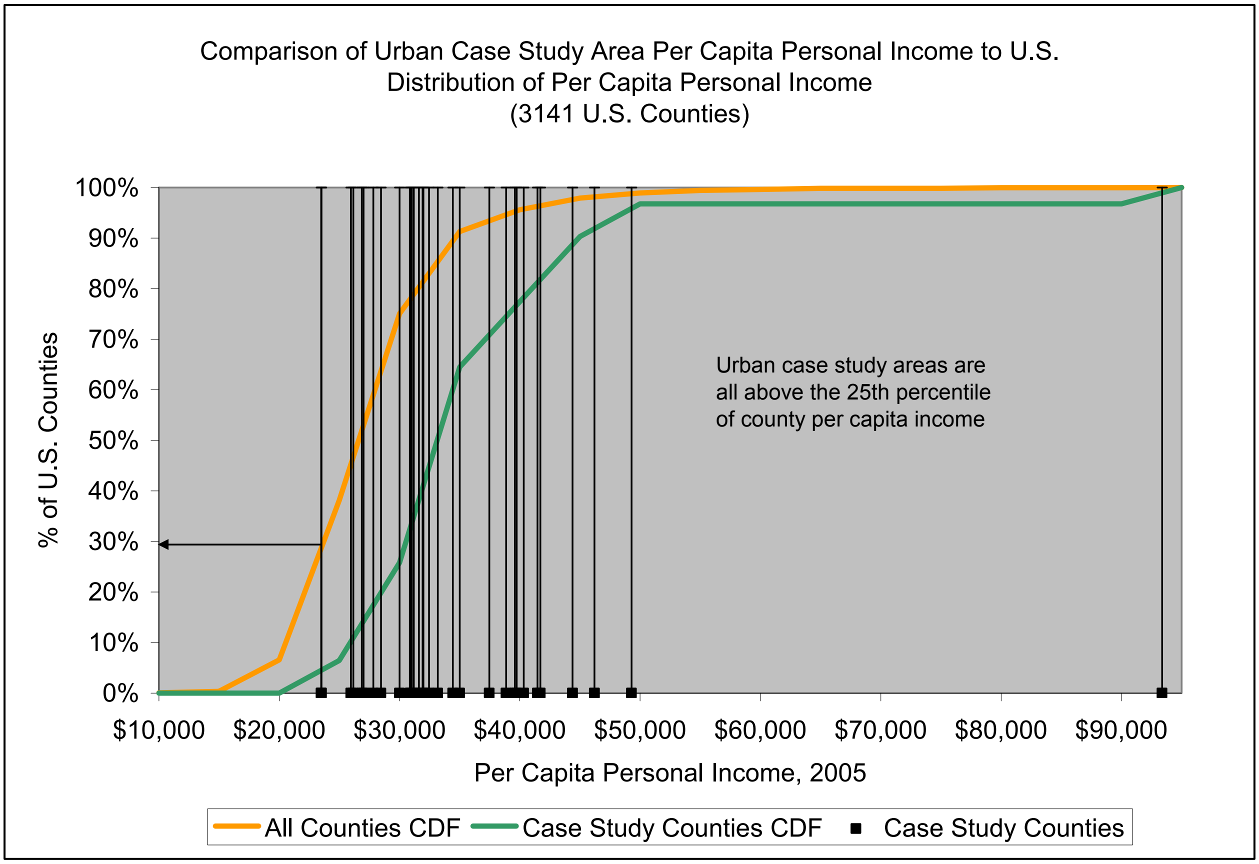


Figure D-19. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Air Conditioning Prevalence

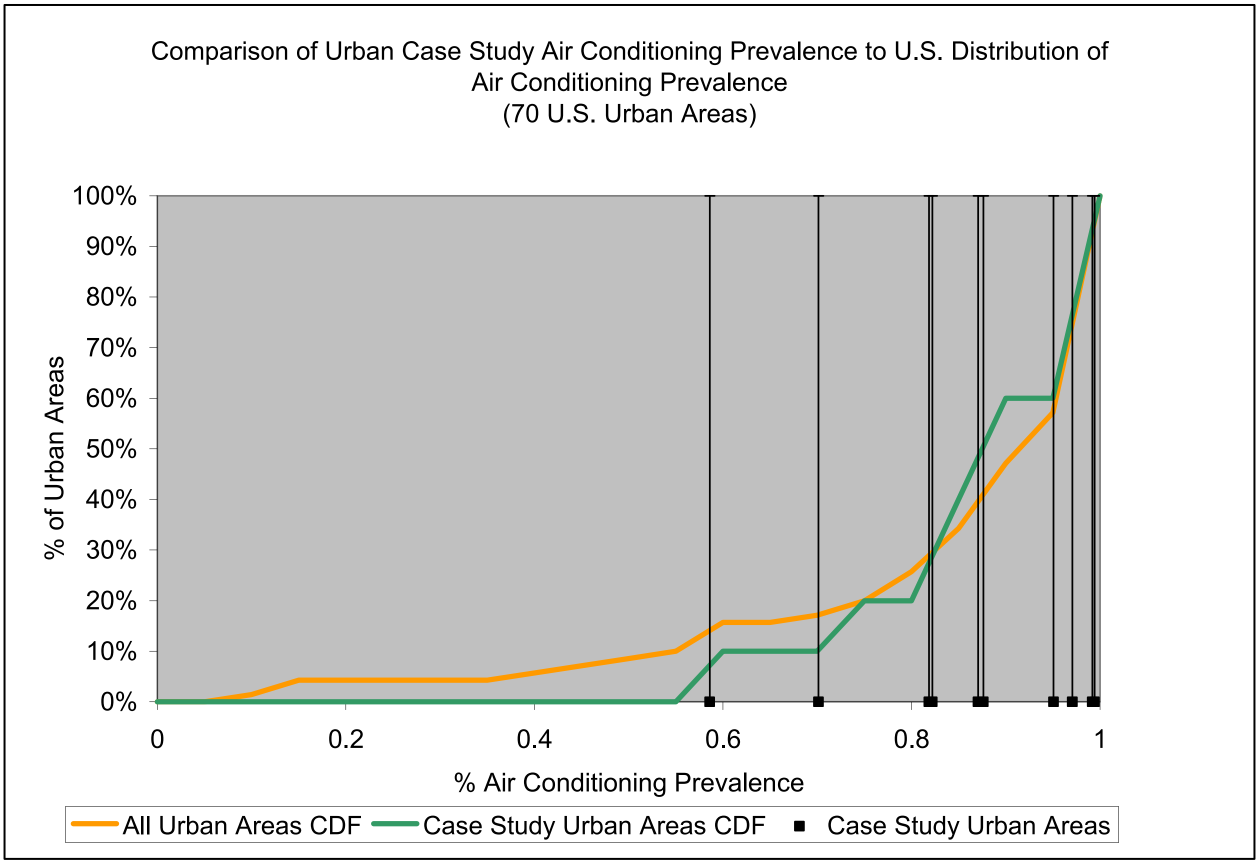
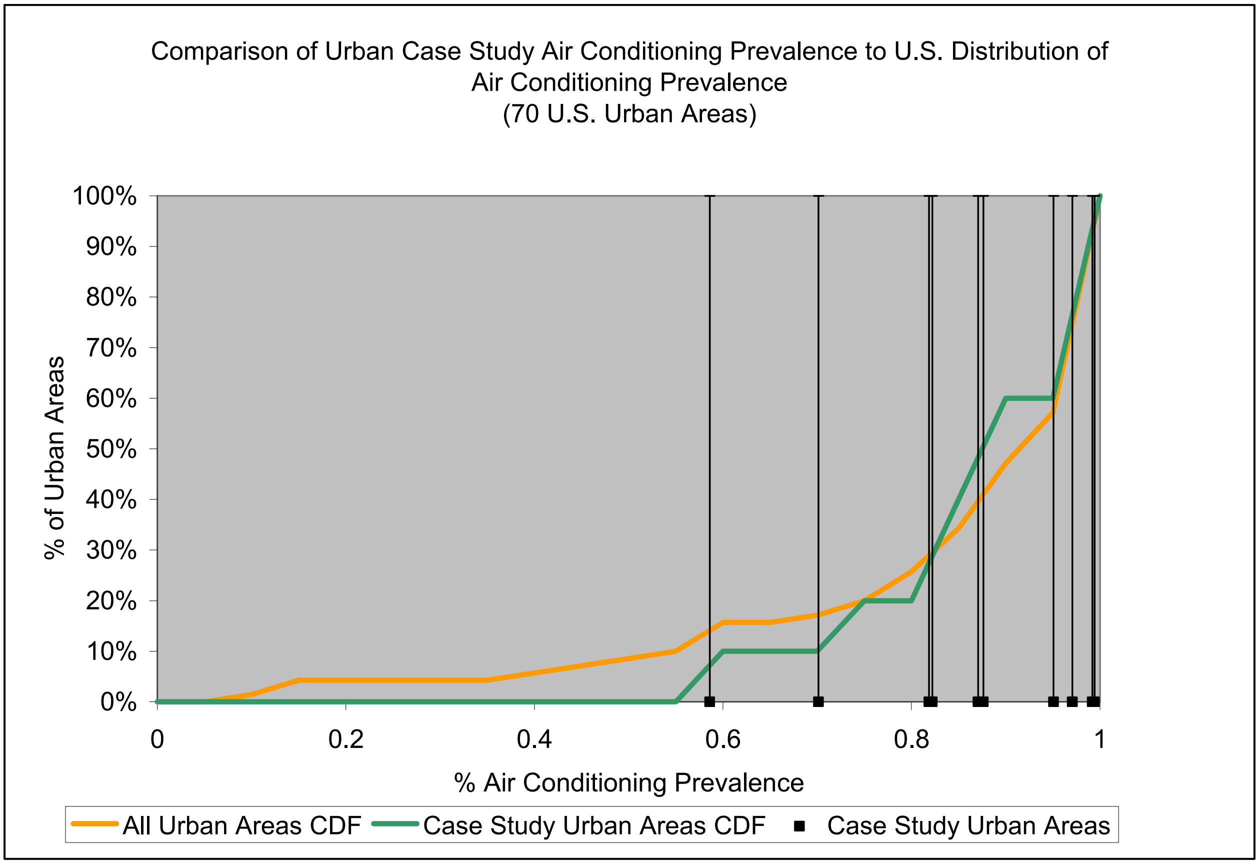


Figure D-20. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: % Non-white Population



D.2.2. Health Conditions

Figure D-21. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Angina/Coronary Heart Disease Prevalence

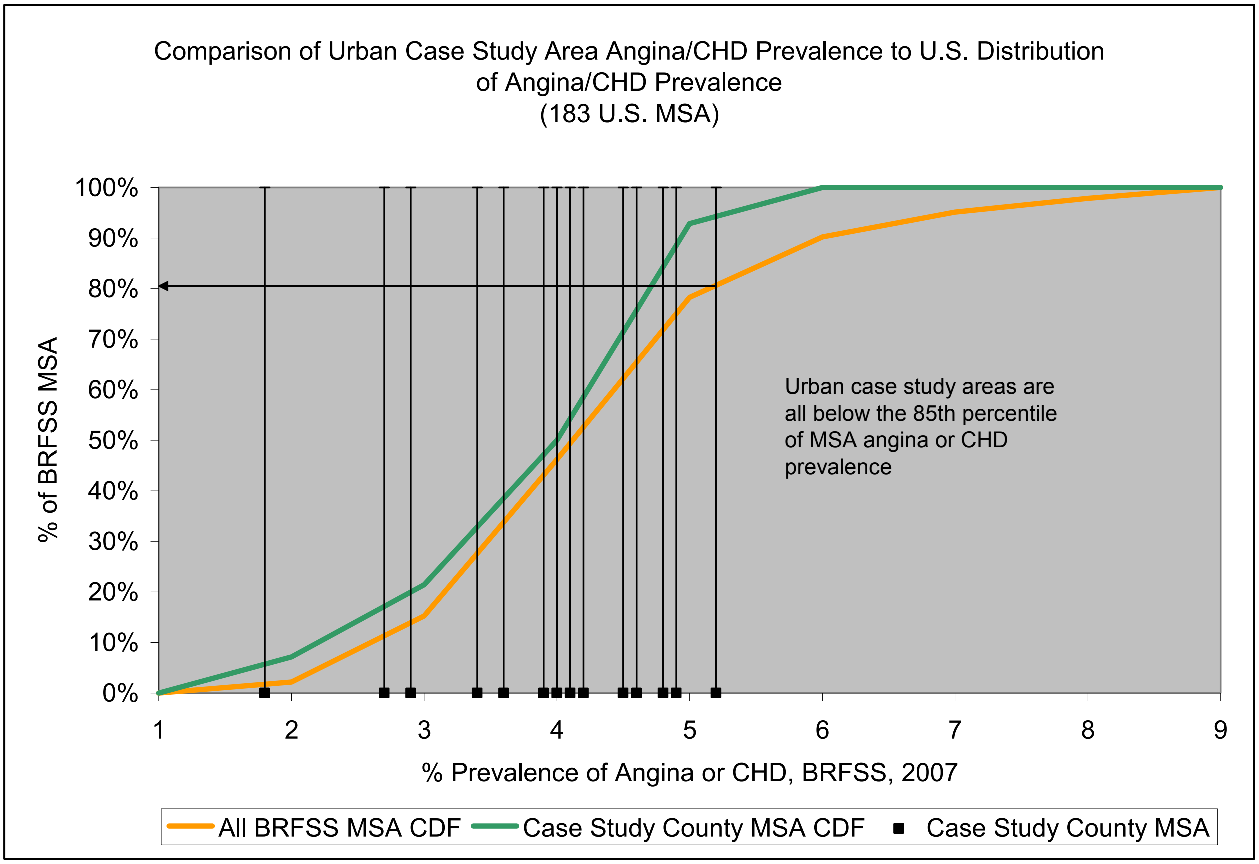


Figure D-22. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Asthma Prevalence

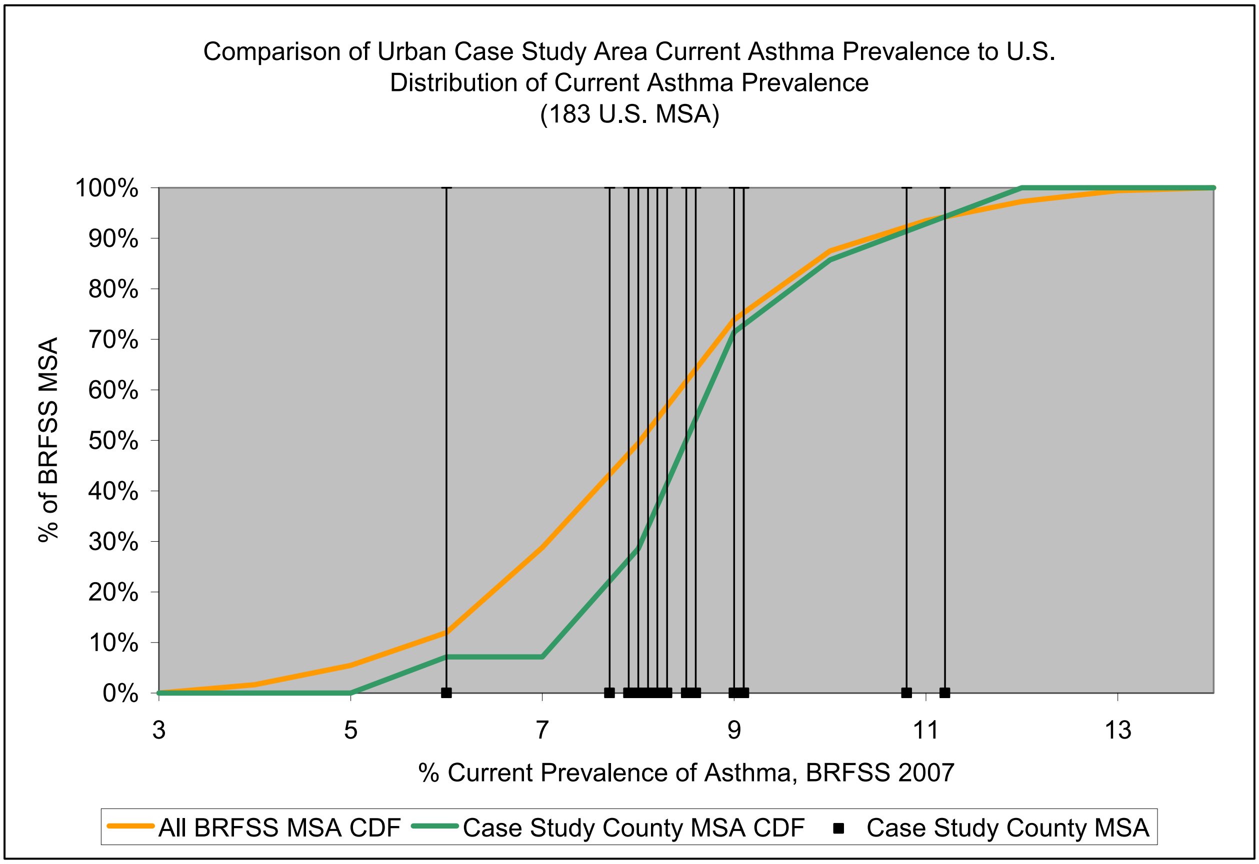


Figure D-23. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Diabetes Prevalence

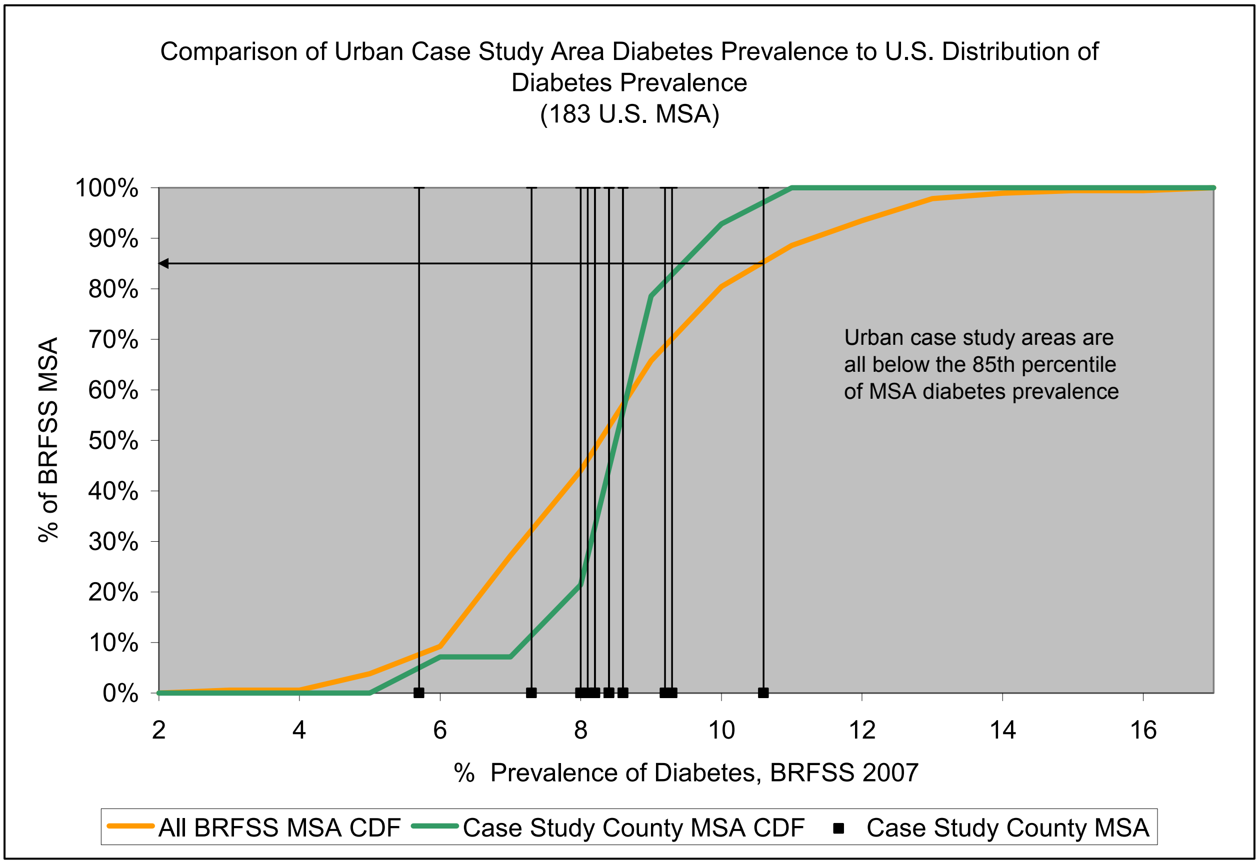


Figure D-24. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Heart Attack Prevalence

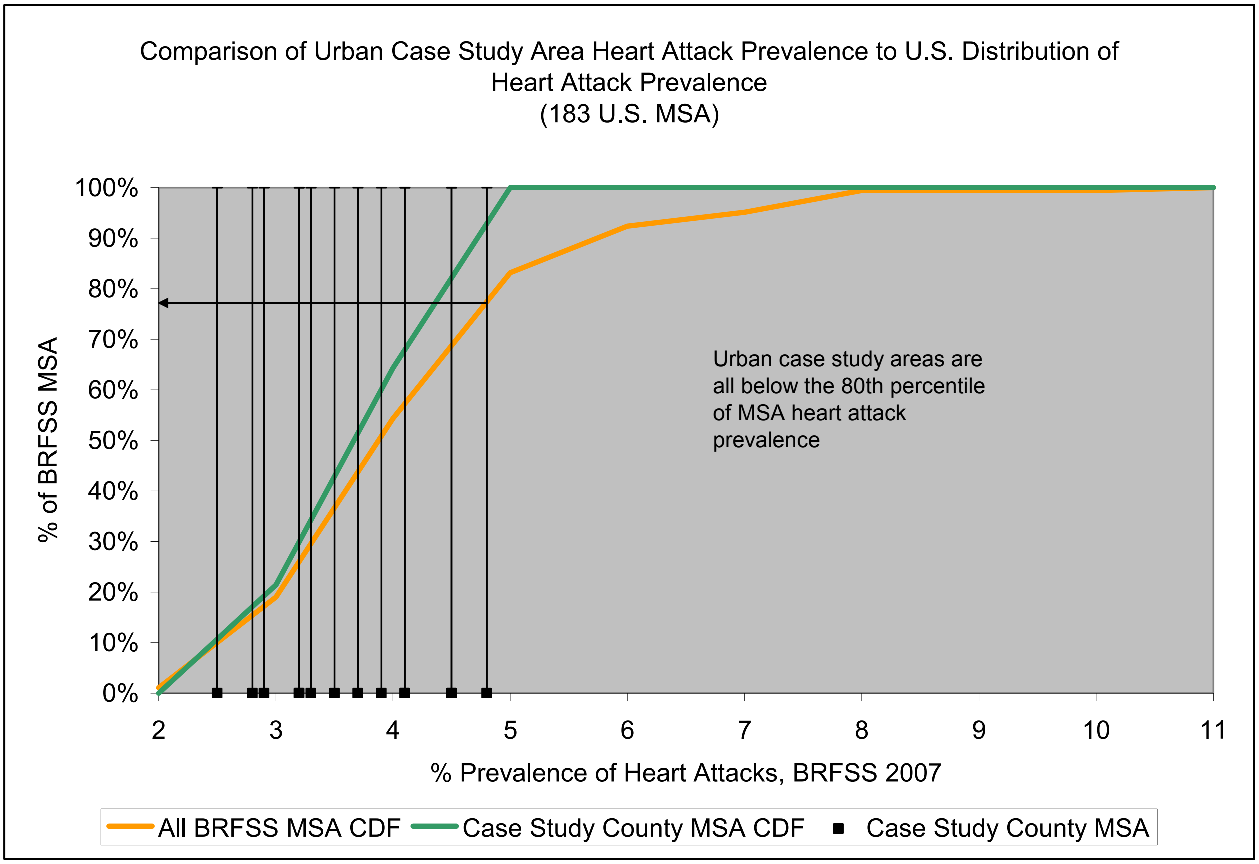


Figure D-25. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Obesity Prevalence

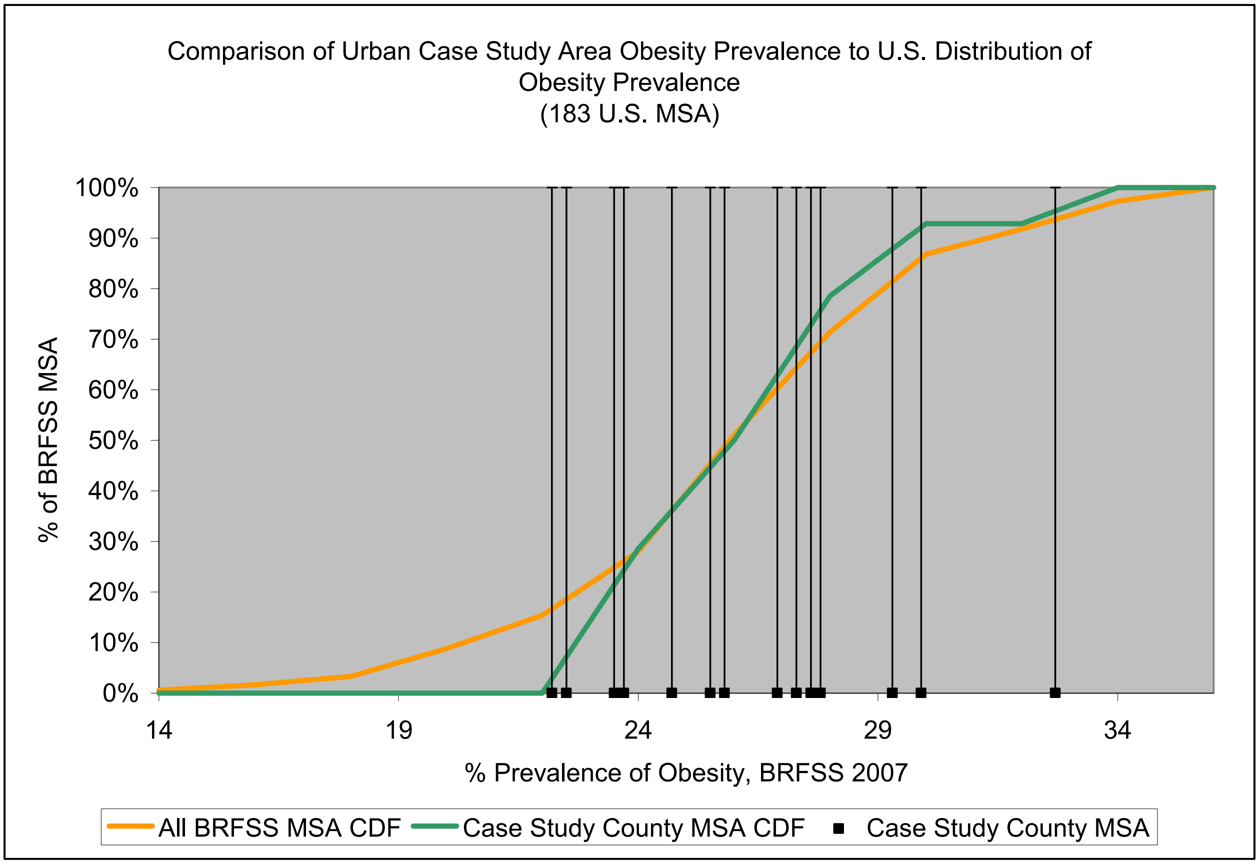


Figure D-26. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Stroke Prevalence

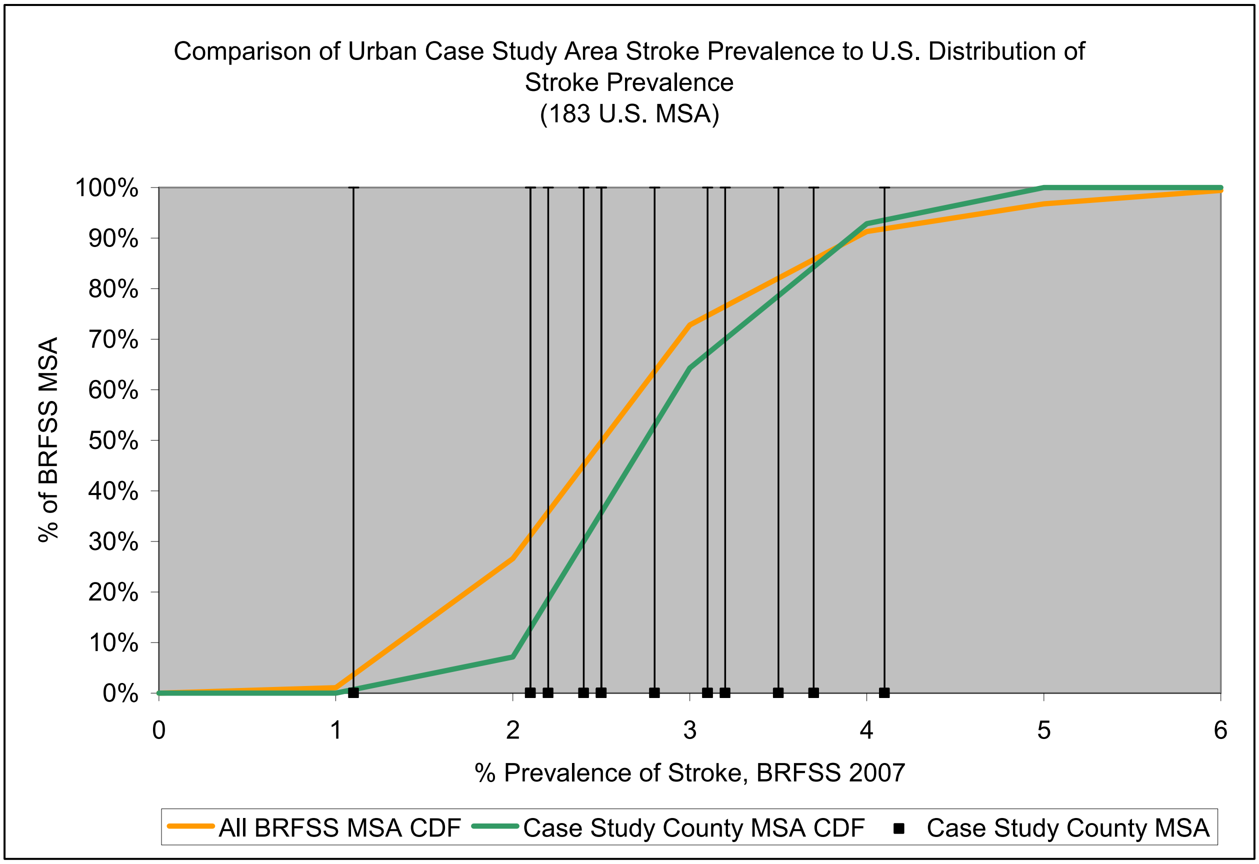


Figure D-27. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Smoking Prevalence

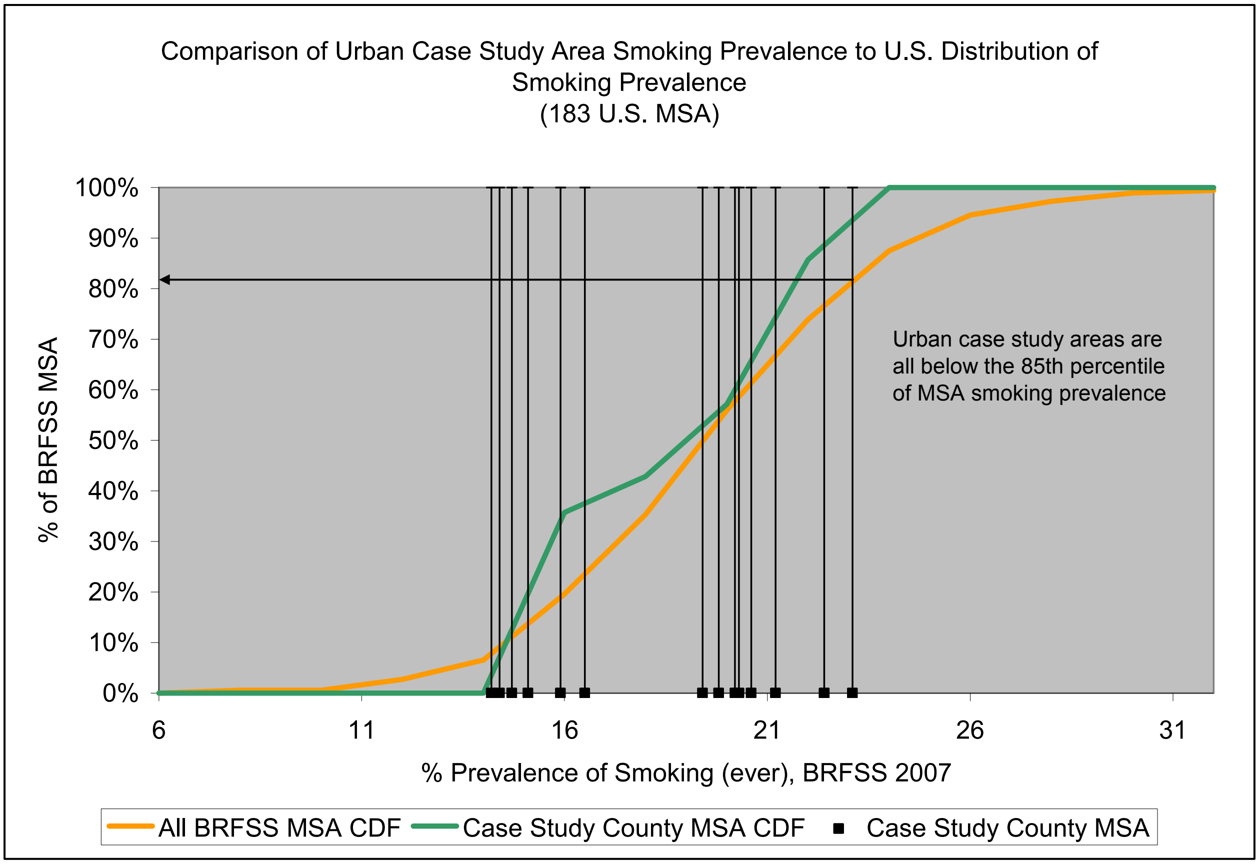
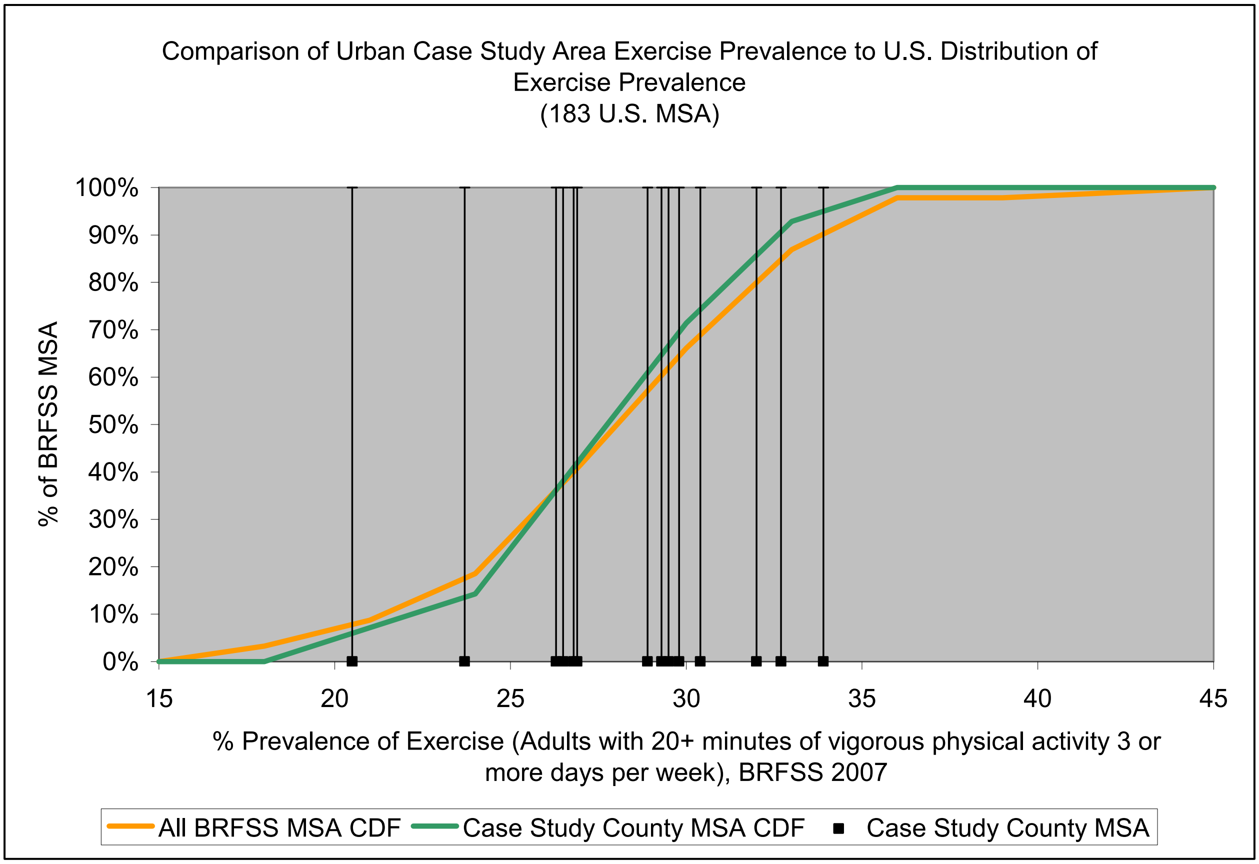


Figure D-28. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: Exercise Prevalence



D.2.3. Air Quality and Climate Variables

Figure D-29. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: 4th Highest Daily Max 8-hour Average

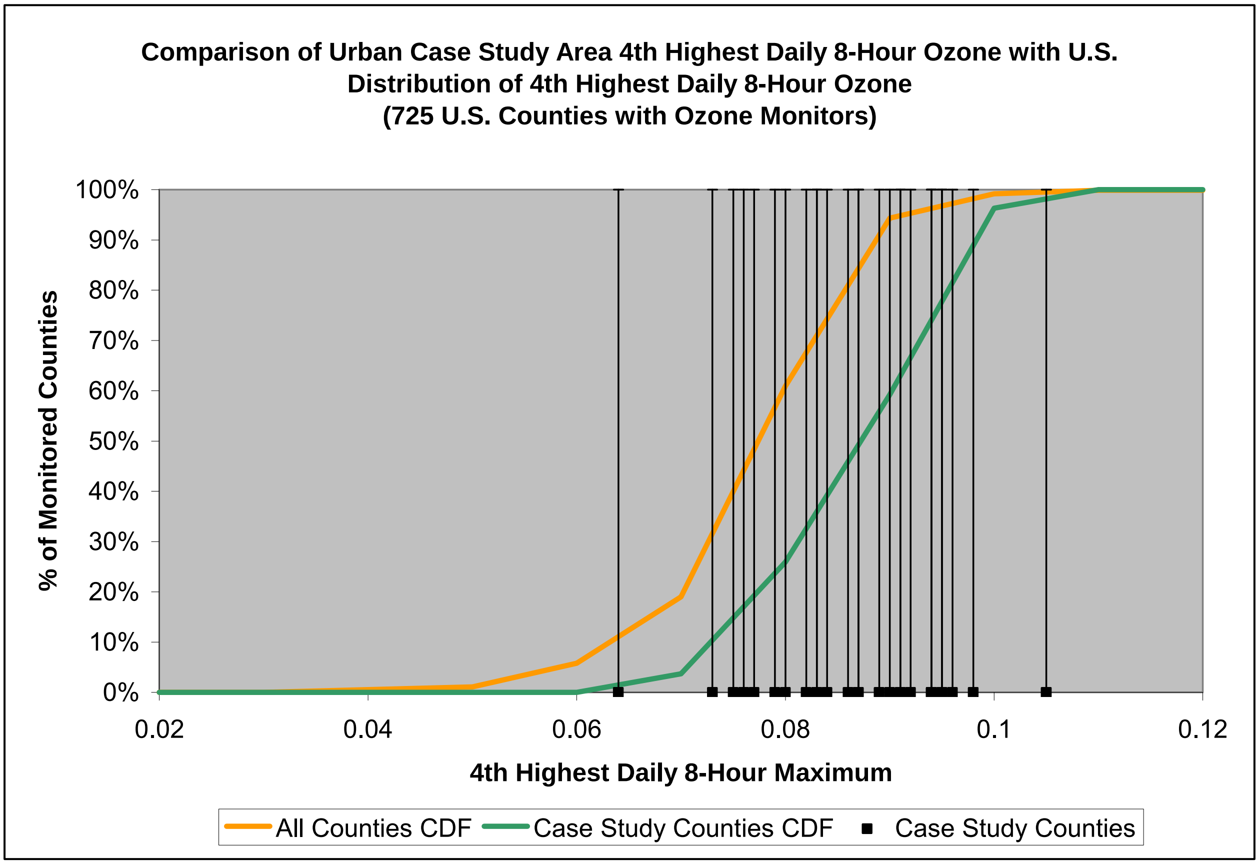


Figure D-30. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: % Mobile Source Direct PM2.5 Emissions

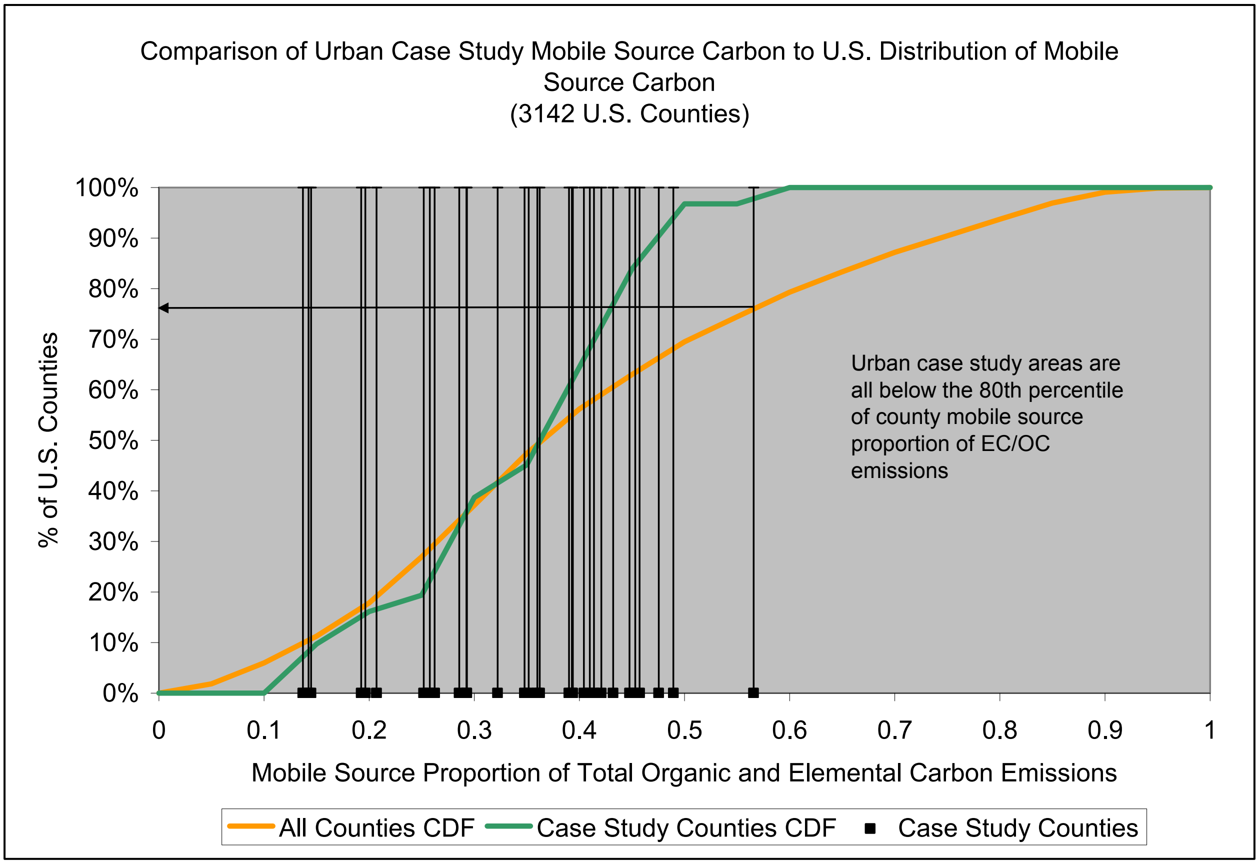


Figure D-31. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: July Temperature Long Term Average

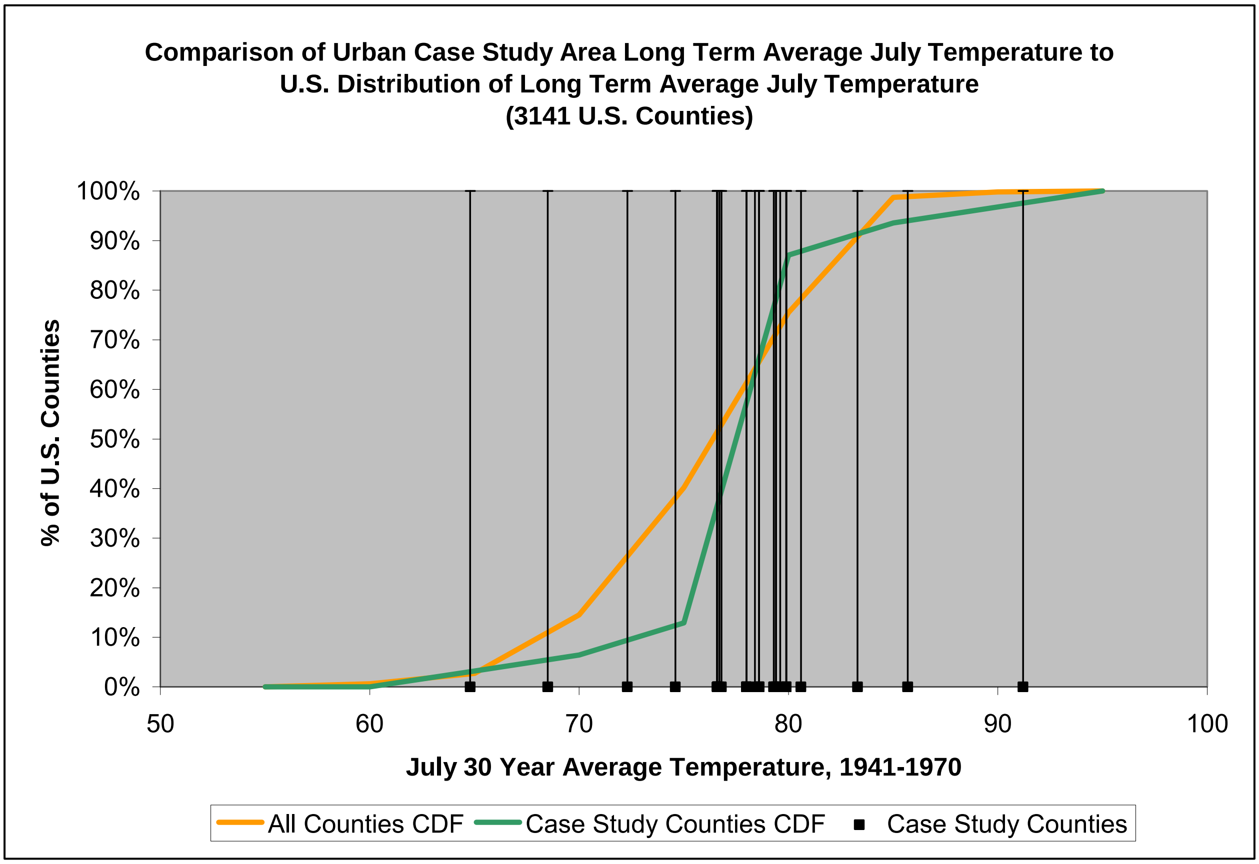
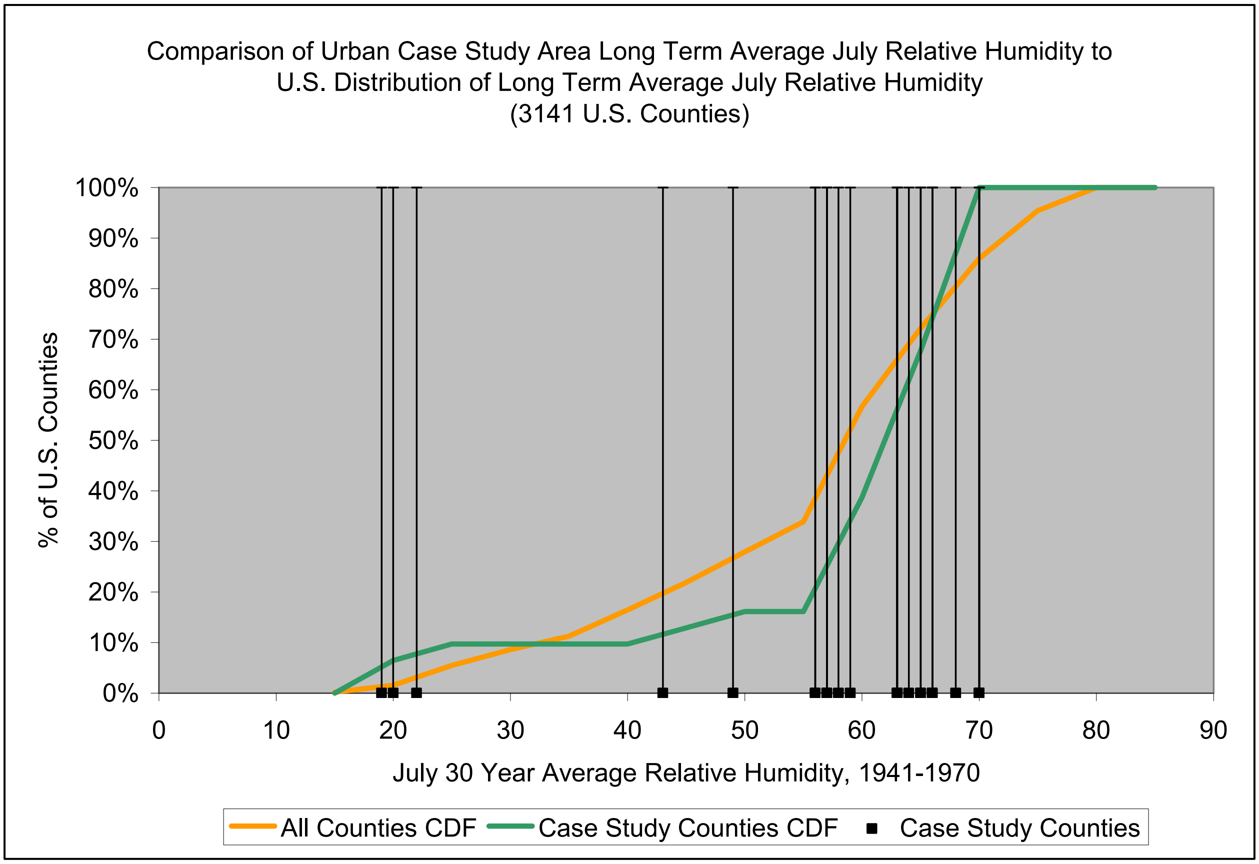


Figure D-32. Comparison of Distributions for Selected Variables Expected to Influence the Relative Risk from PM2.5: July Relative Humidity Long Term Average



APPENDIX E: RISK ESTIMATES (CORE ANALYSIS)

Appendix E. Risk Analysis (core analysis)

This Appendix provides detailed risk estimates generated for the core analysis for the 15 urban study areas. The tables cover all of the air quality scenarios modeled, including recent conditions, the current standard, and alternative standard levels. For additional detail on the types of risk metrics (and figures summarizing key metrics) presented in this Appendix, see section 4.0.

We have identified an error in the approach used to simulate ambient $PM_{2.5}$ levels for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Consequently, this error impacts the risk estimates generated for the current and alternative standards but does not impact the risk estimates for the recent conditions scenario. There was insufficient time after identifying this error to either generate corrected risk estimates or remove the erroneous risk estimates from the summary tables presented in this Appendix. We will correct this error and release updated results for the Pittsburgh study area as soon as is practicable and will include the corrected results in the next version of this document. Note, that this error does not impact risk estimates for any of the other urban study areas.

Table E-1. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	645 (419 - 869)	572 (371 - 770)	449 (290 - 605)	386 (250 - 522)	449 (290 - 605)	377 (244 - 509)
Baltimore, MD	592 (384 - 796)	543 (352 - 732)	438 (284 - 590)	378 (245 - 510)	422 (273 - 569)	299 (194 - 404)
Birmingham, AL	494 (321 - 663)	352 (228 - 474)	275 (178 - 370)	236 (152 - 318)	275 (178 - 370)	199 (129 - 269)
Dallas, TX	366 (237 - 494)	366 (237 - 494)	366 (237 - 494)	324 (210 - 437)	366 (237 - 494)	324 (210 - 437)
Detroit, MI	754 (490 - 1015)	544 (352 - 733)	469 (303 - 633)	400 (259 - 540)	411 (266 - 555)	277 (179 - 375)
Fresno, CA	249 (161 - 334)	86 (55 - 116)	86 (55 - 116)	86 (55 - 116)	56 (36 - 76)	26 (17 - 35)
Houston, TX	721 (468 - 971)	663 (430 - 893)	517 (335 - 697)	443 (287 - 599)	517 (335 - 697)	443 (287 - 599)
Los Angeles, CA	2443 (1585 - 3286)	1116 (721 - 1507)	1116 (721 - 1507)	985 (636 - 1332)	779 (503 - 1053)	440 (284 - 596)
New York, NY	1725 (1118 - 2326)	1247 (807 - 1684)	1186 (767 - 1601)	998 (645 - 1349)	903 (583 - 1220)	556 (359 - 752)
Philadelphia, PA	490 (318 - 661)	427 (276 - 576)	379 (245 - 512)	324 (209 - 437)	320 (207 - 432)	213 (137 - 287)
Phoenix, AZ	476 (308 - 643)	476 (308 - 643)	476 (308 - 643)	427 (276 - 577)	414 (267 - 559)	257 (166 - 348)
Pittsburgh, PA	698 (454 - 938)	285 (184 - 386)	285 (184 - 386)	285 (184 - 386)	201 (130 - 272)	117 (75 - 158)
Salt Lake City, UT	123 (80 - 166)	42 (27 - 57)	42 (27 - 57)	42 (27 - 57)	22 (14 - 29)	1 (1 - 1)
St. Louis, MO	791 (513 - 1064)	669 (433 - 901)	530 (343 - 715)	454 (294 - 614)	515 (334 - 695)	361 (233 - 487)
Tacoma, WA	121 (79 - 164)	79 (51 - 107)	79 (51 - 107)	79 (51 - 107)	52 (34 - 70)	25 (16 - 34)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-2. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	624 (405 - 840)	551 (357 - 743)	430 (278 - 580)	368 (238 - 497)	430 (278 - 580)	359 (232 - 485)
Baltimore, MD	515 (334 - 693)	470 (305 - 634)	374 (242 - 504)	319 (206 - 431)	359 (232 - 485)	247 (159 - 333)
Birmingham, AL	478 (310 - 642)	339 (220 - 457)	263 (170 - 355)	225 (145 - 304)	263 (170 - 355)	189 (122 - 256)
Dallas, TX	281 (181 - 379)	281 (181 - 379)	281 (181 - 379)	244 (158 - 330)	281 (181 - 379)	244 (158 - 330)
Detroit, MI	573 (371 - 773)	396 (256 - 534)	332 (215 - 449)	275 (177 - 371)	284 (183 - 384)	171 (110 - 232)
Fresno, CA	264 (172 - 355)	94 (60 - 127)	94 (60 - 127)	94 (60 - 127)	63 (40 - 85)	31 (20 - 42)
Houston, TX	762 (494 - 1026)	701 (455 - 945)	548 (355 - 739)	471 (304 - 635)	548 (355 - 739)	471 (304 - 635)
Los Angeles, CA	2191 (1421 - 2951)	950 (614 - 1285)	950 (614 - 1285)	829 (535 - 1121)	636 (410 - 861)	320 (206 - 433)
New York, NY	1489 (964 - 2009)	1047 (677 - 1415)	991 (640 - 1339)	818 (528 - 1106)	729 (471 - 987)	409 (264 - 554)
Philadelphia, PA	481 (311 - 648)	418 (270 - 563)	371 (240 - 501)	316 (204 - 426)	312 (202 - 422)	206 (133 - 279)
Phoenix, AZ	520 (336 - 703)	520 (336 - 703)	520 (336 - 703)	468 (303 - 633)	454 (294 - 614)	288 (186 - 389)
Pittsburgh, PA	605 (393 - 814)	231 (149 - 312)	231 (149 - 312)	231 (149 - 312)	155 (100 - 210)	78 (51 - 106)
Salt Lake City, UT	102 (66 - 138)	27 (18 - 37)	27 (18 - 37)	27 (18 - 37)	8 (5 - 11)	0 (0 - 0)
St. Louis, MO	613 (397 - 826)	508 (329 - 686)	389 (252 - 526)	325 (210 - 439)	377 (244 - 510)	245 (158 - 331)
Tacoma, WA	79 (51 - 106)	44 (28 - 59)	44 (28 - 59)	44 (28 - 59)	22 (14 - 29)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-3. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	646 (419 - 869)	571 (370 - 769)	445 (288 - 600)	382 (247 - 516)	445 (288 - 600)	372 (241 - 503)
Baltimore, MD	482 (312 - 649)	439 (284 - 592)	346 (224 - 467)	294 (190 - 397)	332 (215 - 449)	224 (145 - 303)
Birmingham, AL	473 (307 - 636)	335 (217 - 451)	259 (168 - 350)	221 (143 - 299)	259 (168 - 350)	186 (120 - 251)
Dallas, TX	311 (201 - 420)	311 (201 - 420)	311 (201 - 420)	272 (176 - 367)	311 (201 - 420)	272 (176 - 367)
Detroit, MI	536 (347 - 723)	366 (236 - 494)	305 (197 - 412)	250 (161 - 337)	258 (167 - 349)	150 (97 - 204)
Fresno, CA	299 (194 - 402)	112 (73 - 152)	112 (73 - 152)	112 (73 - 152)	78 (51 - 106)	44 (28 - 60)
Houston, TX	748 (485 - 1007)	687 (445 - 926)	535 (346 - 721)	458 (296 - 618)	535 (346 - 721)	458 (296 - 618)
Los Angeles, CA	2240 (1453 - 3016)	979 (632 - 1323)	979 (632 - 1323)	855 (552 - 1156)	659 (425 - 892)	338 (218 - 457)
New York, NY	1514 (980 - 2043)	1067 (690 - 1442)	1010 (652 - 1364)	834 (539 - 1128)	745 (481 - 1008)	421 (272 - 570)
Philadelphia, PA	476 (308 - 641)	413 (267 - 557)	367 (237 - 495)	312 (202 - 421)	308 (199 - 417)	203 (131 - 274)
Phoenix, AZ	451 (292 - 610)	451 (292 - 610)	451 (292 - 610)	402 (260 - 543)	388 (251 - 525)	230 (148 - 311)
Pittsburgh, PA	613 (398 - 825)	236 (153 - 319)	236 (153 - 319)	236 (153 - 319)	160 (103 - 216)	83 (53 - 112)
Salt Lake City, UT	142 (92 - 192)	52 (34 - 71)	52 (34 - 71)	52 (34 - 71)	29 (19 - 40)	6 (4 - 9)
St. Louis, MO	653 (423 - 880)	545 (353 - 735)	421 (272 - 569)	354 (229 - 479)	408 (264 - 551)	271 (175 - 366)
Tacoma, WA	91 (59 - 123)	53 (34 - 72)	53 (34 - 72)	53 (34 - 72)	30 (19 - 40)	6 (4 - 8)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-4. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	4.3% (2.8% - 5.8%)	3.8% (2.5% - 5.1%)	3% (1.9% - 4%)	2.6% (1.7% - 3.5%)	3% (1.9% - 4%)	2.5% (1.6% - 3.4%)
Baltimore, MD	4.2% (2.7% - 5.6%)	3.8% (2.5% - 5.2%)	3.1% (2% - 4.2%)	2.7% (1.7% - 3.6%)	3% (1.9% - 4%)	2.1% (1.4% - 2.9%)
Birmingham, AL	5% (3.3% - 6.8%)	3.6% (2.3% - 4.8%)	2.8% (1.8% - 3.8%)	2.4% (1.6% - 3.2%)	2.8% (1.8% - 3.8%)	2% (1.3% - 2.7%)
Dallas, TX	2.9% (1.8% - 3.8%)	2.9% (1.8% - 3.8%)	2.9% (1.8% - 3.8%)	2.5% (1.6% - 3.4%)	2.9% (1.8% - 3.8%)	2.5% (1.6% - 3.4%)
Detroit, MI	4.2% (2.7% - 5.7%)	3% (2% - 4.1%)	2.6% (1.7% - 3.5%)	2.2% (1.5% - 3%)	2.3% (1.5% - 3.1%)	1.6% (1% - 2.1%)
Fresno, CA	4.5% (2.9% - 6%)	1.5% (1% - 2.1%)	1.5% (1% - 2.1%)	1.5% (1% - 2.1%)	1% (0.6% - 1.4%)	0.5% (0.3% - 0.6%)
Houston, TX	3.9% (2.5% - 5.2%)	3.6% (2.3% - 4.8%)	2.8% (1.8% - 3.7%)	2.4% (1.5% - 3.2%)	2.8% (1.8% - 3.7%)	2.4% (1.5% - 3.2%)
Los Angeles, CA	4.3% (2.8% - 5.8%)	2% (1.3% - 2.7%)	2% (1.3% - 2.7%)	1.7% (1.1% - 2.3%)	1.4% (0.9% - 1.9%)	0.8% (0.5% - 1%)
New York, NY	3.3% (2.1% - 4.4%)	2.4% (1.5% - 3.2%)	2.3% (1.5% - 3%)	1.9% (1.2% - 2.6%)	1.7% (1.1% - 2.3%)	1.1% (0.7% - 1.4%)
Philadelphia, PA	3.4% (2.2% - 4.5%)	2.9% (1.9% - 4%)	2.6% (1.7% - 3.5%)	2.2% (1.4% - 3%)	2.2% (1.4% - 3%)	1.5% (0.9% - 2%)
Phoenix, AZ	2.1% (1.3% - 2.8%)	2.1% (1.3% - 2.8%)	2.1% (1.3% - 2.8%)	1.9% (1.2% - 2.5%)	1.8% (1.2% - 2.4%)	1.1% (0.7% - 1.5%)
Pittsburgh, PA	5% (3.3% - 6.7%)	2.1% (1.3% - 2.8%)	2.1% (1.3% - 2.8%)	2.1% (1.3% - 2.8%)	1.4% (0.9% - 2%)	0.8% (0.5% - 1.1%)
Salt Lake City, UT	2.6% (1.7% - 3.5%)	0.9% (0.6% - 1.2%)	0.9% (0.6% - 1.2%)	0.9% (0.6% - 1.2%)	0.5% (0.3% - 0.6%)	0% (0% - 0%)
St. Louis, MO	4.2% (2.7% - 5.6%)	3.6% (2.3% - 4.8%)	2.8% (1.8% - 3.8%)	2.4% (1.6% - 3.3%)	2.7% (1.8% - 3.7%)	1.9% (1.2% - 2.6%)
Tacoma, WA	2.4% (1.5% - 3.2%)	1.6% (1% - 2.1%)	1.6% (1% - 2.1%)	1.6% (1% - 2.1%)	1% (0.7% - 1.4%)	0.5% (0.3% - 0.7%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-5. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	4% (2.6% - 5.4%)	3.5% (2.3% - 4.8%)	2.8% (1.8% - 3.7%)	2.4% (1.5% - 3.2%)	2.8% (1.8% - 3.7%)	2.3% (1.5% - 3.1%)
Baltimore, MD	3.6% (2.4% - 4.9%)	3.3% (2.2% - 4.5%)	2.6% (1.7% - 3.6%)	2.3% (1.5% - 3%)	2.5% (1.6% - 3.4%)	1.7% (1.1% - 2.4%)
Birmingham, AL	4.8% (3.1% - 6.5%)	3.4% (2.2% - 4.6%)	2.6% (1.7% - 3.6%)	2.3% (1.5% - 3.1%)	2.6% (1.7% - 3.6%)	1.9% (1.2% - 2.6%)
Dallas, TX	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.9% (1.2% - 2.5%)	2.1% (1.4% - 2.9%)	1.9% (1.2% - 2.5%)
Detroit, MI	3.2% (2.1% - 4.3%)	2.2% (1.4% - 3%)	1.9% (1.2% - 2.5%)	1.5% (1% - 2.1%)	1.6% (1% - 2.2%)	1% (0.6% - 1.3%)
Fresno, CA	4.7% (3% - 6.3%)	1.7% (1.1% - 2.2%)	1.7% (1.1% - 2.2%)	1.7% (1.1% - 2.2%)	1.1% (0.7% - 1.5%)	0.6% (0.4% - 0.8%)
Houston, TX	4% (2.6% - 5.3%)	3.6% (2.4% - 4.9%)	2.8% (1.8% - 3.8%)	2.4% (1.6% - 3.3%)	2.8% (1.8% - 3.8%)	2.4% (1.6% - 3.3%)
Los Angeles, CA	3.8% (2.5% - 5.2%)	1.7% (1.1% - 2.2%)	1.7% (1.1% - 2.2%)	1.5% (0.9% - 2%)	1.1% (0.7% - 1.5%)	0.6% (0.4% - 0.8%)
New York, NY	2.8% (1.8% - 3.8%)	2% (1.3% - 2.7%)	1.9% (1.2% - 2.5%)	1.5% (1% - 2.1%)	1.4% (0.9% - 1.9%)	0.8% (0.5% - 1%)
Philadelphia, PA	3.3% (2.1% - 4.5%)	2.9% (1.9% - 3.9%)	2.6% (1.7% - 3.4%)	2.2% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.4% (0.9% - 1.9%)
Phoenix, AZ	2.2% (1.4% - 2.9%)	2.2% (1.4% - 2.9%)	2.2% (1.4% - 2.9%)	2% (1.3% - 2.6%)	1.9% (1.2% - 2.6%)	1.2% (0.8% - 1.6%)
Pittsburgh, PA	4.4% (2.8% - 5.9%)	1.7% (1.1% - 2.3%)	1.7% (1.1% - 2.3%)	1.7% (1.1% - 2.3%)	1.1% (0.7% - 1.5%)	0.6% (0.4% - 0.8%)
Salt Lake City, UT	2.1% (1.3% - 2.8%)	0.6% (0.4% - 0.8%)	0.6% (0.4% - 0.8%)	0.6% (0.4% - 0.8%)	0.2% (0.1% - 0.2%)	0% (0% - 0%)
St. Louis, MO	3.2% (2.1% - 4.4%)	2.7% (1.7% - 3.6%)	2.1% (1.3% - 2.8%)	1.7% (1.1% - 2.3%)	2% (1.3% - 2.7%)	1.3% (0.8% - 1.8%)
Tacoma, WA	1.5% (1% - 2.1%)	0.8% (0.5% - 1.1%)	0.8% (0.5% - 1.1%)	0.8% (0.5% - 1.1%)	0.4% (0.3% - 0.6%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-6. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	4% (2.6% - 5.4%)	3.6% (2.3% - 4.8%)	2.8% (1.8% - 3.8%)	2.4% (1.5% - 3.2%)	2.8% (1.8% - 3.8%)	2.3% (1.5% - 3.2%)
Baltimore, MD	3.4% (2.2% - 4.6%)	3.1% (2% - 4.2%)	2.5% (1.6% - 3.3%)	2.1% (1.3% - 2.8%)	2.4% (1.5% - 3.2%)	1.6% (1% - 2.1%)
Birmingham, AL	4.7% (3.1% - 6.3%)	3.3% (2.2% - 4.5%)	2.6% (1.7% - 3.5%)	2.2% (1.4% - 3%)	2.6% (1.7% - 3.5%)	1.9% (1.2% - 2.5%)
Dallas, TX	2.3% (1.5% - 3.1%)	2.3% (1.5% - 3.1%)	2.3% (1.5% - 3.1%)	2% (1.3% - 2.8%)	2.3% (1.5% - 3.1%)	2% (1.3% - 2.8%)
Detroit, MI	3% (2% - 4.1%)	2.1% (1.3% - 2.8%)	1.7% (1.1% - 2.3%)	1.4% (0.9% - 1.9%)	1.5% (0.9% - 2%)	0.9% (0.5% - 1.2%)
Fresno, CA	5.2% (3.4% - 7%)	2% (1.3% - 2.6%)	2% (1.3% - 2.6%)	2% (1.3% - 2.6%)	1.4% (0.9% - 1.8%)	0.8% (0.5% - 1%)
Houston, TX	3.8% (2.5% - 5.1%)	3.5% (2.3% - 4.7%)	2.7% (1.8% - 3.7%)	2.3% (1.5% - 3.1%)	2.7% (1.8% - 3.7%)	2.3% (1.5% - 3.1%)
Los Angeles, CA	3.9% (2.5% - 5.2%)	1.7% (1.1% - 2.3%)	1.7% (1.1% - 2.3%)	1.5% (1% - 2%)	1.1% (0.7% - 1.6%)	0.6% (0.4% - 0.8%)
New York, NY	2.8% (1.8% - 3.8%)	2% (1.3% - 2.7%)	1.9% (1.2% - 2.5%)	1.6% (1% - 2.1%)	1.4% (0.9% - 1.9%)	0.8% (0.5% - 1.1%)
Philadelphia, PA	3.3% (2.1% - 4.4%)	2.8% (1.8% - 3.8%)	2.5% (1.6% - 3.4%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.4% (0.9% - 1.9%)
Phoenix, AZ	1.8% (1.2% - 2.5%)	1.8% (1.2% - 2.5%)	1.8% (1.2% - 2.5%)	1.6% (1.1% - 2.2%)	1.6% (1% - 2.1%)	0.9% (0.6% - 1.3%)
Pittsburgh, PA	4.5% (2.9% - 6%)	1.7% (1.1% - 2.3%)	1.7% (1.1% - 2.3%)	1.7% (1.1% - 2.3%)	1.2% (0.7% - 1.6%)	0.6% (0.4% - 0.8%)
Salt Lake City, UT	2.8% (1.8% - 3.8%)	1% (0.7% - 1.4%)	1% (0.7% - 1.4%)	1% (0.7% - 1.4%)	0.6% (0.4% - 0.8%)	0.1% (0.1% - 0.2%)
St. Louis, MO	3.4% (2.2% - 4.6%)	2.9% (1.9% - 3.9%)	2.2% (1.4% - 3%)	1.9% (1.2% - 2.5%)	2.2% (1.4% - 2.9%)	1.4% (0.9% - 1.9%)
Tacoma, WA	1.7% (1.1% - 2.3%)	1% (0.7% - 1.4%)	1% (0.7% - 1.4%)	1% (0.7% - 1.4%)	0.6% (0.4% - 0.8%)	0.1% (0.1% - 0.2%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-7. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (21% - 22%)	32% (32% - 33%)	22% (21% - 22%)	34% (34% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	19% (19% - 20%)	30% (30% - 31%)	22% (22% - 22%)	45% (45% - 45%)
Birmingham, AL	-40% (-40% - -41%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	43% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 12%)	0% (0% - 0%)	11% (11% - 12%)
Detroit, MI	-39% (-38% - -39%)	0% (0% - 0%)	14% (14% - 14%)	26% (26% - 27%)	24% (24% - 25%)	49% (49% - 49%)
Fresno, CA	-191% (-189% - -192%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	35% (35% - 35%)	69% (69% - 70%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-119% (-118% - -120%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	30% (30% - 30%)	61% (60% - 61%)
New York, NY	-38% (-38% - -39%)	0% (0% - 0%)	5% (5% - 5%)	20% (20% - 20%)	28% (28% - 28%)	55% (55% - 56%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	46% (46% - 46%)
Pittsburgh, PA	-145% (-143% - -146%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 30%)	59% (59% - 59%)
Salt Lake City, UT	-193% (-192% - -194%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	49% (49% - 49%)	98% (98% - 98%)
St. Louis, MO	-18% (-18% - -18%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	23% (23% - 23%)	46% (46% - 46%)
Tacoma, WA	-54% (-54% - -54%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	68% (68% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009). Percents are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-8. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	35% (35% - 35%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	21% (20% - 21%)	32% (32% - 32%)	24% (24% - 24%)	48% (47% - 48%)
Birmingham, AL	-41% (-41% - -41%)	0% (0% - 0%)	22% (22% - 22%)	34% (33% - 34%)	22% (22% - 22%)	44% (44% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-45% (-45% - -45%)	0% (0% - 0%)	16% (16% - 16%)	31% (31% - 31%)	28% (28% - 28%)	57% (57% - 57%)
Fresno, CA	-182% (-181% - -184%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	67% (66% - 67%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-131% (-130% - -131%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (66% - 66%)
New York, NY	-42% (-42% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	61% (61% - 61%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	51% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	45% (45% - 45%)
Pittsburgh, PA	-162% (-161% - -163%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 66%)
Salt Lake City, UT	-274% (-273% - -275%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-21% (-20% - -21%)	0% (0% - 0%)	23% (23% - 23%)	36% (36% - 36%)	26% (26% - 26%)	52% (52% - 52%)
Tacoma, WA	-80% (-80% - -80%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009). Percents are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

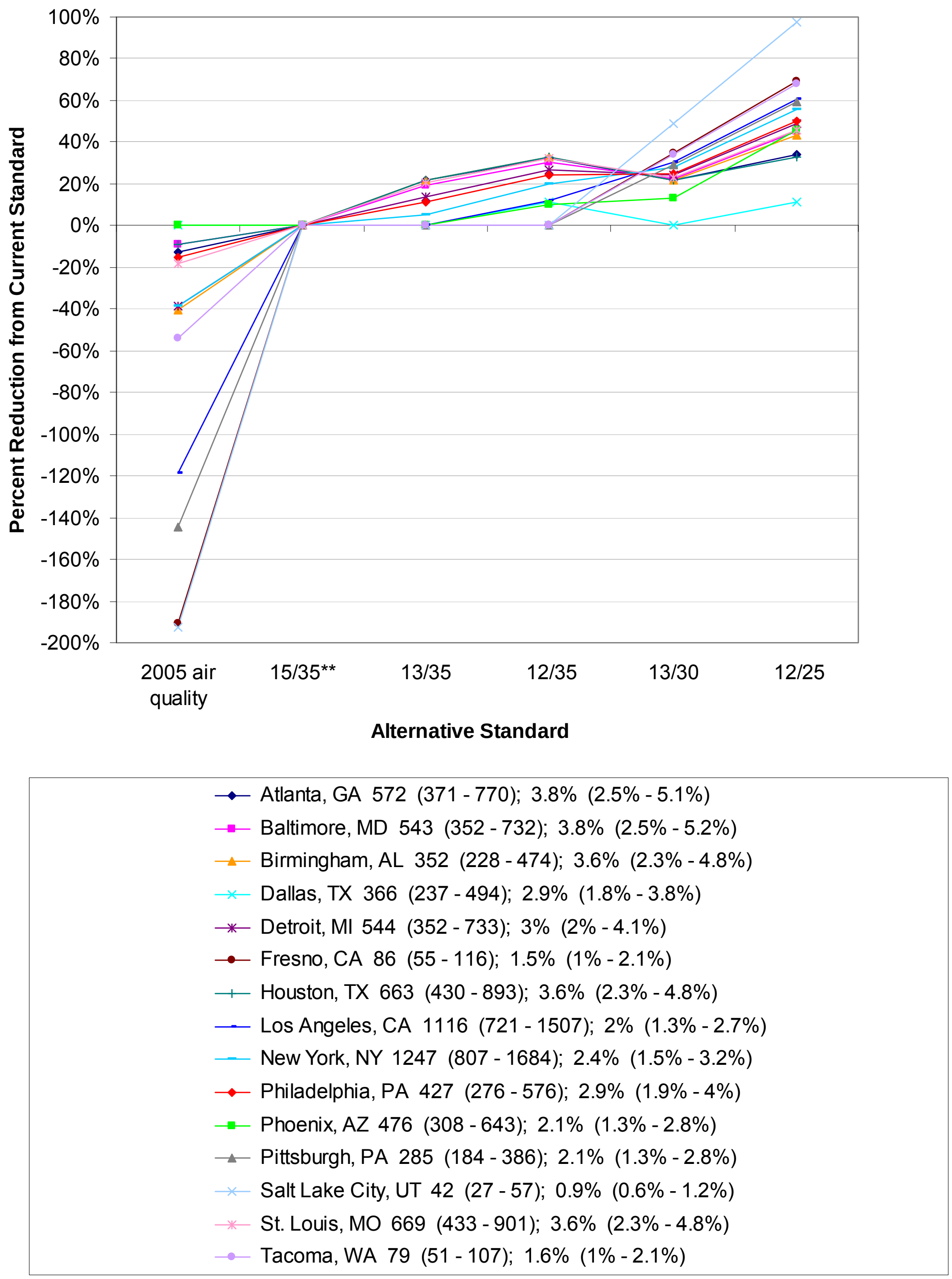
Table E-9. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	35% (35% - 35%)
Baltimore, MD	-10% (-10% - -10%)	0% (0% - 0%)	21% (21% - 21%)	33% (33% - 33%)	24% (24% - 24%)	49% (49% - 49%)
Birmingham, AL	-41% (-41% - -42%)	0% (0% - 0%)	23% (22% - 23%)	34% (34% - 34%)	23% (22% - 23%)	44% (44% - 45%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	0% (0% - 0%)	12% (12% - 13%)
Detroit, MI	-47% (-46% - -47%)	0% (0% - 0%)	17% (17% - 17%)	32% (32% - 32%)	29% (29% - 29%)	59% (59% - 59%)
Fresno, CA	-166% (-165% - -168%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (30% - 30%)	61% (61% - 61%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-129% (-128% - -130%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (65% - 66%)
New York, NY	-42% (-42% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	61% (60% - 61%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	25% (24% - 25%)	25% (25% - 25%)	51% (51% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (49% - 49%)
Pittsburgh, PA	-160% (-158% - -161%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 33%)	65% (65% - 65%)
Salt Lake City, UT	-173% (-172% - -174%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	88% (88% - 88%)
St. Louis, MO	-20% (-20% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 35%)	25% (25% - 25%)	50% (50% - 50%)
Tacoma, WA	-71% (-70% - -71%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009). Percents are rounded to the nearest whole number.

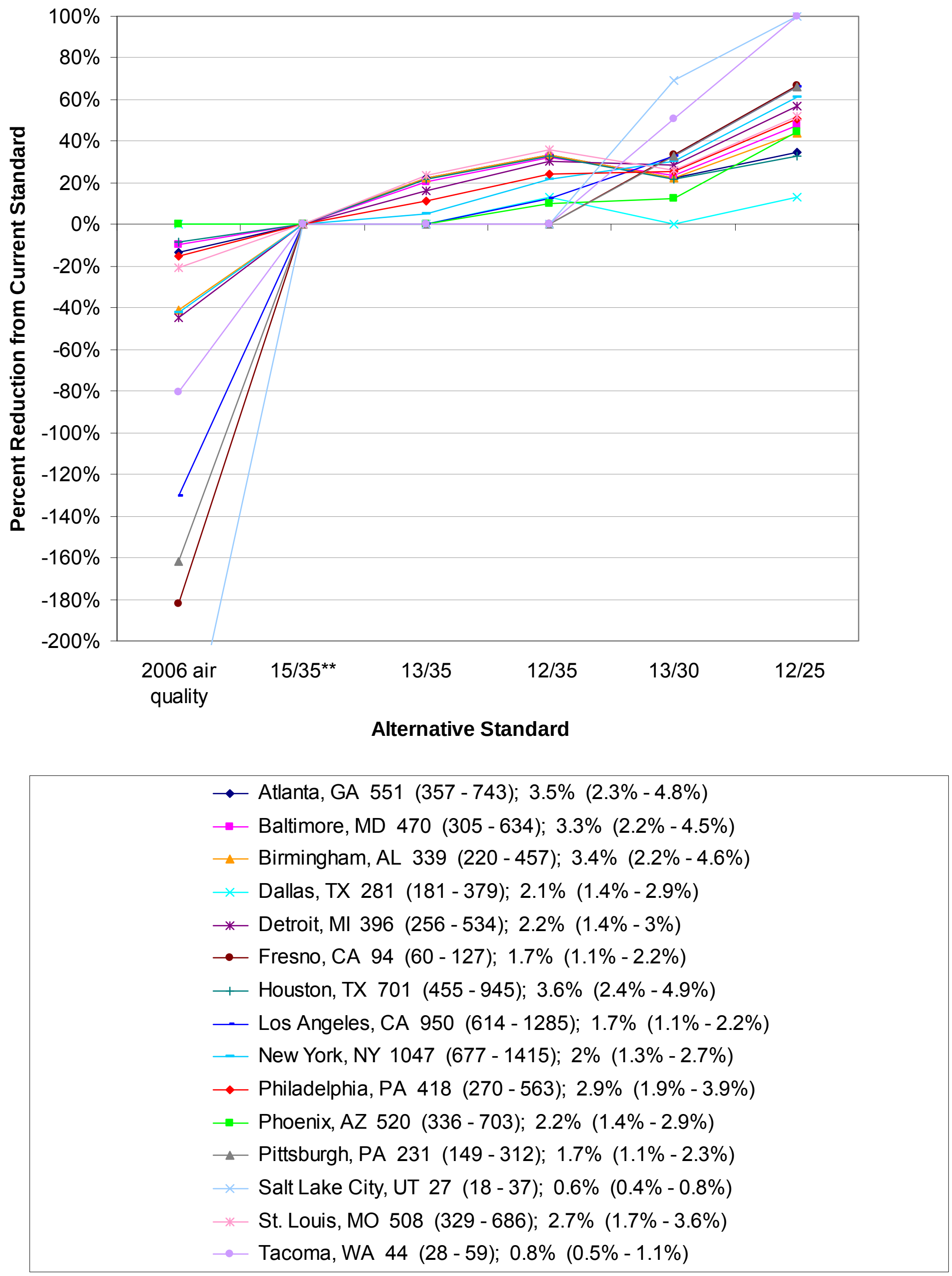
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-1. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2005 Air Quality Data*



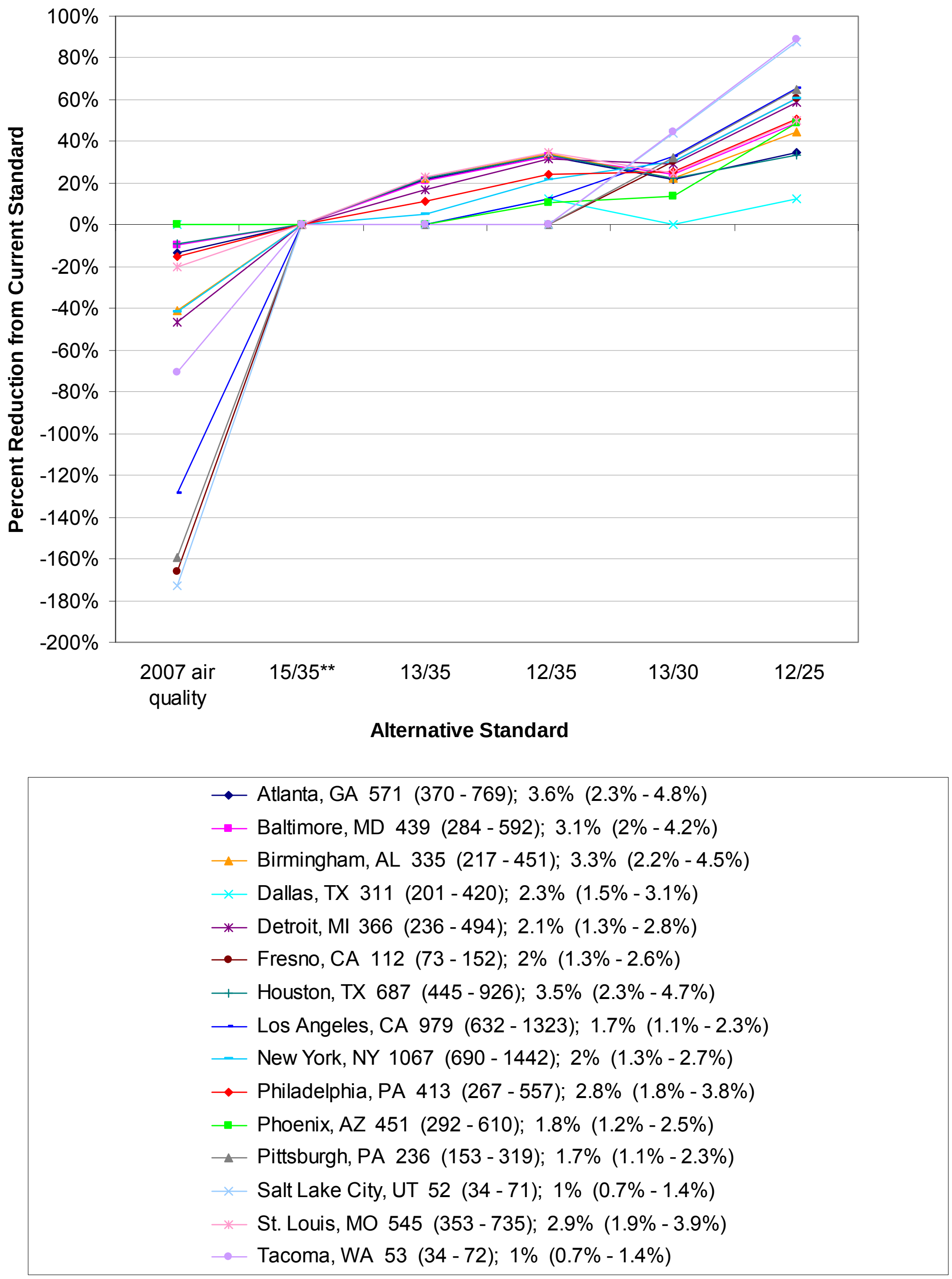
*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-2. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -274%.

Figure E-3. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-10. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	826 (528 - 1117)	732 (468 - 992)	575 (367 - 780)	496 (316 - 673)	575 (367 - 780)	484 (308 - 657)
Baltimore, MD	757 (484 - 1024)	696 (444 - 942)	561 (358 - 761)	485 (309 - 659)	541 (345 - 734)	384 (245 - 522)
Birmingham, AL	631 (404 - 852)	451 (288 - 611)	352 (224 - 478)	302 (193 - 411)	352 (224 - 478)	256 (163 - 348)
Dallas, TX	469 (299 - 637)	469 (299 - 637)	469 (299 - 637)	416 (265 - 565)	469 (299 - 637)	416 (265 - 565)
Detroit, MI	965 (617 - 1306)	697 (445 - 946)	601 (383 - 817)	514 (327 - 698)	528 (336 - 717)	356 (226 - 485)
Fresno, CA	318 (204 - 430)	110 (70 - 150)	110 (70 - 150)	110 (70 - 150)	72 (46 - 98)	34 (21 - 46)
Houston, TX	923 (590 - 1250)	849 (542 - 1151)	663 (422 - 900)	569 (362 - 773)	663 (422 - 900)	569 (362 - 773)
Los Angeles, CA	3125 (1999 - 4227)	1432 (911 - 1948)	1432 (911 - 1948)	1265 (804 - 1722)	1001 (636 - 1363)	566 (359 - 772)
New York, NY	2211 (1411 - 2998)	1600 (1019 - 2174)	1521 (969 - 2068)	1282 (815 - 1744)	1159 (737 - 1578)	714 (454 - 974)
Philadelphia, PA	628 (401 - 852)	547 (349 - 743)	487 (310 - 661)	415 (264 - 564)	411 (261 - 558)	273 (174 - 372)
Phoenix, AZ	611 (389 - 831)	611 (389 - 831)	611 (389 - 831)	548 (349 - 746)	531 (338 - 723)	331 (210 - 451)
Pittsburgh, PA	892 (572 - 1205)	366 (233 - 498)	366 (233 - 498)	366 (233 - 498)	259 (164 - 352)	150 (95 - 205)
Salt Lake City, UT	158 (101 - 214)	54 (34 - 74)	54 (34 - 74)	54 (34 - 74)	28 (18 - 38)	1 (1 - 2)
St. Louis, MO	1012 (647 - 1369)	857 (547 - 1161)	679 (433 - 922)	583 (371 - 792)	661 (421 - 897)	463 (295 - 630)
Tacoma, WA	156 (99 - 212)	101 (64 - 138)	101 (64 - 138)	101 (64 - 138)	67 (42 - 91)	32 (21 - 44)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-11. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	798 (510 - 1081)	706 (451 - 957)	551 (351 - 748)	473 (301 - 642)	551 (351 - 748)	461 (293 - 626)
Baltimore, MD	659 (421 - 893)	603 (385 - 817)	479 (305 - 651)	409 (261 - 557)	460 (293 - 626)	317 (201 - 431)
Birmingham, AL	611 (391 - 825)	434 (277 - 589)	337 (215 - 458)	289 (184 - 392)	337 (215 - 458)	243 (155 - 331)
Dallas, TX	360 (229 - 490)	360 (229 - 490)	360 (229 - 490)	314 (199 - 427)	360 (229 - 490)	314 (199 - 427)
Detroit, MI	735 (469 - 996)	508 (323 - 690)	427 (271 - 581)	353 (224 - 480)	364 (232 - 496)	220 (140 - 300)
Fresno, CA	338 (216 - 457)	120 (76 - 164)	120 (76 - 164)	120 (76 - 164)	80 (51 - 110)	40 (26 - 55)
Houston, TX	976 (624 - 1321)	898 (574 - 1217)	702 (448 - 953)	604 (384 - 820)	702 (448 - 953)	604 (384 - 820)
Los Angeles, CA	2805 (1793 - 3799)	1221 (776 - 1662)	1221 (776 - 1662)	1064 (676 - 1450)	817 (519 - 1114)	411 (261 - 561)
New York, NY	1910 (1217 - 2593)	1345 (855 - 1829)	1272 (809 - 1731)	1050 (668 - 1430)	937 (595 - 1277)	526 (334 - 718)
Philadelphia, PA	616 (393 - 835)	536 (341 - 727)	476 (303 - 646)	405 (258 - 551)	401 (255 - 545)	265 (168 - 361)
Phoenix, AZ	668 (425 - 908)	668 (425 - 908)	668 (425 - 908)	601 (382 - 818)	583 (371 - 793)	370 (235 - 504)
Pittsburgh, PA	774 (496 - 1047)	297 (189 - 404)	297 (189 - 404)	297 (189 - 404)	199 (126 - 272)	101 (64 - 138)
Salt Lake City, UT	131 (83 - 178)	35 (22 - 48)	35 (22 - 48)	35 (22 - 48)	11 (7 - 15)	0 (0 - 0)
St. Louis, MO	785 (501 - 1065)	652 (415 - 885)	500 (318 - 680)	417 (265 - 568)	484 (308 - 659)	315 (200 - 429)
Tacoma, WA	101 (64 - 138)	56 (36 - 77)	56 (36 - 77)	56 (36 - 77)	28 (18 - 38)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-12. Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	826 (528 - 1118)	731 (467 - 990)	571 (364 - 775)	490 (312 - 666)	571 (364 - 775)	478 (304 - 649)
Baltimore, MD	617 (394 - 837)	563 (359 - 764)	444 (283 - 604)	377 (240 - 513)	426 (271 - 579)	288 (183 - 393)
Birmingham, AL	605 (387 - 817)	429 (274 - 581)	332 (212 - 452)	284 (181 - 386)	332 (212 - 452)	239 (152 - 325)
Dallas, TX	399 (254 - 542)	399 (254 - 542)	399 (254 - 542)	349 (222 - 475)	399 (254 - 542)	349 (222 - 475)
Detroit, MI	687 (438 - 932)	469 (299 - 638)	392 (249 - 533)	321 (204 - 437)	332 (211 - 452)	193 (123 - 264)
Fresno, CA	382 (245 - 516)	144 (92 - 196)	144 (92 - 196)	144 (92 - 196)	101 (64 - 137)	57 (36 - 78)
Houston, TX	957 (612 - 1297)	880 (562 - 1193)	686 (437 - 931)	588 (374 - 799)	686 (437 - 931)	588 (374 - 799)
Los Angeles, CA	2867 (1833 - 3883)	1257 (799 - 1711)	1257 (799 - 1711)	1098 (698 - 1496)	847 (538 - 1155)	434 (275 - 593)
New York, NY	1942 (1238 - 2636)	1370 (871 - 1863)	1296 (824 - 1764)	1072 (681 - 1459)	957 (608 - 1304)	541 (343 - 739)
Philadelphia, PA	609 (389 - 826)	530 (338 - 719)	470 (300 - 639)	400 (255 - 544)	396 (252 - 538)	261 (166 - 355)
Phoenix, AZ	580 (369 - 789)	580 (369 - 789)	580 (369 - 789)	516 (328 - 703)	499 (317 - 679)	296 (188 - 403)
Pittsburgh, PA	784 (502 - 1061)	303 (193 - 413)	303 (193 - 413)	303 (193 - 413)	205 (130 - 280)	106 (67 - 145)
Salt Lake City, UT	183 (116 - 248)	67 (43 - 91)	67 (43 - 91)	67 (43 - 91)	38 (24 - 52)	8 (5 - 11)
St. Louis, MO	837 (534 - 1134)	698 (445 - 948)	540 (344 - 735)	455 (289 - 619)	524 (334 - 713)	348 (221 - 474)
Tacoma, WA	117 (74 - 159)	69 (44 - 94)	69 (44 - 94)	69 (44 - 94)	38 (24 - 52)	8 (5 - 10)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-13. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	5.5% (3.5% - 7.4%)	4.9% (3.1% - 6.6%)	3.8% (2.4% - 5.2%)	3.3% (2.1% - 4.5%)	3.8% (2.4% - 5.2%)	3.2% (2% - 4.4%)
Baltimore, MD	5.4% (3.4% - 7.3%)	4.9% (3.1% - 6.7%)	4% (2.5% - 5.4%)	3.4% (2.2% - 4.7%)	3.8% (2.4% - 5.2%)	2.7% (1.7% - 3.7%)
Birmingham, AL	6.4% (4.1% - 8.7%)	4.6% (2.9% - 6.2%)	3.6% (2.3% - 4.9%)	3.1% (2% - 4.2%)	3.6% (2.3% - 4.9%)	2.6% (1.7% - 3.5%)
Dallas, TX	3.7% (2.3% - 5%)	3.7% (2.3% - 5%)	3.7% (2.3% - 5%)	3.2% (2.1% - 4.4%)	3.7% (2.3% - 5%)	3.2% (2.1% - 4.4%)
Detroit, MI	5.4% (3.5% - 7.3%)	3.9% (2.5% - 5.3%)	3.4% (2.1% - 4.6%)	2.9% (1.8% - 3.9%)	3% (1.9% - 4%)	2% (1.3% - 2.7%)
Fresno, CA	5.7% (3.7% - 7.7%)	2% (1.3% - 2.7%)	2% (1.3% - 2.7%)	2% (1.3% - 2.7%)	1.3% (0.8% - 1.8%)	0.6% (0.4% - 0.8%)
Houston, TX	5% (3.2% - 6.7%)	4.6% (2.9% - 6.2%)	3.6% (2.3% - 4.8%)	3.1% (1.9% - 4.1%)	3.6% (2.3% - 4.8%)	3.1% (1.9% - 4.1%)
Los Angeles, CA	5.5% (3.5% - 7.4%)	2.5% (1.6% - 3.4%)	2.5% (1.6% - 3.4%)	2.2% (1.4% - 3%)	1.8% (1.1% - 2.4%)	1% (0.6% - 1.4%)
New York, NY	4.2% (2.7% - 5.7%)	3% (1.9% - 4.1%)	2.9% (1.8% - 3.9%)	2.4% (1.5% - 3.3%)	2.2% (1.4% - 3%)	1.4% (0.9% - 1.8%)
Philadelphia, PA	4.3% (2.8% - 5.8%)	3.8% (2.4% - 5.1%)	3.3% (2.1% - 4.5%)	2.8% (1.8% - 3.9%)	2.8% (1.8% - 3.8%)	1.9% (1.2% - 2.6%)
Phoenix, AZ	2.6% (1.7% - 3.6%)	2.6% (1.7% - 3.6%)	2.6% (1.7% - 3.6%)	2.4% (1.5% - 3.2%)	2.3% (1.5% - 3.1%)	1.4% (0.9% - 2%)
Pittsburgh, PA	6.4% (4.1% - 8.7%)	2.6% (1.7% - 3.6%)	2.6% (1.7% - 3.6%)	2.6% (1.7% - 3.6%)	1.9% (1.2% - 2.5%)	1.1% (0.7% - 1.5%)
Salt Lake City, UT	3.3% (2.1% - 4.5%)	1.1% (0.7% - 1.6%)	1.1% (0.7% - 1.6%)	1.1% (0.7% - 1.6%)	0.6% (0.4% - 0.8%)	0% (0% - 0%)
St. Louis, MO	5.4% (3.4% - 7.3%)	4.5% (2.9% - 6.2%)	3.6% (2.3% - 4.9%)	3.1% (2% - 4.2%)	3.5% (2.2% - 4.8%)	2.5% (1.6% - 3.3%)
Tacoma, WA	3.1% (1.9% - 4.2%)	2% (1.3% - 2.7%)	2% (1.3% - 2.7%)	2% (1.3% - 2.7%)	1.3% (0.8% - 1.8%)	0.6% (0.4% - 0.9%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-14. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	5.1% (3.3% - 7%)	4.5% (2.9% - 6.2%)	3.5% (2.3% - 4.8%)	3% (1.9% - 4.1%)	3.5% (2.3% - 4.8%)	3% (1.9% - 4%)
Baltimore, MD	4.7% (3% - 6.3%)	4.3% (2.7% - 5.8%)	3.4% (2.2% - 4.6%)	2.9% (1.8% - 3.9%)	3.3% (2.1% - 4.4%)	2.2% (1.4% - 3%)
Birmingham, AL	6.1% (3.9% - 8.3%)	4.4% (2.8% - 5.9%)	3.4% (2.2% - 4.6%)	2.9% (1.8% - 3.9%)	3.4% (2.2% - 4.6%)	2.4% (1.6% - 3.3%)
Dallas, TX	2.7% (1.7% - 3.7%)	2.7% (1.7% - 3.7%)	2.7% (1.7% - 3.7%)	2.4% (1.5% - 3.3%)	2.7% (1.7% - 3.7%)	2.4% (1.5% - 3.3%)
Detroit, MI	4.1% (2.6% - 5.6%)	2.8% (1.8% - 3.9%)	2.4% (1.5% - 3.3%)	2% (1.3% - 2.7%)	2% (1.3% - 2.8%)	1.2% (0.8% - 1.7%)
Fresno, CA	6% (3.8% - 8.1%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.4% (0.9% - 1.9%)	0.7% (0.5% - 1%)
Houston, TX	5.1% (3.2% - 6.9%)	4.7% (3% - 6.3%)	3.6% (2.3% - 4.9%)	3.1% (2% - 4.3%)	3.6% (2.3% - 4.9%)	3.1% (2% - 4.3%)
Los Angeles, CA	4.9% (3.1% - 6.7%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.9% (1.2% - 2.5%)	1.4% (0.9% - 2%)	0.7% (0.5% - 1%)
New York, NY	3.6% (2.3% - 4.9%)	2.5% (1.6% - 3.4%)	2.4% (1.5% - 3.3%)	2% (1.3% - 2.7%)	1.8% (1.1% - 2.4%)	1% (0.6% - 1.3%)
Philadelphia, PA	4.2% (2.7% - 5.7%)	3.7% (2.3% - 5%)	3.3% (2.1% - 4.4%)	2.8% (1.8% - 3.8%)	2.8% (1.8% - 3.7%)	1.8% (1.2% - 2.5%)
Phoenix, AZ	2.8% (1.8% - 3.8%)	2.8% (1.8% - 3.8%)	2.8% (1.8% - 3.8%)	2.5% (1.6% - 3.4%)	2.4% (1.5% - 3.3%)	1.5% (1% - 2.1%)
Pittsburgh, PA	5.6% (3.6% - 7.6%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	2.1% (1.4% - 2.9%)	1.4% (0.9% - 2%)	0.7% (0.5% - 1%)
Salt Lake City, UT	2.7% (1.7% - 3.6%)	0.7% (0.5% - 1%)	0.7% (0.5% - 1%)	0.7% (0.5% - 1%)	0.2% (0.1% - 0.3%)	0% (0% - 0%)
St. Louis, MO	4.1% (2.6% - 5.6%)	3.4% (2.2% - 4.7%)	2.6% (1.7% - 3.6%)	2.2% (1.4% - 3%)	2.6% (1.6% - 3.5%)	1.7% (1.1% - 2.3%)
Tacoma, WA	2% (1.2% - 2.7%)	1.1% (0.7% - 1.5%)	1.1% (0.7% - 1.5%)	1.1% (0.7% - 1.5%)	0.5% (0.3% - 0.7%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-15. Estimated Percent of Total Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	5.2% (3.3% - 7%)	4.6% (2.9% - 6.2%)	3.6% (2.3% - 4.9%)	3.1% (2% - 4.2%)	3.6% (2.3% - 4.9%)	3% (1.9% - 4.1%)
Baltimore, MD	4.4% (2.8% - 5.9%)	4% (2.5% - 5.4%)	3.1% (2% - 4.3%)	2.7% (1.7% - 3.6%)	3% (1.9% - 4.1%)	2% (1.3% - 2.8%)
Birmingham, AL	6% (3.9% - 8.2%)	4.3% (2.7% - 5.8%)	3.3% (2.1% - 4.5%)	2.8% (1.8% - 3.9%)	3.3% (2.1% - 4.5%)	2.4% (1.5% - 3.2%)
Dallas, TX	3% (1.9% - 4.1%)	3% (1.9% - 4.1%)	3% (1.9% - 4.1%)	2.6% (1.7% - 3.6%)	3% (1.9% - 4.1%)	2.6% (1.7% - 3.6%)
Detroit, MI	3.9% (2.5% - 5.3%)	2.7% (1.7% - 3.6%)	2.2% (1.4% - 3%)	1.8% (1.2% - 2.5%)	1.9% (1.2% - 2.6%)	1.1% (0.7% - 1.5%)
Fresno, CA	6.7% (4.3% - 9%)	2.5% (1.6% - 3.4%)	2.5% (1.6% - 3.4%)	2.5% (1.6% - 3.4%)	1.8% (1.1% - 2.4%)	1% (0.6% - 1.4%)
Houston, TX	4.9% (3.1% - 6.6%)	4.5% (2.9% - 6.1%)	3.5% (2.2% - 4.7%)	3% (1.9% - 4.1%)	3.5% (2.2% - 4.7%)	3% (1.9% - 4.1%)
Los Angeles, CA	5% (3.2% - 6.8%)	2.2% (1.4% - 3%)	2.2% (1.4% - 3%)	1.9% (1.2% - 2.6%)	1.5% (0.9% - 2%)	0.8% (0.5% - 1%)
New York, NY	3.6% (2.3% - 4.9%)	2.6% (1.6% - 3.5%)	2.4% (1.5% - 3.3%)	2% (1.3% - 2.7%)	1.8% (1.1% - 2.4%)	1% (0.6% - 1.4%)
Philadelphia, PA	4.2% (2.7% - 5.7%)	3.6% (2.3% - 4.9%)	3.2% (2.1% - 4.4%)	2.8% (1.8% - 3.7%)	2.7% (1.7% - 3.7%)	1.8% (1.1% - 2.4%)
Phoenix, AZ	2.3% (1.5% - 3.2%)	2.3% (1.5% - 3.2%)	2.3% (1.5% - 3.2%)	2.1% (1.3% - 2.8%)	2% (1.3% - 2.8%)	1.2% (0.8% - 1.6%)
Pittsburgh, PA	5.7% (3.6% - 7.7%)	2.2% (1.4% - 3%)	2.2% (1.4% - 3%)	2.2% (1.4% - 3%)	1.5% (0.9% - 2%)	0.8% (0.5% - 1.1%)
Salt Lake City, UT	3.6% (2.3% - 4.9%)	1.3% (0.8% - 1.8%)	1.3% (0.8% - 1.8%)	1.3% (0.8% - 1.8%)	0.7% (0.5% - 1%)	0.2% (0.1% - 0.2%)
St. Louis, MO	4.4% (2.8% - 6%)	3.7% (2.3% - 5%)	2.9% (1.8% - 3.9%)	2.4% (1.5% - 3.3%)	2.8% (1.8% - 3.8%)	1.8% (1.2% - 2.5%)
Tacoma, WA	2.2% (1.4% - 3%)	1.3% (0.8% - 1.8%)	1.3% (0.8% - 1.8%)	1.3% (0.8% - 1.8%)	0.7% (0.5% - 1%)	0.1% (0.1% - 0.2%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-16. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (34% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	19% (19% - 19%)	30% (30% - 30%)	22% (22% - 22%)	45% (45% - 45%)
Birmingham, AL	-40% (-39% - -40%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	43% (43% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-38% (-38% - -39%)	0% (0% - 0%)	14% (14% - 14%)	26% (26% - 26%)	24% (24% - 24%)	49% (49% - 49%)
Fresno, CA	-189% (-187% - -191%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	35% (35% - 35%)	69% (69% - 70%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-118% (-117% - -119%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	30% (30% - 30%)	60% (60% - 61%)
New York, NY	-38% (-38% - -38%)	0% (0% - 0%)	5% (5% - 5%)	20% (20% - 20%)	28% (27% - 28%)	55% (55% - 55%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	46% (46% - 46%)
Pittsburgh, PA	-144% (-142% - -145%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 29%)	59% (59% - 59%)
Salt Lake City, UT	-192% (-191% - -193%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	49% (49% - 49%)	98% (98% - 98%)
St. Louis, MO	-18% (-18% - -18%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	23% (23% - 23%)	46% (46% - 46%)
Tacoma, WA	-54% (-53% - -54%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	68% (68% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-17. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	35% (35% - 35%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 21%)	32% (32% - 32%)	24% (23% - 24%)	47% (47% - 48%)
Birmingham, AL	-41% (-40% - -41%)	0% (0% - 0%)	22% (22% - 22%)	34% (33% - 34%)	22% (22% - 22%)	44% (44% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-45% (-44% - -45%)	0% (0% - 0%)	16% (16% - 16%)	31% (30% - 31%)	28% (28% - 28%)	57% (57% - 57%)
Fresno, CA	-181% (-179% - -183%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 67%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-130% (-129% - -131%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (66% - 66%)
New York, NY	-42% (-42% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	61% (61% - 61%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	51% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	45% (44% - 45%)
Pittsburgh, PA	-161% (-159% - -163%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 66%)
Salt Lake City, UT	-273% (-272% - -274%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-20% - -21%)	0% (0% - 0%)	23% (23% - 23%)	36% (36% - 36%)	26% (26% - 26%)	52% (52% - 52%)
Tacoma, WA	-80% (-80% - -80%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

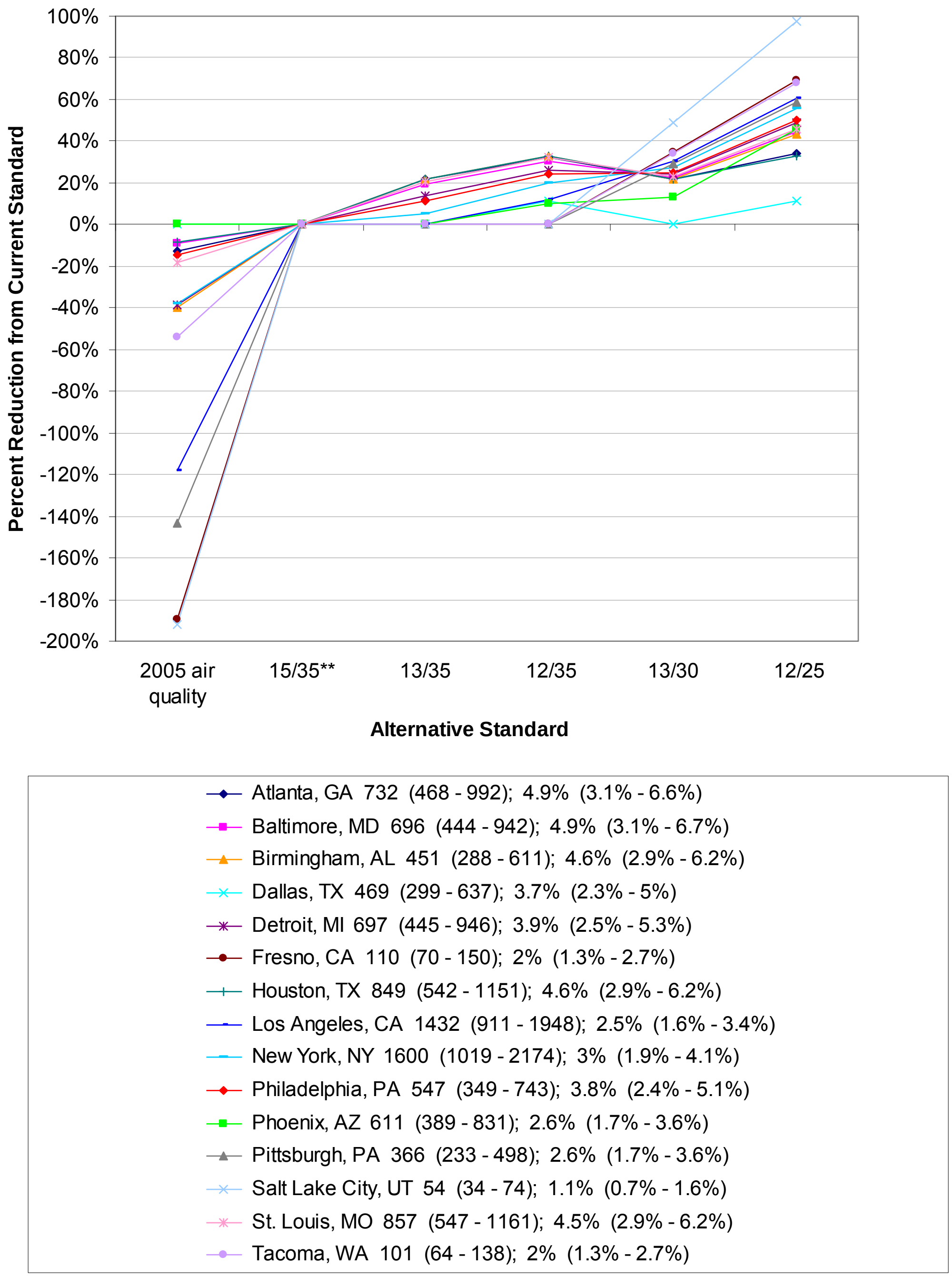
Table E-18. Percent Reduction from the Current Standards: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	35% (34% - 35%)
Baltimore, MD	-10% (-10% - -10%)	0% (0% - 0%)	21% (21% - 21%)	33% (33% - 33%)	24% (24% - 24%)	49% (49% - 49%)
Birmingham, AL	-41% (-41% - -41%)	0% (0% - 0%)	22% (22% - 23%)	34% (34% - 34%)	22% (22% - 23%)	44% (44% - 45%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	0% (0% - 0%)	12% (12% - 13%)
Detroit, MI	-46% (-46% - -47%)	0% (0% - 0%)	17% (16% - 17%)	32% (32% - 32%)	29% (29% - 29%)	59% (59% - 59%)
Fresno, CA	-165% (-163% - -167%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (30% - 30%)	61% (61% - 61%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-128% (-127% - -129%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	65% (65% - 66%)
New York, NY	-42% (-41% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	60% (60% - 61%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 25%)	25% (25% - 25%)	51% (51% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (49% - 49%)
Pittsburgh, PA	-158% (-157% - -160%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (65% - 65%)
Salt Lake City, UT	-172% (-171% - -174%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	88% (88% - 88%)
St. Louis, MO	-20% (-20% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 35%)	25% (25% - 25%)	50% (50% - 50%)
Tacoma, WA	-70% (-70% - -71%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

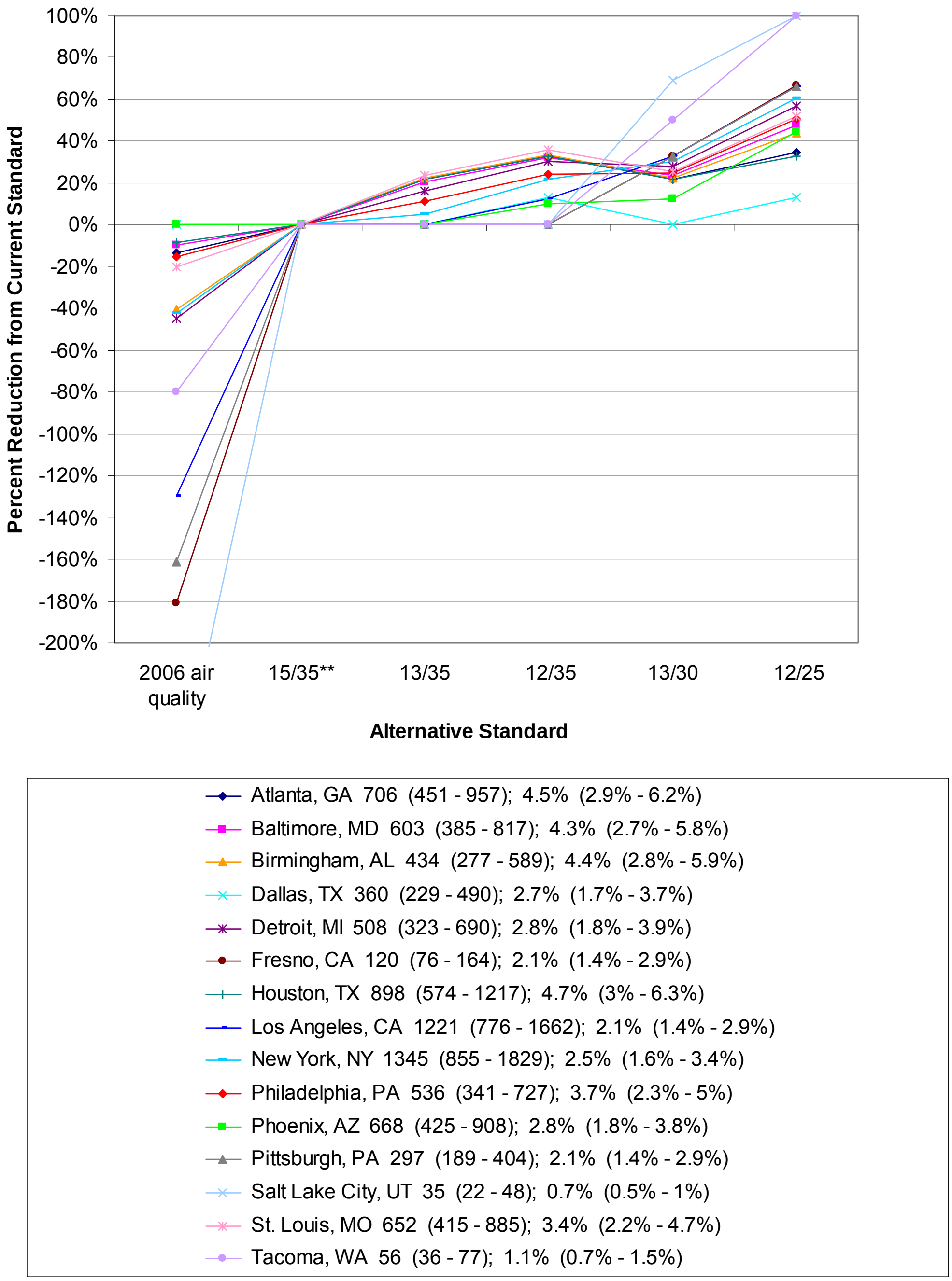
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-4. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2005 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 - 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-5. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 - 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 μg/m^3 and a daily standard of 35 μg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -274%.

Figure E-6. Estimated Percent Reductions From the Current Standard to Alternative Standards in All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data*

*Based on Krewski et al. (2009), exposure period from 1999 - 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-19. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	247 (204 - 290)	221 (181 - 259)	175 (144 - 206)	152 (124 - 179)	175 (144 - 206)	148 (121 - 175)
Baltimore, MD	393 (323 - 461)	363 (298 - 426)	296 (242 - 348)	257 (210 - 303)	285 (234 - 336)	205 (167 - 242)
Birmingham, AL	214 (177 - 250)	156 (128 - 183)	123 (101 - 145)	106 (87 - 125)	123 (101 - 145)	90 (74 - 107)
Dallas, TX	224 (183 - 264)	224 (183 - 264)	224 (183 - 264)	199 (163 - 235)	224 (183 - 264)	199 (163 - 235)
Detroit, MI	653 (538 - 766)	479 (393 - 564)	416 (340 - 490)	357 (291 - 421)	366 (299 - 432)	250 (204 - 296)
Fresno, CA	183 (151 - 215)	66 (54 - 78)	66 (54 - 78)	66 (54 - 78)	43 (35 - 51)	20 (17 - 24)
Houston, TX	435 (357 - 510)	402 (330 - 472)	317 (259 - 373)	273 (223 - 322)	317 (259 - 373)	273 (223 - 322)
Los Angeles, CA	2217 (1824 - 2596)	1048 (855 - 1238)	1048 (855 - 1238)	928 (757 - 1098)	738 (601 - 874)	420 (342 - 499)
New York, NY	2273 (1863 - 2672)	1665 (1360 - 1964)	1586 (1295 - 1871)	1342 (1095 - 1586)	1217 (992 - 1439)	757 (615 - 897)
Philadelphia, PA	314 (258 - 369)	275 (225 - 324)	246 (201 - 290)	211 (172 - 249)	209 (170 - 246)	140 (114 - 166)
Phoenix, AZ	346 (283 - 409)	346 (283 - 409)	346 (283 - 409)	312 (254 - 368)	302 (246 - 357)	190 (154 - 225)
Pittsburgh, PA	508 (419 - 593)	217 (177 - 256)	217 (177 - 256)	217 (177 - 256)	154 (126 - 183)	90 (73 - 107)
Salt Lake City, UT	48 (39 - 56)	17 (14 - 20)	17 (14 - 20)	17 (14 - 20)	9 (7 - 10)	0 (0 - 0)
St. Louis, MO	610 (502 - 715)	521 (428 - 612)	417 (341 - 491)	360 (294 - 425)	406 (333 - 479)	288 (235 - 340)
Tacoma, WA	91 (74 - 108)	60 (49 - 71)	60 (49 - 71)	60 (49 - 71)	40 (32 - 47)	19 (16 - 23)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-20. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	240 (197 - 282)	214 (175 - 251)	168 (138 - 198)	145 (119 - 171)	168 (138 - 198)	142 (116 - 167)
Baltimore, MD	345 (283 - 405)	317 (260 - 372)	254 (208 - 299)	218 (178 - 257)	244 (200 - 288)	170 (139 - 201)
Birmingham, AL	208 (172 - 243)	151 (124 - 177)	118 (97 - 139)	102 (83 - 120)	118 (97 - 139)	86 (70 - 102)
Dallas, TX	173 (142 - 205)	173 (142 - 205)	173 (142 - 205)	151 (124 - 179)	173 (142 - 205)	151 (124 - 179)
Detroit, MI	504 (413 - 593)	353 (288 - 417)	298 (243 - 352)	247 (202 - 293)	255 (208 - 302)	156 (126 - 184)
Fresno, CA	194 (160 - 227)	72 (59 - 85)	72 (59 - 85)	72 (59 - 85)	48 (39 - 57)	24 (20 - 29)
Houston, TX	459 (377 - 538)	424 (348 - 498)	335 (274 - 395)	290 (237 - 342)	335 (274 - 395)	290 (237 - 342)
Los Angeles, CA	2002 (1645 - 2349)	897 (731 - 1060)	897 (731 - 1060)	784 (638 - 928)	605 (492 - 717)	306 (249 - 364)
New York, NY	1976 (1617 - 2327)	1407 (1148 - 1662)	1333 (1087 - 1575)	1105 (900 - 1308)	988 (804 - 1170)	560 (455 - 664)
Philadelphia, PA	308 (253 - 362)	270 (221 - 317)	241 (197 - 284)	206 (168 - 243)	204 (166 - 241)	136 (111 - 161)
Phoenix, AZ	378 (309 - 446)	378 (309 - 446)	378 (309 - 446)	341 (278 - 403)	331 (270 - 391)	212 (172 - 251)
Pittsburgh, PA	445 (366 - 521)	177 (144 - 209)	177 (144 - 209)	177 (144 - 209)	119 (97 - 141)	61 (49 - 72)
Salt Lake City, UT	40 (33 - 47)	11 (9 - 13)	11 (9 - 13)	11 (9 - 13)	3 (3 - 4)	0 (0 - 0)
St. Louis, MO	480 (393 - 564)	401 (328 - 473)	310 (253 - 366)	260 (212 - 308)	301 (245 - 355)	197 (161 - 234)
Tacoma, WA	60 (49 - 71)	34 (27 - 40)	34 (27 - 40)	34 (27 - 40)	17 (14 - 20)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-21. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	248 (204 - 291)	221 (181 - 260)	174 (143 - 205)	151 (123 - 178)	174 (143 - 205)	147 (120 - 173)
Baltimore, MD	324 (266 - 381)	296 (243 - 349)	236 (193 - 278)	201 (164 - 238)	227 (185 - 268)	155 (126 - 183)
Birmingham, AL	206 (170 - 241)	149 (122 - 175)	117 (95 - 138)	100 (82 - 118)	117 (95 - 138)	85 (69 - 100)
Dallas, TX	191 (156 - 226)	191 (156 - 226)	191 (156 - 226)	168 (137 - 199)	191 (156 - 226)	168 (137 - 199)
Detroit, MI	472 (387 - 556)	327 (267 - 386)	274 (223 - 324)	225 (183 - 267)	233 (190 - 276)	137 (111 - 162)
Fresno, CA	218 (180 - 255)	86 (70 - 102)	86 (70 - 102)	86 (70 - 102)	60 (49 - 72)	34 (28 - 41)
Houston, TX	451 (371 - 530)	417 (342 - 489)	328 (268 - 386)	282 (231 - 333)	328 (268 - 386)	282 (231 - 333)
Los Angeles, CA	2045 (1680 - 2399)	923 (752 - 1091)	923 (752 - 1091)	809 (659 - 957)	627 (510 - 743)	324 (263 - 384)
New York, NY	2008 (1644 - 2365)	1432 (1169 - 1692)	1358 (1107 - 1604)	1127 (918 - 1334)	1009 (821 - 1195)	575 (467 - 683)
Philadelphia, PA	305 (250 - 359)	267 (218 - 314)	238 (194 - 280)	203 (166 - 240)	201 (164 - 238)	134 (109 - 158)
Phoenix, AZ	329 (269 - 389)	329 (269 - 389)	329 (269 - 389)	294 (240 - 348)	284 (232 - 337)	170 (138 - 202)
Pittsburgh, PA	450 (370 - 527)	180 (147 - 213)	180 (147 - 213)	180 (147 - 213)	123 (100 - 146)	64 (52 - 76)
Salt Lake City, UT	55 (45 - 65)	21 (17 - 25)	21 (17 - 25)	21 (17 - 25)	12 (10 - 14)	3 (2 - 3)
St. Louis, MO	510 (418 - 599)	429 (351 - 505)	335 (273 - 395)	283 (231 - 334)	325 (265 - 383)	218 (177 - 258)
Tacoma, WA	69 (56 - 82)	41 (33 - 48)	41 (33 - 48)	41 (33 - 48)	23 (19 - 27)	5 (4 - 5)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-22. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	15.8% (13% - 18.5%)	14.1% (11.6% - 16.5%)	11.2% (9.1% - 13.1%)	9.7% (7.9% - 11.4%)	11.2% (9.1% - 13.1%)	9.5% (7.7% - 11.2%)
Baltimore, MD	15.4% (12.7% - 18.1%)	14.3% (11.7% - 16.7%)	11.6% (9.5% - 13.7%)	10.1% (8.3% - 11.9%)	11.2% (9.2% - 13.2%)	8.1% (6.6% - 9.5%)
Birmingham, AL	18.3% (15.1% - 21.4%)	13.3% (11% - 15.7%)	10.5% (8.6% - 12.4%)	9.1% (7.4% - 10.7%)	10.5% (8.6% - 12.4%)	7.7% (6.3% - 9.1%)
Dallas, TX	10.7% (8.8% - 12.6%)	10.7% (8.8% - 12.6%)	10.7% (8.8% - 12.6%)	9.5% (7.8% - 11.3%)	10.7% (8.8% - 12.6%)	9.5% (7.8% - 11.3%)
Detroit, MI	15.6% (12.8% - 18.3%)	11.4% (9.4% - 13.5%)	9.9% (8.1% - 11.7%)	8.5% (7% - 10%)	8.7% (7.1% - 10.3%)	6% (4.9% - 7.1%)
Fresno, CA	16.4% (13.5% - 19.2%)	5.9% (4.8% - 7%)	5.9% (4.8% - 7%)	5.9% (4.8% - 7%)	3.9% (3.2% - 4.6%)	1.8% (1.5% - 2.2%)
Houston, TX	14.3% (11.8% - 16.8%)	13.2% (10.9% - 15.6%)	10.4% (8.5% - 12.3%)	9% (7.4% - 10.6%)	10.4% (8.5% - 12.3%)	9% (7.4% - 10.6%)
Los Angeles, CA	15.8% (13% - 18.6%)	7.5% (6.1% - 8.8%)	7.5% (6.1% - 8.8%)	6.6% (5.4% - 7.8%)	5.3% (4.3% - 6.2%)	3% (2.4% - 3.6%)
New York, NY	12.2% (10% - 14.4%)	9% (7.3% - 10.6%)	8.5% (7% - 10.1%)	7.2% (5.9% - 8.5%)	6.6% (5.3% - 7.7%)	4.1% (3.3% - 4.8%)
Philadelphia, PA	12.6% (10.3% - 14.8%)	11% (9% - 13%)	9.8% (8% - 11.6%)	8.4% (6.9% - 9.9%)	8.3% (6.8% - 9.8%)	5.6% (4.6% - 6.6%)
Phoenix, AZ	7.9% (6.4% - 9.3%)	7.9% (6.4% - 9.3%)	7.9% (6.4% - 9.3%)	7.1% (5.8% - 8.4%)	6.9% (5.6% - 8.1%)	4.3% (3.5% - 5.1%)
Pittsburgh, PA	18.3% (15.1% - 21.4%)	7.8% (6.4% - 9.2%)	7.8% (6.4% - 9.2%)	7.8% (6.4% - 9.2%)	5.6% (4.5% - 6.6%)	3.2% (2.6% - 3.9%)
Salt Lake City, UT	9.8% (8% - 11.5%)	3.4% (2.8% - 4.1%)	3.4% (2.8% - 4.1%)	3.4% (2.8% - 4.1%)	1.8% (1.4% - 2.1%)	0.1% (0.1% - 0.1%)
St. Louis, MO	15.5% (12.7% - 18.1%)	13.2% (10.9% - 15.5%)	10.6% (8.7% - 12.5%)	9.1% (7.5% - 10.8%)	10.3% (8.4% - 12.1%)	7.3% (6% - 8.6%)
Tacoma, WA	9% (7.4% - 10.7%)	5.9% (4.8% - 7%)	5.9% (4.8% - 7%)	5.9% (4.8% - 7%)	4% (3.2% - 4.7%)	1.9% (1.6% - 2.3%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-23. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	14.8% (12.2% - 17.4%)	13.2% (10.8% - 15.5%)	10.4% (8.5% - 12.3%)	9% (7.3% - 10.6%)	10.4% (8.5% - 12.3%)	8.8% (7.2% - 10.3%)
Baltimore, MD	13.5% (11.1% - 15.9%)	12.4% (10.2% - 14.6%)	10% (8.2% - 11.7%)	8.6% (7% - 10.1%)	9.6% (7.8% - 11.3%)	6.7% (5.4% - 7.9%)
Birmingham, AL	17.6% (14.5% - 20.5%)	12.7% (10.4% - 15%)	10% (8.2% - 11.8%)	8.6% (7% - 10.1%)	10% (8.2% - 11.8%)	7.3% (5.9% - 8.6%)
Dallas, TX	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	7.1% (5.8% - 8.4%)	8.1% (6.6% - 9.6%)	7.1% (5.8% - 8.4%)
Detroit, MI	12% (9.9% - 14.2%)	8.4% (6.9% - 10%)	7.1% (5.8% - 8.4%)	5.9% (4.8% - 7%)	6.1% (5% - 7.2%)	3.7% (3% - 4.4%)
Fresno, CA	17.1% (14.1% - 20.1%)	6.3% (5.2% - 7.5%)	6.3% (5.2% - 7.5%)	6.3% (5.2% - 7.5%)	4.3% (3.5% - 5.1%)	2.2% (1.8% - 2.6%)
Houston, TX	14.6% (12% - 17.2%)	13.5% (11.1% - 15.9%)	10.7% (8.8% - 12.6%)	9.2% (7.6% - 10.9%)	10.7% (8.8% - 12.6%)	9.2% (7.6% - 10.9%)
Los Angeles, CA	14.2% (11.7% - 16.7%)	6.4% (5.2% - 7.5%)	6.4% (5.2% - 7.5%)	5.6% (4.5% - 6.6%)	4.3% (3.5% - 5.1%)	2.2% (1.8% - 2.6%)
New York, NY	10.5% (8.6% - 12.4%)	7.5% (6.1% - 8.9%)	7.1% (5.8% - 8.4%)	5.9% (4.8% - 7%)	5.3% (4.3% - 6.2%)	3% (2.4% - 3.5%)
Philadelphia, PA	12.4% (10.1% - 14.5%)	10.8% (8.8% - 12.7%)	9.6% (7.9% - 11.4%)	8.3% (6.7% - 9.7%)	8.2% (6.7% - 9.6%)	5.4% (4.4% - 6.5%)
Phoenix, AZ	8.3% (6.7% - 9.7%)	8.3% (6.7% - 9.7%)	8.3% (6.7% - 9.7%)	7.5% (6.1% - 8.8%)	7.2% (5.9% - 8.5%)	4.6% (3.8% - 5.5%)
Pittsburgh, PA	16.1% (13.3% - 18.9%)	6.4% (5.2% - 7.6%)	6.4% (5.2% - 7.6%)	6.4% (5.2% - 7.6%)	4.3% (3.5% - 5.1%)	2.2% (1.8% - 2.6%)
Salt Lake City, UT	7.9% (6.4% - 9.3%)	2.2% (1.8% - 2.6%)	2.2% (1.8% - 2.6%)	2.2% (1.8% - 2.6%)	0.7% (0.5% - 0.8%)	0% (0% - 0%)
St. Louis, MO	12.1% (9.9% - 14.2%)	10.1% (8.3% - 11.9%)	7.8% (6.4% - 9.2%)	6.6% (5.4% - 7.8%)	7.6% (6.2% - 9%)	5% (4.1% - 5.9%)
Tacoma, WA	5.8% (4.7% - 6.9%)	3.3% (2.7% - 3.9%)	3.3% (2.7% - 3.9%)	3.3% (2.7% - 3.9%)	1.6% (1.3% - 1.9%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-24. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	15% (12.3% - 17.5%)	13.3% (10.9% - 15.6%)	10.5% (8.6% - 12.4%)	9.1% (7.4% - 10.7%)	10.5% (8.6% - 12.4%)	8.8% (7.2% - 10.4%)
Baltimore, MD	12.7% (10.4% - 15%)	11.7% (9.6% - 13.7%)	9.3% (7.6% - 10.9%)	7.9% (6.5% - 9.4%)	8.9% (7.3% - 10.5%)	6.1% (5% - 7.2%)
Birmingham, AL	17.3% (14.2% - 20.2%)	12.5% (10.2% - 14.7%)	9.8% (8% - 11.5%)	8.4% (6.8% - 9.9%)	9.8% (8% - 11.5%)	7.1% (5.8% - 8.4%)
Dallas, TX	8.8% (7.2% - 10.4%)	8.8% (7.2% - 10.4%)	8.8% (7.2% - 10.4%)	7.8% (6.3% - 9.2%)	8.8% (7.2% - 10.4%)	7.8% (6.3% - 9.2%)
Detroit, MI	11.4% (9.3% - 13.4%)	7.9% (6.4% - 9.3%)	6.6% (5.4% - 7.8%)	5.4% (4.4% - 6.4%)	5.6% (4.6% - 6.6%)	3.3% (2.7% - 3.9%)
Fresno, CA	18.9% (15.6% - 22.1%)	7.5% (6.1% - 8.8%)	7.5% (6.1% - 8.8%)	7.5% (6.1% - 8.8%)	5.3% (4.3% - 6.2%)	3% (2.4% - 3.5%)
Houston, TX	14.1% (11.6% - 16.6%)	13% (10.7% - 15.3%)	10.2% (8.4% - 12.1%)	8.8% (7.2% - 10.4%)	10.2% (8.4% - 12.1%)	8.8% (7.2% - 10.4%)
Los Angeles, CA	14.4% (11.9% - 16.9%)	6.5% (5.3% - 7.7%)	6.5% (5.3% - 7.7%)	5.7% (4.6% - 6.8%)	4.4% (3.6% - 5.2%)	2.3% (1.9% - 2.7%)
New York, NY	10.6% (8.7% - 12.5%)	7.6% (6.2% - 9%)	7.2% (5.9% - 8.5%)	6% (4.9% - 7.1%)	5.3% (4.3% - 6.3%)	3% (2.5% - 3.6%)
Philadelphia, PA	12.2% (10% - 14.4%)	10.7% (8.7% - 12.6%)	9.5% (7.8% - 11.2%)	8.1% (6.7% - 9.6%)	8.1% (6.6% - 9.5%)	5.4% (4.4% - 6.3%)
Phoenix, AZ	7% (5.7% - 8.3%)	7% (5.7% - 8.3%)	7% (5.7% - 8.3%)	6.2% (5.1% - 7.4%)	6% (4.9% - 7.1%)	3.6% (2.9% - 4.3%)
Pittsburgh, PA	16.4% (13.5% - 19.2%)	6.6% (5.3% - 7.8%)	6.6% (5.3% - 7.8%)	6.6% (5.3% - 7.8%)	4.5% (3.6% - 5.3%)	2.3% (1.9% - 2.8%)
Salt Lake City, UT	10.6% (8.7% - 12.5%)	4% (3.2% - 4.7%)	4% (3.2% - 4.7%)	4% (3.2% - 4.7%)	2.3% (1.8% - 2.7%)	0.5% (0.4% - 0.6%)
St. Louis, MO	12.9% (10.5% - 15.1%)	10.8% (8.8% - 12.7%)	8.4% (6.9% - 10%)	7.1% (5.8% - 8.4%)	8.2% (6.7% - 9.7%)	5.5% (4.5% - 6.5%)
Tacoma, WA	6.6% (5.4% - 7.8%)	3.9% (3.2% - 4.6%)	3.9% (3.2% - 4.6%)	3.9% (3.2% - 4.6%)	2.2% (1.8% - 2.6%)	0.4% (0.4% - 0.5%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-25. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -12%)	0% (0% - 0%)	21% (20% - 21%)	31% (31% - 32%)	21% (20% - 21%)	33% (32% - 33%)
Baltimore, MD	-8% (-8% - -8%)	0% (0% - 0%)	19% (18% - 19%)	29% (29% - 29%)	21% (21% - 22%)	43% (43% - 44%)
Birmingham, AL	-37% (-37% - -38%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	42% (42% - 42%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-36% (-36% - -37%)	0% (0% - 0%)	13% (13% - 13%)	26% (25% - 26%)	24% (23% - 24%)	48% (48% - 48%)
Fresno, CA	-178% (-175% - -181%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	69% (69% - 69%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	32% (32% - 32%)
Los Angeles, CA	-112% (-110% - -113%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	30% (29% - 30%)	60% (60% - 60%)
New York, NY	-37% (-36% - -37%)	0% (0% - 0%)	5% (5% - 5%)	19% (19% - 20%)	27% (27% - 27%)	55% (54% - 55%)
Philadelphia, PA	-14% (-14% - -14%)	0% (0% - 0%)	11% (11% - 11%)	23% (23% - 24%)	24% (24% - 24%)	49% (49% - 49%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	45% (45% - 45%)
Pittsburgh, PA	-134% (-132% - -137%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 29%)	58% (58% - 59%)
Salt Lake City, UT	-186% (-184% - -187%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	48% (48% - 48%)	98% (98% - 98%)
St. Louis, MO	-17% (-17% - -17%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 31%)	22% (22% - 22%)	45% (44% - 45%)
Tacoma, WA	-52% (-52% - -53%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 34%)	68% (67% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-26. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -13%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	34% (33% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 31%)	23% (23% - 23%)	46% (46% - 47%)
Birmingham, AL	-38% (-37% - -39%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	43% (43% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-43% (-42% - -43%)	0% (0% - 0%)	16% (15% - 16%)	30% (30% - 30%)	28% (27% - 28%)	56% (56% - 56%)
Fresno, CA	-170% (-167% - -173%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (32% - 33%)	66% (66% - 66%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (31% - 32%)	21% (21% - 21%)	32% (31% - 32%)
Los Angeles, CA	-123% (-122% - -125%)	0% (0% - 0%)	0% (0% - 0%)	13% (12% - 13%)	33% (32% - 33%)	66% (66% - 66%)
New York, NY	-40% (-40% - -41%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 22%)	30% (30% - 30%)	60% (60% - 60%)
Philadelphia, PA	-14% (-14% - -14%)	0% (0% - 0%)	11% (11% - 11%)	24% (23% - 24%)	24% (24% - 25%)	50% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	12% (12% - 12%)	44% (44% - 44%)
Pittsburgh, PA	-152% (-149% - -154%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 33%)	66% (65% - 66%)
Salt Lake City, UT	-266% (-263% - -268%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-19% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 35%)	25% (25% - 25%)	51% (51% - 51%)
Tacoma, WA	-78% (-78% - -79%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

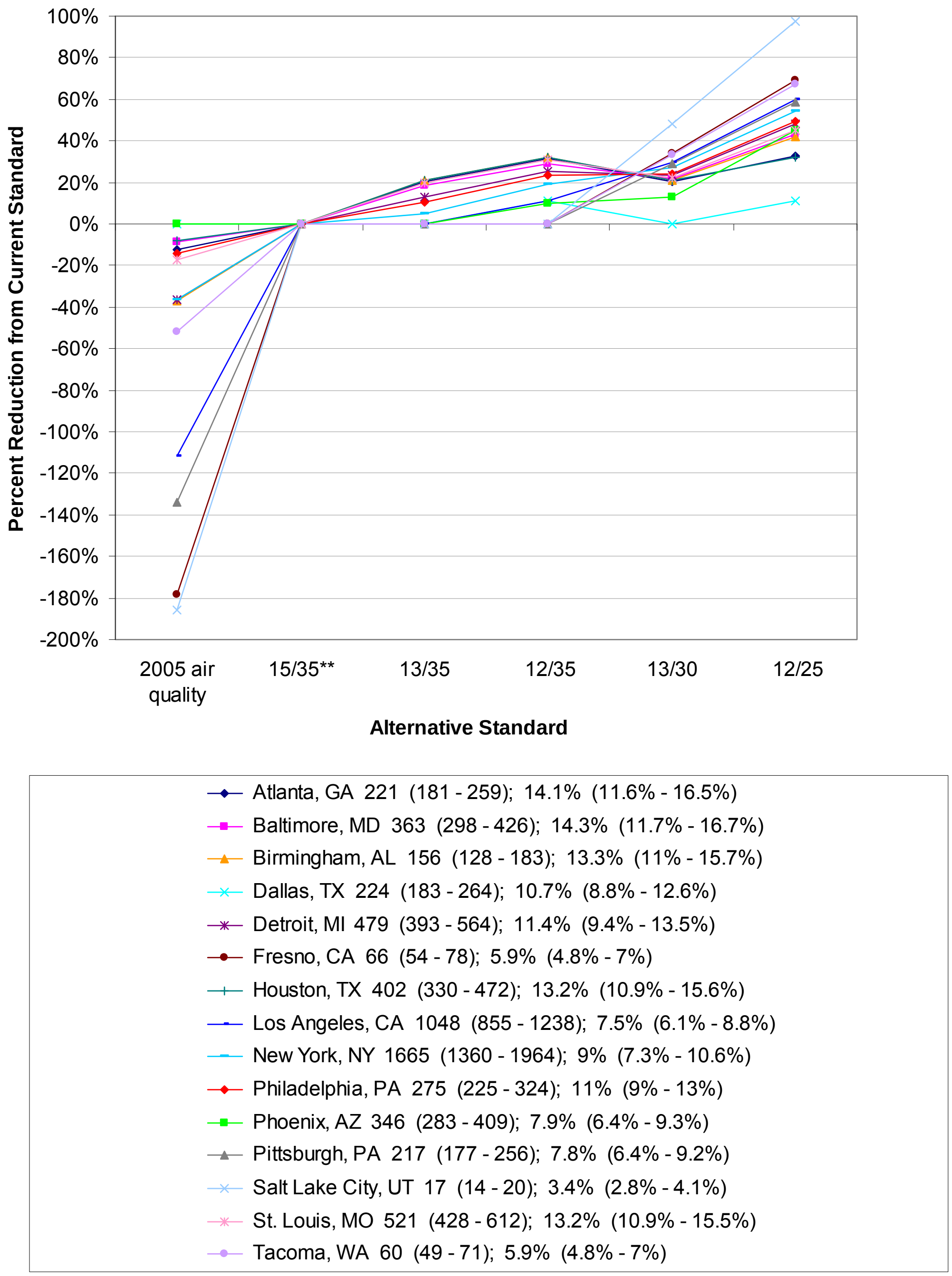
Table E-27. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -13%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	34% (33% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 21%)	32% (32% - 32%)	24% (23% - 24%)	48% (47% - 48%)
Birmingham, AL	-38% (-38% - -39%)	0% (0% - 0%)	22% (21% - 22%)	33% (33% - 33%)	22% (21% - 22%)	43% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	0% (0% - 0%)	12% (12% - 12%)
Detroit, MI	-45% (-44% - -45%)	0% (0% - 0%)	16% (16% - 16%)	31% (31% - 31%)	29% (29% - 29%)	58% (58% - 58%)
Fresno, CA	-154% (-151% - -157%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (29% - 30%)	60% (60% - 60%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 32%)	21% (21% - 22%)	32% (32% - 32%)
Los Angeles, CA	-122% (-120% - -123%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	32% (32% - 32%)	65% (65% - 65%)
New York, NY	-40% (-40% - -41%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 21%)	30% (29% - 30%)	60% (60% - 60%)
Philadelphia, PA	-14% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (24% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	48% (48% - 49%)
Pittsburgh, PA	-149% (-147% - -152%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (64% - 65%)
Salt Lake City, UT	-166% (-164% - -168%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	43% (43% - 43%)	88% (88% - 88%)
St. Louis, MO	-19% (-19% - -19%)	0% (0% - 0%)	22% (22% - 22%)	34% (34% - 34%)	24% (24% - 24%)	49% (49% - 49%)
Tacoma, WA	-69% (-68% - -69%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

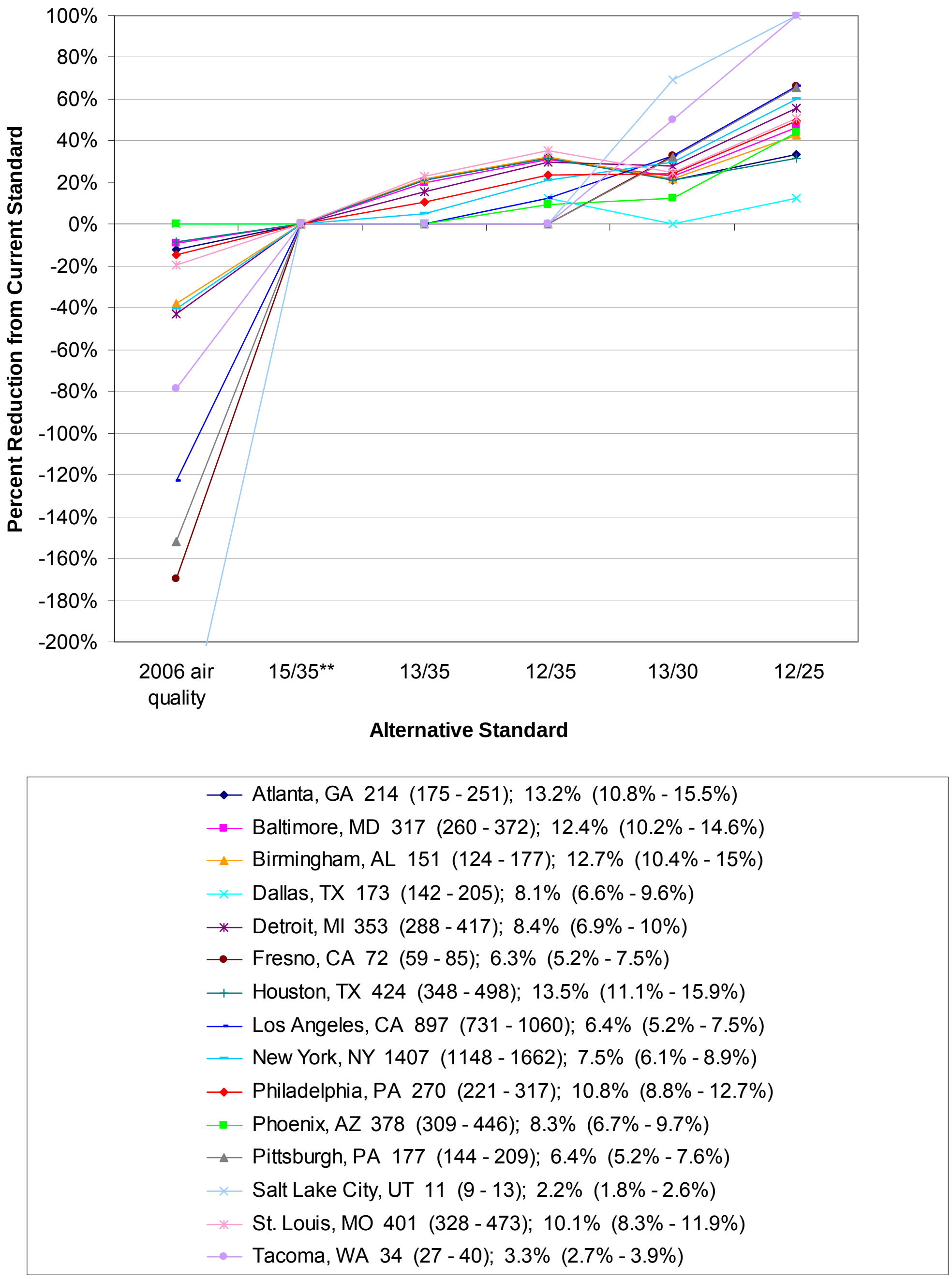
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-7. Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2005 Air Quality Data*



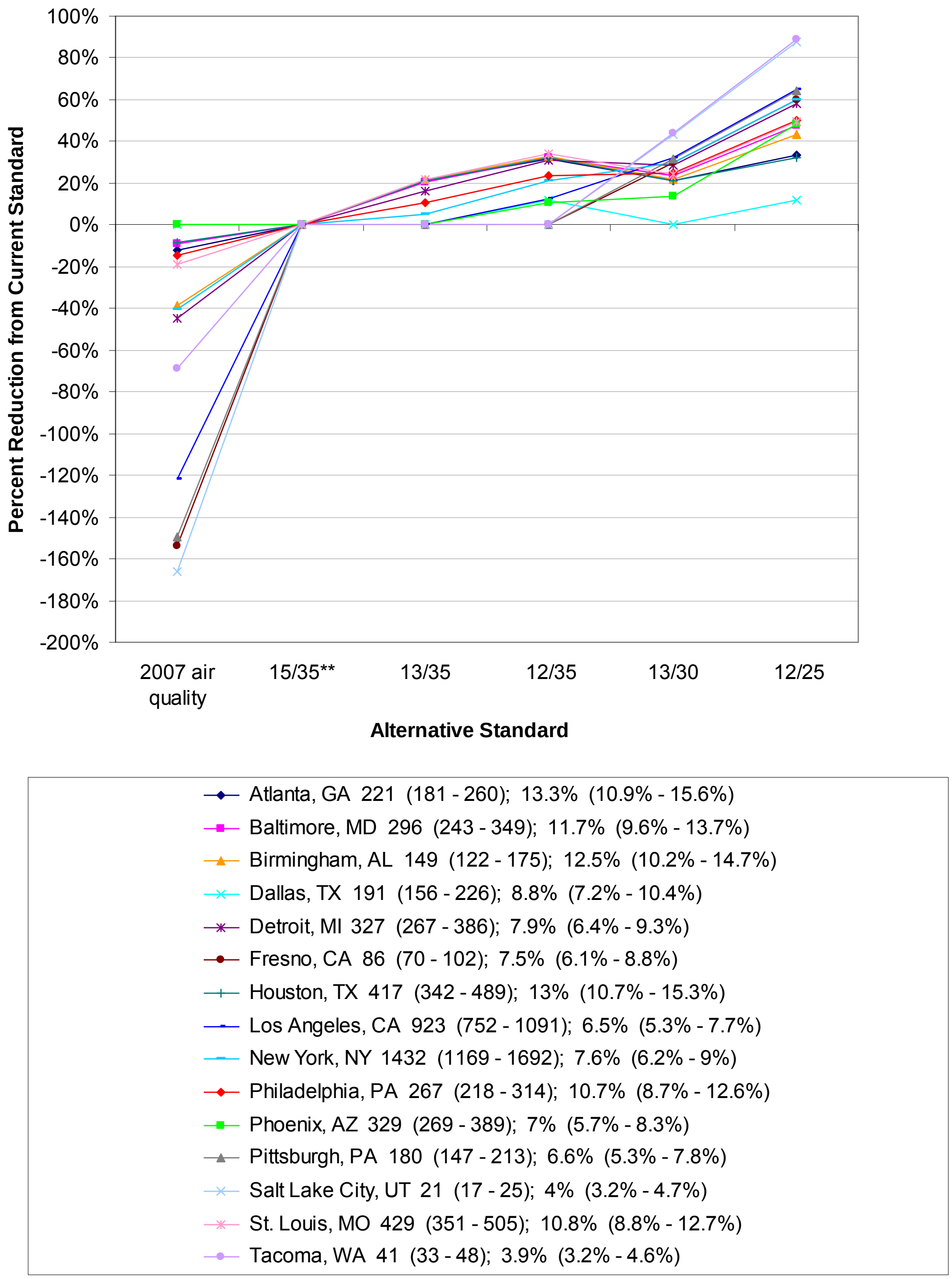
*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-8. Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
** The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -264%.

Figure E-9. **Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data***



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-28. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	310 (255 - 363)	278 (228 - 325)	221 (181 - 260)	192 (157 - 227)	221 (181 - 260)	188 (153 - 221)
Baltimore, MD	493 (406 - 577)	456 (375 - 534)	373 (305 - 438)	325 (266 - 383)	360 (295 - 424)	260 (212 - 307)
Birmingham, AL	268 (221 - 312)	197 (161 - 230)	156 (127 - 183)	135 (110 - 159)	156 (127 - 183)	115 (94 - 136)
Dallas, TX	283 (231 - 333)	283 (231 - 333)	283 (231 - 333)	252 (206 - 297)	283 (231 - 333)	252 (206 - 297)
Detroit, MI	819 (674 - 958)	605 (495 - 711)	526 (430 - 619)	452 (369 - 534)	464 (379 - 548)	318 (258 - 376)
Fresno, CA	229 (189 - 268)	84 (68 - 99)	84 (68 - 99)	84 (68 - 99)	55 (45 - 66)	26 (21 - 31)
Houston, TX	546 (449 - 640)	505 (415 - 593)	400 (327 - 471)	346 (282 - 408)	400 (327 - 471)	346 (282 - 408)
Los Angeles, CA	2778 (2288 - 3247)	1330 (1083 - 1572)	1330 (1083 - 1572)	1180 (960 - 1396)	940 (763 - 1114)	537 (435 - 639)
New York, NY	2865 (2348 - 3365)	2109 (1721 - 2487)	2010 (1639 - 2372)	1704 (1388 - 2015)	1546 (1258 - 1830)	965 (783 - 1146)
Philadelphia, PA	396 (325 - 465)	347 (284 - 409)	311 (254 - 366)	267 (218 - 315)	264 (216 - 312)	178 (145 - 211)
Phoenix, AZ	439 (358 - 519)	439 (358 - 519)	439 (358 - 519)	396 (322 - 468)	384 (312 - 454)	242 (196 - 287)
Pittsburgh, PA	634 (524 - 739)	275 (224 - 325)	275 (224 - 325)	275 (224 - 325)	196 (160 - 233)	115 (93 - 137)
Salt Lake City, UT	61 (50 - 71)	21 (17 - 25)	21 (17 - 25)	21 (17 - 25)	11 (9 - 13)	1 (0 - 1)
St. Louis, MO	765 (630 - 895)	656 (538 - 769)	527 (431 - 621)	456 (372 - 538)	514 (420 - 605)	366 (298 - 432)
Tacoma, WA	115 (94 - 136)	76 (62 - 90)	76 (62 - 90)	76 (62 - 90)	51 (41 - 60)	25 (20 - 30)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-29. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	301 (248 - 353)	269 (221 - 315)	213 (174 - 251)	184 (150 - 217)	213 (174 - 251)	180 (146 - 212)
Baltimore, MD	434 (356 - 509)	399 (327 - 468)	321 (263 - 378)	276 (225 - 326)	309 (253 - 365)	216 (176 - 255)
Birmingham, AL	260 (215 - 303)	190 (156 - 223)	150 (122 - 176)	129 (105 - 152)	150 (122 - 176)	109 (89 - 129)
Dallas, TX	220 (179 - 260)	220 (179 - 260)	220 (179 - 260)	192 (157 - 227)	220 (179 - 260)	192 (157 - 227)
Detroit, MI	635 (521 - 746)	447 (365 - 528)	379 (308 - 448)	315 (256 - 373)	325 (264 - 385)	198 (161 - 236)
Fresno, CA	243 (200 - 283)	91 (74 - 108)	91 (74 - 108)	91 (74 - 108)	62 (50 - 73)	31 (25 - 37)
Houston, TX	576 (474 - 675)	534 (438 - 626)	424 (347 - 499)	367 (300 - 433)	424 (347 - 499)	367 (300 - 433)
Los Angeles, CA	2515 (2067 - 2947)	1140 (927 - 1349)	1140 (927 - 1349)	998 (811 - 1182)	771 (626 - 915)	392 (317 - 466)
New York, NY	2497 (2042 - 2939)	1785 (1454 - 2110)	1693 (1378 - 2001)	1406 (1143 - 1665)	1258 (1022 - 1492)	715 (579 - 850)
Philadelphia, PA	388 (318 - 456)	340 (279 - 401)	304 (249 - 359)	261 (213 - 308)	258 (211 - 305)	173 (141 - 205)
Phoenix, AZ	479 (391 - 566)	479 (391 - 566)	479 (391 - 566)	433 (353 - 512)	420 (342 - 497)	270 (219 - 320)
Pittsburgh, PA	557 (459 - 651)	224 (183 - 266)	224 (183 - 266)	224 (183 - 266)	152 (124 - 181)	78 (63 - 93)
Salt Lake City, UT	51 (41 - 60)	14 (11 - 17)	14 (11 - 17)	14 (11 - 17)	4 (4 - 5)	0 (0 - 0)
St. Louis, MO	605 (495 - 710)	507 (415 - 597)	393 (321 - 465)	331 (269 - 391)	382 (311 - 451)	251 (204 - 298)
Tacoma, WA	76 (62 - 90)	43 (35 - 51)	43 (35 - 51)	43 (35 - 51)	21 (17 - 26)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-30. Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	312 (256 - 365)	278 (228 - 326)	220 (180 - 259)	191 (156 - 225)	220 (180 - 259)	186 (152 - 220)
Baltimore, MD	408 (334 - 479)	374 (306 - 440)	299 (244 - 352)	255 (208 - 302)	287 (234 - 339)	197 (160 - 233)
Birmingham, AL	258 (213 - 301)	188 (154 - 220)	148 (121 - 174)	127 (104 - 150)	148 (121 - 174)	107 (87 - 127)
Dallas, TX	243 (198 - 286)	243 (198 - 286)	243 (198 - 286)	213 (174 - 252)	243 (198 - 286)	213 (174 - 252)
Detroit, MI	596 (488 - 701)	415 (338 - 490)	348 (283 - 412)	287 (233 - 340)	297 (241 - 351)	175 (142 - 208)
Fresno, CA	272 (225 - 316)	109 (89 - 129)	109 (89 - 129)	109 (89 - 129)	77 (63 - 91)	44 (36 - 52)
Houston, TX	567 (466 - 665)	524 (430 - 615)	415 (339 - 488)	358 (292 - 422)	415 (339 - 488)	358 (292 - 422)
Los Angeles, CA	2568 (2111 - 3008)	1173 (954 - 1388)	1173 (954 - 1388)	1029 (836 - 1219)	799 (648 - 948)	414 (335 - 492)
New York, NY	2537 (2075 - 2987)	1818 (1481 - 2148)	1724 (1404 - 2038)	1434 (1166 - 1698)	1285 (1044 - 1523)	735 (595 - 874)
Philadelphia, PA	385 (315 - 452)	337 (276 - 397)	301 (246 - 355)	258 (210 - 305)	255 (208 - 301)	170 (138 - 202)
Phoenix, AZ	418 (341 - 495)	418 (341 - 495)	418 (341 - 495)	374 (304 - 443)	362 (294 - 428)	217 (176 - 258)
Pittsburgh, PA	563 (464 - 658)	229 (187 - 271)	229 (187 - 271)	229 (187 - 271)	157 (127 - 186)	82 (66 - 97)
Salt Lake City, UT	70 (57 - 82)	27 (22 - 31)	27 (22 - 31)	27 (22 - 31)	15 (12 - 18)	3 (3 - 4)
St. Louis, MO	642 (527 - 753)	541 (443 - 637)	424 (346 - 501)	359 (292 - 425)	412 (336 - 486)	277 (225 - 328)
Tacoma, WA	88 (71 - 104)	52 (42 - 62)	52 (42 - 62)	52 (42 - 62)	29 (24 - 35)	6 (5 - 7)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-31. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	19.8% (16.3% - 23.1%)	17.7% (14.5% - 20.7%)	14.1% (11.5% - 16.6%)	12.3% (10% - 14.4%)	14.1% (11.5% - 16.6%)	12% (9.8% - 14.1%)
Baltimore, MD	19.4% (15.9% - 22.7%)	17.9% (14.7% - 21%)	14.7% (12% - 17.2%)	12.8% (10.4% - 15%)	14.2% (11.6% - 16.6%)	10.2% (8.3% - 12.1%)
Birmingham, AL	22.9% (18.9% - 26.6%)	16.8% (13.8% - 19.7%)	13.3% (10.9% - 15.7%)	11.5% (9.4% - 13.6%)	13.3% (10.9% - 15.7%)	9.8% (8% - 11.6%)
Dallas, TX	13.5% (11.1% - 15.9%)	13.5% (11.1% - 15.9%)	13.5% (11.1% - 15.9%)	12.1% (9.9% - 14.2%)	13.5% (11.1% - 15.9%)	12.1% (9.9% - 14.2%)
Detroit, MI	19.5% (16.1% - 22.9%)	14.4% (11.8% - 17%)	12.5% (10.3% - 14.8%)	10.8% (8.8% - 12.7%)	11.1% (9% - 13.1%)	7.6% (6.2% - 9%)
Fresno, CA	20.6% (16.9% - 24%)	7.5% (6.1% - 8.9%)	7.5% (6.1% - 8.9%)	7.5% (6.1% - 8.9%)	5% (4% - 5.9%)	2.3% (1.9% - 2.8%)
Houston, TX	18% (14.8% - 21.1%)	16.7% (13.7% - 19.6%)	13.2% (10.8% - 15.5%)	11.4% (9.3% - 13.5%)	13.2% (10.8% - 15.5%)	11.4% (9.3% - 13.5%)
Los Angeles, CA	19.9% (16.4% - 23.2%)	9.5% (7.7% - 11.2%)	9.5% (7.7% - 11.2%)	8.4% (6.9% - 10%)	6.7% (5.5% - 8%)	3.8% (3.1% - 4.6%)
New York, NY	15.4% (12.6% - 18.1%)	11.4% (9.3% - 13.4%)	10.8% (8.8% - 12.8%)	9.2% (7.5% - 10.9%)	8.3% (6.8% - 9.9%)	5.2% (4.2% - 6.2%)
Philadelphia, PA	15.8% (13% - 18.6%)	13.9% (11.4% - 16.3%)	12.4% (10.2% - 14.6%)	10.7% (8.7% - 12.6%)	10.6% (8.6% - 12.5%)	7.1% (5.8% - 8.4%)
Phoenix, AZ	10% (8.1% - 11.8%)	10% (8.1% - 11.8%)	10% (8.1% - 11.8%)	9% (7.3% - 10.6%)	8.7% (7.1% - 10.3%)	5.5% (4.5% - 6.5%)
Pittsburgh, PA	22.8% (18.9% - 26.6%)	9.9% (8.1% - 11.7%)	9.9% (8.1% - 11.7%)	9.9% (8.1% - 11.7%)	7.1% (5.7% - 8.4%)	4.2% (3.4% - 4.9%)
Salt Lake City, UT	12.4% (10.1% - 14.6%)	4.4% (3.5% - 5.2%)	4.4% (3.5% - 5.2%)	4.4% (3.5% - 5.2%)	2.3% (1.8% - 2.7%)	0.1% (0.1% - 0.1%)
St. Louis, MO	19.4% (16% - 22.7%)	16.6% (13.7% - 19.5%)	13.4% (10.9% - 15.7%)	11.6% (9.4% - 13.6%)	13% (10.7% - 15.3%)	9.3% (7.6% - 11%)
Tacoma, WA	11.4% (9.3% - 13.5%)	7.6% (6.1% - 9%)	7.6% (6.1% - 9%)	7.6% (6.1% - 9%)	5% (4.1% - 6%)	2.5% (2% - 2.9%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-32. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	18.6% (15.3% - 21.8%)	16.6% (13.6% - 19.5%)	13.2% (10.8% - 15.5%)	11.4% (9.3% - 13.4%)	13.2% (10.8% - 15.5%)	11.1% (9.1% - 13.1%)
Baltimore, MD	17% (14% - 20%)	15.6% (12.8% - 18.4%)	12.6% (10.3% - 14.8%)	10.8% (8.8% - 12.8%)	12.1% (9.9% - 14.3%)	8.5% (6.9% - 10%)
Birmingham, AL	22% (18.1% - 25.6%)	16% (13.1% - 18.8%)	12.6% (10.3% - 14.9%)	10.9% (8.9% - 12.8%)	12.6% (10.3% - 14.9%)	9.2% (7.5% - 10.9%)
Dallas, TX	10.3% (8.4% - 12.2%)	10.3% (8.4% - 12.2%)	10.3% (8.4% - 12.2%)	9% (7.3% - 10.7%)	10.3% (8.4% - 12.2%)	9% (7.3% - 10.7%)
Detroit, MI	15.2% (12.4% - 17.8%)	10.7% (8.7% - 12.6%)	9% (7.4% - 10.7%)	7.5% (6.1% - 8.9%)	7.8% (6.3% - 9.2%)	4.7% (3.8% - 5.6%)
Fresno, CA	21.4% (17.7% - 25%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	5.5% (4.4% - 6.5%)	2.8% (2.2% - 3.3%)
Houston, TX	18.4% (15.1% - 21.5%)	17% (14% - 20%)	13.5% (11% - 15.9%)	11.7% (9.6% - 13.8%)	13.5% (11% - 15.9%)	11.7% (9.6% - 13.8%)
Los Angeles, CA	17.9% (14.7% - 20.9%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	7.1% (5.8% - 8.4%)	5.5% (4.4% - 6.5%)	2.8% (2.3% - 3.3%)
New York, NY	13.3% (10.9% - 15.7%)	9.5% (7.8% - 11.3%)	9% (7.3% - 10.7%)	7.5% (6.1% - 8.9%)	6.7% (5.5% - 8%)	3.8% (3.1% - 4.5%)
Philadelphia, PA	15.6% (12.8% - 18.3%)	13.6% (11.2% - 16.1%)	12.2% (10% - 14.4%)	10.5% (8.5% - 12.4%)	10.4% (8.4% - 12.2%)	6.9% (5.6% - 8.2%)
Phoenix, AZ	10.5% (8.5% - 12.4%)	10.5% (8.5% - 12.4%)	10.5% (8.5% - 12.4%)	9.5% (7.7% - 11.2%)	9.2% (7.5% - 10.9%)	5.9% (4.8% - 7%)
Pittsburgh, PA	20.2% (16.6% - 23.6%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	8.1% (6.6% - 9.6%)	5.5% (4.5% - 6.5%)	2.8% (2.3% - 3.4%)
Salt Lake City, UT	10% (8.2% - 11.8%)	2.8% (2.2% - 3.3%)	2.8% (2.2% - 3.3%)	2.8% (2.2% - 3.3%)	0.9% (0.7% - 1%)	0% (0% - 0%)
St. Louis, MO	15.3% (12.5% - 17.9%)	12.8% (10.5% - 15.1%)	9.9% (8.1% - 11.7%)	8.3% (6.8% - 9.9%)	9.6% (7.8% - 11.4%)	6.3% (5.2% - 7.5%)
Tacoma, WA	7.4% (6% - 8.8%)	4.2% (3.4% - 5%)	4.2% (3.4% - 5%)	4.2% (3.4% - 5%)	2.1% (1.7% - 2.5%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-33. Estimated Percent of Total Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	18.8% (15.4% - 22%)	16.8% (13.7% - 19.6%)	13.3% (10.9% - 15.6%)	11.5% (9.4% - 13.5%)	13.3% (10.9% - 15.6%)	11.2% (9.1% - 13.2%)
Baltimore, MD	16% (13.2% - 18.8%)	14.7% (12% - 17.3%)	11.8% (9.6% - 13.9%)	10% (8.2% - 11.9%)	11.3% (9.2% - 13.3%)	7.7% (6.3% - 9.2%)
Birmingham, AL	21.6% (17.8% - 25.2%)	15.7% (12.9% - 18.4%)	12.4% (10.1% - 14.6%)	10.6% (8.7% - 12.5%)	12.4% (10.1% - 14.6%)	9% (7.3% - 10.6%)
Dallas, TX	11.2% (9.1% - 13.2%)	11.2% (9.1% - 13.2%)	11.2% (9.1% - 13.2%)	9.8% (8% - 11.6%)	11.2% (9.1% - 13.2%)	9.8% (8% - 11.6%)
Detroit, MI	14.3% (11.7% - 16.9%)	10% (8.1% - 11.8%)	8.4% (6.8% - 9.9%)	6.9% (5.6% - 8.2%)	7.1% (5.8% - 8.5%)	4.2% (3.4% - 5%)
Fresno, CA	23.6% (19.5% - 27.5%)	9.5% (7.7% - 11.2%)	9.5% (7.7% - 11.2%)	9.5% (7.7% - 11.2%)	6.7% (5.4% - 7.9%)	3.8% (3.1% - 4.5%)
Houston, TX	17.7% (14.6% - 20.8%)	16.4% (13.5% - 19.2%)	13% (10.6% - 15.3%)	11.2% (9.1% - 13.2%)	13% (10.6% - 15.3%)	11.2% (9.1% - 13.2%)
Los Angeles, CA	18.1% (14.9% - 21.2%)	8.3% (6.7% - 9.8%)	8.3% (6.7% - 9.8%)	7.3% (5.9% - 8.6%)	5.6% (4.6% - 6.7%)	2.9% (2.4% - 3.5%)
New York, NY	13.4% (11% - 15.8%)	9.6% (7.8% - 11.4%)	9.1% (7.4% - 10.8%)	7.6% (6.2% - 9%)	6.8% (5.5% - 8.1%)	3.9% (3.2% - 4.6%)
Philadelphia, PA	15.4% (12.6% - 18.1%)	13.5% (11% - 15.9%)	12.1% (9.8% - 14.2%)	10.3% (8.4% - 12.2%)	10.2% (8.3% - 12.1%)	6.8% (5.5% - 8.1%)
Phoenix, AZ	8.9% (7.2% - 10.5%)	8.9% (7.2% - 10.5%)	8.9% (7.2% - 10.5%)	7.9% (6.4% - 9.4%)	7.7% (6.2% - 9.1%)	4.6% (3.7% - 5.5%)
Pittsburgh, PA	20.5% (16.9% - 23.9%)	8.3% (6.8% - 9.9%)	8.3% (6.8% - 9.9%)	8.3% (6.8% - 9.9%)	5.7% (4.6% - 6.8%)	3% (2.4% - 3.5%)
Salt Lake City, UT	13.4% (11% - 15.8%)	5.1% (4.1% - 6.1%)	5.1% (4.1% - 6.1%)	5.1% (4.1% - 6.1%)	2.9% (2.3% - 3.4%)	0.6% (0.5% - 0.8%)
St. Louis, MO	16.2% (13.3% - 19%)	13.7% (11.2% - 16.1%)	10.7% (8.7% - 12.6%)	9.1% (7.4% - 10.7%)	10.4% (8.5% - 12.3%)	7% (5.7% - 8.3%)
Tacoma, WA	8.4% (6.8% - 9.9%)	5% (4.1% - 5.9%)	5% (4.1% - 5.9%)	5% (4.1% - 5.9%)	2.8% (2.3% - 3.3%)	0.6% (0.5% - 0.7%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-34. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-11% - -12%)	0% (0% - 0%)	20% (20% - 21%)	31% (30% - 31%)	20% (20% - 21%)	32% (32% - 33%)
Baltimore, MD	-8% (-8% - -8%)	0% (0% - 0%)	18% (18% - 18%)	29% (28% - 29%)	21% (21% - 21%)	43% (42% - 43%)
Birmingham, AL	-36% (-35% - -37%)	0% (0% - 0%)	21% (20% - 21%)	31% (31% - 32%)	21% (20% - 21%)	42% (41% - 42%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-35% (-35% - -36%)	0% (0% - 0%)	13% (13% - 13%)	25% (25% - 26%)	23% (23% - 24%)	47% (47% - 48%)
Fresno, CA	-174% (-170% - -178%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	69% (69% - 69%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (31% - 32%)	21% (21% - 21%)	32% (31% - 32%)
Los Angeles, CA	-109% (-107% - -111%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	29% (29% - 30%)	60% (59% - 60%)
New York, NY	-36% (-35% - -36%)	0% (0% - 0%)	5% (5% - 5%)	19% (19% - 19%)	27% (26% - 27%)	54% (54% - 55%)
Philadelphia, PA	-14% (-14% - -14%)	0% (0% - 0%)	11% (10% - 11%)	23% (23% - 23%)	24% (24% - 24%)	49% (48% - 49%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (12% - 13%)	45% (45% - 45%)
Pittsburgh, PA	-130% (-127% - -134%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (28% - 29%)	58% (58% - 58%)
Salt Lake City, UT	-183% (-181% - -185%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	48% (48% - 48%)	98% (98% - 98%)
St. Louis, MO	-17% (-16% - -17%)	0% (0% - 0%)	20% (19% - 20%)	30% (30% - 31%)	22% (21% - 22%)	44% (44% - 45%)
Tacoma, WA	-51% (-51% - -52%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	67% (67% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-35. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -12%)	0% (0% - 0%)	21% (21% - 21%)	32% (31% - 32%)	21% (21% - 21%)	33% (33% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	19% (19% - 20%)	31% (30% - 31%)	22% (22% - 23%)	46% (45% - 46%)
Birmingham, AL	-37% (-36% - -38%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	42% (42% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	0% (0% - 0%)	12% (12% - 13%)
Detroit, MI	-42% (-41% - -43%)	0% (0% - 0%)	15% (15% - 16%)	30% (29% - 30%)	27% (27% - 28%)	56% (55% - 56%)
Fresno, CA	-166% (-162% - -170%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 33%)	66% (66% - 66%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (20% - 21%)	31% (31% - 32%)	21% (20% - 21%)	31% (31% - 32%)
Los Angeles, CA	-121% (-118% - -123%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	32% (32% - 33%)	66% (65% - 66%)
New York, NY	-40% (-39% - -40%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 21%)	30% (29% - 30%)	60% (60% - 60%)
Philadelphia, PA	-14% (-14% - -14%)	0% (0% - 0%)	11% (10% - 11%)	23% (23% - 24%)	24% (24% - 24%)	49% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	12% (12% - 12%)	44% (43% - 44%)
Pittsburgh, PA	-148% (-145% - -151%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (65% - 65%)
Salt Lake City, UT	-262% (-260% - -265%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-19% (-19% - -20%)	0% (0% - 0%)	22% (22% - 23%)	35% (35% - 35%)	25% (25% - 25%)	50% (50% - 51%)
Tacoma, WA	-78% (-77% - -78%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

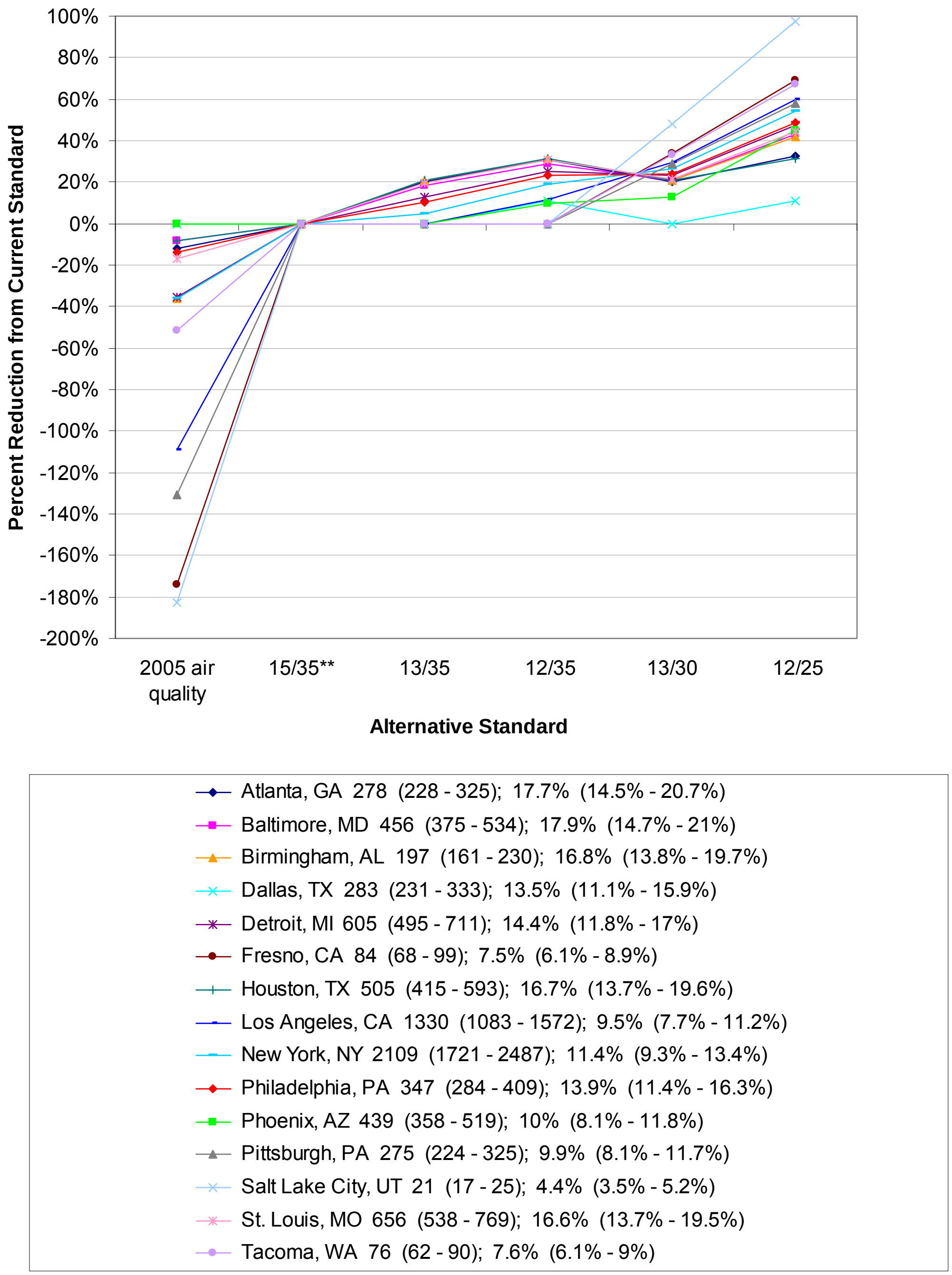
Table E-36. Percent Reduction from the Current Standards: Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -12%)	0% (0% - 0%)	21% (20% - 21%)	31% (31% - 32%)	21% (20% - 21%)	33% (33% - 33%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 20%)	32% (31% - 32%)	23% (23% - 23%)	47% (47% - 48%)
Birmingham, AL	-37% (-37% - -38%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	43% (42% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	0% (0% - 0%)	12% (12% - 12%)
Detroit, MI	-44% (-43% - -44%)	0% (0% - 0%)	16% (16% - 16%)	31% (31% - 31%)	28% (28% - 29%)	58% (58% - 58%)
Fresno, CA	-149% (-145% - -153%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 30%)	60% (59% - 60%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (31% - 32%)	21% (21% - 21%)	32% (31% - 32%)
Los Angeles, CA	-119% (-117% - -121%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	32% (32% - 32%)	65% (65% - 65%)
New York, NY	-40% (-39% - -40%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 21%)	29% (29% - 30%)	60% (59% - 60%)
Philadelphia, PA	-14% (-14% - -14%)	0% (0% - 0%)	11% (11% - 11%)	23% (23% - 24%)	24% (24% - 25%)	49% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (13% - 14%)	48% (48% - 48%)
Pittsburgh, PA	-146% (-142% - -149%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	64% (64% - 64%)
Salt Lake City, UT	-163% (-161% - -166%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	43% (43% - 43%)	87% (87% - 88%)
St. Louis, MO	-19% (-18% - -19%)	0% (0% - 0%)	22% (21% - 22%)	34% (33% - 34%)	24% (24% - 24%)	49% (48% - 49%)
Tacoma, WA	-68% (-68% - -69%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

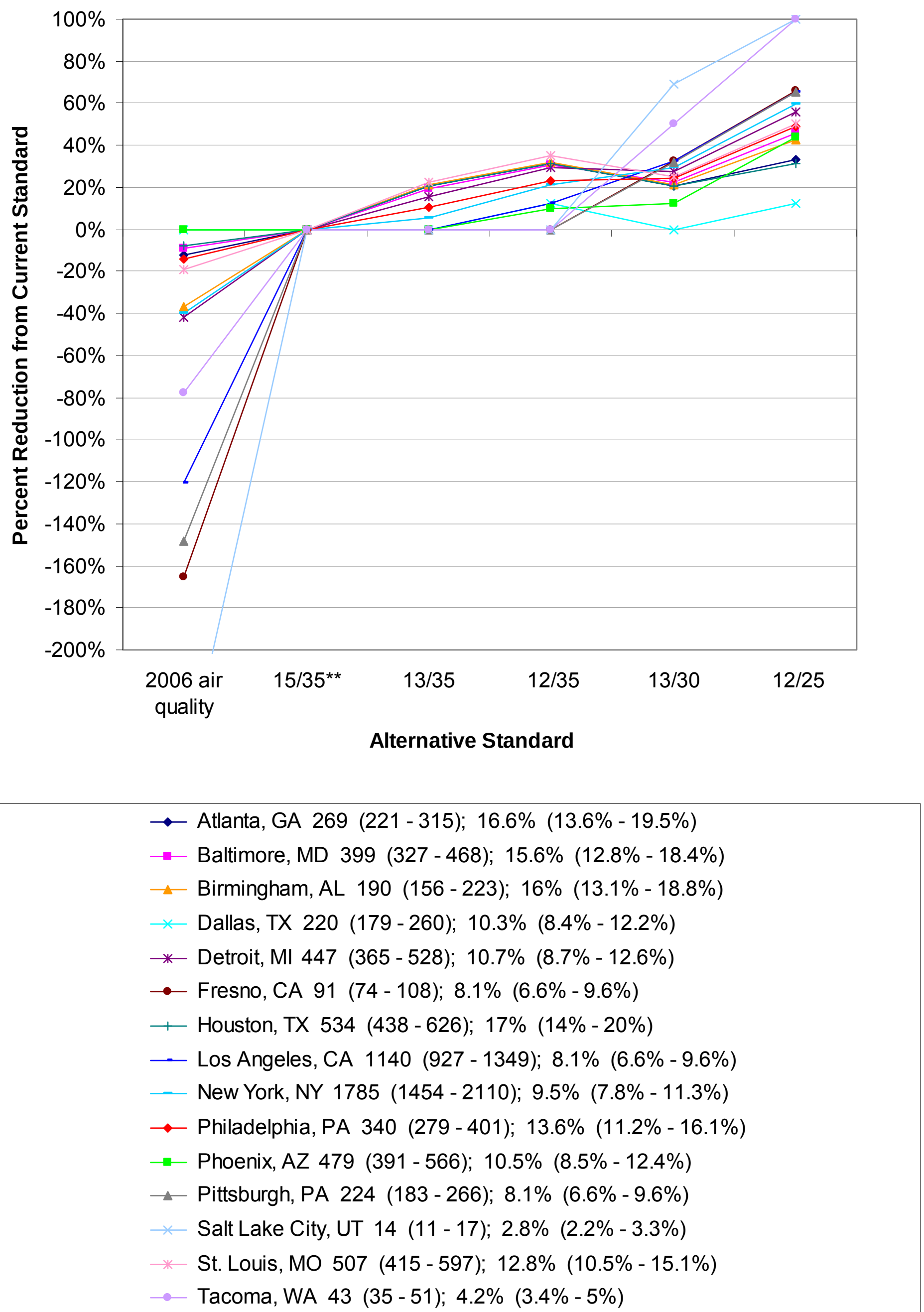
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-10. Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2005 Air Quality Data*



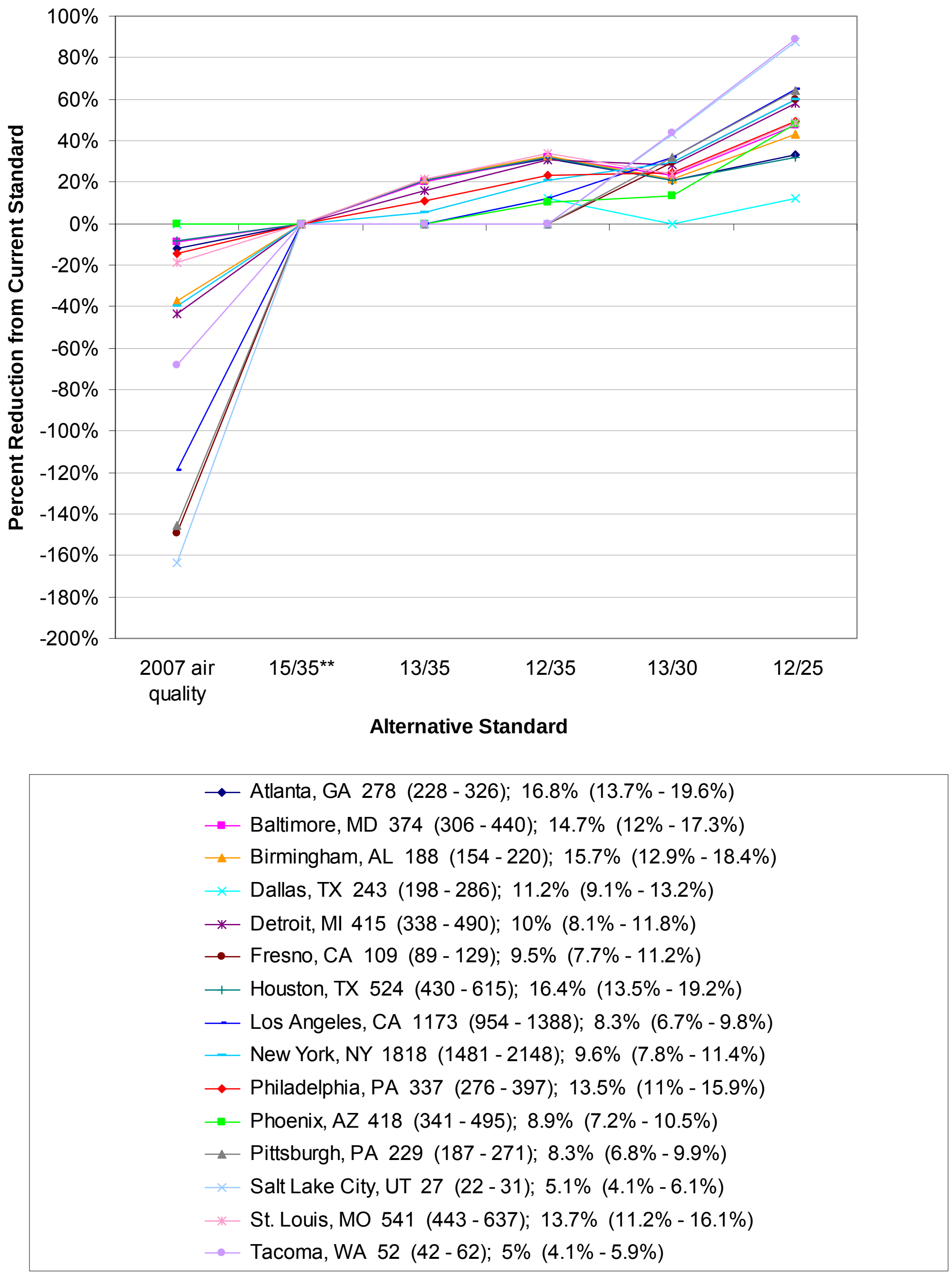
*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-11. Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -262%.

Figure E-12. Estimated Percent Reductions From the Current Standard to Alternative Standards in Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-37. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	510 (389 - 627)	453 (346 - 558)	357 (272 - 440)	308 (234 - 381)	357 (272 - 440)	301 (229 - 372)
Baltimore, MD	503 (384 - 619)	463 (353 - 570)	374 (285 - 462)	324 (247 - 401)	361 (275 - 446)	257 (196 - 318)
Birmingham, AL	424 (324 - 520)	305 (232 - 376)	239 (182 - 295)	205 (156 - 254)	239 (182 - 295)	174 (132 - 215)
Dallas, TX	310 (236 - 383)	310 (236 - 383)	310 (236 - 383)	275 (209 - 340)	310 (236 - 383)	275 (209 - 340)
Detroit, MI	708 (541 - 871)	514 (391 - 634)	444 (338 - 548)	380 (288 - 470)	390 (296 - 482)	264 (200 - 327)
Fresno, CA	235 (180 - 289)	82 (62 - 102)	82 (62 - 102)	82 (62 - 102)	54 (41 - 67)	25 (19 - 31)
Houston, TX	589 (450 - 726)	543 (414 - 669)	425 (323 - 525)	365 (278 - 452)	425 (323 - 525)	365 (278 - 452)
Los Angeles, CA	2465 (1883 - 3033)	1140 (866 - 1412)	1140 (866 - 1412)	1008 (765 - 1249)	799 (606 - 990)	453 (343 - 562)
New York, NY	1908 (1454 - 2354)	1386 (1054 - 1714)	1318 (1002 - 1631)	1112 (845 - 1377)	1007 (764 - 1247)	622 (471 - 772)
Philadelphia, PA	413 (315 - 510)	361 (275 - 445)	321 (244 - 397)	274 (209 - 339)	271 (206 - 336)	181 (137 - 224)
Phoenix, AZ	401 (305 - 496)	401 (305 - 496)	401 (305 - 496)	360 (273 - 446)	349 (265 - 432)	218 (165 - 270)
Pittsburgh, PA	621 (475 - 762)	258 (196 - 319)	258 (196 - 319)	258 (196 - 319)	183 (138 - 226)	106 (80 - 132)
Salt Lake City, UT	91 (70 - 113)	32 (24 - 39)	32 (24 - 39)	32 (24 - 39)	16 (12 - 20)	1 (1 - 1)
St. Louis, MO	727 (555 - 895)	617 (471 - 761)	491 (374 - 606)	422 (321 - 522)	478 (364 - 590)	336 (255 - 416)
Tacoma, WA	108 (82 - 134)	71 (54 - 88)	71 (54 - 88)	71 (54 - 88)	47 (35 - 58)	23 (17 - 28)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-38. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1979 - 1983[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	493 (377 - 607)	437 (333 - 539)	342 (260 - 422)	294 (223 - 363)	342 (260 - 422)	287 (218 - 354)
Baltimore, MD	439 (335 - 541)	402 (306 - 496)	320 (244 - 396)	274 (208 - 339)	308 (234 - 381)	212 (161 - 263)
Birmingham, AL	411 (314 - 505)	294 (224 - 362)	229 (174 - 283)	196 (149 - 243)	229 (174 - 283)	165 (126 - 205)
Dallas, TX	239 (181 - 295)	239 (181 - 295)	239 (181 - 295)	208 (158 - 257)	239 (181 - 295)	208 (158 - 257)
Detroit, MI	541 (412 - 667)	375 (285 - 464)	316 (240 - 391)	261 (198 - 324)	270 (205 - 335)	163 (124 - 203)
Fresno, CA	249 (191 - 307)	90 (68 - 111)	90 (68 - 111)	90 (68 - 111)	60 (46 - 75)	30 (23 - 38)
Houston, TX	622 (475 - 767)	574 (438 - 707)	450 (343 - 556)	387 (295 - 479)	450 (343 - 556)	387 (295 - 479)
Los Angeles, CA	2217 (1692 - 2731)	973 (739 - 1206)	973 (739 - 1206)	849 (644 - 1053)	653 (495 - 810)	329 (249 - 409)
New York, NY	1651 (1257 - 2040)	1167 (886 - 1444)	1104 (838 - 1367)	913 (693 - 1131)	815 (618 - 1011)	459 (348 - 570)
Philadelphia, PA	405 (309 - 500)	353 (269 - 436)	314 (239 - 388)	268 (204 - 331)	265 (201 - 328)	176 (133 - 218)
Phoenix, AZ	438 (333 - 542)	438 (333 - 542)	438 (333 - 542)	395 (300 - 489)	383 (291 - 474)	244 (185 - 302)
Pittsburgh, PA	540 (413 - 665)	209 (159 - 259)	209 (159 - 259)	209 (159 - 259)	141 (107 - 175)	71 (54 - 89)
Salt Lake City, UT	76 (58 - 94)	20 (16 - 25)	20 (16 - 25)	20 (16 - 25)	6 (5 - 8)	0 (0 - 0)
St. Louis, MO	566 (432 - 699)	471 (359 - 582)	362 (275 - 448)	303 (230 - 375)	351 (267 - 435)	229 (174 - 284)
Tacoma, WA	71 (54 - 87)	39 (30 - 49)	39 (30 - 49)	39 (30 - 49)	20 (15 - 24)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-39. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	510 (390 - 628)	452 (345 - 558)	354 (270 - 438)	305 (232 - 377)	354 (270 - 438)	297 (226 - 367)
Baltimore, MD	411 (313 - 507)	375 (286 - 463)	297 (226 - 367)	253 (192 - 313)	285 (217 - 353)	193 (147 - 240)
Birmingham, AL	407 (311 - 500)	290 (221 - 358)	226 (172 - 279)	193 (147 - 239)	226 (172 - 279)	162 (123 - 201)
Dallas, TX	264 (201 - 326)	264 (201 - 326)	264 (201 - 326)	231 (176 - 286)	264 (201 - 326)	231 (176 - 286)
Detroit, MI	506 (385 - 625)	347 (264 - 430)	290 (220 - 359)	238 (180 - 295)	246 (187 - 305)	144 (109 - 178)
Fresno, CA	281 (216 - 346)	108 (82 - 133)	108 (82 - 133)	108 (82 - 133)	75 (57 - 93)	43 (32 - 53)
Houston, TX	611 (466 - 753)	563 (429 - 694)	440 (335 - 543)	377 (287 - 467)	440 (335 - 543)	377 (287 - 467)
Los Angeles, CA	2265 (1729 - 2791)	1002 (761 - 1241)	1002 (761 - 1241)	876 (665 - 1086)	677 (513 - 840)	348 (263 - 432)
New York, NY	1679 (1278 - 2074)	1188 (903 - 1471)	1125 (854 - 1393)	931 (707 - 1154)	832 (631 - 1032)	472 (357 - 586)
Philadelphia, PA	401 (306 - 495)	349 (266 - 431)	310 (236 - 384)	265 (201 - 327)	262 (199 - 324)	173 (131 - 214)
Phoenix, AZ	381 (289 - 471)	381 (289 - 471)	381 (289 - 471)	339 (257 - 420)	328 (249 - 406)	195 (148 - 242)
Pittsburgh, PA	547 (418 - 673)	214 (162 - 265)	214 (162 - 265)	214 (162 - 265)	145 (110 - 180)	75 (57 - 93)
Salt Lake City, UT	106 (80 - 130)	39 (30 - 48)	39 (30 - 48)	39 (30 - 48)	22 (17 - 27)	5 (4 - 6)
St. Louis, MO	603 (460 - 744)	505 (384 - 623)	391 (297 - 484)	330 (250 - 408)	380 (289 - 470)	253 (192 - 313)
Tacoma, WA	81 (62 - 101)	48 (36 - 60)	48 (36 - 60)	48 (36 - 60)	27 (20 - 33)	5 (4 - 7)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-40. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8.7% (6.7% - 10.7%)	7.8% (5.9% - 9.6%)	6.1% (4.7% - 7.5%)	5.3% (4% - 6.5%)	6.1% (4.7% - 7.5%)	5.1% (3.9% - 6.4%)
Baltimore, MD	8.5% (6.5% - 10.5%)	7.9% (6% - 9.7%)	6.4% (4.8% - 7.8%)	5.5% (4.2% - 6.8%)	6.1% (4.7% - 7.6%)	4.4% (3.3% - 5.4%)
Birmingham, AL	10.2% (7.8% - 12.5%)	7.3% (5.6% - 9%)	5.7% (4.4% - 7.1%)	4.9% (3.8% - 6.1%)	5.7% (4.4% - 7.1%)	4.2% (3.2% - 5.2%)
Dallas, TX	5.9% (4.5% - 7.2%)	5.9% (4.5% - 7.2%)	5.9% (4.5% - 7.2%)	5.2% (4% - 6.4%)	5.9% (4.5% - 7.2%)	5.2% (4% - 6.4%)
Detroit, MI	8.6% (6.6% - 10.6%)	6.3% (4.8% - 7.7%)	5.4% (4.1% - 6.7%)	4.6% (3.5% - 5.7%)	4.7% (3.6% - 5.9%)	3.2% (2.4% - 4%)
Fresno, CA	9.1% (7% - 11.2%)	3.2% (2.4% - 3.9%)	3.2% (2.4% - 3.9%)	3.2% (2.4% - 3.9%)	2.1% (1.6% - 2.6%)	1% (0.7% - 1.2%)
Houston, TX	7.9% (6% - 9.7%)	7.3% (5.6% - 9%)	5.7% (4.3% - 7%)	4.9% (3.7% - 6.1%)	5.7% (4.3% - 7%)	4.9% (3.7% - 6.1%)
Los Angeles, CA	8.8% (6.7% - 10.8%)	4.1% (3.1% - 5%)	4.1% (3.1% - 5%)	3.6% (2.7% - 4.4%)	2.8% (2.2% - 3.5%)	1.6% (1.2% - 2%)
New York, NY	6.7% (5.1% - 8.3%)	4.9% (3.7% - 6%)	4.6% (3.5% - 5.7%)	3.9% (3% - 4.8%)	3.5% (2.7% - 4.4%)	2.2% (1.7% - 2.7%)
Philadelphia, PA	6.9% (5.3% - 8.5%)	6% (4.6% - 7.4%)	5.4% (4.1% - 6.6%)	4.6% (3.5% - 5.7%)	4.5% (3.4% - 5.6%)	3% (2.3% - 3.7%)
Phoenix, AZ	4.3% (3.2% - 5.3%)	4.3% (3.2% - 5.3%)	4.3% (3.2% - 5.3%)	3.8% (2.9% - 4.7%)	3.7% (2.8% - 4.6%)	2.3% (1.8% - 2.9%)
Pittsburgh, PA	10.2% (7.8% - 12.5%)	4.2% (3.2% - 5.2%)	4.2% (3.2% - 5.2%)	4.2% (3.2% - 5.2%)	3% (2.3% - 3.7%)	1.7% (1.3% - 2.2%)
Salt Lake City, UT	5.3% (4.1% - 6.6%)	1.8% (1.4% - 2.3%)	1.8% (1.4% - 2.3%)	1.8% (1.4% - 2.3%)	0.9% (0.7% - 1.2%)	0% (0% - 0.1%)
St. Louis, MO	8.6% (6.5% - 10.5%)	7.3% (5.5% - 9%)	5.8% (4.4% - 7.1%)	5% (3.8% - 6.1%)	5.6% (4.3% - 6.9%)	4% (3% - 4.9%)
Tacoma, WA	4.9% (3.7% - 6.1%)	3.2% (2.4% - 4%)	3.2% (2.4% - 4%)	3.2% (2.4% - 4%)	2.1% (1.6% - 2.6%)	1% (0.8% - 1.3%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-41. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8.2% (6.3% - 10.1%)	7.3% (5.5% - 8.9%)	5.7% (4.3% - 7%)	4.9% (3.7% - 6%)	5.7% (4.3% - 7%)	4.8% (3.6% - 5.9%)
Baltimore, MD	7.4% (5.7% - 9.2%)	6.8% (5.2% - 8.4%)	5.4% (4.1% - 6.7%)	4.6% (3.5% - 5.7%)	5.2% (4% - 6.5%)	3.6% (2.7% - 4.5%)
Birmingham, AL	9.8% (7.5% - 12%)	7% (5.3% - 8.6%)	5.4% (4.1% - 6.7%)	4.7% (3.5% - 5.8%)	5.4% (4.1% - 6.7%)	3.9% (3% - 4.9%)
Dallas, TX	4.4% (3.4% - 5.5%)	4.4% (3.4% - 5.5%)	4.4% (3.4% - 5.5%)	3.8% (2.9% - 4.8%)	4.4% (3.4% - 5.5%)	3.8% (2.9% - 4.8%)
Detroit, MI	6.6% (5% - 8.1%)	4.6% (3.5% - 5.7%)	3.9% (2.9% - 4.8%)	3.2% (2.4% - 4%)	3.3% (2.5% - 4.1%)	2% (1.5% - 2.5%)
Fresno, CA	9.5% (7.3% - 11.7%)	3.4% (2.6% - 4.2%)	3.4% (2.6% - 4.2%)	3.4% (2.6% - 4.2%)	2.3% (1.7% - 2.9%)	1.2% (0.9% - 1.4%)
Houston, TX	8.1% (6.2% - 9.9%)	7.4% (5.7% - 9.2%)	5.8% (4.4% - 7.2%)	5% (3.8% - 6.2%)	5.8% (4.4% - 7.2%)	5% (3.8% - 6.2%)
Los Angeles, CA	7.8% (6% - 9.7%)	3.4% (2.6% - 4.3%)	3.4% (2.6% - 4.3%)	3% (2.3% - 3.7%)	2.3% (1.8% - 2.9%)	1.2% (0.9% - 1.4%)
New York, NY	5.8% (4.4% - 7.1%)	4.1% (3.1% - 5%)	3.8% (2.9% - 4.8%)	3.2% (2.4% - 3.9%)	2.8% (2.2% - 3.5%)	1.6% (1.2% - 2%)
Philadelphia, PA	6.8% (5.2% - 8.4%)	5.9% (4.5% - 7.3%)	5.2% (4% - 6.5%)	4.5% (3.4% - 5.5%)	4.4% (3.4% - 5.5%)	2.9% (2.2% - 3.6%)
Phoenix, AZ	4.5% (3.4% - 5.5%)	4.5% (3.4% - 5.5%)	4.5% (3.4% - 5.5%)	4% (3.1% - 5%)	3.9% (3% - 4.8%)	2.5% (1.9% - 3.1%)
Pittsburgh, PA	8.9% (6.8% - 11%)	3.5% (2.6% - 4.3%)	3.5% (2.6% - 4.3%)	3.5% (2.6% - 4.3%)	2.3% (1.8% - 2.9%)	1.2% (0.9% - 1.5%)
Salt Lake City, UT	4.3% (3.3% - 5.3%)	1.2% (0.9% - 1.4%)	1.2% (0.9% - 1.4%)	1.2% (0.9% - 1.4%)	0.4% (0.3% - 0.4%)	0% (0% - 0%)
St. Louis, MO	6.6% (5.1% - 8.2%)	5.5% (4.2% - 6.8%)	4.2% (3.2% - 5.3%)	3.5% (2.7% - 4.4%)	4.1% (3.1% - 5.1%)	2.7% (2% - 3.3%)
Tacoma, WA	3.1% (2.4% - 3.9%)	1.8% (1.3% - 2.2%)	1.8% (1.3% - 2.2%)	1.8% (1.3% - 2.2%)	0.9% (0.7% - 1.1%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-42. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8.3% (6.3% - 10.2%)	7.3% (5.6% - 9%)	5.7% (4.4% - 7.1%)	4.9% (3.7% - 6.1%)	5.7% (4.4% - 7.1%)	4.8% (3.7% - 5.9%)
Baltimore, MD	7% (5.3% - 8.6%)	6.4% (4.9% - 7.9%)	5% (3.8% - 6.2%)	4.3% (3.3% - 5.3%)	4.8% (3.7% - 6%)	3.3% (2.5% - 4.1%)
Birmingham, AL	9.6% (7.3% - 11.8%)	6.8% (5.2% - 8.4%)	5.3% (4% - 6.6%)	4.5% (3.5% - 5.6%)	5.3% (4% - 6.6%)	3.8% (2.9% - 4.7%)
Dallas, TX	4.8% (3.6% - 5.9%)	4.8% (3.6% - 5.9%)	4.8% (3.6% - 5.9%)	4.2% (3.2% - 5.2%)	4.8% (3.6% - 5.9%)	4.2% (3.2% - 5.2%)
Detroit, MI	6.2% (4.7% - 7.7%)	4.3% (3.2% - 5.3%)	3.6% (2.7% - 4.4%)	2.9% (2.2% - 3.6%)	3% (2.3% - 3.7%)	1.8% (1.3% - 2.2%)
Fresno, CA	10.6% (8.1% - 13%)	4% (3.1% - 5%)	4% (3.1% - 5%)	4% (3.1% - 5%)	2.8% (2.1% - 3.5%)	1.6% (1.2% - 2%)
Houston, TX	7.8% (5.9% - 9.6%)	7.2% (5.5% - 8.8%)	5.6% (4.3% - 6.9%)	4.8% (3.6% - 5.9%)	5.6% (4.3% - 6.9%)	4.8% (3.6% - 5.9%)
Los Angeles, CA	8% (6.1% - 9.8%)	3.5% (2.7% - 4.4%)	3.5% (2.7% - 4.4%)	3.1% (2.3% - 3.8%)	2.4% (1.8% - 3%)	1.2% (0.9% - 1.5%)
New York, NY	5.8% (4.4% - 7.2%)	4.1% (3.1% - 5.1%)	3.9% (3% - 4.8%)	3.2% (2.4% - 4%)	2.9% (2.2% - 3.6%)	1.6% (1.2% - 2%)
Philadelphia, PA	6.7% (5.1% - 8.3%)	5.8% (4.4% - 7.2%)	5.2% (3.9% - 6.4%)	4.4% (3.4% - 5.5%)	4.4% (3.3% - 5.4%)	2.9% (2.2% - 3.6%)
Phoenix, AZ	3.8% (2.9% - 4.7%)	3.8% (2.9% - 4.7%)	3.8% (2.9% - 4.7%)	3.4% (2.6% - 4.2%)	3.3% (2.5% - 4%)	1.9% (1.5% - 2.4%)
Pittsburgh, PA	9.1% (6.9% - 11.2%)	3.5% (2.7% - 4.4%)	3.5% (2.7% - 4.4%)	3.5% (2.7% - 4.4%)	2.4% (1.8% - 3%)	1.2% (0.9% - 1.5%)
Salt Lake City, UT	5.8% (4.4% - 7.2%)	2.1% (1.6% - 2.7%)	2.1% (1.6% - 2.7%)	2.1% (1.6% - 2.7%)	1.2% (0.9% - 1.5%)	0.3% (0.2% - 0.3%)
St. Louis, MO	7.1% (5.4% - 8.7%)	5.9% (4.5% - 7.3%)	4.6% (3.5% - 5.7%)	3.9% (2.9% - 4.8%)	4.4% (3.4% - 5.5%)	3% (2.2% - 3.7%)
Tacoma, WA	3.6% (2.7% - 4.4%)	2.1% (1.6% - 2.6%)	2.1% (1.6% - 2.6%)	2.1% (1.6% - 2.6%)	1.2% (0.9% - 1.5%)	0.2% (0.2% - 0.3%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-43. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	34% (33% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	19% (19% - 19%)	30% (30% - 30%)	22% (22% - 22%)	44% (44% - 45%)
Birmingham, AL	-39% (-39% - -40%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	43% (43% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-38% (-37% - -38%)	0% (0% - 0%)	14% (14% - 14%)	26% (26% - 26%)	24% (24% - 24%)	49% (48% - 49%)
Fresno, CA	-186% (-184% - -188%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 35%)	69% (69% - 69%)
Houston, TX	-9% (-8% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-116% (-115% - -117%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	30% (30% - 30%)	60% (60% - 60%)
New York, NY	-38% (-37% - -38%)	0% (0% - 0%)	5% (5% - 5%)	20% (20% - 20%)	27% (27% - 27%)	55% (55% - 55%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	46% (46% - 46%)
Pittsburgh, PA	-141% (-139% - -142%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 29%)	59% (59% - 59%)
Salt Lake City, UT	-190% (-189% - -191%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	49% (49% - 49%)	98% (98% - 98%)
St. Louis, MO	-18% (-18% - -18%)	0% (0% - 0%)	20% (20% - 21%)	32% (31% - 32%)	23% (22% - 23%)	46% (45% - 46%)
Tacoma, WA	-53% (-53% - -54%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	68% (68% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-44. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (34% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 32%)	23% (23% - 23%)	47% (46% - 47%)
Birmingham, AL	-39% (-38% - -40%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	43% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-43% (-43% - -44%)	0% (0% - 0%)	16% (16% - 16%)	30% (30% - 30%)	28% (28% - 28%)	56% (56% - 56%)
Fresno, CA	-174% (-171% - -177%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 66%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	32% (32% - 32%)
Los Angeles, CA	-126% (-124% - -127%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (66% - 66%)
New York, NY	-41% (-41% - -41%)	0% (0% - 0%)	5% (5% - 5%)	22% (21% - 22%)	30% (30% - 30%)	60% (60% - 61%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (24% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	12% (12% - 13%)	44% (44% - 44%)
Pittsburgh, PA	-155% (-153% - -157%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (32% - 33%)	66% (66% - 66%)
Salt Lake City, UT	-268% (-266% - -270%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-20% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 36%)	25% (25% - 25%)	51% (51% - 51%)
Tacoma, WA	-79% (-79% - -79%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

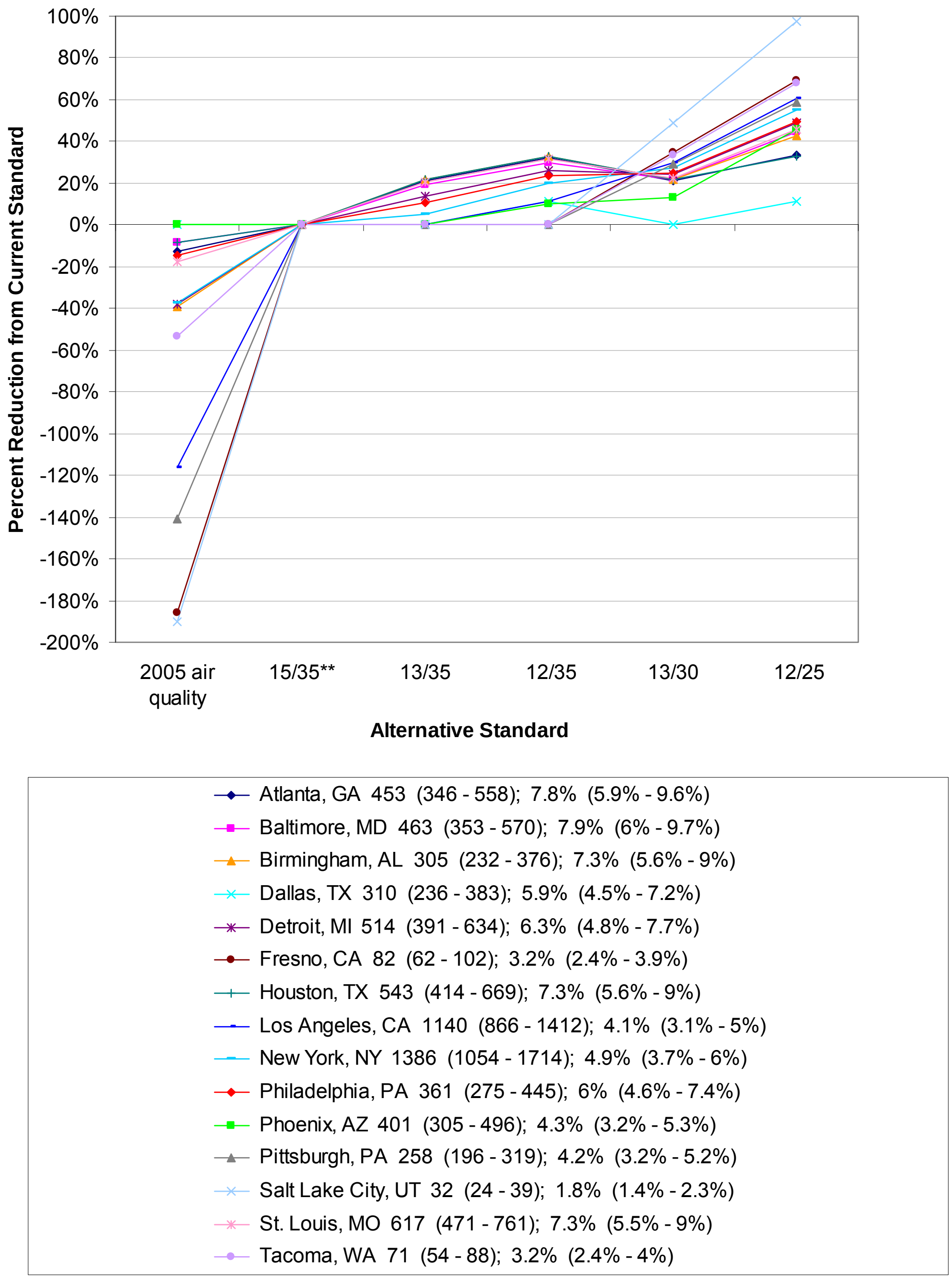
Table E-45. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (22% - 22%)	33% (32% - 33%)	22% (22% - 22%)	34% (34% - 35%)
Baltimore, MD	-10% (-9% - -10%)	0% (0% - 0%)	21% (21% - 21%)	33% (33% - 33%)	24% (24% - 24%)	48% (48% - 49%)
Birmingham, AL	-40% (-40% - -41%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 34%)	22% (22% - 22%)	44% (44% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	0% (0% - 0%)	12% (12% - 12%)
Detroit, MI	-46% (-45% - -46%)	0% (0% - 0%)	16% (16% - 17%)	32% (31% - 32%)	29% (29% - 29%)	59% (58% - 59%)
Fresno, CA	-161% (-159% - -164%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (30% - 30%)	60% (60% - 61%)
Houston, TX	-9% (-9% - -9%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	33% (33% - 33%)
Los Angeles, CA	-126% (-125% - -127%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	32% (32% - 33%)	65% (65% - 65%)
New York, NY	-41% (-41% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	60% (60% - 60%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (49% - 49%)
Pittsburgh, PA	-156% (-154% - -157%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (65% - 65%)
Salt Lake City, UT	-170% (-169% - -172%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	88% (88% - 88%)
St. Louis, MO	-20% (-19% - -20%)	0% (0% - 0%)	22% (22% - 23%)	35% (34% - 35%)	25% (25% - 25%)	50% (50% - 50%)
Tacoma, WA	-70% (-70% - -70%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

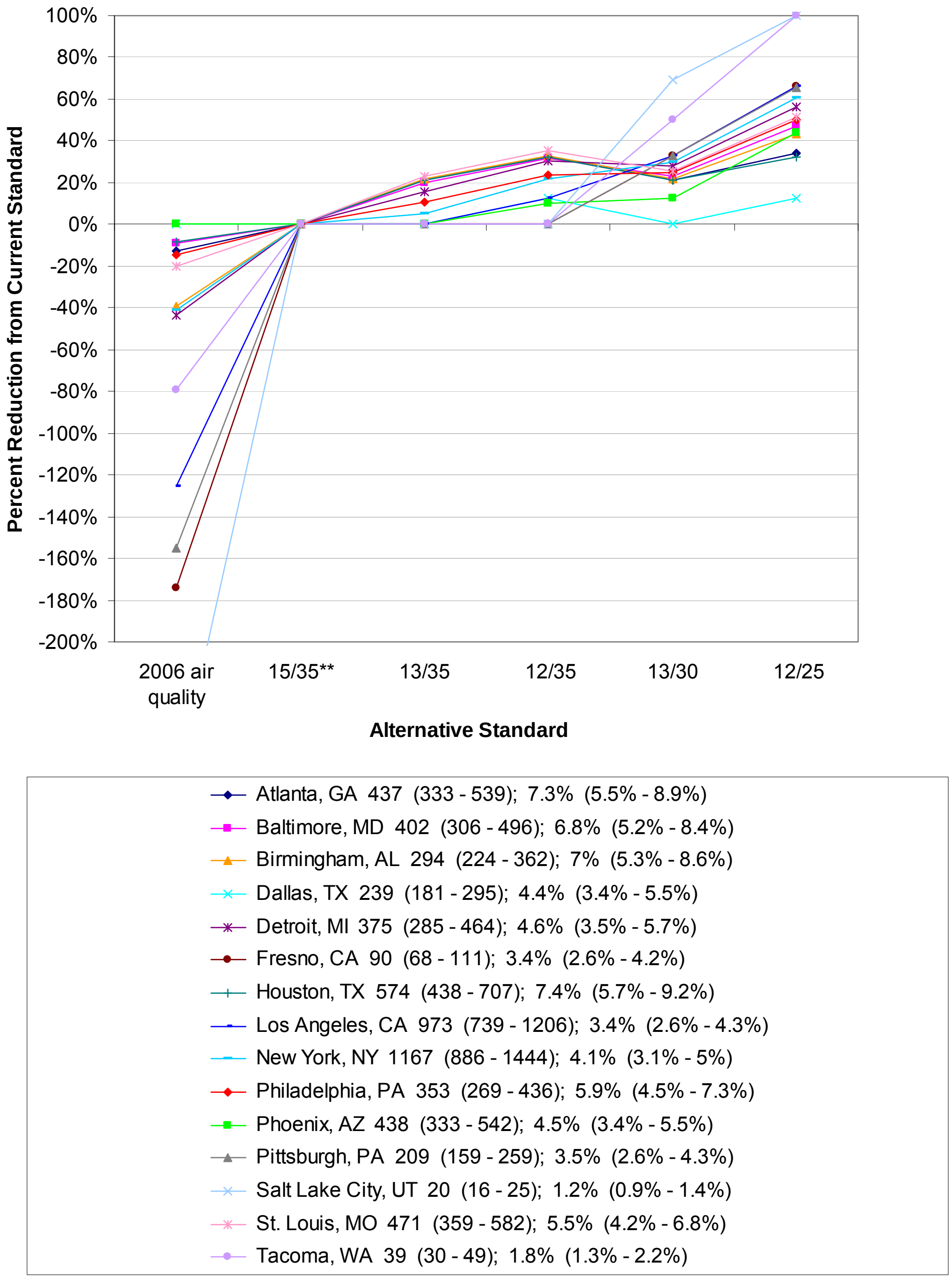
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-13. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2005 Air Quality Data*



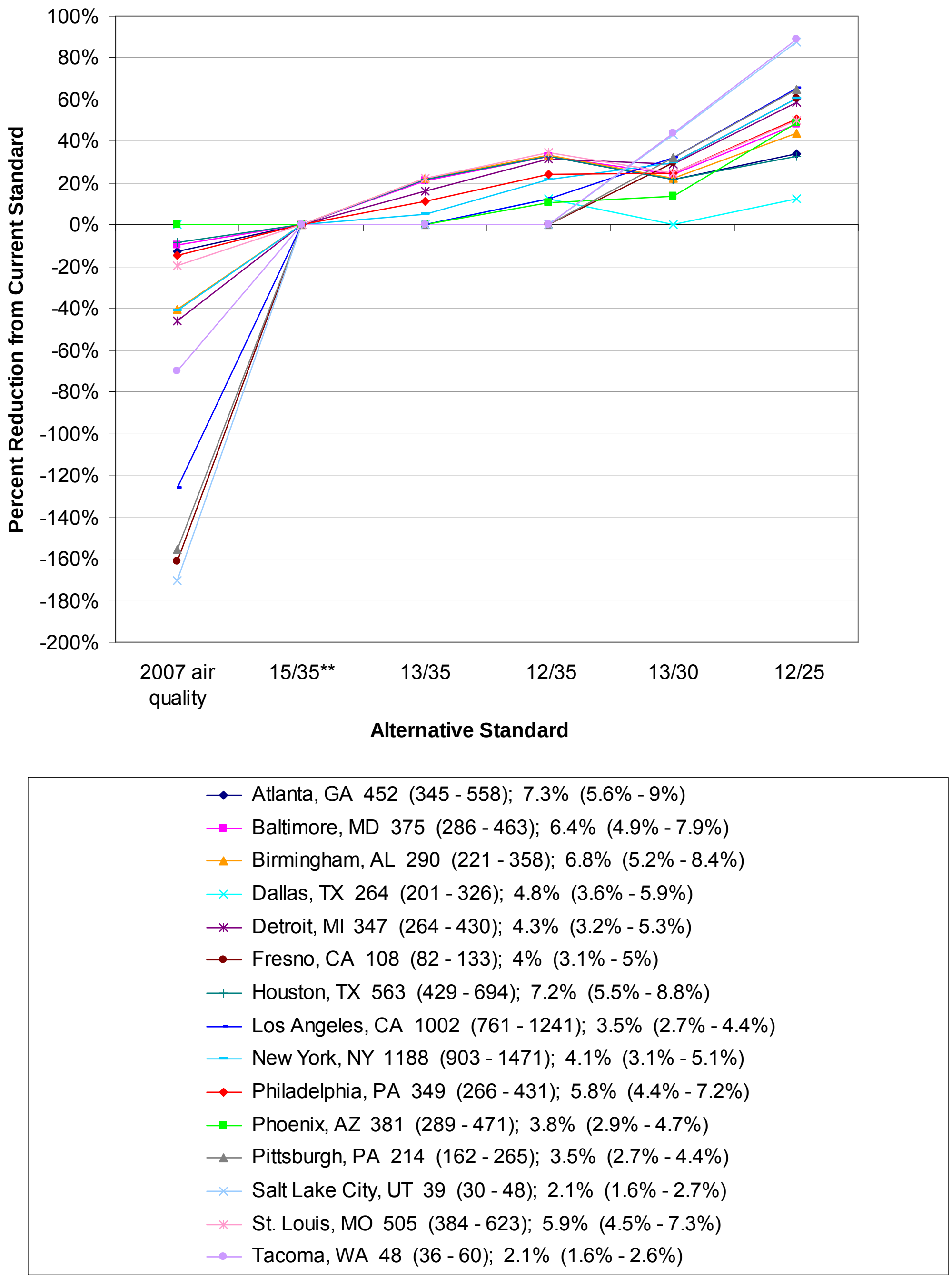
*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-14. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -268%.

Figure E-15. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-46. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	719 (566 - 868)	640 (503 - 774)	506 (397 - 614)	438 (343 - 532)	506 (397 - 614)	428 (335 - 519)
Baltimore, MD	710 (558 - 857)	654 (514 - 790)	531 (416 - 643)	461 (361 - 559)	512 (401 - 621)	367 (287 - 446)
Birmingham, AL	596 (470 - 717)	431 (339 - 522)	339 (266 - 411)	292 (228 - 355)	339 (266 - 411)	248 (194 - 301)
Dallas, TX	440 (345 - 534)	440 (345 - 534)	440 (345 - 534)	391 (306 - 475)	440 (345 - 534)	391 (306 - 475)
Detroit, MI	999 (786 - 1205)	729 (571 - 883)	631 (494 - 765)	541 (423 - 657)	555 (434 - 674)	377 (294 - 459)
Fresno, CA	331 (261 - 399)	117 (92 - 143)	117 (92 - 143)	117 (92 - 143)	77 (60 - 94)	36 (28 - 44)
Houston, TX	833 (655 - 1007)	768 (603 - 929)	604 (473 - 732)	520 (406 - 631)	604 (473 - 732)	520 (406 - 631)
Los Angeles, CA	3477 (2737 - 4196)	1626 (1270 - 1977)	1626 (1270 - 1977)	1439 (1123 - 1752)	1142 (890 - 1392)	649 (505 - 792)
New York, NY	2704 (2121 - 3274)	1972 (1542 - 2395)	1878 (1468 - 2281)	1586 (1239 - 1930)	1437 (1121 - 1749)	891 (694 - 1087)
Philadelphia, PA	586 (459 - 709)	512 (401 - 620)	457 (357 - 554)	391 (305 - 475)	387 (302 - 470)	259 (202 - 315)
Phoenix, AZ	571 (446 - 695)	571 (446 - 695)	571 (446 - 695)	514 (401 - 625)	498 (389 - 606)	312 (243 - 381)
Pittsburgh, PA	873 (689 - 1051)	368 (287 - 447)	368 (287 - 447)	368 (287 - 447)	261 (203 - 318)	152 (118 - 186)
Salt Lake City, UT	130 (102 - 158)	45 (35 - 55)	45 (35 - 55)	45 (35 - 55)	23 (18 - 28)	1 (1 - 1)
St. Louis, MO	1026 (807 - 1238)	874 (686 - 1057)	697 (546 - 845)	601 (470 - 729)	679 (532 - 823)	479 (374 - 583)
Tacoma, WA	154 (121 - 187)	101 (79 - 123)	101 (79 - 123)	101 (79 - 123)	67 (52 - 82)	33 (25 - 40)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-47. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	697 (548 - 841)	619 (486 - 748)	486 (380 - 589)	418 (327 - 508)	486 (380 - 589)	408 (319 - 496)
Baltimore, MD	621 (488 - 751)	569 (447 - 689)	455 (356 - 552)	390 (305 - 474)	438 (343 - 532)	303 (237 - 369)
Birmingham, AL	578 (456 - 696)	416 (326 - 503)	325 (255 - 395)	279 (218 - 339)	325 (255 - 395)	236 (184 - 287)
Dallas, TX	340 (266 - 413)	340 (266 - 413)	340 (266 - 413)	297 (232 - 361)	340 (266 - 413)	297 (232 - 361)
Detroit, MI	767 (601 - 929)	535 (418 - 650)	451 (352 - 548)	373 (291 - 455)	386 (301 - 470)	234 (182 - 286)
Fresno, CA	351 (277 - 423)	128 (100 - 156)	128 (100 - 156)	128 (100 - 156)	86 (67 - 105)	43 (34 - 53)
Houston, TX	879 (691 - 1062)	812 (637 - 982)	639 (501 - 775)	551 (431 - 669)	639 (501 - 775)	551 (431 - 669)
Los Angeles, CA	3134 (2463 - 3788)	1390 (1084 - 1692)	1390 (1084 - 1692)	1214 (946 - 1479)	935 (728 - 1140)	473 (367 - 577)
New York, NY	2346 (1837 - 2845)	1663 (1299 - 2023)	1575 (1230 - 1916)	1304 (1017 - 1588)	1165 (908 - 1420)	658 (512 - 804)
Philadelphia, PA	574 (450 - 695)	501 (393 - 608)	447 (349 - 542)	382 (298 - 464)	378 (295 - 459)	251 (196 - 306)
Phoenix, AZ	624 (488 - 758)	624 (488 - 758)	624 (488 - 758)	563 (440 - 685)	546 (426 - 664)	349 (271 - 425)
Pittsburgh, PA	762 (600 - 919)	299 (233 - 364)	299 (233 - 364)	299 (233 - 364)	202 (157 - 246)	103 (80 - 125)
Salt Lake City, UT	108 (85 - 132)	29 (23 - 36)	29 (23 - 36)	29 (23 - 36)	9 (7 - 11)	0 (0 - 0)
St. Louis, MO	803 (630 - 972)	670 (524 - 813)	516 (403 - 628)	433 (338 - 526)	500 (391 - 609)	327 (255 - 399)
Tacoma, WA	101 (79 - 123)	56 (44 - 69)	56 (44 - 69)	56 (44 - 69)	28 (22 - 34)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-48. Estimated Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	721 (567 - 870)	640 (503 - 774)	503 (394 - 610)	434 (339 - 527)	503 (394 - 610)	423 (331 - 514)
Baltimore, MD	582 (457 - 705)	533 (418 - 645)	423 (331 - 513)	360 (281 - 438)	406 (317 - 493)	276 (216 - 337)
Birmingham, AL	573 (451 - 690)	411 (322 - 498)	321 (251 - 389)	275 (215 - 334)	321 (251 - 389)	232 (181 - 282)
Dallas, TX	376 (294 - 456)	376 (294 - 456)	376 (294 - 456)	330 (258 - 401)	376 (294 - 456)	330 (258 - 401)
Detroit, MI	718 (563 - 870)	495 (387 - 602)	414 (323 - 504)	340 (265 - 414)	352 (274 - 429)	206 (160 - 252)
Fresno, CA	395 (312 - 476)	154 (120 - 187)	154 (120 - 187)	154 (120 - 187)	108 (84 - 131)	61 (48 - 75)
Houston, TX	864 (679 - 1044)	797 (625 - 964)	625 (489 - 758)	537 (420 - 652)	625 (489 - 758)	537 (420 - 652)
Los Angeles, CA	3202 (2517 - 3869)	1431 (1116 - 1741)	1431 (1116 - 1741)	1252 (976 - 1525)	969 (755 - 1181)	499 (388 - 610)
New York, NY	2385 (1868 - 2891)	1694 (1323 - 2060)	1605 (1253 - 1952)	1331 (1038 - 1620)	1190 (928 - 1450)	677 (526 - 826)
Philadelphia, PA	568 (446 - 688)	496 (388 - 601)	441 (345 - 536)	377 (295 - 458)	373 (291 - 453)	247 (193 - 301)
Phoenix, AZ	543 (424 - 661)	543 (424 - 661)	543 (424 - 661)	485 (378 - 590)	469 (365 - 571)	279 (217 - 341)
Pittsburgh, PA	771 (607 - 930)	305 (238 - 372)	305 (238 - 372)	305 (238 - 372)	208 (162 - 253)	108 (84 - 132)
Salt Lake City, UT	150 (118 - 182)	56 (44 - 68)	56 (44 - 68)	56 (44 - 68)	32 (25 - 39)	7 (5 - 8)
St. Louis, MO	854 (670 - 1034)	717 (561 - 869)	557 (436 - 677)	471 (367 - 572)	541 (423 - 657)	361 (282 - 440)
Tacoma, WA	116 (91 - 142)	69 (53 - 84)	69 (53 - 84)	69 (53 - 84)	38 (30 - 47)	8 (6 - 9)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-49. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	12.3% (9.7% - 14.9%)	11% (8.6% - 13.2%)	8.7% (6.8% - 10.5%)	7.5% (5.9% - 9.1%)	8.7% (6.8% - 10.5%)	7.3% (5.7% - 8.9%)
Baltimore, MD	12.1% (9.5% - 14.6%)	11.1% (8.7% - 13.4%)	9% (7.1% - 10.9%)	7.8% (6.1% - 9.5%)	8.7% (6.8% - 10.5%)	6.2% (4.9% - 7.6%)
Birmingham, AL	14.3% (11.3% - 17.3%)	10.4% (8.2% - 12.6%)	8.2% (6.4% - 9.9%)	7% (5.5% - 8.5%)	8.2% (6.4% - 9.9%)	6% (4.7% - 7.3%)
Dallas, TX	8.3% (6.5% - 10.1%)	8.3% (6.5% - 10.1%)	8.3% (6.5% - 10.1%)	7.4% (5.8% - 9%)	8.3% (6.5% - 10.1%)	7.4% (5.8% - 9%)
Detroit, MI	12.2% (9.6% - 14.7%)	8.9% (7% - 10.8%)	7.7% (6% - 9.3%)	6.6% (5.1% - 8%)	6.8% (5.3% - 8.2%)	4.6% (3.6% - 5.6%)
Fresno, CA	12.8% (10.1% - 15.5%)	4.5% (3.5% - 5.5%)	4.5% (3.5% - 5.5%)	4.5% (3.5% - 5.5%)	3% (2.3% - 3.6%)	1.4% (1.1% - 1.7%)
Houston, TX	11.2% (8.8% - 13.5%)	10.3% (8.1% - 12.5%)	8.1% (6.3% - 9.8%)	7% (5.5% - 8.5%)	8.1% (6.3% - 9.8%)	7% (5.5% - 8.5%)
Los Angeles, CA	12.4% (9.7% - 14.9%)	5.8% (4.5% - 7%)	5.8% (4.5% - 7%)	5.1% (4% - 6.2%)	4.1% (3.2% - 5%)	2.3% (1.8% - 2.8%)
New York, NY	9.5% (7.5% - 11.5%)	6.9% (5.4% - 8.4%)	6.6% (5.2% - 8%)	5.6% (4.4% - 6.8%)	5.1% (3.9% - 6.2%)	3.1% (2.4% - 3.8%)
Philadelphia, PA	9.8% (7.7% - 11.8%)	8.5% (6.7% - 10.3%)	7.6% (6% - 9.2%)	6.5% (5.1% - 7.9%)	6.5% (5% - 7.8%)	4.3% (3.4% - 5.3%)
Phoenix, AZ	6.1% (4.7% - 7.4%)	6.1% (4.7% - 7.4%)	6.1% (4.7% - 7.4%)	5.5% (4.3% - 6.6%)	5.3% (4.1% - 6.4%)	3.3% (2.6% - 4%)
Pittsburgh, PA	14.3% (11.3% - 17.2%)	6% (4.7% - 7.3%)	6% (4.7% - 7.3%)	6% (4.7% - 7.3%)	4.3% (3.3% - 5.2%)	2.5% (1.9% - 3%)
Salt Lake City, UT	7.6% (5.9% - 9.2%)	2.6% (2% - 3.2%)	2.6% (2% - 3.2%)	2.6% (2% - 3.2%)	1.4% (1.1% - 1.7%)	0.1% (0% - 0.1%)
St. Louis, MO	12.1% (9.5% - 14.6%)	10.3% (8.1% - 12.4%)	8.2% (6.4% - 10%)	7.1% (5.5% - 8.6%)	8% (6.3% - 9.7%)	5.6% (4.4% - 6.9%)
Tacoma, WA	7% (5.5% - 8.5%)	4.6% (3.6% - 5.6%)	4.6% (3.6% - 5.6%)	4.6% (3.6% - 5.6%)	3% (2.4% - 3.7%)	1.5% (1.1% - 1.8%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-50. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	11.6% (9.1% - 14%)	10.3% (8.1% - 12.4%)	8.1% (6.3% - 9.8%)	6.9% (5.4% - 8.4%)	8.1% (6.3% - 9.8%)	6.8% (5.3% - 8.2%)
Baltimore, MD	10.5% (8.3% - 12.7%)	9.7% (7.6% - 11.7%)	7.7% (6% - 9.4%)	6.6% (5.2% - 8%)	7.4% (5.8% - 9%)	5.1% (4% - 6.3%)
Birmingham, AL	13.8% (10.8% - 16.6%)	9.9% (7.8% - 12%)	7.7% (6.1% - 9.4%)	6.6% (5.2% - 8.1%)	7.7% (6.1% - 9.4%)	5.6% (4.4% - 6.8%)
Dallas, TX	6.3% (4.9% - 7.6%)	6.3% (4.9% - 7.6%)	6.3% (4.9% - 7.6%)	5.5% (4.3% - 6.7%)	6.3% (4.9% - 7.6%)	5.5% (4.3% - 6.7%)
Detroit, MI	9.4% (7.3% - 11.3%)	6.5% (5.1% - 7.9%)	5.5% (4.3% - 6.7%)	4.6% (3.6% - 5.5%)	4.7% (3.7% - 5.7%)	2.9% (2.2% - 3.5%)
Fresno, CA	13.4% (10.6% - 16.2%)	4.9% (3.8% - 6%)	4.9% (3.8% - 6%)	4.9% (3.8% - 6%)	3.3% (2.6% - 4%)	1.7% (1.3% - 2%)
Houston, TX	11.4% (9% - 13.8%)	10.5% (8.3% - 12.7%)	8.3% (6.5% - 10.1%)	7.2% (5.6% - 8.7%)	8.3% (6.5% - 10.1%)	7.2% (5.6% - 8.7%)
Los Angeles, CA	11.1% (8.7% - 13.4%)	4.9% (3.8% - 6%)	4.9% (3.8% - 6%)	4.3% (3.3% - 5.2%)	3.3% (2.6% - 4%)	1.7% (1.3% - 2%)
New York, NY	8.2% (6.4% - 9.9%)	5.8% (4.5% - 7%)	5.5% (4.3% - 6.7%)	4.5% (3.5% - 5.5%)	4.1% (3.2% - 4.9%)	2.3% (1.8% - 2.8%)
Philadelphia, PA	9.6% (7.5% - 11.6%)	8.4% (6.6% - 10.2%)	7.5% (5.8% - 9.1%)	6.4% (5% - 7.8%)	6.3% (4.9% - 7.7%)	4.2% (3.3% - 5.1%)
Phoenix, AZ	6.4% (5% - 7.8%)	6.4% (5% - 7.8%)	6.4% (5% - 7.8%)	5.8% (4.5% - 7%)	5.6% (4.4% - 6.8%)	3.6% (2.8% - 4.3%)
Pittsburgh, PA	12.6% (9.9% - 15.2%)	4.9% (3.8% - 6%)	4.9% (3.8% - 6%)	4.9% (3.8% - 6%)	3.3% (2.6% - 4.1%)	1.7% (1.3% - 2.1%)
Salt Lake City, UT	6.1% (4.8% - 7.4%)	1.7% (1.3% - 2%)	1.7% (1.3% - 2%)	1.7% (1.3% - 2%)	0.5% (0.4% - 0.6%)	0% (0% - 0%)
St. Louis, MO	9.4% (7.4% - 11.4%)	7.8% (6.1% - 9.5%)	6.1% (4.7% - 7.4%)	5.1% (4% - 6.2%)	5.9% (4.6% - 7.1%)	3.8% (3% - 4.7%)
Tacoma, WA	4.5% (3.5% - 5.5%)	2.5% (2% - 3.1%)	2.5% (2% - 3.1%)	2.5% (2% - 3.1%)	1.2% (1% - 1.5%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-51. Estimated Percent of Total Annual Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Cardiopulmonary Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	11.7% (9.2% - 14.1%)	10.4% (8.1% - 12.5%)	8.1% (6.4% - 9.9%)	7% (5.5% - 8.5%)	8.1% (6.4% - 9.9%)	6.8% (5.4% - 8.3%)
Baltimore, MD	9.9% (7.8% - 12%)	9.1% (7.1% - 11%)	7.2% (5.6% - 8.7%)	6.1% (4.8% - 7.4%)	6.9% (5.4% - 8.4%)	4.7% (3.7% - 5.7%)
Birmingham, AL	13.5% (10.6% - 16.3%)	9.7% (7.6% - 11.7%)	7.6% (5.9% - 9.2%)	6.5% (5.1% - 7.9%)	7.6% (5.9% - 9.2%)	5.5% (4.3% - 6.6%)
Dallas, TX	6.8% (5.3% - 8.3%)	6.8% (5.3% - 8.3%)	6.8% (5.3% - 8.3%)	6% (4.7% - 7.3%)	6.8% (5.3% - 8.3%)	6% (4.7% - 7.3%)
Detroit, MI	8.8% (6.9% - 10.7%)	6.1% (4.7% - 7.4%)	5.1% (4% - 6.2%)	4.2% (3.3% - 5.1%)	4.3% (3.4% - 5.3%)	2.5% (2% - 3.1%)
Fresno, CA	14.8% (11.7% - 17.8%)	5.8% (4.5% - 7%)	5.8% (4.5% - 7%)	5.8% (4.5% - 7%)	4% (3.2% - 4.9%)	2.3% (1.8% - 2.8%)
Houston, TX	11% (8.6% - 13.3%)	10.1% (8% - 12.3%)	7.9% (6.2% - 9.6%)	6.8% (5.3% - 8.3%)	7.9% (6.2% - 9.6%)	6.8% (5.3% - 8.3%)
Los Angeles, CA	11.2% (8.8% - 13.6%)	5% (3.9% - 6.1%)	5% (3.9% - 6.1%)	4.4% (3.4% - 5.4%)	3.4% (2.7% - 4.2%)	1.8% (1.4% - 2.1%)
New York, NY	8.2% (6.5% - 10%)	5.9% (4.6% - 7.1%)	5.5% (4.3% - 6.8%)	4.6% (3.6% - 5.6%)	4.1% (3.2% - 5%)	2.3% (1.8% - 2.9%)
Philadelphia, PA	9.5% (7.4% - 11.5%)	8.3% (6.5% - 10%)	7.4% (5.8% - 9%)	6.3% (4.9% - 7.7%)	6.2% (4.9% - 7.6%)	4.1% (3.2% - 5%)
Phoenix, AZ	5.4% (4.2% - 6.6%)	5.4% (4.2% - 6.6%)	5.4% (4.2% - 6.6%)	4.8% (3.8% - 5.9%)	4.6% (3.6% - 5.7%)	2.8% (2.2% - 3.4%)
Pittsburgh, PA	12.8% (10.1% - 15.4%)	5.1% (4% - 6.2%)	5.1% (4% - 6.2%)	5.1% (4% - 6.2%)	3.4% (2.7% - 4.2%)	1.8% (1.4% - 2.2%)
Salt Lake City, UT	8.2% (6.5% - 10%)	3.1% (2.4% - 3.7%)	3.1% (2.4% - 3.7%)	3.1% (2.4% - 3.7%)	1.7% (1.3% - 2.1%)	0.4% (0.3% - 0.5%)
St. Louis, MO	10% (7.8% - 12.1%)	8.4% (6.6% - 10.2%)	6.5% (5.1% - 7.9%)	5.5% (4.3% - 6.7%)	6.3% (4.9% - 7.7%)	4.2% (3.3% - 5.2%)
Tacoma, WA	5.1% (4% - 6.2%)	3% (2.3% - 3.7%)	3% (2.3% - 3.7%)	3% (2.3% - 3.7%)	1.7% (1.3% - 2.1%)	0.3% (0.3% - 0.4%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-52. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -12%)	0% (0% - 0%)	21% (21% - 21%)	32% (31% - 32%)	21% (21% - 21%)	33% (33% - 33%)
Baltimore, MD	-9% (-8% - -9%)	0% (0% - 0%)	19% (19% - 19%)	30% (29% - 30%)	22% (21% - 22%)	44% (44% - 44%)
Birmingham, AL	-38% (-38% - -39%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	42% (42% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-37% (-36% - -38%)	0% (0% - 0%)	13% (13% - 14%)	26% (26% - 26%)	24% (24% - 24%)	48% (48% - 49%)
Fresno, CA	-182% (-179% - -185%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	69% (69% - 69%)
Houston, TX	-8% (-8% - -9%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	32% (32% - 33%)
Los Angeles, CA	-114% (-112% - -116%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 12%)	30% (30% - 30%)	60% (60% - 60%)
New York, NY	-37% (-37% - -38%)	0% (0% - 0%)	5% (5% - 5%)	20% (19% - 20%)	27% (27% - 27%)	55% (55% - 55%)
Philadelphia, PA	-14% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (23% - 24%)	24% (24% - 25%)	49% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	45% (45% - 46%)
Pittsburgh, PA	-137% (-135% - -140%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 29%)	59% (58% - 59%)
Salt Lake City, UT	-188% (-186% - -189%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	48% (48% - 49%)	98% (98% - 98%)
St. Louis, MO	-17% (-17% - -18%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 32%)	22% (22% - 23%)	45% (45% - 45%)
Tacoma, WA	-53% (-52% - -53%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (33% - 34%)	68% (68% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-53. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (34% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 32%)	23% (23% - 23%)	47% (46% - 47%)
Birmingham, AL	-39% (-38% - -40%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	43% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-43% (-43% - -44%)	0% (0% - 0%)	16% (16% - 16%)	30% (30% - 30%)	28% (28% - 28%)	56% (56% - 56%)
Fresno, CA	-174% (-171% - -177%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 66%)
Houston, TX	-8% (-8% - -8%)	0% (0% - 0%)	21% (21% - 21%)	32% (32% - 32%)	21% (21% - 21%)	32% (32% - 32%)
Los Angeles, CA	-126% (-124% - -127%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (66% - 66%)
New York, NY	-41% (-41% - -41%)	0% (0% - 0%)	5% (5% - 5%)	22% (21% - 22%)	30% (30% - 30%)	60% (60% - 61%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (24% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	12% (12% - 13%)	44% (44% - 44%)
Pittsburgh, PA	-155% (-153% - -157%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (32% - 33%)	66% (66% - 66%)
Salt Lake City, UT	-268% (-266% - -270%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-20% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 36%)	25% (25% - 25%)	51% (51% - 51%)
Tacoma, WA	-79% (-79% - -79%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

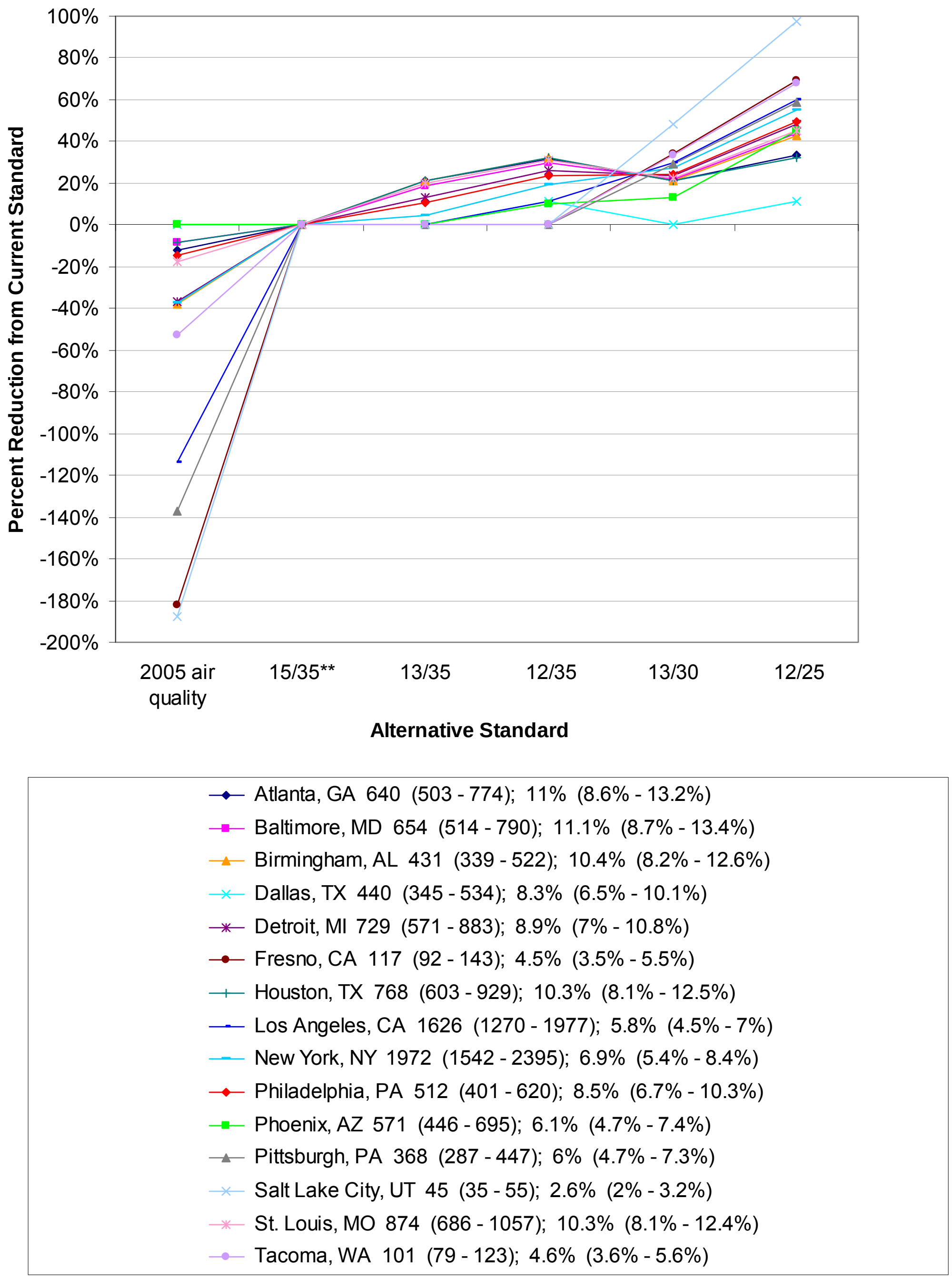
Table E-54. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (34% - 34%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	21% (20% - 21%)	32% (32% - 33%)	24% (24% - 24%)	48% (48% - 48%)
Birmingham, AL	-39% (-39% - -40%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 33%)	22% (22% - 22%)	44% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	0% (0% - 0%)	12% (12% - 12%)
Detroit, MI	-45% (-45% - -46%)	0% (0% - 0%)	16% (16% - 16%)	31% (31% - 31%)	29% (29% - 29%)	58% (58% - 59%)
Fresno, CA	-157% (-155% - -160%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (30% - 30%)	60% (60% - 60%)
Houston, TX	-8% (-8% - -9%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	33% (32% - 33%)
Los Angeles, CA	-124% (-122% - -125%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	32% (32% - 32%)	65% (65% - 65%)
New York, NY	-41% (-40% - -41%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 22%)	30% (30% - 30%)	60% (60% - 60%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (48% - 49%)
Pittsburgh, PA	-152% (-150% - -155%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (65% - 65%)
Salt Lake City, UT	-168% (-167% - -170%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (43% - 44%)	88% (88% - 88%)
St. Louis, MO	-19% (-19% - -19%)	0% (0% - 0%)	22% (22% - 22%)	34% (34% - 35%)	25% (24% - 25%)	50% (49% - 50%)
Tacoma, WA	-69% (-69% - -70%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

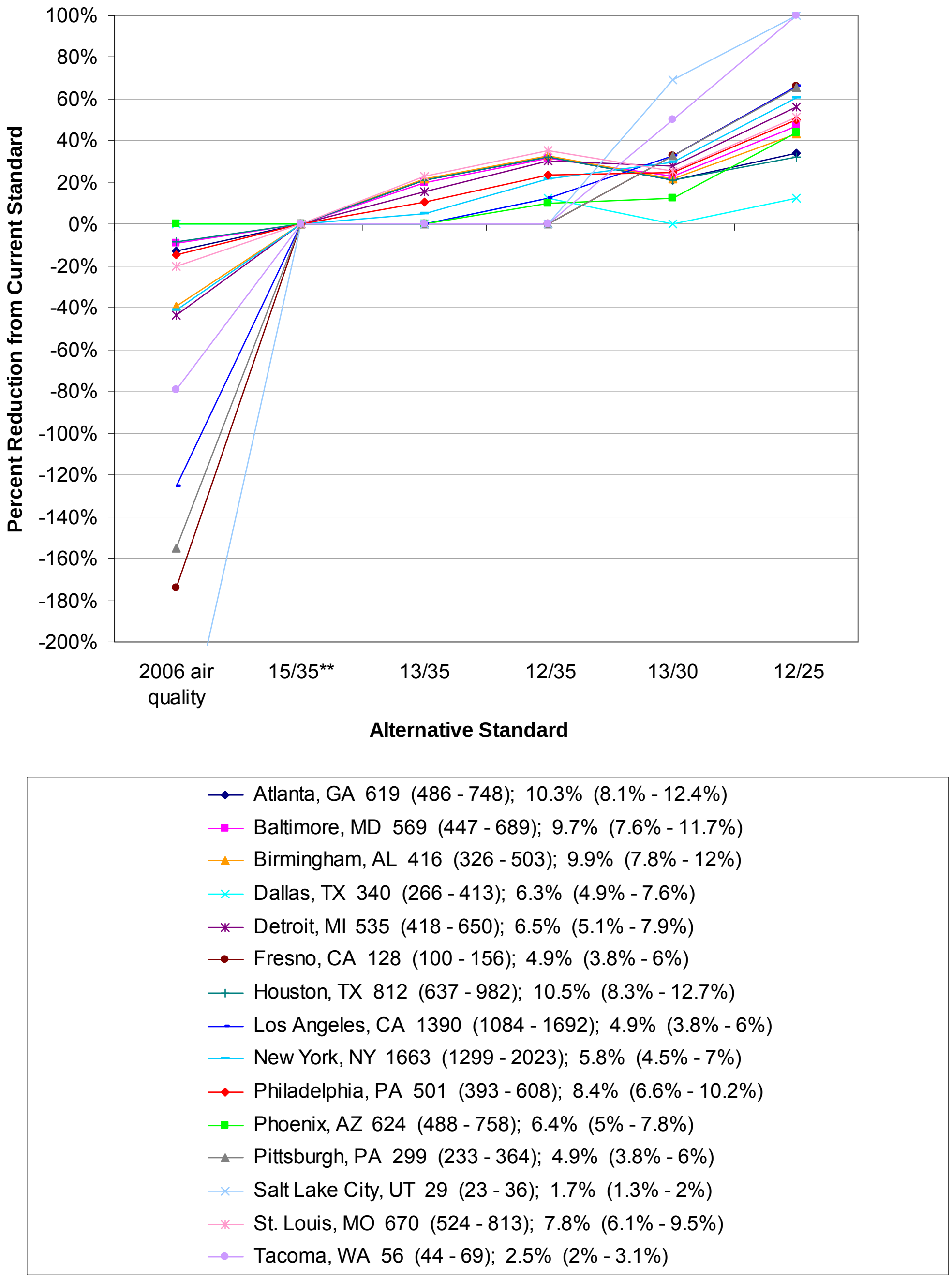
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-16. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2005 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-17. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2006 Air Quality Data*

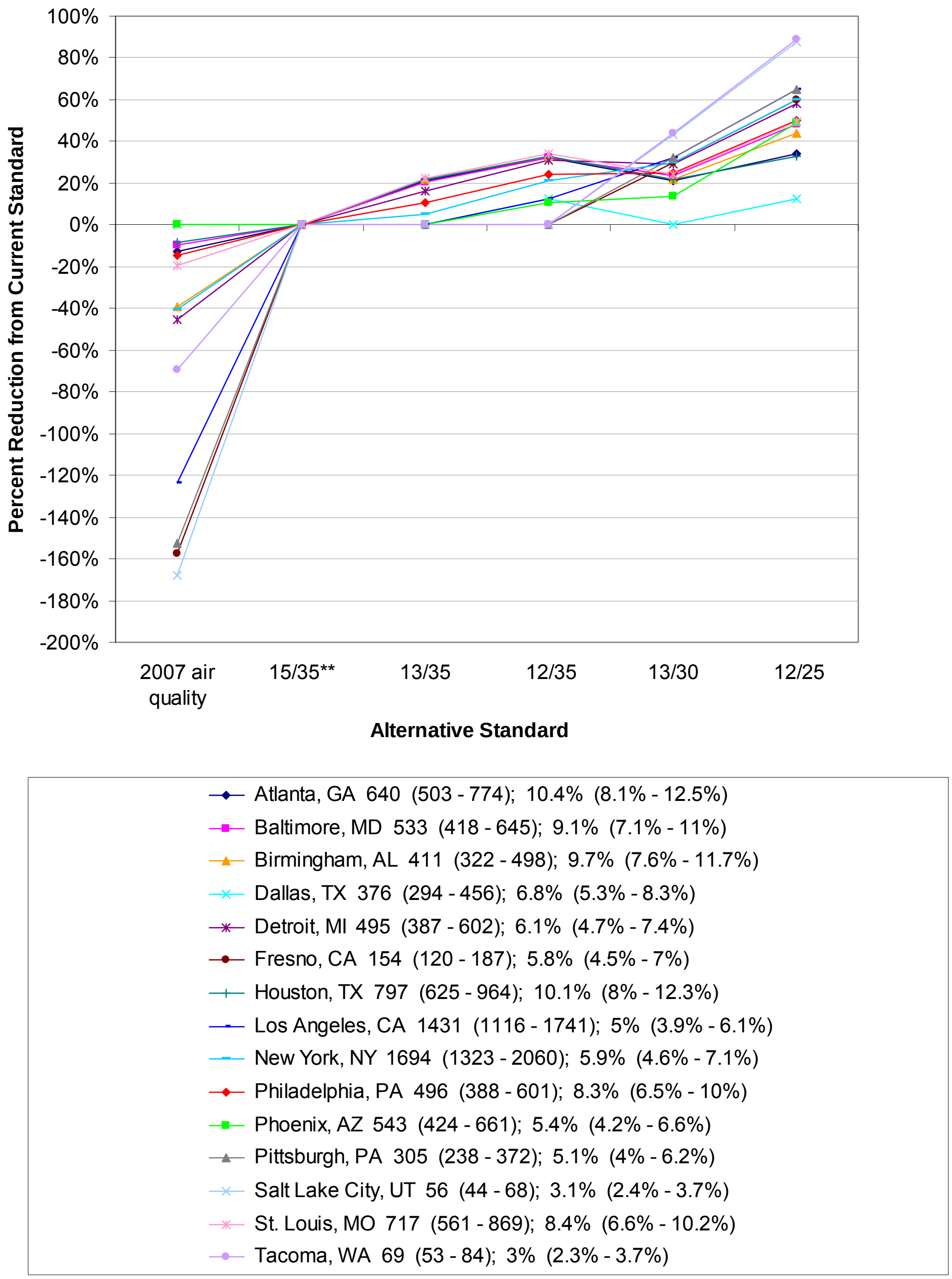


*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

***The percent reduction for 2006 air quality in Salt Lake City is -268%.

Figure E-18. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiopulmonary Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1979 – 1983. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-55. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	76 (29 - 121)	68 (26 - 108)	53 (20 - 85)	46 (17 - 74)	53 (20 - 85)	45 (17 - 72)
Baltimore, MD	80 (31 - 127)	74 (28 - 117)	60 (23 - 95)	52 (20 - 83)	58 (22 - 92)	41 (15 - 66)
Birmingham, AL	64 (24 - 101)	46 (17 - 73)	36 (14 - 58)	31 (12 - 50)	36 (14 - 58)	26 (10 - 42)
Dallas, TX	48 (18 - 77)	48 (18 - 77)	48 (18 - 77)	43 (16 - 68)	48 (18 - 77)	43 (16 - 68)
Detroit, MI	106 (40 - 168)	77 (29 - 123)	67 (25 - 107)	57 (21 - 91)	59 (22 - 94)	40 (15 - 64)
Fresno, CA	26 (10 - 41)	9 (3 - 14)	9 (3 - 14)	9 (3 - 14)	6 (2 - 10)	3 (1 - 4)
Houston, TX	90 (34 - 144)	83 (32 - 132)	65 (25 - 104)	56 (21 - 90)	65 (25 - 104)	56 (21 - 90)
Los Angeles, CA	259 (99 - 411)	120 (45 - 193)	120 (45 - 193)	106 (40 - 171)	84 (31 - 136)	48 (18 - 77)
New York, NY	180 (68 - 287)	131 (49 - 210)	124 (47 - 200)	105 (39 - 169)	95 (36 - 153)	59 (22 - 95)
Philadelphia, PA	66 (25 - 105)	57 (22 - 92)	51 (19 - 82)	44 (16 - 70)	43 (16 - 69)	29 (11 - 46)
Phoenix, AZ	58 (22 - 93)	58 (22 - 93)	58 (22 - 93)	52 (19 - 83)	50 (19 - 81)	31 (12 - 51)
Pittsburgh, PA	94 (36 - 148)	39 (15 - 63)	39 (15 - 63)	39 (15 - 63)	28 (10 - 45)	16 (6 - 26)
Salt Lake City, UT	9 (4 - 15)	3 (1 - 5)	3 (1 - 5)	3 (1 - 5)	2 (1 - 3)	0 (0 - 0)
St. Louis, MO	111 (42 - 176)	94 (36 - 150)	75 (28 - 120)	64 (24 - 103)	73 (28 - 117)	51 (19 - 83)
Tacoma, WA	18 (7 - 29)	12 (4 - 19)	12 (4 - 19)	12 (4 - 19)	8 (3 - 13)	4 (1 - 6)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-56. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	74 (28 - 117)	65 (25 - 104)	51 (19 - 82)	44 (17 - 71)	51 (19 - 82)	43 (16 - 69)
Baltimore, MD	70 (27 - 111)	64 (24 - 102)	51 (19 - 82)	44 (16 - 70)	49 (19 - 79)	34 (13 - 55)
Birmingham, AL	62 (24 - 98)	44 (17 - 71)	34 (13 - 55)	30 (11 - 47)	34 (13 - 55)	25 (9 - 40)
Dallas, TX	37 (14 - 59)	37 (14 - 59)	37 (14 - 59)	32 (12 - 52)	37 (14 - 59)	32 (12 - 52)
Detroit, MI	81 (31 - 130)	56 (21 - 90)	47 (18 - 76)	39 (15 - 63)	41 (15 - 65)	25 (9 - 40)
Fresno, CA	27 (10 - 43)	10 (4 - 16)	10 (4 - 16)	10 (4 - 16)	7 (2 - 11)	3 (1 - 5)
Houston, TX	95 (36 - 152)	88 (33 - 140)	69 (26 - 110)	59 (22 - 95)	69 (26 - 110)	59 (22 - 95)
Los Angeles, CA	233 (89 - 371)	102 (38 - 165)	102 (38 - 165)	89 (33 - 144)	69 (26 - 111)	35 (13 - 56)
New York, NY	156 (59 - 249)	110 (41 - 177)	104 (39 - 168)	86 (32 - 139)	77 (29 - 124)	43 (16 - 70)
Philadelphia, PA	64 (24 - 103)	56 (21 - 90)	50 (19 - 80)	43 (16 - 68)	42 (16 - 68)	28 (10 - 45)
Phoenix, AZ	63 (24 - 101)	63 (24 - 101)	63 (24 - 101)	57 (21 - 91)	55 (21 - 89)	35 (13 - 57)
Pittsburgh, PA	82 (31 - 130)	32 (12 - 51)	32 (12 - 51)	32 (12 - 51)	21 (8 - 34)	11 (4 - 18)
Salt Lake City, UT	8 (3 - 13)	2 (1 - 3)	2 (1 - 3)	2 (1 - 3)	1 (0 - 1)	0 (0 - 0)
St. Louis, MO	87 (33 - 138)	72 (27 - 115)	55 (21 - 89)	46 (17 - 75)	54 (20 - 86)	35 (13 - 56)
Tacoma, WA	12 (4 - 19)	7 (2 - 11)	7 (2 - 11)	7 (2 - 11)	3 (1 - 5)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m3 and a daily standard set at 35 ug/m3.

Table E-57. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	76 (29 - 121)	68 (26 - 108)	53 (20 - 85)	46 (17 - 73)	53 (20 - 85)	45 (17 - 71)
Baltimore, MD	66 (25 - 105)	60 (23 - 96)	47 (18 - 76)	40 (15 - 65)	46 (17 - 73)	31 (12 - 50)
Birmingham, AL	61 (23 - 97)	44 (17 - 70)	34 (13 - 54)	29 (11 - 47)	34 (13 - 54)	24 (9 - 39)
Dallas, TX	41 (15 - 66)	41 (15 - 66)	41 (15 - 66)	36 (13 - 58)	41 (15 - 66)	36 (13 - 58)
Detroit, MI	76 (29 - 121)	52 (20 - 84)	44 (16 - 70)	36 (13 - 58)	37 (14 - 60)	22 (8 - 35)
Fresno, CA	31 (12 - 48)	12 (4 - 19)	12 (4 - 19)	12 (4 - 19)	8 (3 - 13)	5 (2 - 8)
Houston, TX	94 (36 - 149)	86 (33 - 137)	67 (25 - 108)	58 (22 - 93)	67 (25 - 108)	58 (22 - 93)
Los Angeles, CA	238 (91 - 379)	105 (39 - 170)	105 (39 - 170)	92 (34 - 149)	71 (27 - 115)	37 (14 - 59)
New York, NY	158 (60 - 254)	112 (42 - 180)	106 (40 - 171)	88 (33 - 142)	79 (29 - 127)	45 (17 - 72)
Philadelphia, PA	64 (24 - 102)	56 (21 - 89)	49 (19 - 79)	42 (16 - 68)	42 (16 - 67)	27 (10 - 44)
Phoenix, AZ	55 (21 - 88)	55 (21 - 88)	55 (21 - 88)	49 (18 - 79)	47 (18 - 76)	28 (10 - 45)
Pittsburgh, PA	83 (32 - 131)	32 (12 - 52)	32 (12 - 52)	32 (12 - 52)	22 (8 - 35)	11 (4 - 18)
Salt Lake City, UT	11 (4 - 17)	4 (2 - 7)	4 (2 - 7)	4 (2 - 7)	2 (1 - 4)	0 (0 - 1)
St. Louis, MO	92 (35 - 147)	77 (29 - 123)	60 (22 - 96)	50 (19 - 81)	58 (22 - 93)	39 (14 - 62)
Tacoma, WA	14 (5 - 22)	8 (3 - 13)	8 (3 - 13)	8 (3 - 13)	5 (2 - 7)	1 (0 - 1)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m3 and a daily standard set at 35 ug/m3.

Table E-58. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8.6% (3.3% - 13.6%)	7.6% (2.9% - 12.1%)	6% (2.3% - 9.6%)	5.2% (1.9% - 8.3%)	6% (2.3% - 9.6%)	5% (1.9% - 8.1%)
Baltimore, MD	8.4% (3.2% - 13.3%)	7.7% (2.9% - 12.2%)	6.2% (2.4% - 10%)	5.4% (2% - 8.6%)	6% (2.3% - 9.6%)	4.3% (1.6% - 6.9%)
Birmingham, AL	10% (3.8% - 15.8%)	7.2% (2.7% - 11.4%)	5.6% (2.1% - 9%)	4.8% (1.8% - 7.8%)	5.6% (2.1% - 9%)	4.1% (1.5% - 6.6%)
Dallas, TX	5.7% (2.2% - 9.2%)	5.7% (2.2% - 9.2%)	5.7% (2.2% - 9.2%)	5.1% (1.9% - 8.2%)	5.7% (2.2% - 9.2%)	5.1% (1.9% - 8.2%)
Detroit, MI	8.5% (3.2% - 13.4%)	6.1% (2.3% - 9.8%)	5.3% (2% - 8.5%)	4.5% (1.7% - 7.3%)	4.7% (1.8% - 7.5%)	3.2% (1.2% - 5.1%)
Fresno, CA	8.9% (3.4% - 14.1%)	3.1% (1.2% - 5%)	3.1% (1.2% - 5%)	3.1% (1.2% - 5%)	2% (0.8% - 3.3%)	1% (0.4% - 1.6%)
Houston, TX	7.8% (2.9% - 12.3%)	7.1% (2.7% - 11.4%)	5.6% (2.1% - 8.9%)	4.8% (1.8% - 7.7%)	5.6% (2.1% - 8.9%)	4.8% (1.8% - 7.7%)
Los Angeles, CA	8.6% (3.3% - 13.6%)	4% (1.5% - 6.4%)	4% (1.5% - 6.4%)	3.5% (1.3% - 5.7%)	2.8% (1% - 4.5%)	1.6% (0.6% - 2.6%)
New York, NY	6.6% (2.5% - 10.5%)	4.8% (1.8% - 7.7%)	4.5% (1.7% - 7.3%)	3.8% (1.4% - 6.2%)	3.5% (1.3% - 5.6%)	2.1% (0.8% - 3.5%)
Philadelphia, PA	6.8% (2.6% - 10.8%)	5.9% (2.2% - 9.4%)	5.2% (2% - 8.4%)	4.5% (1.7% - 7.2%)	4.4% (1.7% - 7.1%)	3% (1.1% - 4.8%)
Phoenix, AZ	4.2% (1.6% - 6.7%)	4.2% (1.6% - 6.7%)	4.2% (1.6% - 6.7%)	3.7% (1.4% - 6%)	3.6% (1.4% - 5.9%)	2.3% (0.8% - 3.7%)
Pittsburgh, PA	10% (3.8% - 15.7%)	4.1% (1.6% - 6.7%)	4.1% (1.6% - 6.7%)	4.1% (1.6% - 6.7%)	2.9% (1.1% - 4.7%)	1.7% (0.6% - 2.8%)
Salt Lake City, UT	5.2% (2% - 8.4%)	1.8% (0.7% - 2.9%)	1.8% (0.7% - 2.9%)	1.8% (0.7% - 2.9%)	0.9% (0.3% - 1.5%)	0% (0% - 0.1%)
St. Louis, MO	8.4% (3.2% - 13.3%)	7.1% (2.7% - 11.3%)	5.7% (2.1% - 9.1%)	4.9% (1.8% - 7.8%)	5.5% (2.1% - 8.8%)	3.9% (1.5% - 6.2%)
Tacoma, WA	4.8% (1.8% - 7.7%)	3.1% (1.2% - 5.1%)	3.1% (1.2% - 5.1%)	3.1% (1.2% - 5.1%)	2.1% (0.8% - 3.4%)	1% (0.4% - 1.6%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-59. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8% (3.1% - 12.7%)	7.1% (2.7% - 11.3%)	5.6% (2.1% - 8.9%)	4.8% (1.8% - 7.7%)	5.6% (2.1% - 8.9%)	4.7% (1.8% - 7.5%)
Baltimore, MD	7.3% (2.8% - 11.6%)	6.7% (2.5% - 10.6%)	5.3% (2% - 8.5%)	4.6% (1.7% - 7.3%)	5.1% (1.9% - 8.2%)	3.5% (1.3% - 5.7%)
Birmingham, AL	9.6% (3.7% - 15.1%)	6.8% (2.6% - 10.9%)	5.3% (2% - 8.5%)	4.6% (1.7% - 7.3%)	5.3% (2% - 8.5%)	3.9% (1.4% - 6.2%)
Dallas, TX	4.3% (1.6% - 6.9%)	4.3% (1.6% - 6.9%)	4.3% (1.6% - 6.9%)	3.8% (1.4% - 6.1%)	4.3% (1.6% - 6.9%)	3.8% (1.4% - 6.1%)
Detroit, MI	6.5% (2.4% - 10.3%)	4.5% (1.7% - 7.2%)	3.8% (1.4% - 6.1%)	3.1% (1.2% - 5%)	3.2% (1.2% - 5.2%)	2% (0.7% - 3.2%)
Fresno, CA	9.3% (3.6% - 14.8%)	3.4% (1.3% - 5.4%)	3.4% (1.3% - 5.4%)	3.4% (1.3% - 5.4%)	2.3% (0.8% - 3.6%)	1.1% (0.4% - 1.8%)
Houston, TX	7.9% (3% - 12.6%)	7.3% (2.8% - 11.6%)	5.7% (2.2% - 9.2%)	4.9% (1.9% - 7.9%)	5.7% (2.2% - 9.2%)	4.9% (1.9% - 7.9%)
Los Angeles, CA	7.7% (2.9% - 12.2%)	3.4% (1.3% - 5.4%)	3.4% (1.3% - 5.4%)	2.9% (1.1% - 4.8%)	2.3% (0.8% - 3.7%)	1.1% (0.4% - 1.9%)
New York, NY	5.6% (2.1% - 9%)	4% (1.5% - 6.4%)	3.8% (1.4% - 6.1%)	3.1% (1.2% - 5%)	2.8% (1% - 4.5%)	1.6% (0.6% - 2.5%)
Philadelphia, PA	6.6% (2.5% - 10.6%)	5.8% (2.2% - 9.3%)	5.1% (1.9% - 8.2%)	4.4% (1.6% - 7.1%)	4.3% (1.6% - 7%)	2.9% (1.1% - 4.6%)
Phoenix, AZ	4.4% (1.7% - 7.1%)	4.4% (1.7% - 7.1%)	4.4% (1.7% - 7.1%)	4% (1.5% - 6.4%)	3.8% (1.4% - 6.2%)	2.4% (0.9% - 3.9%)
Pittsburgh, PA	8.7% (3.3% - 13.8%)	3.4% (1.3% - 5.5%)	3.4% (1.3% - 5.5%)	3.4% (1.3% - 5.5%)	2.3% (0.9% - 3.7%)	1.2% (0.4% - 1.9%)
Salt Lake City, UT	4.2% (1.6% - 6.7%)	1.1% (0.4% - 1.8%)	1.1% (0.4% - 1.8%)	1.1% (0.4% - 1.8%)	0.4% (0.1% - 0.6%)	0% (0% - 0%)
St. Louis, MO	6.5% (2.5% - 10.4%)	5.4% (2% - 8.7%)	4.2% (1.6% - 6.7%)	3.5% (1.3% - 5.6%)	4% (1.5% - 6.5%)	2.6% (1% - 4.2%)
Tacoma, WA	3.1% (1.2% - 5%)	1.7% (0.6% - 2.8%)	1.7% (0.6% - 2.8%)	1.7% (0.6% - 2.8%)	0.9% (0.3% - 1.4%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m3 and a daily standard set at 35 ug/m3.

Table E-60. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient PM2.5 Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	8.1% (3.1% - 12.9%)	7.2% (2.7% - 11.4%)	5.6% (2.1% - 9%)	4.8% (1.8% - 7.8%)	5.6% (2.1% - 9%)	4.7% (1.8% - 7.6%)
Baltimore, MD	6.9% (2.6% - 10.9%)	6.3% (2.4% - 10%)	4.9% (1.9% - 7.9%)	4.2% (1.6% - 6.8%)	4.8% (1.8% - 7.6%)	3.2% (1.2% - 5.2%)
Birmingham, AL	9.4% (3.6% - 14.9%)	6.7% (2.5% - 10.7%)	5.2% (2% - 8.4%)	4.5% (1.7% - 7.2%)	5.2% (2% - 8.4%)	3.8% (1.4% - 6%)
Dallas, TX	4.7% (1.8% - 7.5%)	4.7% (1.8% - 7.5%)	4.7% (1.8% - 7.5%)	4.1% (1.5% - 6.6%)	4.7% (1.8% - 7.5%)	4.1% (1.5% - 6.6%)
Detroit, MI	6.1% (2.3% - 9.7%)	4.2% (1.6% - 6.7%)	3.5% (1.3% - 5.6%)	2.9% (1.1% - 4.6%)	3% (1.1% - 4.8%)	1.7% (0.6% - 2.8%)
Fresno, CA	10.4% (4% - 16.3%)	4% (1.5% - 6.4%)	4% (1.5% - 6.4%)	4% (1.5% - 6.4%)	2.8% (1% - 4.5%)	1.6% (0.6% - 2.5%)
Houston, TX	7.6% (2.9% - 12.1%)	7% (2.7% - 11.2%)	5.5% (2.1% - 8.8%)	4.7% (1.8% - 7.5%)	5.5% (2.1% - 8.8%)	4.7% (1.8% - 7.5%)
Los Angeles, CA	7.8% (3% - 12.4%)	3.5% (1.3% - 5.6%)	3.5% (1.3% - 5.6%)	3% (1.1% - 4.9%)	2.3% (0.9% - 3.8%)	1.2% (0.4% - 1.9%)
New York, NY	5.7% (2.1% - 9.1%)	4% (1.5% - 6.5%)	3.8% (1.4% - 6.1%)	3.2% (1.2% - 5.1%)	2.8% (1.1% - 4.6%)	1.6% (0.6% - 2.6%)
Philadelphia, PA	6.6% (2.5% - 10.5%)	5.7% (2.2% - 9.1%)	5.1% (1.9% - 8.1%)	4.3% (1.6% - 7%)	4.3% (1.6% - 6.9%)	2.8% (1.1% - 4.6%)
Phoenix, AZ	3.7% (1.4% - 6%)	3.7% (1.4% - 6%)	3.7% (1.4% - 6%)	3.3% (1.2% - 5.3%)	3.2% (1.2% - 5.1%)	1.9% (0.7% - 3.1%)
Pittsburgh, PA	8.9% (3.4% - 14.1%)	3.5% (1.3% - 5.6%)	3.5% (1.3% - 5.6%)	3.5% (1.3% - 5.6%)	2.4% (0.9% - 3.8%)	1.2% (0.5% - 2%)
Salt Lake City, UT	5.7% (2.1% - 9.1%)	2.1% (0.8% - 3.4%)	2.1% (0.8% - 3.4%)	2.1% (0.8% - 3.4%)	1.2% (0.4% - 1.9%)	0.3% (0.1% - 0.4%)
St. Louis, MO	6.9% (2.6% - 11%)	5.8% (2.2% - 9.3%)	4.5% (1.7% - 7.2%)	3.8% (1.4% - 6.1%)	4.4% (1.6% - 7%)	2.9% (1.1% - 4.7%)
Tacoma, WA	3.5% (1.3% - 5.6%)	2.1% (0.8% - 3.3%)	2.1% (0.8% - 3.3%)	2.1% (0.8% - 3.3%)	1.1% (0.4% - 1.9%)	0.2% (0.1% - 0.4%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m3 and a daily standard set at 35 ug/m3.

Table E-61. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (31% - 33%)	21% (21% - 22%)	34% (33% - 34%)
Baltimore, MD	-9% (-8% - -9%)	0% (0% - 0%)	19% (19% - 19%)	30% (29% - 30%)	22% (22% - 22%)	44% (44% - 45%)
Birmingham, AL	-39% (-38% - -40%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	43% (42% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-38% (-37% - -39%)	0% (0% - 0%)	14% (13% - 14%)	26% (26% - 27%)	24% (24% - 24%)	49% (48% - 49%)
Fresno, CA	-186% (-181% - -192%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 35%)	69% (69% - 70%)
Houston, TX	-9% (-8% - -9%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	33% (32% - 33%)
Los Angeles, CA	-116% (-113% - -120%)	0% (0% - 0%)	0% (0% - 0%)	12% (11% - 12%)	30% (30% - 30%)	60% (60% - 61%)
New York, NY	-38% (-37% - -39%)	0% (0% - 0%)	5% (5% - 5%)	20% (20% - 20%)	27% (27% - 28%)	55% (55% - 55%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (24% - 25%)	50% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	46% (45% - 46%)
Pittsburgh, PA	-141% (-136% - -146%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 30%)	59% (59% - 59%)
Salt Lake City, UT	-190% (-187% - -193%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	49% (48% - 49%)	98% (98% - 98%)
St. Louis, MO	-18% (-17% - -18%)	0% (0% - 0%)	20% (20% - 21%)	32% (31% - 32%)	23% (22% - 23%)	46% (45% - 46%)
Tacoma, WA	-53% (-52% - -54%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 34%)	68% (68% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-62. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-13% - -13%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	34% (34% - 35%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 21%)	32% (31% - 32%)	23% (23% - 24%)	47% (47% - 48%)
Birmingham, AL	-40% (-39% - -41%)	0% (0% - 0%)	22% (22% - 22%)	33% (33% - 34%)	22% (22% - 22%)	44% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-44% (-43% - -45%)	0% (0% - 0%)	16% (16% - 16%)	30% (30% - 31%)	28% (28% - 28%)	56% (56% - 57%)
Fresno, CA	-178% (-172% - -183%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 67%)
Houston, TX	-9% (-8% - -9%)	0% (0% - 0%)	22% (21% - 22%)	32% (32% - 33%)	22% (21% - 22%)	32% (32% - 33%)
Los Angeles, CA	-128% (-125% - -131%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	33% (33% - 33%)	66% (66% - 66%)
New York, NY	-42% (-41% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (22% - 22%)	30% (30% - 30%)	61% (60% - 61%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (25% - 25%)	50% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (12% - 13%)	44% (44% - 45%)
Pittsburgh, PA	-158% (-154% - -163%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (33% - 33%)	66% (66% - 66%)
Salt Lake City, UT	-271% (-267% - -274%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-20% - -21%)	0% (0% - 0%)	23% (23% - 23%)	36% (35% - 36%)	26% (25% - 26%)	51% (51% - 52%)
Tacoma, WA	-80% (-79% - -80%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

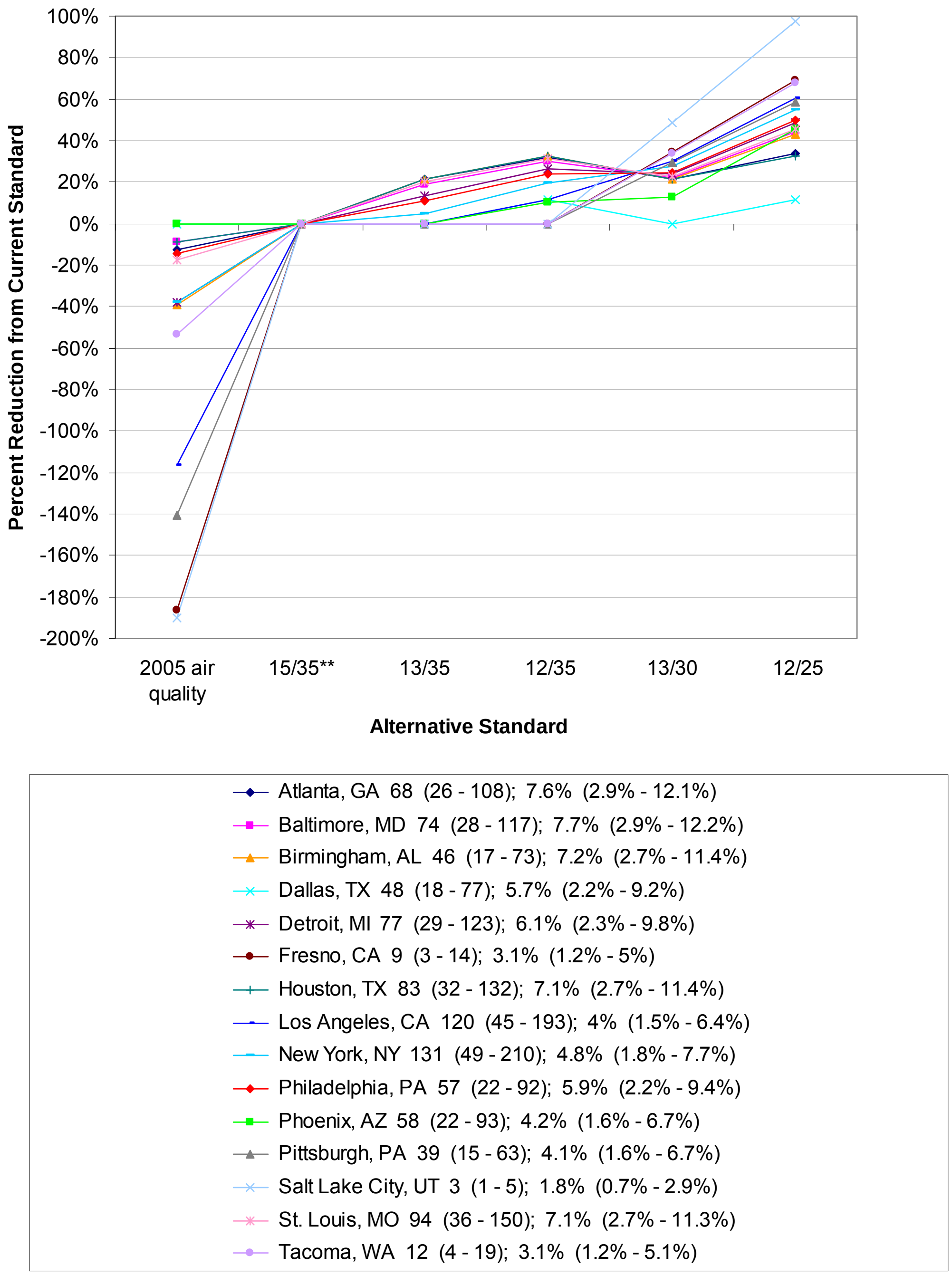
Table E-63. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1979 - 1983[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	34% (34% - 35%)
Baltimore, MD	-10% (-9% - -10%)	0% (0% - 0%)	21% (21% - 21%)	33% (32% - 33%)	24% (24% - 24%)	48% (48% - 49%)
Birmingham, AL	-40% (-39% - -42%)	0% (0% - 0%)	22% (22% - 23%)	34% (33% - 34%)	22% (22% - 23%)	44% (44% - 45%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	0% (0% - 0%)	12% (12% - 13%)
Detroit, MI	-46% (-45% - -47%)	0% (0% - 0%)	16% (16% - 17%)	32% (31% - 32%)	29% (29% - 29%)	59% (58% - 59%)
Fresno, CA	-162% (-156% - -167%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (30% - 30%)	60% (60% - 61%)
Houston, TX	-9% (-8% - -9%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	33% (32% - 33%)
Los Angeles, CA	-126% (-123% - -129%)	0% (0% - 0%)	0% (0% - 0%)	13% (12% - 13%)	32% (32% - 33%)	65% (65% - 66%)
New York, NY	-41% (-41% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (21% - 22%)	30% (30% - 30%)	60% (60% - 61%)
Philadelphia, PA	-15% (-15% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 25%)	25% (25% - 25%)	51% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (49% - 49%)
Pittsburgh, PA	-156% (-151% - -160%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (65% - 65%)
Salt Lake City, UT	-170% (-167% - -174%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (43% - 44%)	88% (88% - 88%)
St. Louis, MO	-20% (-19% - -20%)	0% (0% - 0%)	22% (22% - 23%)	35% (34% - 35%)	25% (24% - 25%)	50% (49% - 50%)
Tacoma, WA	-70% (-69% - -71%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

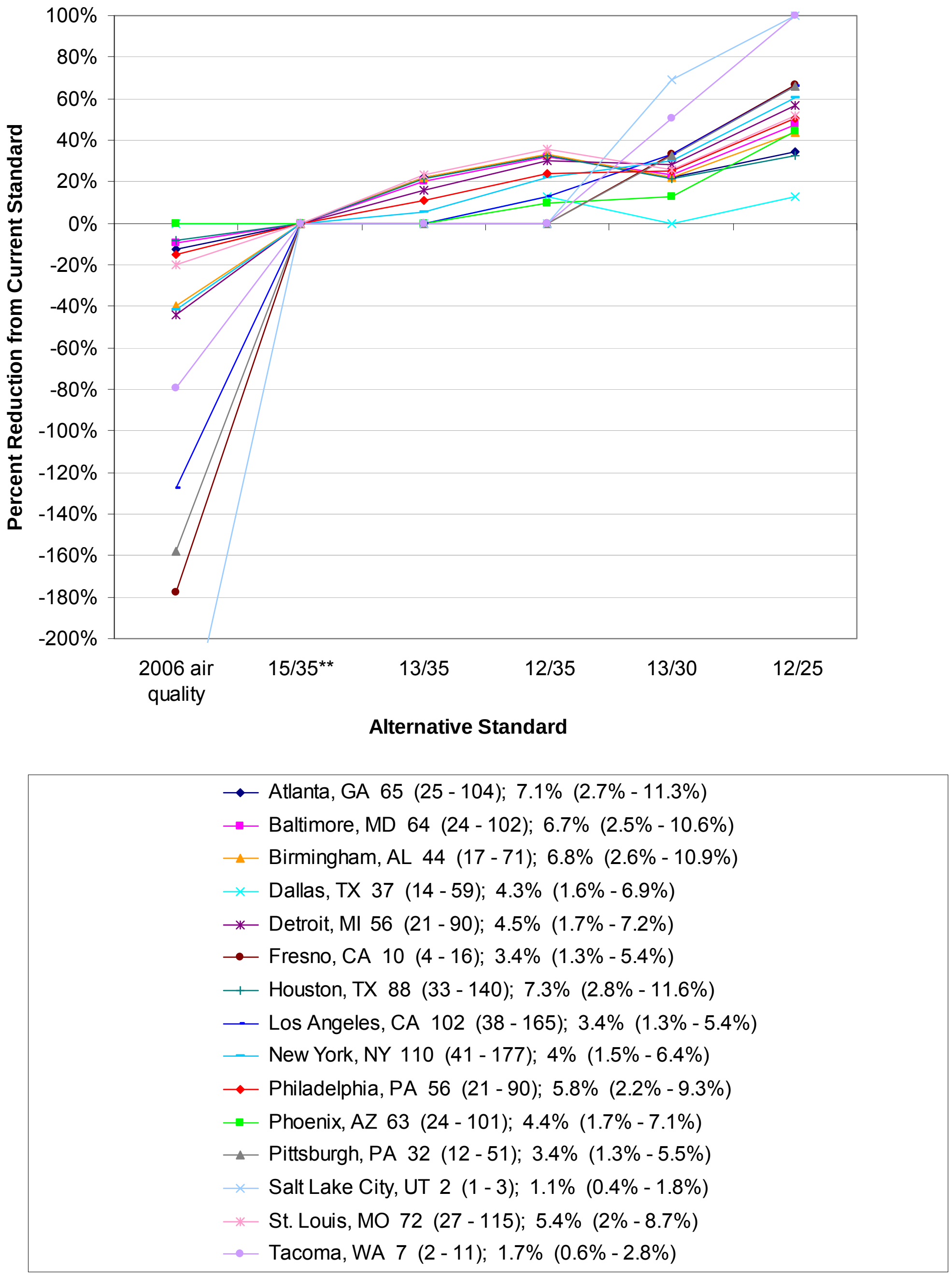
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-19. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2005 Air Quality Data*



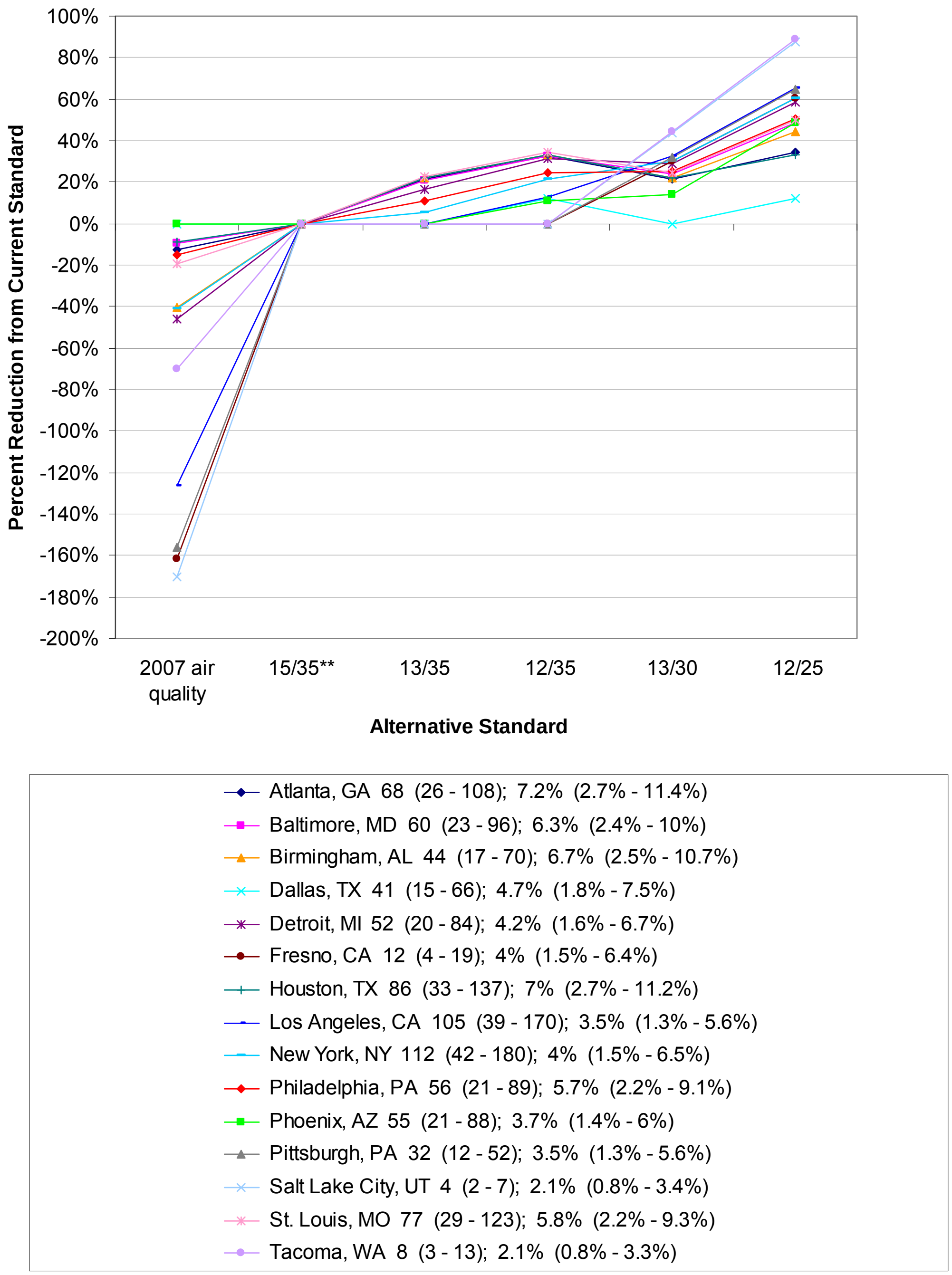
*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-20. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.
***The percent reduction for 2006 air quality in Salt Lake City is -271%.

Figure E-21. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1979 – 1983): Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-64. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	110 (49 - 166)	98 (43 - 149)	77 (34 - 118)	67 (29 - 103)	77 (34 - 118)	65 (29 - 100)
Baltimore, MD	116 (51 - 175)	106 (47 - 162)	86 (38 - 132)	75 (33 - 115)	83 (37 - 128)	60 (26 - 92)
Birmingham, AL	92 (41 - 138)	66 (29 - 101)	52 (23 - 80)	45 (20 - 69)	52 (23 - 80)	38 (17 - 59)
Dallas, TX	69 (31 - 107)	69 (31 - 107)	69 (31 - 107)	62 (27 - 95)	69 (31 - 107)	62 (27 - 95)
Detroit, MI	153 (68 - 232)	112 (49 - 171)	97 (42 - 148)	83 (36 - 128)	85 (37 - 131)	58 (25 - 90)
Fresno, CA	37 (16 - 56)	13 (6 - 20)	13 (6 - 20)	13 (6 - 20)	9 (4 - 13)	4 (2 - 6)
Houston, TX	130 (58 - 198)	120 (53 - 183)	94 (42 - 145)	81 (36 - 125)	94 (42 - 145)	81 (36 - 125)
Los Angeles, CA	373 (166 - 565)	174 (76 - 269)	174 (76 - 269)	154 (67 - 239)	123 (53 - 190)	70 (30 - 109)
New York, NY	260 (115 - 398)	190 (83 - 292)	181 (79 - 279)	153 (67 - 236)	138 (60 - 214)	86 (37 - 134)
Philadelphia, PA	95 (42 - 145)	83 (37 - 127)	74 (33 - 114)	63 (28 - 98)	63 (27 - 97)	42 (18 - 65)
Phoenix, AZ	84 (37 - 129)	84 (37 - 129)	84 (37 - 129)	75 (33 - 117)	73 (32 - 113)	46 (20 - 71)
Pittsburgh, PA	135 (60 - 203)	57 (25 - 88)	57 (25 - 88)	57 (25 - 88)	40 (18 - 63)	24 (10 - 37)
Salt Lake City, UT	14 (6 - 21)	5 (2 - 7)	5 (2 - 7)	5 (2 - 7)	2 (1 - 4)	0 (0 - 0)
St. Louis, MO	160 (71 - 242)	136 (60 - 207)	109 (48 - 167)	94 (41 - 144)	106 (47 - 162)	75 (33 - 115)
Tacoma, WA	27 (12 - 41)	17 (8 - 27)	17 (8 - 27)	17 (8 - 27)	12 (5 - 18)	6 (2 - 9)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-65. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	106 (47 - 162)	95 (42 - 144)	74 (33 - 114)	64 (28 - 98)	74 (33 - 114)	62 (27 - 96)
Baltimore, MD	101 (45 - 154)	93 (41 - 141)	74 (33 - 114)	64 (28 - 98)	71 (31 - 110)	49 (22 - 76)
Birmingham, AL	89 (40 - 134)	64 (28 - 98)	50 (22 - 77)	43 (19 - 66)	50 (22 - 77)	36 (16 - 56)
Dallas, TX	54 (23 - 83)	54 (23 - 83)	54 (23 - 83)	47 (20 - 72)	54 (23 - 83)	47 (20 - 72)
Detroit, MI	117 (52 - 179)	82 (36 - 126)	69 (30 - 107)	57 (25 - 89)	59 (26 - 92)	36 (16 - 56)
Fresno, CA	39 (18 - 59)	14 (6 - 22)	14 (6 - 22)	14 (6 - 22)	10 (4 - 15)	5 (2 - 8)
Houston, TX	138 (61 - 209)	127 (56 - 193)	100 (44 - 153)	86 (38 - 133)	100 (44 - 153)	86 (38 - 133)
Los Angeles, CA	336 (149 - 511)	149 (65 - 231)	149 (65 - 231)	130 (57 - 202)	100 (43 - 156)	51 (22 - 79)
New York, NY	226 (99 - 346)	160 (70 - 247)	152 (66 - 234)	126 (55 - 195)	112 (49 - 174)	63 (27 - 99)
Philadelphia, PA	93 (41 - 142)	81 (36 - 125)	72 (32 - 111)	62 (27 - 95)	61 (27 - 94)	41 (18 - 63)
Phoenix, AZ	92 (40 - 141)	92 (40 - 141)	92 (40 - 141)	83 (36 - 128)	80 (35 - 124)	51 (22 - 79)
Pittsburgh, PA	118 (52 - 178)	46 (20 - 71)	46 (20 - 71)	46 (20 - 71)	31 (13 - 48)	16 (7 - 25)
Salt Lake City, UT	11 (5 - 18)	3 (1 - 5)	3 (1 - 5)	3 (1 - 5)	1 (0 - 2)	0 (0 - 0)
St. Louis, MO	125 (55 - 191)	104 (46 - 160)	80 (35 - 124)	67 (29 - 104)	78 (34 - 120)	51 (22 - 79)
Tacoma, WA	17 (8 - 27)	10 (4 - 15)	10 (4 - 15)	10 (4 - 15)	5 (2 - 8)	0 (0 - 0)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-66. Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient PM2.5 from 1999 - 2000[1]

Risk Assessment Location	Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	110 (49 - 167)	98 (43 - 149)	77 (34 - 118)	66 (29 - 102)	77 (34 - 118)	65 (28 - 100)
Baltimore, MD	95 (42 - 145)	87 (38 - 133)	69 (30 - 106)	59 (26 - 90)	66 (29 - 102)	45 (20 - 70)
Birmingham, AL	88 (39 - 133)	63 (28 - 96)	49 (22 - 76)	42 (18 - 65)	49 (22 - 76)	36 (16 - 55)
Dallas, TX	59 (26 - 91)	59 (26 - 91)	59 (26 - 91)	52 (23 - 80)	59 (26 - 91)	52 (23 - 80)
Detroit, MI	110 (48 - 168)	76 (33 - 117)	63 (28 - 98)	52 (23 - 81)	54 (23 - 84)	32 (14 - 49)
Fresno, CA	44 (20 - 66)	17 (7 - 26)	17 (7 - 26)	17 (7 - 26)	12 (5 - 19)	7 (3 - 11)
Houston, TX	135 (60 - 205)	125 (55 - 190)	98 (43 - 150)	84 (37 - 129)	98 (43 - 150)	84 (37 - 129)
Los Angeles, CA	343 (153 - 522)	153 (67 - 238)	153 (67 - 238)	134 (58 - 208)	104 (45 - 162)	54 (23 - 84)
New York, NY	230 (101 - 352)	163 (71 - 252)	155 (67 - 239)	128 (56 - 199)	115 (50 - 178)	65 (28 - 102)
Philadelphia, PA	92 (41 - 141)	80 (35 - 123)	72 (31 - 110)	61 (27 - 94)	61 (26 - 93)	40 (17 - 62)
Phoenix, AZ	80 (35 - 123)	80 (35 - 123)	80 (35 - 123)	71 (31 - 110)	69 (30 - 106)	41 (18 - 64)
Pittsburgh, PA	119 (53 - 180)	47 (21 - 73)	47 (21 - 73)	47 (21 - 73)	32 (14 - 50)	17 (7 - 26)
Salt Lake City, UT	16 (7 - 24)	6 (3 - 9)	6 (3 - 9)	6 (3 - 9)	3 (1 - 5)	1 (0 - 1)
St. Louis, MO	133 (59 - 203)	112 (49 - 171)	87 (38 - 134)	73 (32 - 113)	84 (37 - 130)	56 (24 - 87)
Tacoma, WA	20 (9 - 31)	12 (5 - 18)	12 (5 - 18)	12 (5 - 18)	7 (3 - 10)	1 (1 - 2)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-67. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	12.3% (5.5% - 18.6%)	11% (4.9% - 16.7%)	8.7% (3.8% - 13.3%)	7.5% (3.3% - 11.5%)	8.7% (3.8% - 13.3%)	7.3% (3.2% - 11.3%)
Baltimore, MD	12.1% (5.4% - 18.3%)	11.1% (4.9% - 16.9%)	9% (4% - 13.8%)	7.8% (3.4% - 12%)	8.7% (3.8% - 13.3%)	6.2% (2.7% - 9.6%)
Birmingham, AL	14.3% (6.4% - 21.6%)	10.4% (4.6% - 15.8%)	8.2% (3.6% - 12.5%)	7% (3.1% - 10.8%)	8.2% (3.6% - 12.5%)	6% (2.6% - 9.2%)
Dallas, TX	8.3% (3.7% - 12.7%)	8.3% (3.7% - 12.7%)	8.3% (3.7% - 12.7%)	7.4% (3.2% - 11.4%)	8.3% (3.7% - 12.7%)	7.4% (3.2% - 11.4%)
Detroit, MI	12.2% (5.4% - 18.4%)	8.9% (3.9% - 13.6%)	7.7% (3.4% - 11.8%)	6.6% (2.9% - 10.1%)	6.8% (3% - 10.4%)	4.6% (2% - 7.1%)
Fresno, CA	12.8% (5.7% - 19.4%)	4.5% (2% - 7%)	4.5% (2% - 7%)	4.5% (2% - 7%)	3% (1.3% - 4.6%)	1.4% (0.6% - 2.2%)
Houston, TX	11.2% (5% - 17%)	10.3% (4.6% - 15.7%)	8.1% (3.6% - 12.4%)	7% (3.1% - 10.7%)	8.1% (3.6% - 12.4%)	7% (3.1% - 10.7%)
Los Angeles, CA	12.4% (5.5% - 18.7%)	5.8% (2.5% - 8.9%)	5.8% (2.5% - 8.9%)	5.1% (2.2% - 7.9%)	4.1% (1.8% - 6.3%)	2.3% (1% - 3.6%)
New York, NY	9.5% (4.2% - 14.5%)	6.9% (3% - 10.7%)	6.6% (2.9% - 10.2%)	5.6% (2.4% - 8.6%)	5.1% (2.2% - 7.8%)	3.1% (1.4% - 4.9%)
Philadelphia, PA	9.8% (4.3% - 14.9%)	8.5% (3.8% - 13.1%)	7.6% (3.3% - 11.7%)	6.5% (2.9% - 10%)	6.5% (2.8% - 9.9%)	4.3% (1.9% - 6.7%)
Phoenix, AZ	6.1% (2.7% - 9.4%)	6.1% (2.7% - 9.4%)	6.1% (2.7% - 9.4%)	5.5% (2.4% - 8.4%)	5.3% (2.3% - 8.2%)	3.3% (1.4% - 5.2%)
Pittsburgh, PA	14.3% (6.4% - 21.5%)	6% (2.6% - 9.3%)	6% (2.6% - 9.3%)	6% (2.6% - 9.3%)	4.3% (1.9% - 6.6%)	2.5% (1.1% - 3.9%)
Salt Lake City, UT	7.6% (3.3% - 11.6%)	2.6% (1.1% - 4.1%)	2.6% (1.1% - 4.1%)	2.6% (1.1% - 4.1%)	1.4% (0.6% - 2.1%)	0.1% (0% - 0.1%)
St. Louis, MO	12.1% (5.4% - 18.3%)	10.3% (4.6% - 15.7%)	8.2% (3.6% - 12.6%)	7.1% (3.1% - 10.9%)	8% (3.5% - 12.3%)	5.6% (2.5% - 8.7%)
Tacoma, WA	7% (3.1% - 10.8%)	4.6% (2% - 7.1%)	4.6% (2% - 7.1%)	4.6% (2% - 7.1%)	3% (1.3% - 4.7%)	1.5% (0.6% - 2.3%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-68. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	11.6% (5.1% - 17.6%)	10.3% (4.5% - 15.7%)	8.1% (3.5% - 12.4%)	6.9% (3% - 10.7%)	8.1% (3.5% - 12.4%)	6.8% (3% - 10.4%)
Baltimore, MD	10.5% (4.7% - 16%)	9.7% (4.3% - 14.7%)	7.7% (3.4% - 11.9%)	6.6% (2.9% - 10.2%)	7.4% (3.3% - 11.4%)	5.1% (2.2% - 8%)
Birmingham, AL	13.8% (6.2% - 20.7%)	9.9% (4.4% - 15.1%)	7.7% (3.4% - 11.9%)	6.6% (2.9% - 10.2%)	7.7% (3.4% - 11.9%)	5.6% (2.4% - 8.7%)
Dallas, TX	6.3% (2.7% - 9.7%)	6.3% (2.7% - 9.7%)	6.3% (2.7% - 9.7%)	5.5% (2.4% - 8.5%)	6.3% (2.7% - 9.7%)	5.5% (2.4% - 8.5%)
Detroit, MI	9.4% (4.1% - 14.3%)	6.5% (2.9% - 10%)	5.5% (2.4% - 8.5%)	4.6% (2% - 7.1%)	4.7% (2% - 7.3%)	2.9% (1.2% - 4.4%)
Fresno, CA	13.4% (6% - 20.2%)	4.9% (2.1% - 7.6%)	4.9% (2.1% - 7.6%)	4.9% (2.1% - 7.6%)	3.3% (1.4% - 5.1%)	1.7% (0.7% - 2.6%)
Houston, TX	11.4% (5.1% - 17.3%)	10.5% (4.7% - 16%)	8.3% (3.6% - 12.7%)	7.2% (3.1% - 11%)	8.3% (3.6% - 12.7%)	7.2% (3.1% - 11%)
Los Angeles, CA	11.1% (4.9% - 16.8%)	4.9% (2.1% - 7.6%)	4.9% (2.1% - 7.6%)	4.3% (1.9% - 6.7%)	3.3% (1.4% - 5.1%)	1.7% (0.7% - 2.6%)
New York, NY	8.2% (3.6% - 12.5%)	5.8% (2.5% - 8.9%)	5.5% (2.4% - 8.5%)	4.5% (2% - 7%)	4.1% (1.8% - 6.3%)	2.3% (1% - 3.6%)
Philadelphia, PA	9.6% (4.2% - 14.7%)	8.4% (3.7% - 12.8%)	7.5% (3.3% - 11.5%)	6.4% (2.8% - 9.8%)	6.3% (2.8% - 9.7%)	4.2% (1.8% - 6.5%)
Phoenix, AZ	6.4% (2.8% - 9.8%)	6.4% (2.8% - 9.8%)	6.4% (2.8% - 9.8%)	5.8% (2.5% - 8.9%)	5.6% (2.4% - 8.6%)	3.6% (1.5% - 5.5%)
Pittsburgh, PA	12.6% (5.6% - 19%)	4.9% (2.1% - 7.6%)	4.9% (2.1% - 7.6%)	4.9% (2.1% - 7.6%)	3.3% (1.4% - 5.2%)	1.7% (0.7% - 2.6%)
Salt Lake City, UT	6.1% (2.7% - 9.4%)	1.7% (0.7% - 2.6%)	1.7% (0.7% - 2.6%)	1.7% (0.7% - 2.6%)	0.5% (0.2% - 0.8%)	0% (0% - 0%)
St. Louis, MO	9.4% (4.2% - 14.4%)	7.8% (3.4% - 12%)	6.1% (2.6% - 9.3%)	5.1% (2.2% - 7.8%)	5.9% (2.6% - 9.1%)	3.8% (1.7% - 6%)
Tacoma, WA	4.5% (2% - 7%)	2.5% (1.1% - 3.9%)	2.5% (1.1% - 3.9%)	2.5% (1.1% - 3.9%)	1.2% (0.5% - 2%)	0% (0% - 0%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-69. Estimated Percent of Total Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent of Total Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	11.7% (5.2% - 17.7%)	10.4% (4.6% - 15.8%)	8.1% (3.6% - 12.5%)	7% (3.1% - 10.8%)	8.1% (3.6% - 12.5%)	6.8% (3% - 10.5%)
Baltimore, MD	9.9% (4.4% - 15.1%)	9.1% (4% - 13.8%)	7.2% (3.2% - 11.1%)	6.1% (2.7% - 9.4%)	6.9% (3% - 10.6%)	4.7% (2% - 7.3%)
Birmingham, AL	13.5% (6% - 20.4%)	9.7% (4.3% - 14.8%)	7.6% (3.3% - 11.6%)	6.5% (2.8% - 10%)	7.6% (3.3% - 11.6%)	5.5% (2.4% - 8.4%)
Dallas, TX	6.8% (3% - 10.5%)	6.8% (3% - 10.5%)	6.8% (3% - 10.5%)	6% (2.6% - 9.2%)	6.8% (3% - 10.5%)	6% (2.6% - 9.2%)
Detroit, MI	8.8% (3.9% - 13.5%)	6.1% (2.7% - 9.4%)	5.1% (2.2% - 7.9%)	4.2% (1.8% - 6.5%)	4.3% (1.9% - 6.7%)	2.5% (1.1% - 3.9%)
Fresno, CA	14.8% (6.7% - 22.3%)	5.8% (2.5% - 8.9%)	5.8% (2.5% - 8.9%)	5.8% (2.5% - 8.9%)	4% (1.8% - 6.3%)	2.3% (1% - 3.6%)
Houston, TX	11% (4.9% - 16.7%)	10.1% (4.5% - 15.4%)	7.9% (3.5% - 12.2%)	6.8% (3% - 10.5%)	7.9% (3.5% - 12.2%)	6.8% (3% - 10.5%)
Los Angeles, CA	11.2% (5% - 17.1%)	5% (2.2% - 7.8%)	5% (2.2% - 7.8%)	4.4% (1.9% - 6.8%)	3.4% (1.5% - 5.3%)	1.8% (0.8% - 2.7%)
New York, NY	8.2% (3.6% - 12.6%)	5.9% (2.6% - 9%)	5.5% (2.4% - 8.6%)	4.6% (2% - 7.1%)	4.1% (1.8% - 6.4%)	2.3% (1% - 3.7%)
Philadelphia, PA	9.5% (4.2% - 14.5%)	8.3% (3.6% - 12.7%)	7.4% (3.2% - 11.3%)	6.3% (2.8% - 9.7%)	6.2% (2.7% - 9.6%)	4.1% (1.8% - 6.4%)
Phoenix, AZ	5.4% (2.4% - 8.3%)	5.4% (2.4% - 8.3%)	5.4% (2.4% - 8.3%)	4.8% (2.1% - 7.4%)	4.6% (2% - 7.2%)	2.8% (1.2% - 4.3%)
Pittsburgh, PA	12.8% (5.7% - 19.3%)	5.1% (2.2% - 7.8%)	5.1% (2.2% - 7.8%)	5.1% (2.2% - 7.8%)	3.4% (1.5% - 5.3%)	1.8% (0.8% - 2.8%)
Salt Lake City, UT	8.2% (3.6% - 12.6%)	3.1% (1.3% - 4.8%)	3.1% (1.3% - 4.8%)	3.1% (1.3% - 4.8%)	1.7% (0.7% - 2.7%)	0.4% (0.2% - 0.6%)
St. Louis, MO	10% (4.4% - 15.2%)	8.4% (3.7% - 12.8%)	6.5% (2.9% - 10%)	5.5% (2.4% - 8.5%)	6.3% (2.8% - 9.8%)	4.2% (1.8% - 6.6%)
Tacoma, WA	5.1% (2.2% - 7.9%)	3% (1.3% - 4.7%)	3% (1.3% - 4.7%)	3% (1.3% - 4.7%)	1.7% (0.7% - 2.6%)	0.3% (0.1% - 0.5%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-70. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations -- Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-12% (-12% - -13%)	0% (0% - 0%)	21% (20% - 21%)	32% (31% - 32%)	21% (20% - 21%)	33% (32% - 34%)
Baltimore, MD	-9% (-8% - -9%)	0% (0% - 0%)	19% (18% - 19%)	30% (29% - 30%)	22% (21% - 22%)	44% (43% - 45%)
Birmingham, AL	-38% (-37% - -40%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	42% (42% - 43%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	0% (0% - 0%)	11% (11% - 11%)
Detroit, MI	-37% (-36% - -38%)	0% (0% - 0%)	13% (13% - 14%)	26% (25% - 26%)	24% (23% - 24%)	48% (48% - 49%)
Fresno, CA	-182% (-175% - -189%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (34% - 35%)	69% (69% - 69%)
Houston, TX	-8% (-8% - -9%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	32% (32% - 33%)
Los Angeles, CA	-114% (-110% - -118%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 12%)	30% (29% - 30%)	60% (60% - 60%)
New York, NY	-37% (-36% - -38%)	0% (0% - 0%)	5% (5% - 5%)	20% (19% - 20%)	27% (27% - 28%)	55% (54% - 55%)
Philadelphia, PA	-14% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (23% - 24%)	24% (24% - 25%)	49% (49% - 50%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	13% (13% - 13%)	45% (45% - 46%)
Pittsburgh, PA	-137% (-131% - -144%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	29% (29% - 29%)	59% (58% - 59%)
Salt Lake City, UT	-188% (-184% - -192%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	48% (48% - 49%)	98% (98% - 98%)
St. Louis, MO	-17% (-17% - -18%)	0% (0% - 0%)	20% (20% - 21%)	31% (31% - 32%)	22% (22% - 23%)	45% (44% - 46%)
Tacoma, WA	-53% (-52% - -54%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	34% (33% - 34%)	68% (67% - 68%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-71. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations -- Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (33% - 35%)
Baltimore, MD	-9% (-9% - -9%)	0% (0% - 0%)	20% (20% - 20%)	31% (31% - 32%)	23% (23% - 24%)	47% (46% - 47%)
Birmingham, AL	-39% (-37% - -41%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 34%)	22% (21% - 22%)	43% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	13% (13% - 13%)	0% (0% - 0%)	13% (13% - 13%)
Detroit, MI	-43% (-42% - -45%)	0% (0% - 0%)	16% (15% - 16%)	30% (30% - 31%)	28% (27% - 28%)	56% (56% - 57%)
Fresno, CA	-174% (-167% - -181%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (32% - 33%)	66% (66% - 66%)
Houston, TX	-8% (-8% - -9%)	0% (0% - 0%)	21% (21% - 22%)	32% (31% - 33%)	21% (21% - 22%)	32% (31% - 33%)
Los Angeles, CA	-126% (-121% - -130%)	0% (0% - 0%)	0% (0% - 0%)	13% (12% - 13%)	33% (32% - 33%)	66% (66% - 66%)
New York, NY	-41% (-40% - -42%)	0% (0% - 0%)	5% (5% - 5%)	22% (21% - 22%)	30% (30% - 30%)	60% (60% - 61%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (23% - 24%)	25% (24% - 25%)	50% (49% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	10% (10% - 10%)	12% (12% - 13%)	44% (44% - 45%)
Pittsburgh, PA	-155% (-149% - -161%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	33% (32% - 33%)	66% (65% - 66%)
Salt Lake City, UT	-268% (-263% - -273%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	69% (69% - 69%)	100% (100% - 100%)
St. Louis, MO	-20% (-19% - -20%)	0% (0% - 0%)	23% (23% - 23%)	35% (35% - 36%)	25% (25% - 26%)	51% (51% - 52%)
Tacoma, WA	-79% (-78% - -80%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	50% (50% - 50%)	100% (100% - 100%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

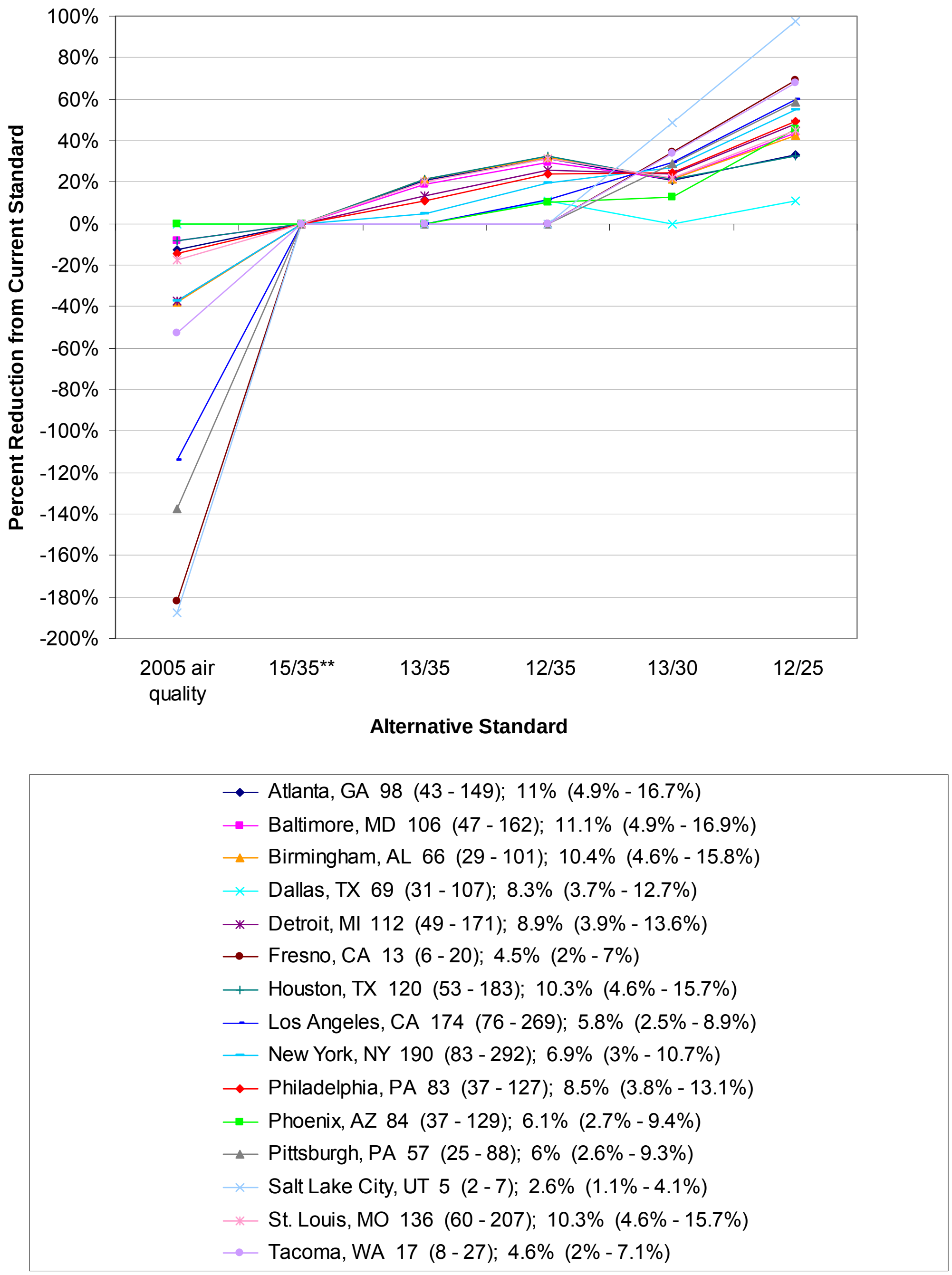
Table E-72. Percent Reduction from the Current Standards: Estimated Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations -- Estimates Based on Krewski et al. (2009), Using Ambient $PM_{2.5}$ from 1999 - 2000[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-13% (-12% - -13%)	0% (0% - 0%)	21% (21% - 22%)	32% (32% - 33%)	21% (21% - 22%)	34% (33% - 35%)
Baltimore, MD	-9% (-9% - -10%)	0% (0% - 0%)	21% (20% - 21%)	32% (32% - 33%)	24% (23% - 24%)	48% (47% - 49%)
Birmingham, AL	-39% (-38% - -41%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 34%)	22% (21% - 22%)	44% (43% - 44%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 12%)	0% (0% - 0%)	12% (12% - 12%)
Detroit, MI	-45% (-44% - -46%)	0% (0% - 0%)	16% (16% - 17%)	31% (31% - 32%)	29% (29% - 29%)	58% (58% - 59%)
Fresno, CA	-157% (-150% - -165%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	30% (29% - 30%)	60% (60% - 61%)
Houston, TX	-8% (-8% - -9%)	0% (0% - 0%)	22% (21% - 22%)	33% (32% - 33%)	22% (21% - 22%)	33% (32% - 33%)
Los Angeles, CA	-124% (-120% - -128%)	0% (0% - 0%)	0% (0% - 0%)	12% (12% - 13%)	32% (32% - 33%)	65% (65% - 65%)
New York, NY	-41% (-40% - -42%)	0% (0% - 0%)	5% (5% - 5%)	21% (21% - 22%)	30% (29% - 30%)	60% (60% - 60%)
Philadelphia, PA	-15% (-14% - -15%)	0% (0% - 0%)	11% (11% - 11%)	24% (24% - 24%)	25% (24% - 25%)	50% (50% - 51%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	11% (11% - 11%)	14% (14% - 14%)	49% (48% - 49%)
Pittsburgh, PA	-152% (-147% - -158%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	32% (32% - 32%)	65% (64% - 65%)
Salt Lake City, UT	-168% (-164% - -172%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (43% - 44%)	88% (88% - 88%)
St. Louis, MO	-19% (-19% - -20%)	0% (0% - 0%)	22% (22% - 23%)	34% (34% - 35%)	25% (24% - 25%)	50% (49% - 50%)
Tacoma, WA	-69% (-68% - -70%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	44% (44% - 44%)	89% (89% - 89%)

[1]Based on follow-up through 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

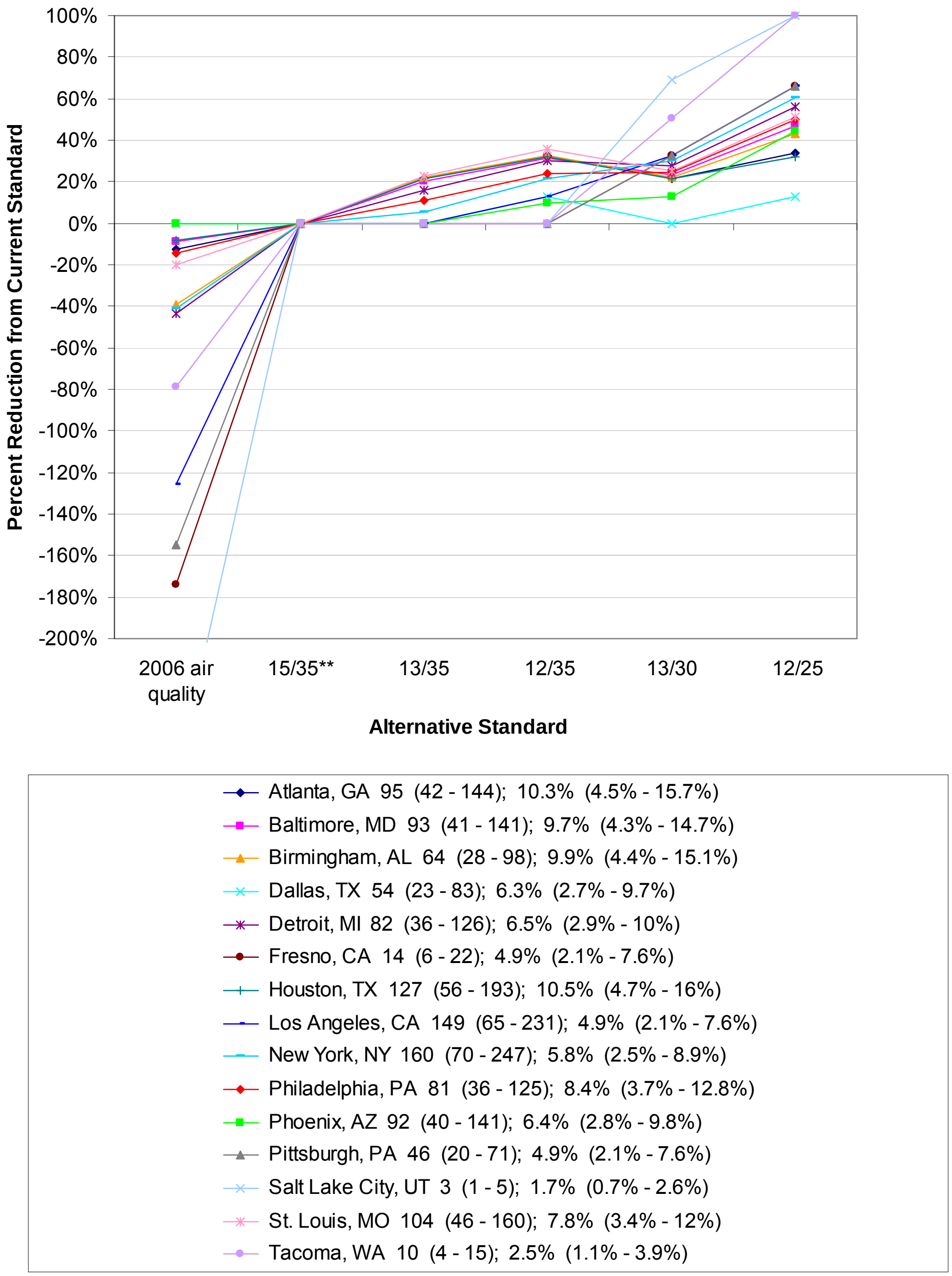
Figure E-22. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2005 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

**The current standards consist of an annual standard of 15 μg/m^3 and a daily standard of 35 μg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-23. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

***The percent reduction for 2006 air quality in Salt Lake City is -268%.

Figure E-24. Estimated Percent Reductions From the Current Standard to Alternative Standards in Lung Cancer Mortality Associated with Long-Term Exposure to $PM_{2.5}$ (Exposure Period: 1999 – 2000): Based on 2007 Air Quality Data*

*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-73. Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	191 (36 - 344)	175 (33 - 316)	149 (28 - 269)	136 (26 - 245)	149 (28 - 269)	134 (25 - 241)
Baltimore, MD	271 (110 - 429)	256 (104 - 406)	224 (91 - 355)	206 (84 - 327)	219 (89 - 348)	182 (74 - 289)
Birmingham, AL	49 (-77 - 173)	38 (-60 - 135)	33 (-51 - 115)	30 (-46 - 105)	33 (-51 - 115)	27 (-42 - 96)
Dallas, TX	151 (36 - 264)	151 (36 - 264)	151 (36 - 264)	140 (34 - 245)	151 (36 - 264)	140 (34 - 245)
Detroit, MI	174 (-31 - 375)	141 (-25 - 305)	129 (-23 - 280)	119 (-21 - 257)	121 (-21 - 260)	100 (-18 - 216)
Fresno, CA	80 (11 - 147)	44 (6 - 82)	44 (6 - 82)	44 (6 - 82)	38 (5 - 70)	31 (4 - 58)
Houston, TX	245 (50 - 438)	232 (47 - 414)	197 (40 - 352)	180 (37 - 321)	197 (40 - 352)	180 (37 - 321)
Los Angeles, CA	134 (-192 - 458)	85 (-121 - 289)	85 (-121 - 289)	80 (-114 - 273)	72 (-103 - 247)	60 (-86 - 205)
New York, NY	858 (504 - 1209)	714 (419 - 1007)	696 (408 - 981)	639 (375 - 902)	611 (358 - 861)	507 (297 - 716)
Philadelphia, PA	229 (85 - 372)	211 (78 - 342)	197 (73 - 321)	181 (67 - 295)	180 (67 - 293)	150 (55 - 244)
Phoenix, AZ	240 (40 - 438)	240 (40 - 438)	240 (40 - 438)	228 (38 - 417)	225 (37 - 411)	187 (31 - 342)
Pittsburgh, PA	233 (69 - 395)	135 (40 - 230)	135 (40 - 230)	135 (40 - 230)	116 (34 - 197)	96 (28 - 163)
Salt Lake City, UT	52 (11 - 93)	33 (7 - 59)	33 (7 - 59)	33 (7 - 59)	28 (6 - 51)	23 (5 - 42)
St. Louis, MO	281 (81 - 478)	252 (73 - 429)	219 (63 - 373)	201 (58 - 342)	215 (62 - 367)	179 (51 - 305)
Tacoma, WA	59 (10 - 107)	48 (8 - 87)	48 (8 - 87)	48 (8 - 87)	41 (7 - 74)	34 (6 - 62)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-74. Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	188 (36 - 338)	172 (33 - 310)	146 (28 - 264)	134 (25 - 241)	146 (28 - 264)	132 (25 - 237)
Baltimore, MD	248 (101 - 393)	234 (95 - 372)	205 (83 - 325)	188 (76 - 299)	201 (81 - 318)	167 (68 - 265)
Birmingham, AL	48 (-75 - 169)	38 (-59 - 132)	32 (-50 - 113)	29 (-45 - 103)	32 (-50 - 113)	26 (-41 - 94)
Dallas, TX	129 (31 - 226)	129 (31 - 226)	129 (31 - 226)	120 (29 - 210)	129 (31 - 226)	120 (29 - 210)
Detroit, MI	145 (-25 - 313)	117 (-21 - 254)	108 (-19 - 233)	99 (-17 - 214)	100 (-18 - 217)	83 (-15 - 180)
Fresno, CA	84 (12 - 155)	46 (7 - 86)	46 (7 - 86)	46 (7 - 86)	40 (6 - 73)	33 (5 - 61)
Houston, TX	258 (53 - 460)	243 (50 - 434)	207 (42 - 369)	188 (38 - 337)	207 (42 - 369)	188 (38 - 337)
Los Angeles, CA	124 (-178 - 423)	78 (-112 - 267)	78 (-112 - 267)	74 (-106 - 252)	67 (-96 - 228)	55 (-79 - 189)
New York, NY	786 (461 - 1107)	654 (384 - 922)	637 (374 - 898)	585 (343 - 826)	559 (328 - 789)	464 (272 - 655)
Philadelphia, PA	226 (83 - 366)	208 (77 - 337)	194 (72 - 315)	179 (66 - 290)	178 (65 - 288)	147 (54 - 240)
Phoenix, AZ	255 (42 - 466)	255 (42 - 466)	255 (42 - 466)	243 (40 - 443)	239 (40 - 436)	199 (33 - 363)
Pittsburgh, PA	210 (62 - 357)	122 (36 - 208)	122 (36 - 208)	122 (36 - 208)	104 (31 - 177)	87 (25 - 147)
Salt Lake City, UT	48 (10 - 86)	30 (6 - 54)	30 (6 - 54)	30 (6 - 54)	26 (5 - 46)	21 (4 - 38)
St. Louis, MO	238 (69 - 406)	214 (62 - 364)	185 (53 - 316)	170 (49 - 290)	183 (53 - 311)	151 (44 - 258)
Tacoma, WA	48 (8 - 88)	39 (7 - 71)	39 (7 - 71)	39 (7 - 71)	34 (6 - 61)	28 (5 - 51)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-75. Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	193 (37 - 347)	177 (34 - 319)	151 (29 - 271)	137 (26 - 248)	151 (29 - 271)	135 (26 - 244)
Baltimore, MD	238 (97 - 377)	225 (91 - 357)	197 (80 - 312)	181 (73 - 287)	192 (78 - 306)	160 (65 - 254)
Birmingham, AL	48 (-74 - 168)	37 (-58 - 131)	32 (-49 - 112)	29 (-45 - 102)	32 (-49 - 112)	26 (-41 - 93)
Dallas, TX	137 (33 - 240)	137 (33 - 240)	137 (33 - 240)	127 (31 - 223)	137 (33 - 240)	127 (31 - 223)
Detroit, MI	138 (-24 - 298)	112 (-20 - 242)	102 (-18 - 222)	94 (-16 - 204)	95 (-17 - 207)	79 (-14 - 171)
Fresno, CA	92 (13 - 168)	51 (7 - 94)	51 (7 - 94)	51 (7 - 94)	43 (6 - 80)	36 (5 - 67)
Houston, TX	254 (52 - 454)	240 (49 - 429)	204 (42 - 365)	186 (38 - 333)	204 (42 - 365)	186 (38 - 333)
Los Angeles, CA	125 (-180 - 427)	79 (-113 - 270)	79 (-113 - 270)	74 (-107 - 255)	67 (-97 - 231)	56 (-80 - 191)
New York, NY	793 (465 - 1117)	659 (387 - 930)	642 (377 - 906)	590 (346 - 833)	564 (331 - 795)	468 (274 - 661)
Philadelphia, PA	224 (83 - 363)	206 (76 - 334)	193 (71 - 313)	177 (65 - 287)	176 (65 - 286)	146 (54 - 238)
Phoenix, AZ	242 (40 - 441)	242 (40 - 441)	242 (40 - 441)	230 (38 - 419)	226 (37 - 413)	188 (31 - 344)
Pittsburgh, PA	212 (62 - 359)	123 (36 - 209)	123 (36 - 209)	123 (36 - 209)	105 (31 - 179)	87 (26 - 148)
Salt Lake City, UT	58 (12 - 102)	36 (7 - 65)	36 (7 - 65)	36 (7 - 65)	31 (6 - 56)	26 (5 - 46)
St. Louis, MO	248 (71 - 421)	222 (64 - 378)	193 (56 - 328)	177 (51 - 301)	190 (55 - 323)	157 (45 - 268)
Tacoma, WA	52 (9 - 94)	42 (7 - 76)	42 (7 - 76)	42 (7 - 76)	36 (6 - 65)	30 (5 - 54)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-76. Estimated Percent of Total Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.3% (0.3% - 2.4%)	1.2% (0.2% - 2.2%)	1% (0.2% - 1.9%)	0.9% (0.2% - 1.7%)	1% (0.2% - 1.9%)	0.9% (0.2% - 1.7%)
Baltimore, MD	2% (0.8% - 3.2%)	1.9% (0.8% - 3%)	1.7% (0.7% - 2.6%)	1.5% (0.6% - 2.4%)	1.6% (0.7% - 2.6%)	1.3% (0.5% - 2.1%)
Birmingham, AL	0.5% (-0.8% - 1.8%)	0.4% (-0.6% - 1.4%)	0.3% (-0.5% - 1.2%)	0.3% (-0.5% - 1.1%)	0.3% (-0.5% - 1.2%)	0.3% (-0.4% - 1%)
Dallas, TX	1.2% (0.3% - 2.1%)	1.2% (0.3% - 2.1%)	1.2% (0.3% - 2.1%)	1.1% (0.3% - 2%)	1.2% (0.3% - 2.1%)	1.1% (0.3% - 2%)
Detroit, MI	1% (-0.2% - 2.2%)	0.8% (-0.1% - 1.8%)	0.7% (-0.1% - 1.6%)	0.7% (-0.1% - 1.5%)	0.7% (-0.1% - 1.5%)	0.6% (-0.1% - 1.3%)
Fresno, CA	1.5% (0.2% - 2.7%)	0.8% (0.1% - 1.5%)	0.8% (0.1% - 1.5%)	0.8% (0.1% - 1.5%)	0.7% (0.1% - 1.3%)	0.6% (0.1% - 1.1%)
Houston, TX	1.4% (0.3% - 2.5%)	1.3% (0.3% - 2.3%)	1.1% (0.2% - 2%)	1% (0.2% - 1.8%)	1.1% (0.2% - 2%)	1% (0.2% - 1.8%)
Los Angeles, CA	0.2% (-0.3% - 0.8%)	0.2% (-0.2% - 0.5%)	0.2% (-0.2% - 0.5%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.4%)	0.1% (-0.2% - 0.4%)
New York, NY	1.7% (1% - 2.3%)	1.4% (0.8% - 2%)	1.3% (0.8% - 1.9%)	1.2% (0.7% - 1.7%)	1.2% (0.7% - 1.7%)	1% (0.6% - 1.4%)
Philadelphia, PA	1.6% (0.6% - 2.6%)	1.5% (0.6% - 2.4%)	1.4% (0.5% - 2.3%)	1.3% (0.5% - 2.1%)	1.3% (0.5% - 2.1%)	1.1% (0.4% - 1.7%)
Phoenix, AZ	1.1% (0.2% - 2%)	1.1% (0.2% - 2%)	1.1% (0.2% - 2%)	1% (0.2% - 1.9%)	1% (0.2% - 1.9%)	0.9% (0.1% - 1.6%)
Pittsburgh, PA	1.7% (0.5% - 2.9%)	1% (0.3% - 1.7%)	1% (0.3% - 1.7%)	1% (0.3% - 1.7%)	0.9% (0.3% - 1.5%)	0.7% (0.2% - 1.2%)
Salt Lake City, UT	1.1% (0.2% - 2%)	0.7% (0.1% - 1.3%)	0.7% (0.1% - 1.3%)	0.7% (0.1% - 1.3%)	0.6% (0.1% - 1.1%)	0.5% (0.1% - 0.9%)
St. Louis, MO	1.5% (0.4% - 2.6%)	1.4% (0.4% - 2.4%)	1.2% (0.3% - 2%)	1.1% (0.3% - 1.9%)	1.2% (0.3% - 2%)	1% (0.3% - 1.7%)
Tacoma, WA	1.2% (0.2% - 2.2%)	1% (0.2% - 1.8%)	1% (0.2% - 1.8%)	1% (0.2% - 1.8%)	0.8% (0.1% - 1.5%)	0.7% (0.1% - 1.3%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-77. Estimated Percent of Total Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.3% (0.2% - 2.3%)	1.2% (0.2% - 2.1%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.6%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.6%)
Baltimore, MD	1.8% (0.7% - 2.9%)	1.7% (0.7% - 2.7%)	1.5% (0.6% - 2.4%)	1.4% (0.6% - 2.2%)	1.5% (0.6% - 2.3%)	1.2% (0.5% - 1.9%)
Birmingham, AL	0.5% (-0.8% - 1.8%)	0.4% (-0.6% - 1.4%)	0.3% (-0.5% - 1.2%)	0.3% (-0.5% - 1.1%)	0.3% (-0.5% - 1.2%)	0.3% (-0.4% - 1%)
Dallas, TX	1% (0.2% - 1.8%)	1% (0.2% - 1.8%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.7%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.7%)
Detroit, MI	0.8% (-0.1% - 1.8%)	0.7% (-0.1% - 1.5%)	0.6% (-0.1% - 1.4%)	0.6% (-0.1% - 1.2%)	0.6% (-0.1% - 1.3%)	0.5% (-0.1% - 1.1%)
Fresno, CA	1.5% (0.2% - 2.8%)	0.8% (0.1% - 1.6%)	0.8% (0.1% - 1.6%)	0.8% (0.1% - 1.6%)	0.7% (0.1% - 1.3%)	0.6% (0.1% - 1.1%)
Houston, TX	1.4% (0.3% - 2.5%)	1.3% (0.3% - 2.3%)	1.1% (0.2% - 2%)	1% (0.2% - 1.8%)	1.1% (0.2% - 2%)	1% (0.2% - 1.8%)
Los Angeles, CA	0.2% (-0.3% - 0.8%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.4%)	0.1% (-0.1% - 0.3%)
New York, NY	1.5% (0.9% - 2.1%)	1.3% (0.7% - 1.8%)	1.2% (0.7% - 1.7%)	1.1% (0.7% - 1.6%)	1.1% (0.6% - 1.5%)	0.9% (0.5% - 1.3%)
Philadelphia, PA	1.6% (0.6% - 2.6%)	1.5% (0.5% - 2.4%)	1.4% (0.5% - 2.2%)	1.3% (0.5% - 2.1%)	1.3% (0.5% - 2.1%)	1% (0.4% - 1.7%)
Phoenix, AZ	1.1% (0.2% - 2.1%)	1.1% (0.2% - 2.1%)	1.1% (0.2% - 2.1%)	1.1% (0.2% - 2%)	1.1% (0.2% - 1.9%)	0.9% (0.1% - 1.6%)
Pittsburgh, PA	1.6% (0.5% - 2.7%)	0.9% (0.3% - 1.5%)	0.9% (0.3% - 1.5%)	0.9% (0.3% - 1.5%)	0.8% (0.2% - 1.3%)	0.6% (0.2% - 1.1%)
Salt Lake City, UT	1% (0.2% - 1.8%)	0.6% (0.1% - 1.1%)	0.6% (0.1% - 1.1%)	0.6% (0.1% - 1.1%)	0.5% (0.1% - 1%)	0.4% (0.1% - 0.8%)
St. Louis, MO	1.3% (0.4% - 2.2%)	1.2% (0.3% - 2%)	1% (0.3% - 1.7%)	0.9% (0.3% - 1.6%)	1% (0.3% - 1.7%)	0.8% (0.2% - 1.4%)
Tacoma, WA	1% (0.2% - 1.8%)	0.8% (0.1% - 1.4%)	0.8% (0.1% - 1.4%)	0.8% (0.1% - 1.4%)	0.7% (0.1% - 1.2%)	0.6% (0.1% - 1%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-78. Estimated Percent of Total Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.3% (0.2% - 2.3%)	1.2% (0.2% - 2.1%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.6%)	1% (0.2% - 1.8%)	0.9% (0.2% - 1.6%)
Baltimore, MD	1.7% (0.7% - 2.8%)	1.7% (0.7% - 2.6%)	1.4% (0.6% - 2.3%)	1.3% (0.5% - 2.1%)	1.4% (0.6% - 2.2%)	1.2% (0.5% - 1.9%)
Birmingham, AL	0.5% (-0.8% - 1.7%)	0.4% (-0.6% - 1.4%)	0.3% (-0.5% - 1.2%)	0.3% (-0.5% - 1.1%)	0.3% (-0.5% - 1.2%)	0.3% (-0.4% - 1%)
Dallas, TX	1.1% (0.3% - 1.9%)	1.1% (0.3% - 1.9%)	1.1% (0.3% - 1.9%)	1% (0.2% - 1.7%)	1.1% (0.3% - 1.9%)	1% (0.2% - 1.7%)
Detroit, MI	0.8% (-0.1% - 1.8%)	0.7% (-0.1% - 1.4%)	0.6% (-0.1% - 1.3%)	0.6% (-0.1% - 1.2%)	0.6% (-0.1% - 1.2%)	0.5% (-0.1% - 1%)
Fresno, CA	1.6% (0.2% - 3%)	0.9% (0.1% - 1.7%)	0.9% (0.1% - 1.7%)	0.9% (0.1% - 1.7%)	0.8% (0.1% - 1.4%)	0.6% (0.1% - 1.2%)
Houston, TX	1.4% (0.3% - 2.4%)	1.3% (0.3% - 2.3%)	1.1% (0.2% - 1.9%)	1% (0.2% - 1.8%)	1.1% (0.2% - 1.9%)	1% (0.2% - 1.8%)
Los Angeles, CA	0.2% (-0.3% - 0.8%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.5%)	0.1% (-0.2% - 0.4%)	0.1% (-0.1% - 0.3%)
New York, NY	1.5% (0.9% - 2.2%)	1.3% (0.7% - 1.8%)	1.2% (0.7% - 1.7%)	1.1% (0.7% - 1.6%)	1.1% (0.6% - 1.5%)	0.9% (0.5% - 1.3%)
Philadelphia, PA	1.6% (0.6% - 2.6%)	1.5% (0.5% - 2.4%)	1.4% (0.5% - 2.2%)	1.3% (0.5% - 2.1%)	1.3% (0.5% - 2%)	1% (0.4% - 1.7%)
Phoenix, AZ	1% (0.2% - 1.9%)	1% (0.2% - 1.9%)	1% (0.2% - 1.9%)	1% (0.2% - 1.8%)	1% (0.2% - 1.8%)	0.8% (0.1% - 1.5%)
Pittsburgh, PA	1.6% (0.5% - 2.7%)	0.9% (0.3% - 1.6%)	0.9% (0.3% - 1.6%)	0.9% (0.3% - 1.6%)	0.8% (0.2% - 1.3%)	0.7% (0.2% - 1.1%)
Salt Lake City, UT	1.2% (0.2% - 2.1%)	0.7% (0.2% - 1.3%)	0.7% (0.2% - 1.3%)	0.7% (0.2% - 1.3%)	0.6% (0.1% - 1.1%)	0.5% (0.1% - 0.9%)
St. Louis, MO	1.4% (0.4% - 2.3%)	1.2% (0.4% - 2.1%)	1.1% (0.3% - 1.8%)	1% (0.3% - 1.7%)	1% (0.3% - 1.8%)	0.9% (0.2% - 1.5%)
Tacoma, WA	1% (0.2% - 1.9%)	0.8% (0.1% - 1.5%)	0.8% (0.1% - 1.5%)	0.8% (0.1% - 1.5%)	0.7% (0.1% - 1.3%)	0.6% (0.1% - 1.1%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-79. Percent Reduction from the Current Standards: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Estimated Percent Reduction From the Current Standards to Several Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -23%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-80. Percent Reduction from the Current Standards: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Estimated Percent Reduction From the Current Standards to Several Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -23%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

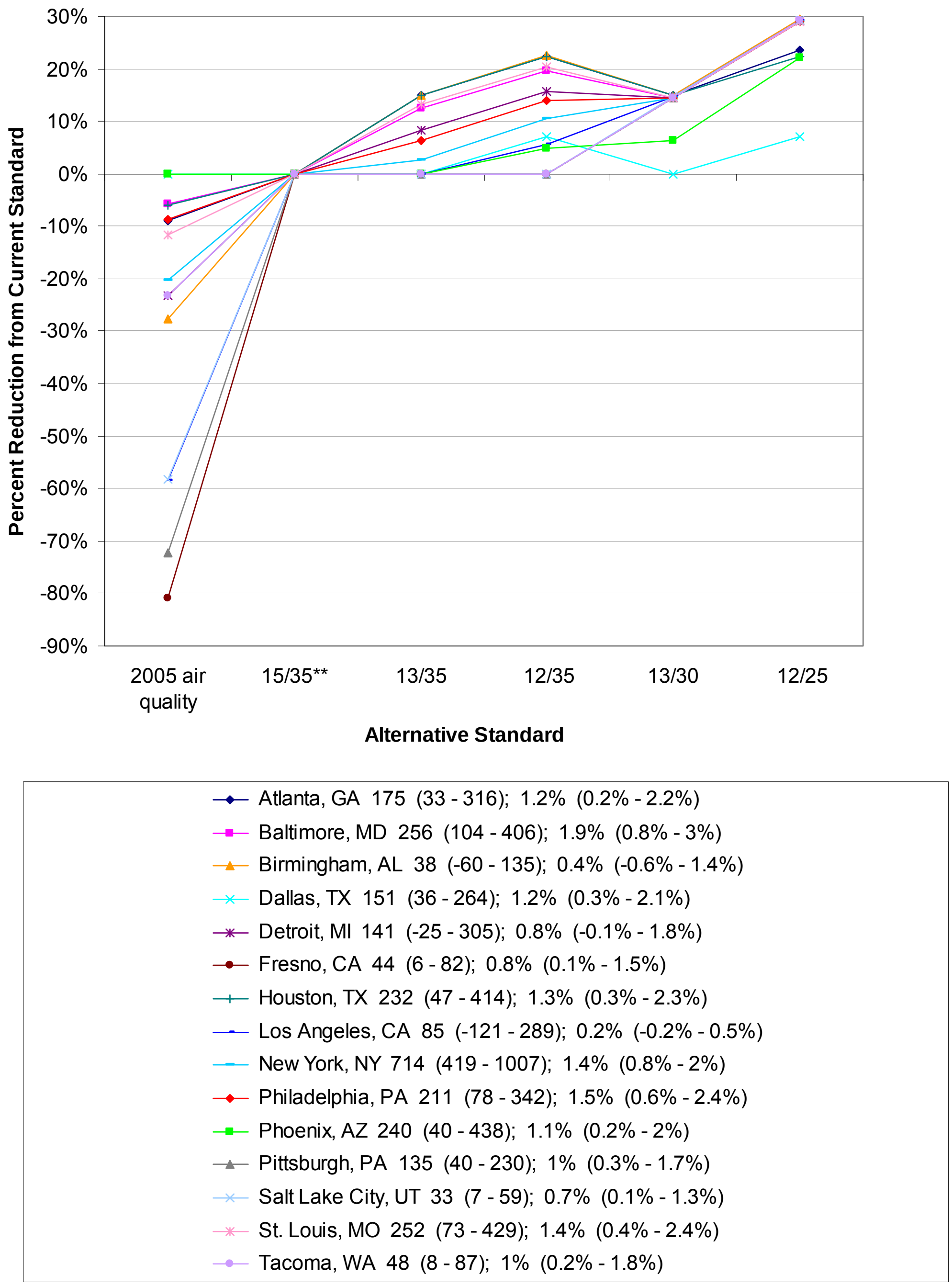
Table E-81. Percent Reduction from the Current Standards: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Estimated Percent Reduction From the Current Standards to Several Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-79% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -23%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

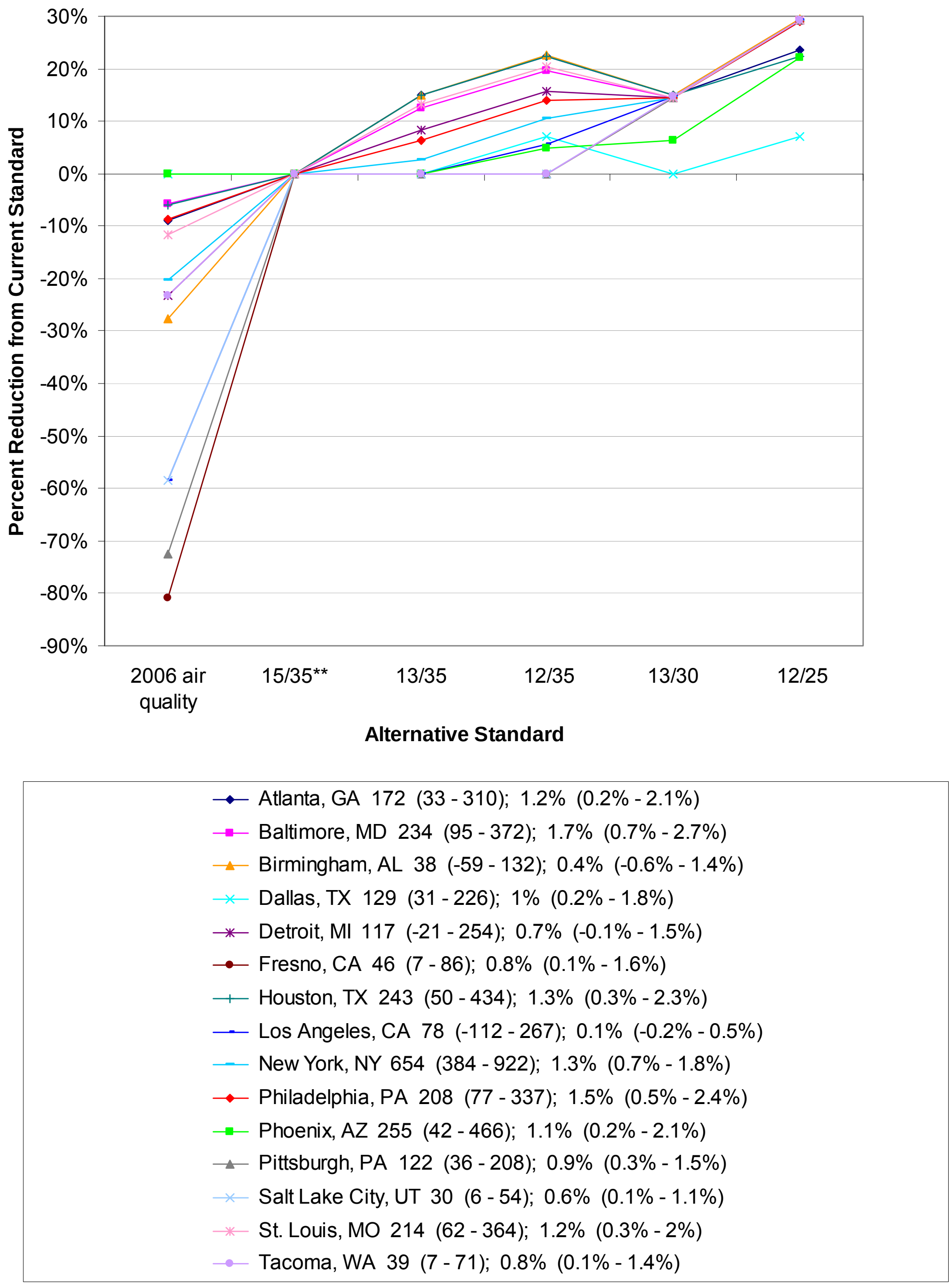
Figure E-25. Estimated Percent Reductions From the Current Standard to Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2005 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.

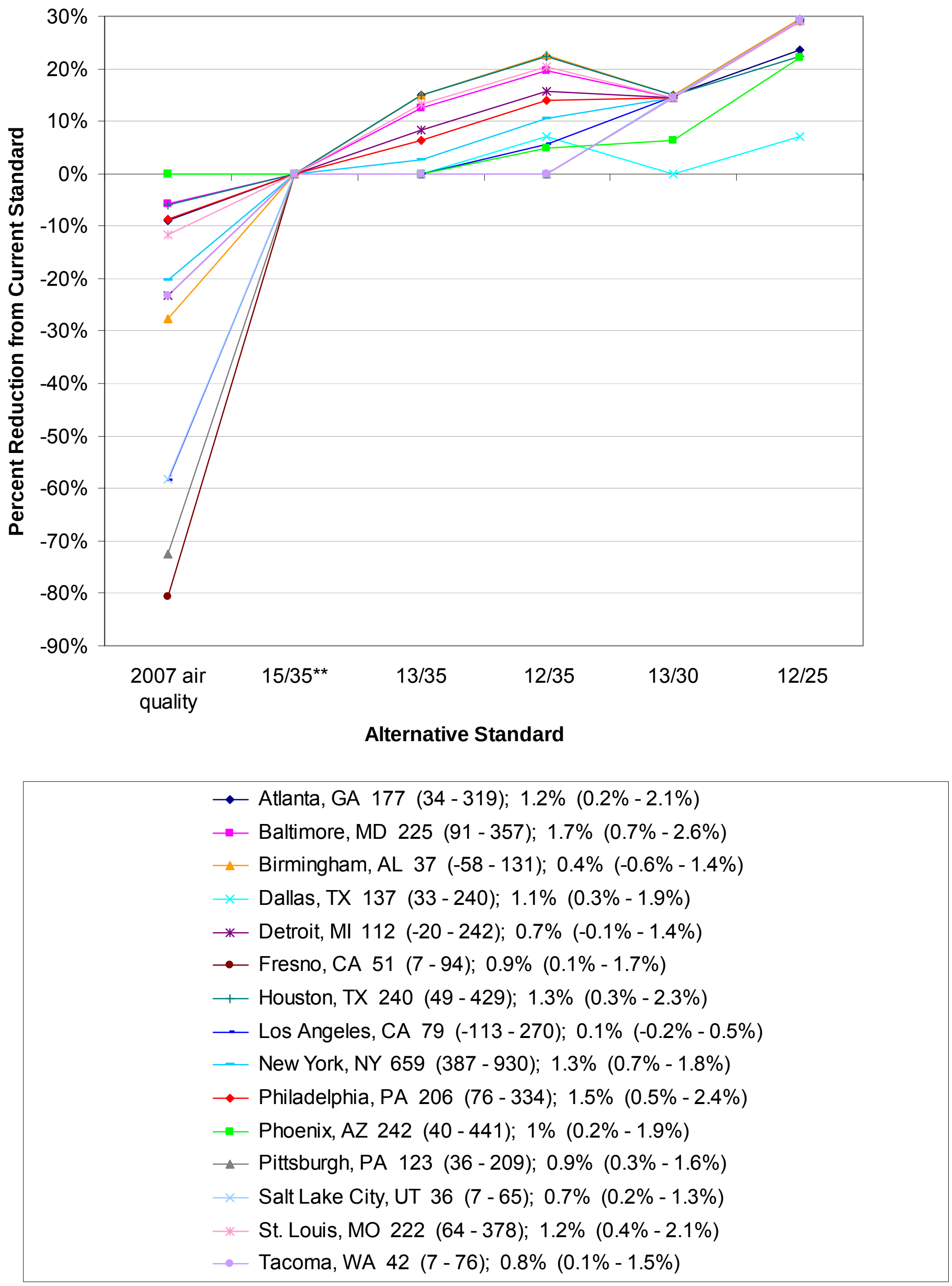
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-26. Estimated Percent Reductions From the Current Standard to Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2006 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-27. Estimated Percent Reductions From the Current Standard to Alternative Standards in Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data*



*Based on Krewski et al. (2009), exposure period from 1999 – 2000. The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-82. Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	34 (-35 - 103)	32 (-32 - 94)	27 (-28 - 80)	25 (-25 - 73)	27 (-28 - 80)	24 (-25 - 72)
Baltimore, MD	74 (-5 - 151)	70 (-5 - 142)	61 (-4 - 125)	56 (-4 - 115)	60 (-4 - 122)	50 (-3 - 102)
Birmingham, AL	-1 (-61 - 58)	-1 (-48 - 45)	-1 (-41 - 38)	-1 (-37 - 35)	-1 (-41 - 38)	-1 (-34 - 32)
Dallas, TX	31 (-21 - 82)	31 (-21 - 82)	31 (-21 - 82)	29 (-19 - 76)	31 (-21 - 82)	29 (-19 - 76)
Detroit, MI	86 (-11 - 180)	70 (-9 - 147)	64 (-8 - 135)	59 (-7 - 124)	60 (-7 - 126)	49 (-6 - 104)
Fresno, CA	21 (-14 - 55)	11 (-8 - 30)	11 (-8 - 30)	11 (-8 - 30)	10 (-7 - 26)	8 (-6 - 22)
Houston, TX	54 (-36 - 142)	51 (-34 - 134)	43 (-29 - 114)	39 (-27 - 104)	43 (-29 - 114)	39 (-27 - 104)
Los Angeles, CA	-52 (-231 - 126)	-33 (-146 - 79)	-33 (-146 - 79)	-31 (-137 - 75)	-28 (-124 - 68)	-23 (-103 - 56)
New York, NY	552 (323 - 779)	460 (268 - 649)	448 (261 - 633)	412 (240 - 582)	394 (229 - 556)	327 (190 - 463)
Philadelphia, PA	92 (24 - 159)	85 (22 - 147)	80 (21 - 137)	73 (19 - 126)	73 (19 - 126)	61 (16 - 105)
Phoenix, AZ	83 (-4 - 169)	83 (-4 - 169)	83 (-4 - 169)	79 (-3 - 160)	78 (-3 - 158)	65 (-3 - 131)
Pittsburgh, PA	70 (-14 - 151)	40 (-8 - 88)	40 (-8 - 88)	40 (-8 - 88)	35 (-7 - 75)	29 (-6 - 63)
Salt Lake City, UT	14 (-3 - 30)	9 (-2 - 19)	9 (-2 - 19)	9 (-2 - 19)	7 (-2 - 16)	6 (-1 - 14)
St. Louis, MO	132 (29 - 232)	118 (26 - 208)	103 (23 - 181)	94 (21 - 167)	101 (23 - 179)	84 (19 - 148)
Tacoma, WA	15 (-8 - 38)	12 (-7 - 31)	12 (-7 - 31)	12 (-7 - 31)	11 (-6 - 27)	9 (-5 - 22)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-83. Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	34 (-35 - 101)	31 (-32 - 93)	26 (-27 - 79)	24 (-25 - 72)	26 (-27 - 79)	24 (-24 - 71)
Baltimore, MD	68 (-5 - 138)	64 (-4 - 130)	56 (-4 - 114)	51 (-3 - 105)	55 (-4 - 112)	45 (-3 - 93)
Birmingham, AL	-1 (-60 - 56)	-1 (-47 - 44)	-1 (-40 - 38)	-1 (-36 - 34)	-1 (-40 - 38)	-1 (-33 - 31)
Dallas, TX	27 (-18 - 71)	27 (-18 - 71)	27 (-18 - 71)	25 (-16 - 66)	27 (-18 - 71)	25 (-16 - 66)
Detroit, MI	72 (-9 - 151)	58 (-7 - 122)	53 (-7 - 112)	49 (-6 - 103)	50 (-6 - 105)	41 (-5 - 87)
Fresno, CA	22 (-15 - 57)	12 (-8 - 32)	12 (-8 - 32)	12 (-8 - 32)	10 (-7 - 27)	9 (-6 - 23)
Houston, TX	56 (-38 - 149)	53 (-36 - 140)	45 (-31 - 119)	41 (-28 - 109)	45 (-31 - 119)	41 (-28 - 109)
Los Angeles, CA	-48 (-214 - 116)	-30 (-134 - 73)	-30 (-134 - 73)	-28 (-127 - 69)	-26 (-115 - 63)	-21 (-95 - 52)
New York, NY	506 (295 - 713)	421 (246 - 595)	410 (239 - 580)	377 (220 - 533)	360 (210 - 509)	299 (174 - 424)
Philadelphia, PA	91 (24 - 157)	84 (22 - 144)	78 (20 - 135)	72 (19 - 124)	72 (19 - 124)	60 (15 - 103)
Phoenix, AZ	88 (-4 - 179)	88 (-4 - 179)	88 (-4 - 179)	84 (-4 - 170)	83 (-4 - 168)	69 (-3 - 140)
Pittsburgh, PA	63 (-13 - 136)	36 (-7 - 80)	36 (-7 - 80)	36 (-7 - 80)	31 (-6 - 68)	26 (-5 - 56)
Salt Lake City, UT	13 (-3 - 28)	8 (-2 - 18)	8 (-2 - 18)	8 (-2 - 18)	7 (-2 - 15)	6 (-1 - 12)
St. Louis, MO	112 (25 - 198)	101 (22 - 177)	87 (19 - 154)	80 (18 - 142)	86 (19 - 152)	71 (16 - 126)
Tacoma, WA	13 (-7 - 31)	10 (-5 - 26)	10 (-5 - 26)	10 (-5 - 26)	9 (-5 - 22)	7 (-4 - 18)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-84. Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	35 (-36 - 104)	32 (-33 - 95)	27 (-28 - 81)	25 (-25 - 74)	27 (-28 - 81)	24 (-25 - 73)
Baltimore, MD	65 (-4 - 132)	61 (-4 - 125)	54 (-4 - 110)	49 (-3 - 101)	52 (-4 - 107)	44 (-3 - 89)
Birmingham, AL	-1 (-59 - 56)	-1 (-46 - 44)	-1 (-39 - 37)	-1 (-36 - 34)	-1 (-39 - 37)	-1 (-33 - 31)
Dallas, TX	29 (-19 - 75)	29 (-19 - 75)	29 (-19 - 75)	26 (-17 - 70)	29 (-19 - 75)	26 (-17 - 70)
Detroit, MI	68 (-9 - 143)	55 (-7 - 117)	51 (-6 - 107)	47 (-6 - 98)	47 (-6 - 100)	39 (-5 - 83)
Fresno, CA	24 (-17 - 62)	13 (-9 - 35)	13 (-9 - 35)	13 (-9 - 35)	11 (-8 - 30)	9 (-6 - 25)
Houston, TX	56 (-38 - 147)	52 (-36 - 139)	45 (-30 - 118)	41 (-28 - 108)	45 (-30 - 118)	41 (-28 - 108)
Los Angeles, CA	-48 (-216 - 117)	-30 (-136 - 74)	-30 (-136 - 74)	-29 (-128 - 70)	-26 (-116 - 63)	-22 (-96 - 52)
New York, NY	510 (298 - 720)	425 (248 - 600)	414 (241 - 585)	381 (222 - 538)	364 (212 - 514)	302 (176 - 427)
Philadelphia, PA	90 (23 - 155)	83 (22 - 143)	78 (20 - 134)	71 (18 - 123)	71 (18 - 123)	59 (15 - 102)
Phoenix, AZ	84 (-4 - 170)	84 (-4 - 170)	84 (-4 - 170)	80 (-3 - 161)	78 (-3 - 159)	65 (-3 - 132)
Pittsburgh, PA	63 (-13 - 137)	37 (-7 - 80)	37 (-7 - 80)	37 (-7 - 80)	31 (-6 - 69)	26 (-5 - 57)
Salt Lake City, UT	15 (-4 - 33)	10 (-2 - 21)	10 (-2 - 21)	10 (-2 - 21)	8 (-2 - 18)	7 (-2 - 15)
St. Louis, MO	116 (26 - 205)	104 (23 - 184)	91 (20 - 160)	83 (18 - 147)	89 (20 - 157)	74 (16 - 131)
Tacoma, WA	14 (-7 - 34)	11 (-6 - 27)	11 (-6 - 27)	11 (-6 - 27)	9 (-5 - 23)	8 (-4 - 19)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-85. Estimated Percent of Total Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.9% (-1% - 2.8%)	0.9% (-0.9% - 2.5%)	0.7% (-0.7% - 2.2%)	0.7% (-0.7% - 2%)	0.7% (-0.7% - 2.2%)	0.7% (-0.7% - 1.9%)
Baltimore, MD	1.9% (-0.1% - 3.9%)	1.8% (-0.1% - 3.7%)	1.6% (-0.1% - 3.2%)	1.4% (-0.1% - 2.9%)	1.5% (-0.1% - 3.1%)	1.3% (-0.1% - 2.6%)
Birmingham, AL	0% (-2.3% - 2.1%)	0% (-1.8% - 1.7%)	0% (-1.5% - 1.4%)	0% (-1.4% - 1.3%)	0% (-1.5% - 1.4%)	0% (-1.2% - 1.2%)
Dallas, TX	0.9% (-0.6% - 2.4%)	0.9% (-0.6% - 2.4%)	0.9% (-0.6% - 2.4%)	0.9% (-0.6% - 2.2%)	0.9% (-0.6% - 2.4%)	0.9% (-0.6% - 2.2%)
Detroit, MI	1.4% (-0.2% - 3%)	1.2% (-0.1% - 2.4%)	1.1% (-0.1% - 2.2%)	1% (-0.1% - 2.1%)	1% (-0.1% - 2.1%)	0.8% (-0.1% - 1.7%)
Fresno, CA	1.3% (-0.9% - 3.3%)	0.7% (-0.5% - 1.8%)	0.7% (-0.5% - 1.8%)	0.7% (-0.5% - 1.8%)	0.6% (-0.4% - 1.6%)	0.5% (-0.3% - 1.3%)
Houston, TX	1.1% (-0.7% - 2.9%)	1% (-0.7% - 2.7%)	0.9% (-0.6% - 2.3%)	0.8% (-0.5% - 2.1%)	0.9% (-0.6% - 2.3%)	0.8% (-0.5% - 2.1%)
Los Angeles, CA	-0.3% (-1.2% - 0.7%)	-0.2% (-0.8% - 0.4%)	-0.2% (-0.8% - 0.4%)	-0.2% (-0.7% - 0.4%)	-0.1% (-0.7% - 0.4%)	-0.1% (-0.5% - 0.3%)
New York, NY	2.5% (1.4% - 3.5%)	2% (1.2% - 2.9%)	2% (1.2% - 2.8%)	1.8% (1.1% - 2.6%)	1.8% (1% - 2.5%)	1.5% (0.8% - 2.1%)
Philadelphia, PA	2.3% (0.6% - 4%)	2.1% (0.5% - 3.6%)	2% (0.5% - 3.4%)	1.8% (0.5% - 3.1%)	1.8% (0.5% - 3.1%)	1.5% (0.4% - 2.6%)
Phoenix, AZ	1.4% (-0.1% - 2.9%)	1.4% (-0.1% - 2.9%)	1.4% (-0.1% - 2.9%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.1% (0% - 2.2%)
Pittsburgh, PA	1.7% (-0.3% - 3.7%)	1% (-0.2% - 2.2%)	1% (-0.2% - 2.2%)	1% (-0.2% - 2.2%)	0.8% (-0.2% - 1.8%)	0.7% (-0.1% - 1.5%)
Salt Lake City, UT	1.3% (-0.3% - 2.8%)	0.8% (-0.2% - 1.8%)	0.8% (-0.2% - 1.8%)	0.8% (-0.2% - 1.8%)	0.7% (-0.2% - 1.5%)	0.6% (-0.1% - 1.2%)
St. Louis, MO	2.3% (0.5% - 4.1%)	2.1% (0.5% - 3.7%)	1.8% (0.4% - 3.2%)	1.7% (0.4% - 2.9%)	1.8% (0.4% - 3.1%)	1.5% (0.3% - 2.6%)
Tacoma, WA	1.1% (-0.6% - 2.7%)	0.9% (-0.5% - 2.2%)	0.9% (-0.5% - 2.2%)	0.9% (-0.5% - 2.2%)	0.7% (-0.4% - 1.8%)	0.6% (-0.3% - 1.5%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-86. Estimated Percent of Total Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.9% (-0.9% - 2.6%)	0.8% (-0.8% - 2.4%)	0.7% (-0.7% - 2.1%)	0.6% (-0.6% - 1.9%)	0.7% (-0.7% - 2.1%)	0.6% (-0.6% - 1.9%)
Baltimore, MD	1.7% (-0.1% - 3.5%)	1.6% (-0.1% - 3.3%)	1.4% (-0.1% - 2.9%)	1.3% (-0.1% - 2.7%)	1.4% (-0.1% - 2.9%)	1.2% (-0.1% - 2.4%)
Birmingham, AL	0% (-2.2% - 2.1%)	0% (-1.7% - 1.6%)	0% (-1.5% - 1.4%)	0% (-1.3% - 1.3%)	0% (-1.5% - 1.4%)	0% (-1.2% - 1.1%)
Dallas, TX	0.8% (-0.5% - 2%)	0.8% (-0.5% - 2%)	0.8% (-0.5% - 2%)	0.7% (-0.5% - 1.9%)	0.8% (-0.5% - 2%)	0.7% (-0.5% - 1.9%)
Detroit, MI	1.2% (-0.2% - 2.5%)	1% (-0.1% - 2.1%)	0.9% (-0.1% - 1.9%)	0.8% (-0.1% - 1.7%)	0.8% (-0.1% - 1.8%)	0.7% (-0.1% - 1.5%)
Fresno, CA	1.3% (-0.9% - 3.4%)	0.7% (-0.5% - 1.9%)	0.7% (-0.5% - 1.9%)	0.7% (-0.5% - 1.9%)	0.6% (-0.4% - 1.6%)	0.5% (-0.4% - 1.4%)
Houston, TX	1.1% (-0.8% - 2.9%)	1.1% (-0.7% - 2.8%)	0.9% (-0.6% - 2.4%)	0.8% (-0.6% - 2.2%)	0.9% (-0.6% - 2.4%)	0.8% (-0.6% - 2.2%)
Los Angeles, CA	-0.3% (-1.1% - 0.6%)	-0.2% (-0.7% - 0.4%)	-0.2% (-0.7% - 0.4%)	-0.2% (-0.7% - 0.4%)	-0.1% (-0.6% - 0.3%)	-0.1% (-0.5% - 0.3%)
New York, NY	2.2% (1.3% - 3.2%)	1.9% (1.1% - 2.6%)	1.8% (1.1% - 2.6%)	1.7% (1% - 2.4%)	1.6% (0.9% - 2.3%)	1.3% (0.8% - 1.9%)
Philadelphia, PA	2.3% (0.6% - 3.9%)	2.1% (0.5% - 3.6%)	2% (0.5% - 3.4%)	1.8% (0.5% - 3.1%)	1.8% (0.5% - 3.1%)	1.5% (0.4% - 2.6%)
Phoenix, AZ	1.5% (-0.1% - 2.9%)	1.5% (-0.1% - 2.9%)	1.5% (-0.1% - 2.9%)	1.4% (-0.1% - 2.8%)	1.4% (-0.1% - 2.8%)	1.1% (0% - 2.3%)
Pittsburgh, PA	1.6% (-0.3% - 3.4%)	0.9% (-0.2% - 2%)	0.9% (-0.2% - 2%)	0.9% (-0.2% - 2%)	0.8% (-0.2% - 1.7%)	0.6% (-0.1% - 1.4%)
Salt Lake City, UT	1.1% (-0.3% - 2.5%)	0.7% (-0.2% - 1.6%)	0.7% (-0.2% - 1.6%)	0.7% (-0.2% - 1.6%)	0.6% (-0.1% - 1.3%)	0.5% (-0.1% - 1.1%)
St. Louis, MO	2% (0.4% - 3.5%)	1.8% (0.4% - 3.1%)	1.5% (0.3% - 2.7%)	1.4% (0.3% - 2.5%)	1.5% (0.3% - 2.7%)	1.3% (0.3% - 2.2%)
Tacoma, WA	0.9% (-0.5% - 2.1%)	0.7% (-0.4% - 1.7%)	0.7% (-0.4% - 1.7%)	0.7% (-0.4% - 1.7%)	0.6% (-0.3% - 1.5%)	0.5% (-0.3% - 1.2%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-87. Estimated Percent of Total Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.9% (-0.9% - 2.7%)	0.8% (-0.8% - 2.4%)	0.7% (-0.7% - 2.1%)	0.6% (-0.6% - 1.9%)	0.7% (-0.7% - 2.1%)	0.6% (-0.6% - 1.9%)
Baltimore, MD	1.7% (-0.1% - 3.4%)	1.6% (-0.1% - 3.2%)	1.4% (-0.1% - 2.8%)	1.3% (-0.1% - 2.6%)	1.3% (-0.1% - 2.8%)	1.1% (-0.1% - 2.3%)
Birmingham, AL	0% (-2.2% - 2%)	0% (-1.7% - 1.6%)	0% (-1.4% - 1.4%)	0% (-1.3% - 1.2%)	0% (-1.4% - 1.4%)	0% (-1.2% - 1.1%)
Dallas, TX	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2%)	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2%)
Detroit, MI	1.2% (-0.1% - 2.4%)	0.9% (-0.1% - 2%)	0.9% (-0.1% - 1.8%)	0.8% (-0.1% - 1.7%)	0.8% (-0.1% - 1.7%)	0.7% (-0.1% - 1.4%)
Fresno, CA	1.4% (-1% - 3.7%)	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2.1%)	0.8% (-0.5% - 2.1%)	0.7% (-0.5% - 1.8%)	0.5% (-0.4% - 1.5%)
Houston, TX	1.1% (-0.7% - 2.9%)	1% (-0.7% - 2.7%)	0.9% (-0.6% - 2.3%)	0.8% (-0.5% - 2.1%)	0.9% (-0.6% - 2.3%)	0.8% (-0.5% - 2.1%)
Los Angeles, CA	-0.3% (-1.1% - 0.6%)	-0.2% (-0.7% - 0.4%)	-0.2% (-0.7% - 0.4%)	-0.2% (-0.7% - 0.4%)	-0.1% (-0.6% - 0.3%)	-0.1% (-0.5% - 0.3%)
New York, NY	2.3% (1.3% - 3.2%)	1.9% (1.1% - 2.7%)	1.8% (1.1% - 2.6%)	1.7% (1% - 2.4%)	1.6% (0.9% - 2.3%)	1.3% (0.8% - 1.9%)
Philadelphia, PA	2.3% (0.6% - 3.9%)	2.1% (0.5% - 3.6%)	1.9% (0.5% - 3.4%)	1.8% (0.5% - 3.1%)	1.8% (0.5% - 3.1%)	1.5% (0.4% - 2.6%)
Phoenix, AZ	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.6%)	1.3% (-0.1% - 2.5%)	1% (0% - 2.1%)
Pittsburgh, PA	1.6% (-0.3% - 3.4%)	0.9% (-0.2% - 2%)	0.9% (-0.2% - 2%)	0.9% (-0.2% - 2%)	0.8% (-0.2% - 1.7%)	0.6% (-0.1% - 1.4%)
Salt Lake City, UT	1.3% (-0.3% - 2.9%)	0.8% (-0.2% - 1.8%)	0.8% (-0.2% - 1.8%)	0.8% (-0.2% - 1.8%)	0.7% (-0.2% - 1.6%)	0.6% (-0.1% - 1.3%)
St. Louis, MO	2% (0.5% - 3.6%)	1.8% (0.4% - 3.2%)	1.6% (0.4% - 2.8%)	1.5% (0.3% - 2.6%)	1.6% (0.3% - 2.8%)	1.3% (0.3% - 2.3%)
Tacoma, WA	0.9% (-0.5% - 2.3%)	0.7% (-0.4% - 1.8%)	0.7% (-0.4% - 1.8%)	0.7% (-0.4% - 1.8%)	0.6% (-0.3% - 1.6%)	0.5% (-0.3% - 1.3%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-88. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-79% - -83%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-59% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 14%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-57% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-89. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -83%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-59% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 14%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-90. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-79% - -83%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-59% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 14%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-57% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

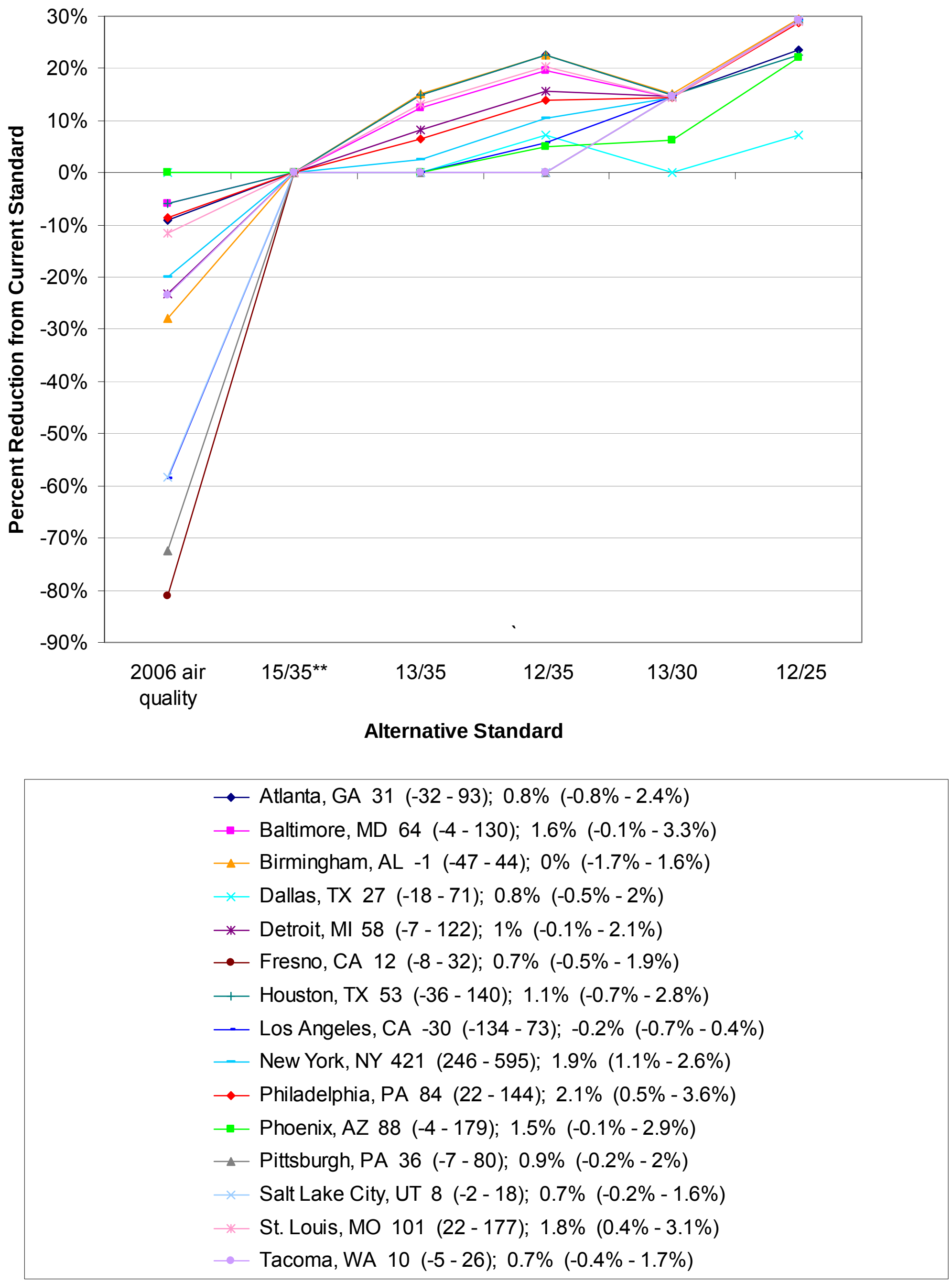
[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-28. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2005 Air Quality Data*

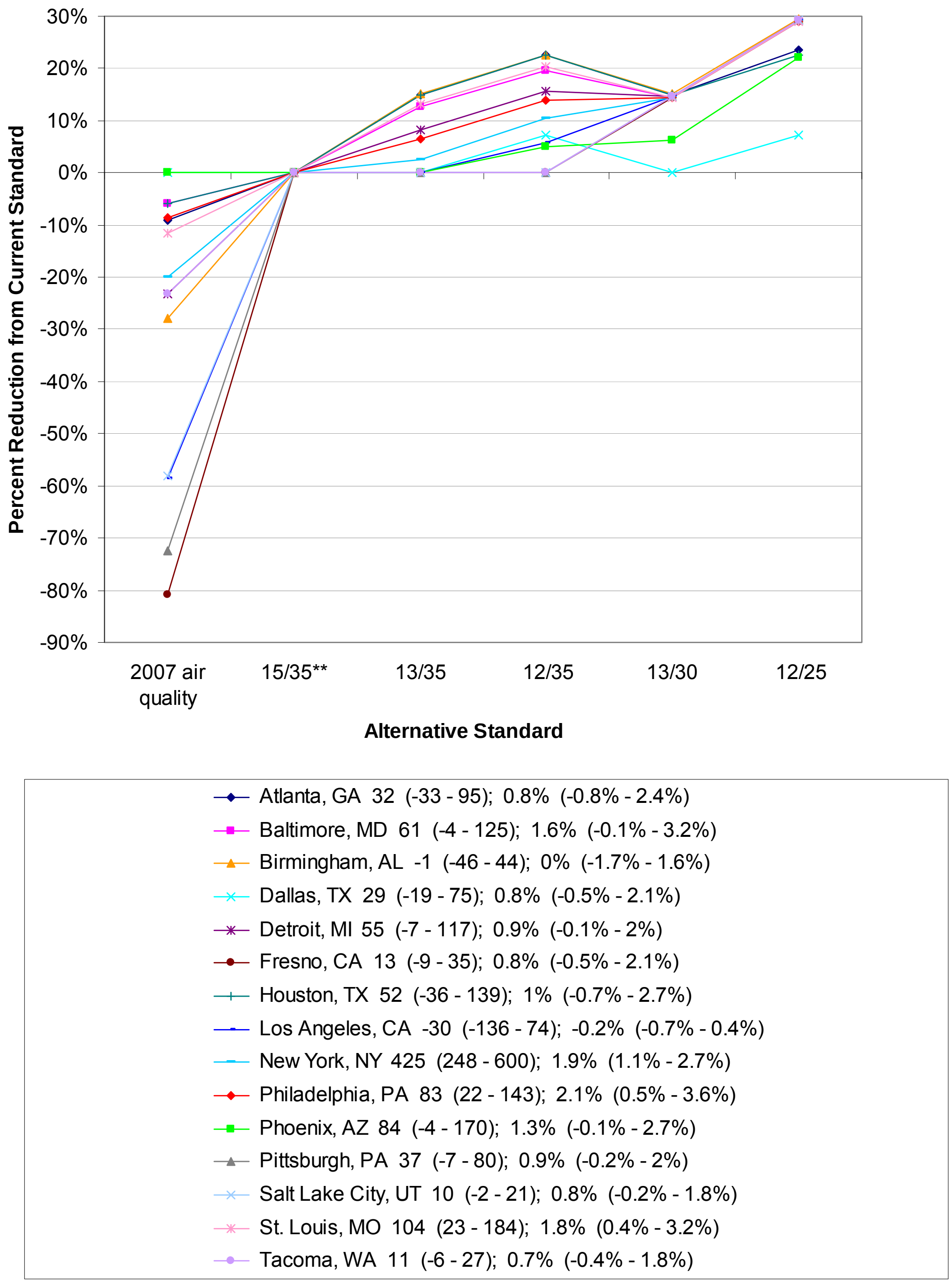
*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-29. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2006 Air Quality Data*



*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-30. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data*



*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 μg/m^3 and a daily standard of 35 μg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-91. Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	21 (-9 - 50)	19 (-8 - 46)	17 (-7 - 39)	15 (-6 - 36)	17 (-7 - 39)	15 (-6 - 35)
Baltimore, MD	38 (7 - 67)	35 (7 - 63)	31 (6 - 56)	29 (5 - 51)	30 (6 - 54)	25 (5 - 45)
Birmingham, AL	13 (-11 - 36)	10 (-8 - 29)	9 (-7 - 24)	8 (-6 - 22)	9 (-7 - 24)	7 (-6 - 20)
Dallas, TX	11 (-10 - 31)	11 (-10 - 31)	11 (-10 - 31)	10 (-9 - 29)	11 (-10 - 31)	10 (-9 - 29)
Detroit, MI	34 (2 - 64)	27 (1 - 52)	25 (1 - 48)	23 (1 - 44)	23 (1 - 45)	19 (1 - 37)
Fresno, CA	16 (1 - 30)	9 (0 - 17)	9 (0 - 17)	9 (0 - 17)	7 (0 - 14)	6 (0 - 12)
Houston, TX	38 (6 - 70)	36 (6 - 66)	31 (5 - 56)	28 (5 - 51)	31 (5 - 56)	28 (5 - 51)
Los Angeles, CA	94 (9 - 177)	59 (6 - 112)	59 (6 - 112)	56 (5 - 106)	51 (5 - 96)	42 (4 - 80)
New York, NY	117 (41 - 190)	97 (34 - 159)	95 (33 - 155)	87 (31 - 142)	83 (29 - 136)	69 (24 - 113)
Philadelphia, PA	24 (-2 - 50)	23 (-2 - 46)	21 (-2 - 44)	19 (-2 - 40)	19 (-2 - 40)	16 (-1 - 33)
Phoenix, AZ	47 (4 - 89)	47 (4 - 89)	47 (4 - 89)	45 (4 - 85)	44 (3 - 84)	37 (3 - 70)
Pittsburgh, PA	29 (-3 - 60)	17 (-2 - 35)	17 (-2 - 35)	17 (-2 - 35)	15 (-1 - 30)	12 (-1 - 25)
Salt Lake City, UT	9 (1 - 17)	6 (1 - 11)	6 (1 - 11)	6 (1 - 11)	5 (1 - 9)	4 (1 - 8)
St. Louis, MO	34 (-9 - 75)	30 (-8 - 67)	26 (-7 - 59)	24 (-6 - 54)	26 (-7 - 58)	21 (-6 - 48)
Tacoma, WA	9 (0 - 18)	7 (0 - 15)	7 (0 - 15)	7 (0 - 15)	6 (0 - 13)	5 (0 - 10)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-92. Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	21 (-8 - 49)	19 (-8 - 45)	16 (-7 - 39)	15 (-6 - 35)	16 (-7 - 39)	15 (-6 - 35)
Baltimore, MD	34 (6 - 61)	32 (6 - 58)	28 (5 - 51)	26 (5 - 47)	28 (5 - 50)	23 (4 - 42)
Birmingham, AL	13 (-11 - 36)	10 (-8 - 28)	9 (-7 - 24)	8 (-6 - 22)	9 (-7 - 24)	7 (-6 - 20)
Dallas, TX	9 (-9 - 27)	9 (-9 - 27)	9 (-9 - 27)	9 (-8 - 25)	9 (-9 - 27)	9 (-8 - 25)
Detroit, MI	28 (1 - 54)	23 (1 - 44)	21 (1 - 40)	19 (1 - 37)	19 (1 - 38)	16 (1 - 31)
Fresno, CA	16 (1 - 32)	9 (0 - 18)	9 (0 - 18)	9 (0 - 18)	8 (0 - 15)	6 (0 - 13)
Houston, TX	40 (6 - 73)	38 (6 - 69)	32 (5 - 59)	30 (5 - 54)	32 (5 - 59)	30 (5 - 54)
Los Angeles, CA	87 (8 - 164)	55 (5 - 104)	55 (5 - 104)	52 (5 - 98)	47 (5 - 89)	39 (4 - 74)
New York, NY	107 (38 - 174)	89 (31 - 145)	87 (31 - 142)	80 (28 - 130)	76 (27 - 125)	63 (22 - 104)
Philadelphia, PA	24 (-2 - 50)	22 (-2 - 46)	21 (-2 - 43)	19 (-2 - 39)	19 (-2 - 39)	16 (-1 - 33)
Phoenix, AZ	50 (4 - 95)	50 (4 - 95)	50 (4 - 95)	47 (4 - 90)	47 (4 - 89)	39 (3 - 74)
Pittsburgh, PA	27 (-3 - 55)	15 (-2 - 32)	15 (-2 - 32)	15 (-2 - 32)	13 (-1 - 27)	11 (-1 - 23)
Salt Lake City, UT	8 (1 - 15)	5 (1 - 10)	5 (1 - 10)	5 (1 - 10)	4 (1 - 8)	4 (0 - 7)
St. Louis, MO	29 (-8 - 64)	26 (-7 - 57)	22 (-6 - 50)	20 (-5 - 46)	22 (-6 - 49)	18 (-5 - 41)
Tacoma, WA	7 (0 - 15)	6 (0 - 12)	6 (0 - 12)	6 (0 - 12)	5 (0 - 10)	4 (0 - 9)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-93. Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	21 (-9 - 51)	20 (-8 - 47)	17 (-7 - 40)	15 (-6 - 36)	17 (-7 - 40)	15 (-6 - 36)
Baltimore, MD	33 (6 - 59)	31 (6 - 56)	27 (5 - 49)	25 (5 - 45)	27 (5 - 48)	22 (4 - 40)
Birmingham, AL	13 (-10 - 35)	10 (-8 - 28)	9 (-7 - 24)	8 (-6 - 22)	9 (-7 - 24)	7 (-6 - 20)
Dallas, TX	10 (-9 - 29)	10 (-9 - 29)	10 (-9 - 29)	9 (-8 - 27)	10 (-9 - 29)	9 (-8 - 27)
Detroit, MI	27 (1 - 51)	22 (1 - 42)	20 (1 - 38)	18 (1 - 35)	19 (1 - 36)	15 (1 - 30)
Fresno, CA	18 (1 - 34)	10 (0 - 19)	10 (0 - 19)	10 (0 - 19)	8 (0 - 16)	7 (0 - 14)
Houston, TX	40 (6 - 72)	38 (6 - 68)	32 (5 - 58)	29 (5 - 53)	32 (5 - 58)	29 (5 - 53)
Los Angeles, CA	88 (9 - 165)	56 (5 - 105)	56 (5 - 105)	52 (5 - 99)	47 (5 - 90)	39 (4 - 75)
New York, NY	108 (38 - 176)	90 (32 - 147)	87 (31 - 143)	80 (28 - 132)	77 (27 - 126)	64 (22 - 105)
Philadelphia, PA	24 (-2 - 49)	22 (-2 - 45)	21 (-2 - 42)	19 (-2 - 39)	19 (-2 - 39)	16 (-1 - 32)
Phoenix, AZ	47 (4 - 90)	47 (4 - 90)	47 (4 - 90)	45 (4 - 85)	44 (4 - 84)	37 (3 - 70)
Pittsburgh, PA	27 (-3 - 55)	16 (-2 - 32)	16 (-2 - 32)	16 (-2 - 32)	13 (-1 - 28)	11 (-1 - 23)
Salt Lake City, UT	10 (1 - 18)	6 (1 - 12)	6 (1 - 12)	6 (1 - 12)	5 (1 - 10)	4 (1 - 8)
St. Louis, MO	30 (-8 - 66)	27 (-7 - 59)	23 (-6 - 52)	21 (-6 - 48)	23 (-6 - 51)	19 (-5 - 42)
Tacoma, WA	8 (0 - 16)	6 (0 - 13)	6 (0 - 13)	6 (0 - 13)	5 (0 - 11)	5 (0 - 9)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-94. Estimated Percent of Total Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.7% (-0.7% - 4%)	1.6% (-0.6% - 3.7%)	1.3% (-0.5% - 3.2%)	1.2% (-0.5% - 2.9%)	1.3% (-0.5% - 3.2%)	1.2% (-0.5% - 2.8%)
Baltimore, MD	3.1% (0.6% - 5.5%)	2.9% (0.5% - 5.3%)	2.6% (0.5% - 4.6%)	2.4% (0.4% - 4.2%)	2.5% (0.5% - 4.5%)	2.1% (0.4% - 3.8%)
Birmingham, AL	1.5% (-1.2% - 4.2%)	1.2% (-1% - 3.3%)	1% (-0.8% - 2.8%)	0.9% (-0.7% - 2.6%)	1% (-0.8% - 2.8%)	0.8% (-0.7% - 2.3%)
Dallas, TX	1% (-0.9% - 2.9%)	1% (-0.9% - 2.9%)	1% (-0.9% - 2.9%)	0.9% (-0.8% - 2.7%)	1% (-0.9% - 2.9%)	0.9% (-0.8% - 2.7%)
Detroit, MI	2.5% (0.1% - 4.8%)	2% (0.1% - 3.9%)	1.9% (0.1% - 3.6%)	1.7% (0.1% - 3.3%)	1.7% (0.1% - 3.3%)	1.4% (0.1% - 2.8%)
Fresno, CA	2.7% (0.1% - 5.1%)	1.5% (0% - 2.9%)	1.5% (0% - 2.9%)	1.5% (0% - 2.9%)	1.3% (0% - 2.5%)	1% (0% - 2%)
Houston, TX	2.7% (0.4% - 5%)	2.6% (0.4% - 4.7%)	2.2% (0.4% - 4%)	2% (0.3% - 3.7%)	2.2% (0.4% - 4%)	2% (0.3% - 3.7%)
Los Angeles, CA	1.7% (0.2% - 3.2%)	1.1% (0.1% - 2%)	1.1% (0.1% - 2%)	1% (0.1% - 1.9%)	0.9% (0.1% - 1.7%)	0.8% (0.1% - 1.4%)
New York, NY	2.7% (1% - 4.4%)	2.3% (0.8% - 3.7%)	2.2% (0.8% - 3.6%)	2% (0.7% - 3.3%)	1.9% (0.7% - 3.2%)	1.6% (0.6% - 2.6%)
Philadelphia, PA	2% (-0.2% - 4.2%)	1.9% (-0.2% - 3.8%)	1.7% (-0.2% - 3.6%)	1.6% (-0.1% - 3.3%)	1.6% (-0.1% - 3.3%)	1.3% (-0.1% - 2.7%)
Phoenix, AZ	1.9% (0.2% - 3.7%)	1.9% (0.2% - 3.7%)	1.9% (0.2% - 3.7%)	1.8% (0.1% - 3.5%)	1.8% (0.1% - 3.4%)	1.5% (0.1% - 2.9%)
Pittsburgh, PA	2.5% (-0.2% - 5.1%)	1.4% (-0.1% - 3%)	1.4% (-0.1% - 3%)	1.4% (-0.1% - 3%)	1.2% (-0.1% - 2.6%)	1% (-0.1% - 2.1%)
Salt Lake City, UT	2.1% (0.3% - 3.8%)	1.3% (0.2% - 2.4%)	1.3% (0.2% - 2.4%)	1.3% (0.2% - 2.4%)	1.1% (0.1% - 2.1%)	0.9% (0.1% - 1.7%)
St. Louis, MO	1.9% (-0.5% - 4.3%)	1.7% (-0.5% - 3.9%)	1.5% (-0.4% - 3.4%)	1.4% (-0.4% - 3.1%)	1.5% (-0.4% - 3.3%)	1.2% (-0.3% - 2.8%)
Tacoma, WA	1.8% (0% - 3.6%)	1.5% (0% - 3%)	1.5% (0% - 3%)	1.5% (0% - 3%)	1.3% (0% - 2.5%)	1.1% (0% - 2.1%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-95. Estimated Percent of Total Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.6% (-0.7% - 3.9%)	1.5% (-0.6% - 3.5%)	1.3% (-0.5% - 3%)	1.2% (-0.5% - 2.8%)	1.3% (-0.5% - 3%)	1.1% (-0.5% - 2.7%)
Baltimore, MD	2.8% (0.5% - 5.1%)	2.7% (0.5% - 4.8%)	2.3% (0.4% - 4.2%)	2.2% (0.4% - 3.9%)	2.3% (0.4% - 4.1%)	1.9% (0.4% - 3.4%)
Birmingham, AL	1.5% (-1.2% - 4%)	1.2% (-0.9% - 3.2%)	1% (-0.8% - 2.7%)	0.9% (-0.7% - 2.5%)	1% (-0.8% - 2.7%)	0.8% (-0.7% - 2.3%)
Dallas, TX	0.8% (-0.8% - 2.4%)	0.8% (-0.8% - 2.4%)	0.8% (-0.8% - 2.4%)	0.8% (-0.7% - 2.2%)	0.8% (-0.8% - 2.4%)	0.8% (-0.7% - 2.2%)
Detroit, MI	2.1% (0.1% - 4%)	1.7% (0.1% - 3.3%)	1.6% (0.1% - 3%)	1.4% (0.1% - 2.8%)	1.5% (0.1% - 2.8%)	1.2% (0.1% - 2.3%)
Fresno, CA	2.8% (0.1% - 5.3%)	1.5% (0% - 3%)	1.5% (0% - 3%)	1.5% (0% - 3%)	1.3% (0% - 2.5%)	1.1% (0% - 2.1%)
Houston, TX	2.8% (0.4% - 5.1%)	2.6% (0.4% - 4.8%)	2.2% (0.4% - 4.1%)	2% (0.3% - 3.7%)	2.2% (0.4% - 4.1%)	2% (0.3% - 3.7%)
Los Angeles, CA	1.6% (0.2% - 2.9%)	1% (0.1% - 1.9%)	1% (0.1% - 1.9%)	0.9% (0.1% - 1.8%)	0.8% (0.1% - 1.6%)	0.7% (0.1% - 1.3%)
New York, NY	2.5% (0.9% - 4%)	2.1% (0.7% - 3.4%)	2% (0.7% - 3.3%)	1.8% (0.6% - 3%)	1.8% (0.6% - 2.9%)	1.5% (0.5% - 2.4%)
Philadelphia, PA	2% (-0.2% - 4.1%)	1.8% (-0.2% - 3.8%)	1.7% (-0.2% - 3.5%)	1.6% (-0.1% - 3.3%)	1.6% (-0.1% - 3.2%)	1.3% (-0.1% - 2.7%)
Phoenix, AZ	2% (0.2% - 3.8%)	2% (0.2% - 3.8%)	2% (0.2% - 3.8%)	1.9% (0.1% - 3.6%)	1.9% (0.1% - 3.5%)	1.5% (0.1% - 2.9%)
Pittsburgh, PA	2.2% (-0.2% - 4.6%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.1% (-0.1% - 2.3%)	0.9% (-0.1% - 1.9%)
Salt Lake City, UT	1.8% (0.2% - 3.4%)	1.2% (0.1% - 2.2%)	1.2% (0.1% - 2.2%)	1.2% (0.1% - 2.2%)	1% (0.1% - 1.9%)	0.8% (0.1% - 1.5%)
St. Louis, MO	1.6% (-0.4% - 3.7%)	1.5% (-0.4% - 3.3%)	1.3% (-0.3% - 2.9%)	1.2% (-0.3% - 2.6%)	1.3% (-0.3% - 2.8%)	1% (-0.3% - 2.3%)
Tacoma, WA	1.5% (0% - 2.9%)	1.2% (0% - 2.4%)	1.2% (0% - 2.4%)	1.2% (0% - 2.4%)	1% (0% - 2%)	0.8% (0% - 1.7%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-96. Estimated Percent of Total Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	1.6% (-0.7% - 3.9%)	1.5% (-0.6% - 3.6%)	1.3% (-0.5% - 3%)	1.2% (-0.5% - 2.8%)	1.3% (-0.5% - 3%)	1.1% (-0.5% - 2.7%)
Baltimore, MD	2.7% (0.5% - 4.9%)	2.6% (0.5% - 4.6%)	2.3% (0.4% - 4%)	2.1% (0.4% - 3.7%)	2.2% (0.4% - 4%)	1.8% (0.3% - 3.3%)
Birmingham, AL	1.5% (-1.2% - 4%)	1.1% (-0.9% - 3.1%)	1% (-0.8% - 2.7%)	0.9% (-0.7% - 2.4%)	1% (-0.8% - 2.7%)	0.8% (-0.6% - 2.2%)
Dallas, TX	0.9% (-0.8% - 2.5%)	0.9% (-0.8% - 2.5%)	0.9% (-0.8% - 2.5%)	0.8% (-0.7% - 2.4%)	0.9% (-0.8% - 2.5%)	0.8% (-0.7% - 2.4%)
Detroit, MI	2% (0.1% - 3.9%)	1.6% (0.1% - 3.2%)	1.5% (0.1% - 2.9%)	1.4% (0.1% - 2.7%)	1.4% (0.1% - 2.7%)	1.2% (0.1% - 2.3%)
Fresno, CA	2.9% (0.1% - 5.6%)	1.6% (0.1% - 3.2%)	1.6% (0.1% - 3.2%)	1.6% (0.1% - 3.2%)	1.4% (0% - 2.7%)	1.2% (0% - 2.3%)
Houston, TX	2.7% (0.4% - 4.9%)	2.6% (0.4% - 4.7%)	2.2% (0.3% - 4%)	2% (0.3% - 3.6%)	2.2% (0.3% - 4%)	2% (0.3% - 3.6%)
Los Angeles, CA	1.6% (0.2% - 3%)	1% (0.1% - 1.9%)	1% (0.1% - 1.9%)	0.9% (0.1% - 1.8%)	0.8% (0.1% - 1.6%)	0.7% (0.1% - 1.3%)
New York, NY	2.5% (0.9% - 4.1%)	2.1% (0.7% - 3.4%)	2% (0.7% - 3.3%)	1.9% (0.7% - 3%)	1.8% (0.6% - 2.9%)	1.5% (0.5% - 2.4%)
Philadelphia, PA	2% (-0.2% - 4.1%)	1.8% (-0.2% - 3.8%)	1.7% (-0.2% - 3.5%)	1.6% (-0.1% - 3.2%)	1.6% (-0.1% - 3.2%)	1.3% (-0.1% - 2.7%)
Phoenix, AZ	1.8% (0.1% - 3.5%)	1.8% (0.1% - 3.5%)	1.8% (0.1% - 3.5%)	1.7% (0.1% - 3.3%)	1.7% (0.1% - 3.2%)	1.4% (0.1% - 2.7%)
Pittsburgh, PA	2.3% (-0.2% - 4.7%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.3% (-0.1% - 2.7%)	1.1% (-0.1% - 2.4%)	0.9% (-0.1% - 2%)
Salt Lake City, UT	2.2% (0.3% - 4%)	1.4% (0.2% - 2.5%)	1.4% (0.2% - 2.5%)	1.4% (0.2% - 2.5%)	1.2% (0.1% - 2.2%)	1% (0.1% - 1.8%)
St. Louis, MO	1.7% (-0.4% - 3.8%)	1.5% (-0.4% - 3.4%)	1.3% (-0.3% - 3%)	1.2% (-0.3% - 2.7%)	1.3% (-0.3% - 2.9%)	1.1% (-0.3% - 2.4%)
Tacoma, WA	1.6% (0% - 3.1%)	1.3% (0% - 2.5%)	1.3% (0% - 2.5%)	1.3% (0% - 2.5%)	1.1% (0% - 2.2%)	0.9% (0% - 1.8%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to the nearest hundredth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-97. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	12% (12% - 13%)	19% (19% - 20%)	14% (14% - 15%)	29% (28% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	29% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (15% - 16%)	14% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-80% (-78% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	14% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-57% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (14% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-57% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-98. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	12% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (28% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	29% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	14% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-80% (-79% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	14% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-57% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (14% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-8% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-57% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

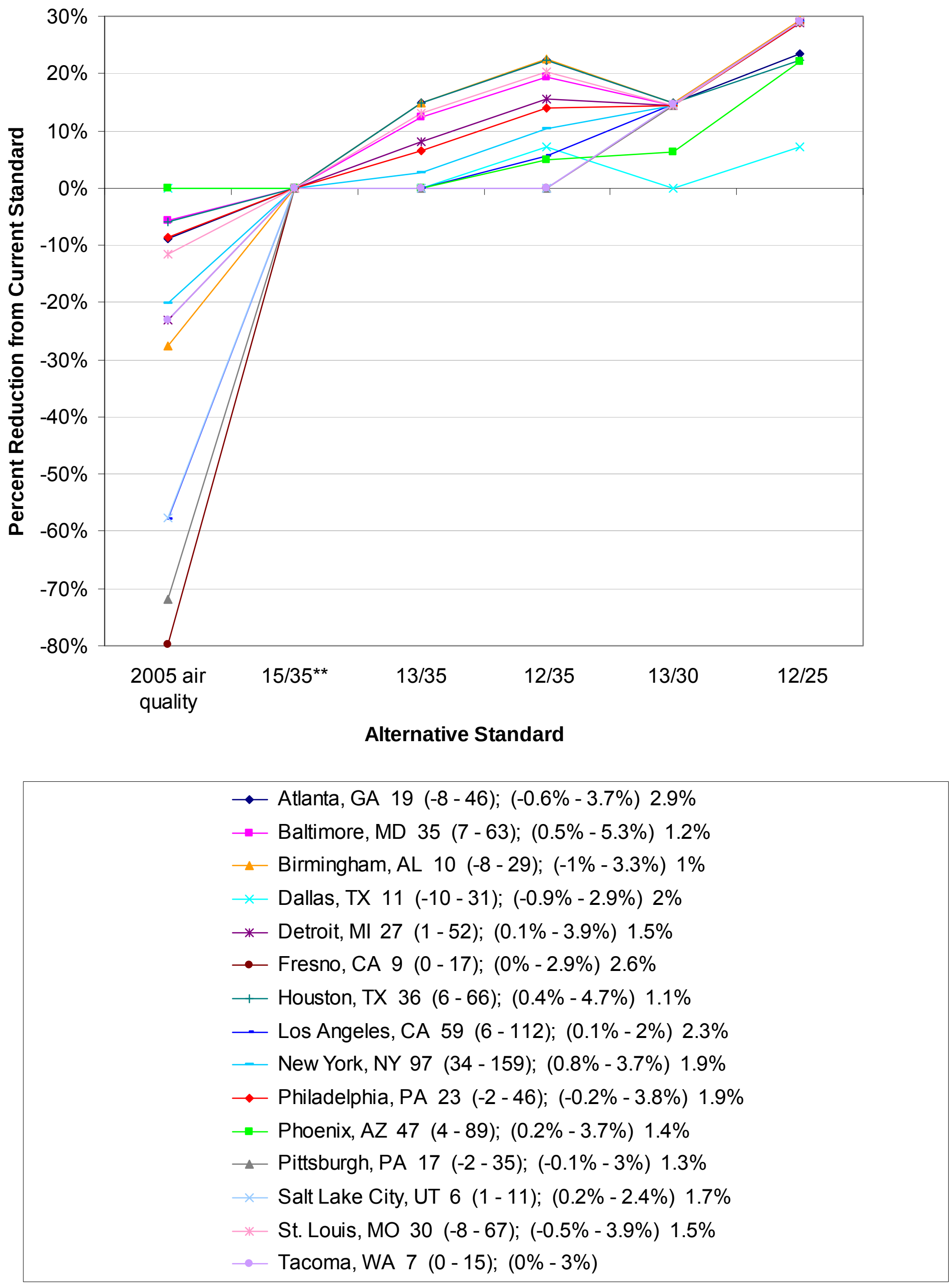
Table E-99. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	24% (23% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	12% (12% - 13%)	20% (19% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-27% - -28%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	29% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-79% (-77% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	14% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	22% (22% - 23%)	15% (15% - 15%)	22% (22% - 23%)
Los Angeles, CA	-58% (-57% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (14% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 11%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-71% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-56% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-11% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Percents are rounded to whole number.

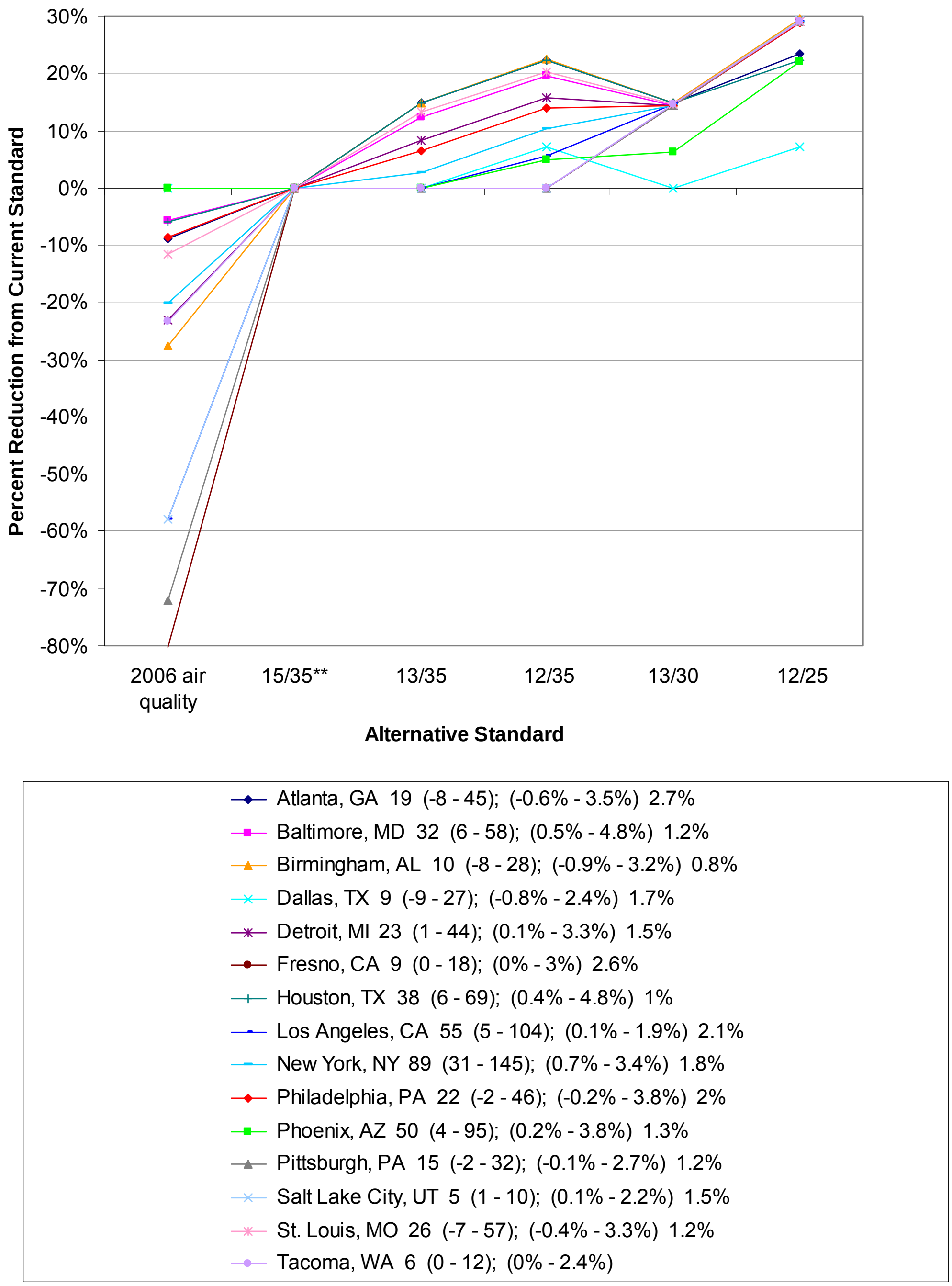
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-31. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2005 Air Quality Data*



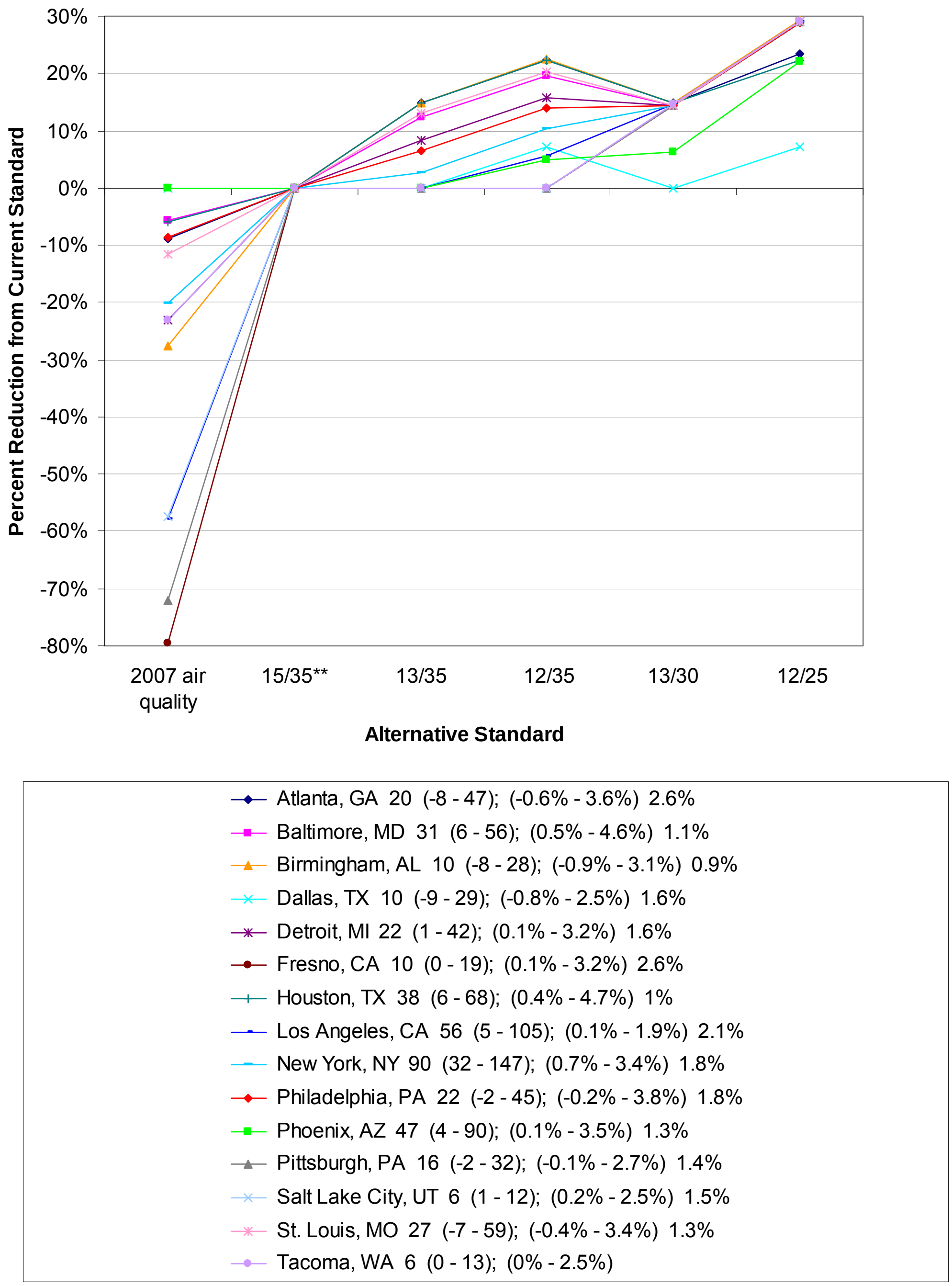
*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-32. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2006 Air Quality Data*



*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-33. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data*



*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-100. Estimated Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	43 (-28 - 114)	40 (-26 - 105)	34 (-22 - 89)	31 (-20 - 81)	34 (-22 - 89)	30 (-20 - 80)
Baltimore, MD	262 (192 - 331)	247 (182 - 313)	216 (159 - 273)	199 (146 - 251)	212 (155 - 267)	176 (129 - 222)
Birmingham, AL	23 (-15 - 62)	18 (-12 - 48)	16 (-10 - 41)	14 (-9 - 37)	16 (-10 - 41)	13 (-8 - 34)
Dallas, TX	30 (-19 - 78)	30 (-19 - 78)	30 (-19 - 78)	27 (-18 - 73)	30 (-19 - 78)	27 (-18 - 73)
Detroit, MI	331 (243 - 418)	269 (198 - 340)	247 (181 - 312)	227 (166 - 286)	230 (169 - 290)	191 (140 - 241)
Fresno, CA	38 (0 - 76)	21 (0 - 42)	21 (0 - 42)	21 (0 - 42)	18 (0 - 36)	15 (0 - 30)
Houston, TX	65 (-42 - 171)	61 (-40 - 161)	52 (-34 - 137)	47 (-31 - 125)	52 (-34 - 137)	47 (-31 - 125)
Los Angeles, CA	434 (5 - 858)	274 (3 - 543)	274 (3 - 543)	259 (3 - 513)	234 (3 - 464)	194 (2 - 385)
New York, NY	870 (639 - 1100)	724 (532 - 915)	705 (518 - 891)	648 (476 - 819)	619 (454 - 783)	514 (377 - 650)
Philadelphia, PA	228 (167 - 288)	210 (154 - 265)	196 (144 - 248)	180 (132 - 228)	179 (132 - 227)	149 (109 - 188)
Phoenix, AZ	107 (1 - 212)	107 (1 - 212)	107 (1 - 212)	102 (1 - 201)	100 (1 - 198)	83 (1 - 165)
Pittsburgh, PA	231 (170 - 291)	134 (98 - 169)	134 (98 - 169)	134 (98 - 169)	114 (84 - 145)	95 (70 - 120)
Salt Lake City, UT	14 (0 - 28)	9 (0 - 17)	9 (0 - 17)	9 (0 - 17)	7 (0 - 15)	6 (0 - 12)
St. Louis, MO	223 (164 - 282)	200 (147 - 253)	174 (128 - 220)	159 (117 - 202)	171 (126 - 216)	142 (104 - 179)
Tacoma, WA	26 (-65 - 113)	21 (-52 - 92)	21 (-52 - 92)	21 (-52 - 92)	18 (-44 - 79)	15 (-37 - 66)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-101. Estimated Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	43 (-28 - 113)	39 (-26 - 103)	33 (-22 - 88)	30 (-20 - 80)	33 (-22 - 88)	30 (-20 - 79)
Baltimore, MD	237 (174 - 300)	224 (165 - 284)	196 (144 - 248)	180 (132 - 228)	192 (141 - 243)	159 (117 - 201)
Birmingham, AL	23 (-15 - 60)	18 (-12 - 47)	15 (-10 - 40)	14 (-9 - 36)	15 (-10 - 40)	12 (-8 - 33)
Dallas, TX	25 (-17 - 67)	25 (-17 - 67)	25 (-17 - 67)	24 (-15 - 63)	25 (-17 - 67)	24 (-15 - 63)
Detroit, MI	276 (203 - 349)	224 (165 - 284)	206 (151 - 260)	189 (139 - 239)	192 (141 - 242)	159 (117 - 201)
Fresno, CA	40 (0 - 79)	22 (0 - 44)	22 (0 - 44)	22 (0 - 44)	19 (0 - 38)	16 (0 - 31)
Houston, TX	68 (-45 - 180)	64 (-42 - 170)	54 (-36 - 144)	50 (-33 - 131)	54 (-36 - 144)	50 (-33 - 131)
Los Angeles, CA	408 (5 - 807)	258 (3 - 511)	258 (3 - 511)	243 (3 - 482)	220 (3 - 437)	183 (2 - 362)
New York, NY	801 (589 - 1013)	666 (489 - 843)	649 (477 - 821)	597 (438 - 755)	570 (418 - 721)	473 (347 - 598)
Philadelphia, PA	222 (163 - 281)	204 (150 - 258)	191 (140 - 242)	176 (129 - 222)	175 (128 - 221)	145 (106 - 183)
Phoenix, AZ	113 (1 - 225)	113 (1 - 225)	113 (1 - 225)	108 (1 - 213)	106 (1 - 210)	88 (1 - 175)
Pittsburgh, PA	207 (152 - 261)	120 (88 - 152)	120 (88 - 152)	120 (88 - 152)	102 (75 - 130)	85 (62 - 107)
Salt Lake City, UT	13 (0 - 25)	8 (0 - 16)	8 (0 - 16)	8 (0 - 16)	7 (0 - 14)	6 (0 - 11)
St. Louis, MO	190 (140 - 241)	171 (125 - 216)	148 (109 - 187)	136 (100 - 172)	146 (107 - 184)	121 (89 - 153)
Tacoma, WA	22 (-53 - 93)	18 (-43 - 76)	18 (-43 - 76)	18 (-43 - 76)	15 (-36 - 65)	12 (-30 - 54)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-102. Estimated Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent Ambient $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	44 (-29 - 117)	41 (-27 - 108)	35 (-23 - 92)	32 (-21 - 84)	35 (-23 - 92)	31 (-20 - 82)
Baltimore, MD	227 (167 - 287)	215 (158 - 271)	188 (138 - 237)	173 (127 - 218)	184 (135 - 232)	152 (112 - 193)
Birmingham, AL	22 (-15 - 59)	17 (-11 - 46)	15 (-10 - 39)	14 (-9 - 36)	15 (-10 - 39)	12 (-8 - 32)
Dallas, TX	27 (-18 - 72)	27 (-18 - 72)	27 (-18 - 72)	25 (-17 - 67)	27 (-18 - 72)	25 (-17 - 67)
Detroit, MI	265 (195 - 335)	215 (158 - 272)	197 (145 - 249)	181 (133 - 229)	184 (135 - 232)	152 (112 - 193)
Fresno, CA	44 (1 - 87)	24 (0 - 48)	24 (0 - 48)	24 (0 - 48)	21 (0 - 41)	17 (0 - 34)
Houston, TX	68 (-45 - 180)	64 (-42 - 169)	54 (-36 - 144)	50 (-33 - 131)	54 (-36 - 144)	50 (-33 - 131)
Los Angeles, CA	420 (5 - 831)	265 (3 - 526)	265 (3 - 526)	250 (3 - 496)	227 (3 - 449)	188 (2 - 373)
New York, NY	813 (597 - 1028)	676 (496 - 855)	659 (484 - 833)	605 (444 - 765)	578 (424 - 731)	480 (352 - 607)
Philadelphia, PA	218 (160 - 276)	201 (148 - 254)	188 (138 - 238)	173 (127 - 218)	172 (126 - 217)	143 (105 - 180)
Phoenix, AZ	108 (1 - 215)	108 (1 - 215)	108 (1 - 215)	103 (1 - 204)	101 (1 - 201)	84 (1 - 167)
Pittsburgh, PA	207 (152 - 261)	120 (88 - 152)	120 (88 - 152)	120 (88 - 152)	102 (75 - 130)	85 (62 - 108)
Salt Lake City, UT	16 (0 - 31)	10 (0 - 20)	10 (0 - 20)	10 (0 - 20)	8 (0 - 17)	7 (0 - 14)
St. Louis, MO	196 (144 - 248)	176 (129 - 222)	152 (112 - 193)	140 (103 - 177)	150 (110 - 190)	124 (91 - 157)
Tacoma, WA	23 (-57 - 100)	19 (-46 - 82)	19 (-46 - 82)	19 (-46 - 82)	16 (-39 - 70)	13 (-33 - 58)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-103. Estimated Percent of Total Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.41% (-0.27% - 1.09%)	0.38% (-0.25% - 1%)	0.32% (-0.21% - 0.85%)	0.29% (-0.19% - 0.77%)	0.32% (-0.21% - 0.85%)	0.29% (-0.19% - 0.76%)
Baltimore, MD	1.59% (1.17% - 2.01%)	1.51% (1.11% - 1.9%)	1.32% (0.97% - 1.66%)	1.21% (0.89% - 1.53%)	1.29% (0.95% - 1.63%)	1.07% (0.79% - 1.35%)
Birmingham, AL	0.47% (-0.31% - 1.23%)	0.37% (-0.24% - 0.97%)	0.31% (-0.2% - 0.82%)	0.28% (-0.19% - 0.75%)	0.31% (-0.2% - 0.82%)	0.26% (-0.17% - 0.68%)
Dallas, TX	0.31% (-0.2% - 0.83%)	0.31% (-0.2% - 0.83%)	0.31% (-0.2% - 0.83%)	0.29% (-0.19% - 0.77%)	0.31% (-0.2% - 0.83%)	0.29% (-0.19% - 0.77%)
Detroit, MI	1.59% (1.17% - 2.01%)	1.29% (0.95% - 1.63%)	1.18% (0.87% - 1.5%)	1.09% (0.8% - 1.37%)	1.1% (0.81% - 1.39%)	0.91% (0.67% - 1.16%)
Fresno, CA	0.82% (0.01% - 1.61%)	0.45% (0.01% - 0.89%)	0.45% (0.01% - 0.89%)	0.45% (0.01% - 0.89%)	0.38% (0% - 0.76%)	0.32% (0% - 0.63%)
Houston, TX	0.38% (-0.25% - 1.01%)	0.36% (-0.24% - 0.95%)	0.31% (-0.2% - 0.81%)	0.28% (-0.18% - 0.74%)	0.31% (-0.2% - 0.81%)	0.28% (-0.18% - 0.74%)
Los Angeles, CA	0.8% (0.01% - 1.58%)	0.5% (0.01% - 1%)	0.5% (0.01% - 1%)	0.48% (0.01% - 0.94%)	0.43% (0.01% - 0.85%)	0.36% (0% - 0.71%)
New York, NY	1.36% (1% - 1.72%)	1.13% (0.83% - 1.43%)	1.1% (0.81% - 1.39%)	1.01% (0.74% - 1.28%)	0.97% (0.71% - 1.22%)	0.8% (0.59% - 1.02%)
Philadelphia, PA	1.38% (1.02% - 1.75%)	1.27% (0.94% - 1.61%)	1.19% (0.88% - 1.51%)	1.09% (0.8% - 1.38%)	1.09% (0.8% - 1.38%)	0.9% (0.66% - 1.14%)
Phoenix, AZ	0.53% (0.01% - 1.05%)	0.53% (0.01% - 1.05%)	0.53% (0.01% - 1.05%)	0.5% (0.01% - 0.99%)	0.49% (0.01% - 0.98%)	0.41% (0% - 0.81%)
Pittsburgh, PA	1.79% (1.32% - 2.26%)	1.04% (0.76% - 1.31%)	1.04% (0.76% - 1.31%)	1.04% (0.76% - 1.31%)	0.89% (0.65% - 1.12%)	0.74% (0.54% - 0.93%)
Salt Lake City, UT	0.57% (0.01% - 1.13%)	0.36% (0% - 0.72%)	0.36% (0% - 0.72%)	0.36% (0% - 0.72%)	0.31% (0% - 0.61%)	0.26% (0% - 0.51%)
St. Louis, MO	1.58% (1.16% - 2%)	1.42% (1.04% - 1.8%)	1.23% (0.91% - 1.56%)	1.13% (0.83% - 1.43%)	1.21% (0.89% - 1.53%)	1.01% (0.74% - 1.27%)
Tacoma, WA	0.76% (-1.86% - 3.26%)	0.62% (-1.5% - 2.65%)	0.62% (-1.5% - 2.65%)	0.62% (-1.5% - 2.65%)	0.53% (-1.28% - 2.27%)	0.44% (-1.06% - 1.89%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-104. Estimated Percent of Total Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.39% (-0.26% - 1.04%)	0.36% (-0.24% - 0.95%)	0.31% (-0.2% - 0.81%)	0.28% (-0.18% - 0.74%)	0.31% (-0.2% - 0.81%)	0.27% (-0.18% - 0.73%)
Baltimore, MD	1.45% (1.07% - 1.84%)	1.37% (1.01% - 1.74%)	1.2% (0.88% - 1.52%)	1.1% (0.81% - 1.4%)	1.17% (0.86% - 1.49%)	0.98% (0.72% - 1.23%)
Birmingham, AL	0.45% (-0.3% - 1.19%)	0.35% (-0.23% - 0.93%)	0.3% (-0.2% - 0.79%)	0.27% (-0.18% - 0.72%)	0.3% (-0.2% - 0.79%)	0.25% (-0.16% - 0.66%)
Dallas, TX	0.26% (-0.17% - 0.7%)	0.26% (-0.17% - 0.7%)	0.26% (-0.17% - 0.7%)	0.24% (-0.16% - 0.65%)	0.26% (-0.17% - 0.7%)	0.24% (-0.16% - 0.65%)
Detroit, MI	1.33% (0.98% - 1.69%)	1.08% (0.79% - 1.37%)	0.99% (0.73% - 1.26%)	0.91% (0.67% - 1.15%)	0.92% (0.68% - 1.17%)	0.77% (0.56% - 0.97%)
Fresno, CA	0.85% (0.01% - 1.67%)	0.47% (0.01% - 0.92%)	0.47% (0.01% - 0.92%)	0.47% (0.01% - 0.92%)	0.4% (0% - 0.79%)	0.33% (0% - 0.65%)
Houston, TX	0.39% (-0.25% - 1.03%)	0.37% (-0.24% - 0.97%)	0.31% (-0.2% - 0.82%)	0.28% (-0.19% - 0.75%)	0.31% (-0.2% - 0.82%)	0.28% (-0.19% - 0.75%)
Los Angeles, CA	0.74% (0.01% - 1.46%)	0.47% (0.01% - 0.93%)	0.47% (0.01% - 0.93%)	0.44% (0.01% - 0.87%)	0.4% (0% - 0.79%)	0.33% (0% - 0.66%)
New York, NY	1.24% (0.91% - 1.57%)	1.03% (0.76% - 1.3%)	1% (0.74% - 1.27%)	0.92% (0.68% - 1.17%)	0.88% (0.65% - 1.12%)	0.73% (0.54% - 0.93%)
Philadelphia, PA	1.37% (1.01% - 1.73%)	1.26% (0.92% - 1.59%)	1.18% (0.87% - 1.49%)	1.08% (0.79% - 1.37%)	1.08% (0.79% - 1.36%)	0.89% (0.66% - 1.13%)
Phoenix, AZ	0.54% (0.01% - 1.07%)	0.54% (0.01% - 1.07%)	0.54% (0.01% - 1.07%)	0.51% (0.01% - 1.02%)	0.51% (0.01% - 1.01%)	0.42% (0.01% - 0.84%)
Pittsburgh, PA	1.63% (1.2% - 2.06%)	0.94% (0.69% - 1.19%)	0.94% (0.69% - 1.19%)	0.94% (0.69% - 1.19%)	0.81% (0.59% - 1.02%)	0.67% (0.49% - 0.85%)
Salt Lake City, UT	0.51% (0.01% - 1.01%)	0.32% (0% - 0.64%)	0.32% (0% - 0.64%)	0.32% (0% - 0.64%)	0.27% (0% - 0.54%)	0.23% (0% - 0.45%)
St. Louis, MO	1.36% (1% - 1.71%)	1.21% (0.89% - 1.54%)	1.05% (0.77% - 1.33%)	0.97% (0.71% - 1.22%)	1.04% (0.76% - 1.31%)	0.86% (0.63% - 1.09%)
Tacoma, WA	0.61% (-1.49% - 2.63%)	0.5% (-1.2% - 2.14%)	0.5% (-1.2% - 2.14%)	0.5% (-1.2% - 2.14%)	0.42% (-1.02% - 1.83%)	0.35% (-0.85% - 1.52%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-105. Estimated Percent of Total Annual Incidence of Hospital Admissions for Cardiovascular Illness Associated with Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.4% (-0.26% - 1.05%)	0.36% (-0.24% - 0.96%)	0.31% (-0.2% - 0.82%)	0.28% (-0.18% - 0.75%)	0.31% (-0.2% - 0.82%)	0.28% (-0.18% - 0.73%)
Baltimore, MD	1.4% (1.03% - 1.76%)	1.32% (0.97% - 1.67%)	1.15% (0.85% - 1.46%)	1.06% (0.78% - 1.34%)	1.13% (0.83% - 1.43%)	0.94% (0.69% - 1.19%)
Birmingham, AL	0.44% (-0.29% - 1.17%)	0.35% (-0.23% - 0.92%)	0.3% (-0.19% - 0.78%)	0.27% (-0.18% - 0.71%)	0.3% (-0.19% - 0.78%)	0.24% (-0.16% - 0.65%)
Dallas, TX	0.28% (-0.18% - 0.73%)	0.28% (-0.18% - 0.73%)	0.28% (-0.18% - 0.73%)	0.26% (-0.17% - 0.68%)	0.28% (-0.18% - 0.73%)	0.26% (-0.17% - 0.68%)
Detroit, MI	1.29% (0.95% - 1.63%)	1.04% (0.77% - 1.32%)	0.96% (0.7% - 1.21%)	0.88% (0.65% - 1.11%)	0.89% (0.65% - 1.13%)	0.74% (0.54% - 0.94%)
Fresno, CA	0.91% (0.01% - 1.79%)	0.5% (0.01% - 0.99%)	0.5% (0.01% - 0.99%)	0.5% (0.01% - 0.99%)	0.43% (0.01% - 0.85%)	0.36% (0% - 0.7%)
Houston, TX	0.38% (-0.25% - 1%)	0.36% (-0.23% - 0.94%)	0.3% (-0.2% - 0.8%)	0.28% (-0.18% - 0.73%)	0.3% (-0.2% - 0.8%)	0.28% (-0.18% - 0.73%)
Los Angeles, CA	0.75% (0.01% - 1.48%)	0.47% (0.01% - 0.93%)	0.47% (0.01% - 0.93%)	0.45% (0.01% - 0.88%)	0.4% (0% - 0.8%)	0.33% (0% - 0.66%)
New York, NY	1.25% (0.92% - 1.58%)	1.04% (0.76% - 1.31%)	1.01% (0.74% - 1.28%)	0.93% (0.68% - 1.17%)	0.89% (0.65% - 1.12%)	0.74% (0.54% - 0.93%)
Philadelphia, PA	1.36% (1% - 1.72%)	1.25% (0.92% - 1.58%)	1.17% (0.86% - 1.48%)	1.08% (0.79% - 1.36%)	1.07% (0.79% - 1.35%)	0.89% (0.65% - 1.12%)
Phoenix, AZ	0.5% (0.01% - 0.99%)	0.5% (0.01% - 0.99%)	0.5% (0.01% - 0.99%)	0.47% (0.01% - 0.94%)	0.47% (0.01% - 0.93%)	0.39% (0% - 0.77%)
Pittsburgh, PA	1.65% (1.21% - 2.08%)	0.96% (0.7% - 1.21%)	0.96% (0.7% - 1.21%)	0.96% (0.7% - 1.21%)	0.82% (0.6% - 1.03%)	0.68% (0.5% - 0.86%)
Salt Lake City, UT	0.6% (0.01% - 1.19%)	0.38% (0% - 0.75%)	0.38% (0% - 0.75%)	0.38% (0% - 0.75%)	0.32% (0% - 0.64%)	0.27% (0% - 0.53%)
St. Louis, MO	1.4% (1.03% - 1.77%)	1.25% (0.92% - 1.58%)	1.09% (0.8% - 1.37%)	1% (0.73% - 1.26%)	1.07% (0.79% - 1.35%)	0.89% (0.65% - 1.12%)
Tacoma, WA	0.65% (-1.58% - 2.77%)	0.52% (-1.28% - 2.26%)	0.52% (-1.28% - 2.26%)	0.52% (-1.28% - 2.26%)	0.45% (-1.09% - 1.93%)	0.37% (-0.9% - 1.6%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-106. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (14% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-81% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-59% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (14% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-107. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-81% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	14% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-59% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

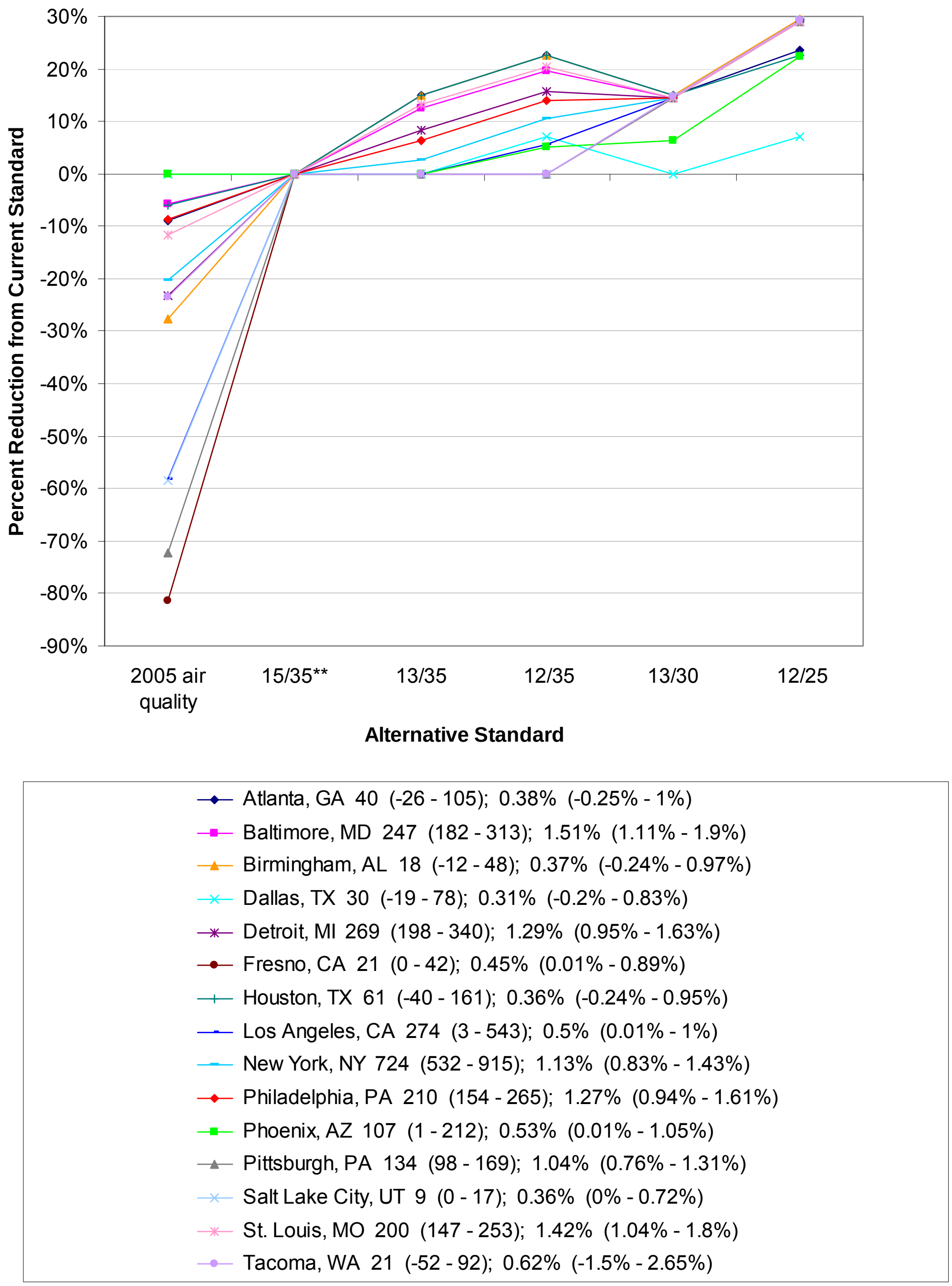
Table E-108. Percent Reduction from the Current Standards: Estimated Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	14% (14% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	10% (10% - 10%)	15% (14% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 6%)	14% (14% - 14%)	14% (14% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-72% (-72% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

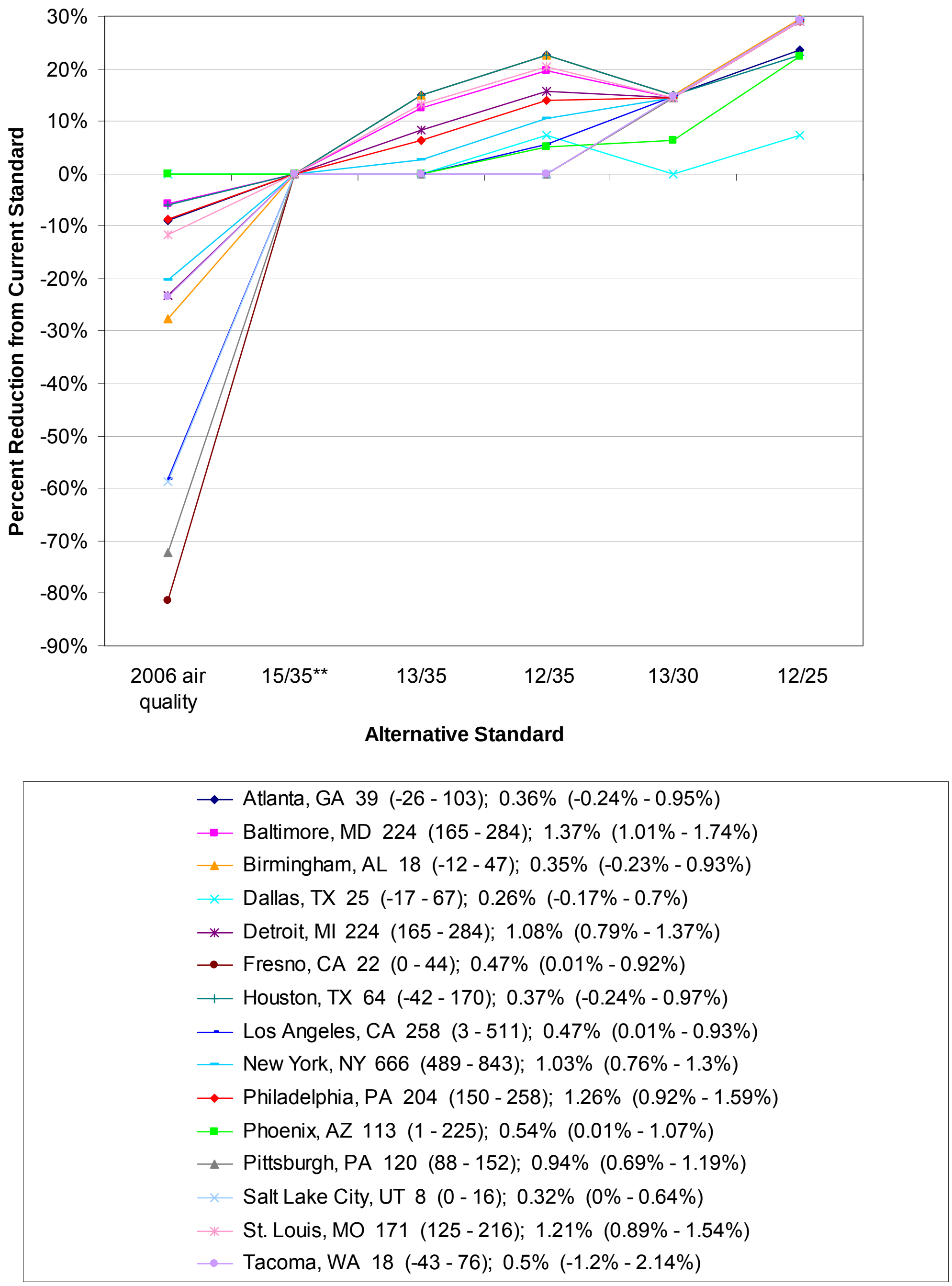
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-34. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2005 Air Quality Data*



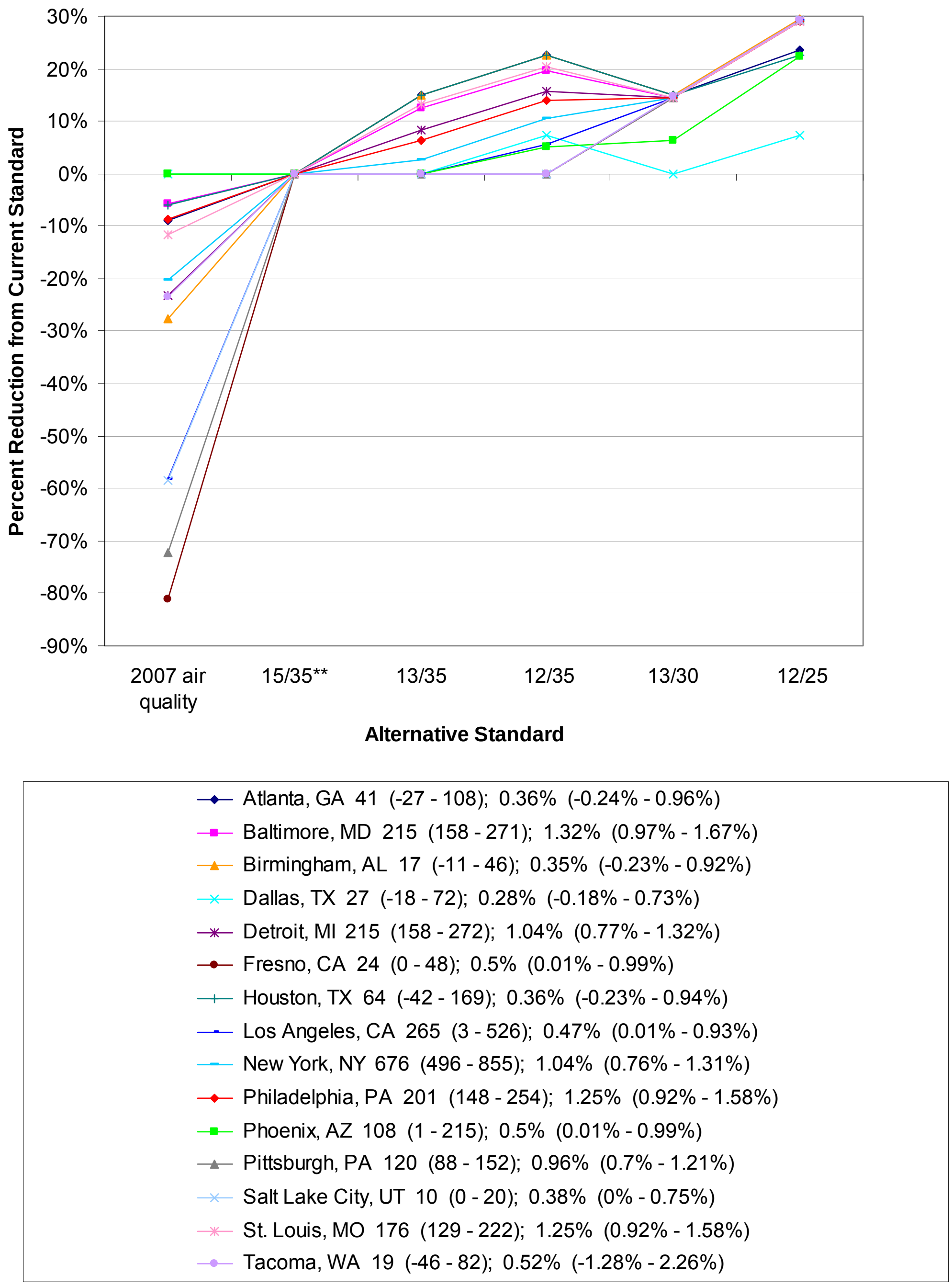
*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-35. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2006 Air Quality Data*



*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-36. Estimated Percent Reductions From the Current Standard to Alternative Standards in Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data*



*Based on Zanobetti and Schwartz (2009). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-109. Estimated Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	19 (-23 - 60)	17 (-21 - 55)	14 (-18 - 47)	13 (-17 - 43)	14 (-18 - 47)	13 (-16 - 42)
Baltimore, MD	21 (-12 - 54)	20 (-12 - 51)	17 (-10 - 45)	16 (-9 - 41)	17 (-10 - 44)	14 (-8 - 36)
Birmingham, AL	10 (-13 - 32)	8 (-10 - 25)	7 (-8 - 21)	6 (-8 - 20)	7 (-8 - 21)	6 (-7 - 18)
Dallas, TX	14 (-18 - 46)	14 (-18 - 46)	14 (-18 - 46)	13 (-17 - 43)	14 (-18 - 46)	13 (-17 - 43)
Detroit, MI	30 (-17 - 76)	24 (-14 - 62)	22 (-13 - 57)	20 (-12 - 52)	20 (-12 - 53)	17 (-10 - 44)
Fresno, CA	26 (6 - 45)	14 (3 - 25)	14 (3 - 25)	14 (3 - 25)	12 (3 - 21)	10 (2 - 18)
Houston, TX	29 (-36 - 93)	27 (-34 - 88)	23 (-29 - 75)	21 (-27 - 68)	23 (-29 - 75)	21 (-27 - 68)
Los Angeles, CA	279 (65 - 490)	177 (41 - 311)	177 (41 - 311)	167 (39 - 293)	151 (35 - 266)	125 (29 - 221)
New York, NY	72 (-42 - 185)	60 (-35 - 154)	58 (-34 - 150)	53 (-31 - 138)	51 (-30 - 132)	42 (-25 - 109)
Philadelphia, PA	18 (-11 - 47)	17 (-10 - 43)	16 (-9 - 41)	14 (-8 - 37)	14 (-8 - 37)	12 (-7 - 31)
Phoenix, AZ	61 (14 - 106)	61 (14 - 106)	61 (14 - 106)	57 (13 - 101)	57 (13 - 100)	47 (11 - 83)
Pittsburgh, PA	19 (-11 - 49)	11 (-6 - 28)	11 (-6 - 28)	11 (-6 - 28)	9 (-5 - 24)	8 (-5 - 20)
Salt Lake City, UT	10 (2 - 18)	6 (1 - 11)	6 (1 - 11)	6 (1 - 11)	5 (1 - 10)	5 (1 - 8)
St. Louis, MO	27 (-16 - 69)	24 (-14 - 62)	21 (-12 - 54)	19 (-11 - 49)	21 (-12 - 53)	17 (-10 - 44)
Tacoma, WA	2 (-34 - 37)	2 (-27 - 30)	2 (-27 - 30)	2 (-27 - 30)	2 (-23 - 26)	1 (-19 - 21)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-110. Estimated Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	18 (-23 - 59)	17 (-21 - 54)	14 (-18 - 46)	13 (-16 - 42)	14 (-18 - 46)	13 (-16 - 41)
Baltimore, MD	19 (-11 - 49)	18 (-11 - 46)	16 (-9 - 41)	14 (-9 - 37)	15 (-9 - 40)	13 (-8 - 33)
Birmingham, AL	10 (-12 - 31)	8 (-10 - 24)	6 (-8 - 21)	6 (-7 - 19)	6 (-8 - 21)	5 (-7 - 17)
Dallas, TX	12 (-15 - 40)	12 (-15 - 40)	12 (-15 - 40)	11 (-14 - 37)	12 (-15 - 40)	11 (-14 - 37)
Detroit, MI	25 (-15 - 64)	20 (-12 - 52)	18 (-11 - 47)	17 (-10 - 43)	17 (-10 - 44)	14 (-8 - 36)
Fresno, CA	27 (6 - 47)	15 (3 - 26)	15 (3 - 26)	15 (3 - 26)	13 (3 - 22)	11 (2 - 19)
Houston, TX	30 (-38 - 98)	29 (-36 - 93)	24 (-31 - 79)	22 (-28 - 72)	24 (-31 - 79)	22 (-28 - 72)
Los Angeles, CA	263 (61 - 462)	166 (39 - 293)	166 (39 - 293)	157 (37 - 276)	142 (33 - 250)	118 (27 - 208)
New York, NY	66 (-39 - 171)	55 (-32 - 142)	54 (-32 - 138)	49 (-29 - 127)	47 (-28 - 121)	39 (-23 - 101)
Philadelphia, PA	18 (-10 - 46)	16 (-10 - 42)	15 (-9 - 39)	14 (-8 - 36)	14 (-8 - 36)	12 (-7 - 30)
Phoenix, AZ	64 (15 - 113)	64 (15 - 113)	64 (15 - 113)	61 (14 - 107)	60 (14 - 106)	50 (12 - 88)
Pittsburgh, PA	17 (-10 - 43)	10 (-6 - 25)	10 (-6 - 25)	10 (-6 - 25)	8 (-5 - 22)	7 (-4 - 18)
Salt Lake City, UT	9 (2 - 16)	6 (1 - 10)	6 (1 - 10)	6 (1 - 10)	5 (1 - 9)	4 (1 - 7)
St. Louis, MO	23 (-13 - 59)	21 (-12 - 53)	18 (-10 - 46)	16 (-10 - 42)	18 (-10 - 45)	15 (-9 - 37)
Tacoma, WA	2 (-28 - 30)	2 (-22 - 25)	2 (-22 - 25)	2 (-22 - 25)	1 (-19 - 21)	1 (-16 - 18)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-111. Estimated Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	19 (-24 - 61)	17 (-22 - 56)	15 (-19 - 48)	14 (-17 - 44)	15 (-19 - 48)	13 (-17 - 43)
Baltimore, MD	18 (-11 - 47)	17 (-10 - 44)	15 (-9 - 39)	14 (-8 - 36)	15 (-9 - 38)	12 (-7 - 31)
Birmingham, AL	10 (-12 - 31)	7 (-9 - 24)	6 (-8 - 21)	6 (-7 - 19)	6 (-8 - 21)	5 (-7 - 17)
Dallas, TX	13 (-16 - 42)	13 (-16 - 42)	13 (-16 - 42)	12 (-15 - 39)	13 (-16 - 42)	12 (-15 - 39)
Detroit, MI	24 (-14 - 61)	19 (-11 - 49)	18 (-10 - 45)	16 (-9 - 42)	16 (-10 - 42)	14 (-8 - 35)
Fresno, CA	29 (7 - 51)	16 (4 - 29)	16 (4 - 29)	16 (4 - 29)	14 (3 - 24)	12 (3 - 20)
Houston, TX	30 (-38 - 98)	29 (-36 - 93)	24 (-31 - 79)	22 (-28 - 72)	24 (-31 - 79)	22 (-28 - 72)
Los Angeles, CA	270 (63 - 475)	171 (40 - 301)	171 (40 - 301)	161 (38 - 284)	146 (34 - 257)	121 (28 - 214)
New York, NY	67 (-40 - 173)	56 (-33 - 144)	54 (-32 - 140)	50 (-29 - 129)	48 (-28 - 123)	40 (-23 - 102)
Philadelphia, PA	18 (-10 - 45)	16 (-9 - 42)	15 (-9 - 39)	14 (-8 - 36)	14 (-8 - 35)	11 (-7 - 29)
Phoenix, AZ	61 (14 - 108)	61 (14 - 108)	61 (14 - 108)	58 (14 - 103)	57 (13 - 101)	48 (11 - 84)
Pittsburgh, PA	17 (-10 - 43)	10 (-6 - 25)	10 (-6 - 25)	10 (-6 - 25)	8 (-5 - 22)	7 (-4 - 18)
Salt Lake City, UT	11 (3 - 20)	7 (2 - 13)	7 (2 - 13)	7 (2 - 13)	6 (1 - 11)	5 (1 - 9)
St. Louis, MO	24 (-14 - 61)	21 (-12 - 54)	18 (-11 - 47)	17 (-10 - 43)	18 (-11 - 46)	15 (-9 - 39)
Tacoma, WA	2 (-30 - 33)	2 (-24 - 27)	2 (-24 - 27)	2 (-24 - 27)	2 (-21 - 23)	1 (-17 - 19)

[1]Incidence estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-112. Estimated Percent of Total Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.5% (-0.63% - 1.6%)	0.46% (-0.57% - 1.47%)	0.39% (-0.49% - 1.25%)	0.35% (-0.44% - 1.14%)	0.39% (-0.49% - 1.25%)	0.35% (-0.44% - 1.12%)
Baltimore, MD	0.42% (-0.25% - 1.08%)	0.4% (-0.23% - 1.02%)	0.35% (-0.2% - 0.89%)	0.32% (-0.19% - 0.82%)	0.34% (-0.2% - 0.87%)	0.28% (-0.16% - 0.72%)
Birmingham, AL	0.56% (-0.71% - 1.82%)	0.44% (-0.56% - 1.43%)	0.37% (-0.47% - 1.21%)	0.34% (-0.43% - 1.11%)	0.37% (-0.47% - 1.21%)	0.31% (-0.39% - 1.01%)
Dallas, TX	0.38% (-0.47% - 1.22%)	0.38% (-0.47% - 1.22%)	0.38% (-0.47% - 1.22%)	0.35% (-0.44% - 1.13%)	0.38% (-0.47% - 1.22%)	0.35% (-0.44% - 1.13%)
Detroit, MI	0.42% (-0.25% - 1.07%)	0.34% (-0.2% - 0.87%)	0.31% (-0.18% - 0.8%)	0.28% (-0.17% - 0.73%)	0.29% (-0.17% - 0.74%)	0.24% (-0.14% - 0.62%)
Fresno, CA	1.44% (0.34% - 2.51%)	0.79% (0.19% - 1.4%)	0.79% (0.19% - 1.4%)	0.79% (0.19% - 1.4%)	0.68% (0.16% - 1.19%)	0.56% (0.13% - 0.99%)
Houston, TX	0.46% (-0.58% - 1.49%)	0.44% (-0.55% - 1.41%)	0.37% (-0.47% - 1.2%)	0.34% (-0.42% - 1.09%)	0.37% (-0.47% - 1.2%)	0.34% (-0.42% - 1.09%)
Los Angeles, CA	1.41% (0.33% - 2.47%)	0.89% (0.21% - 1.57%)	0.89% (0.21% - 1.57%)	0.84% (0.2% - 1.48%)	0.76% (0.18% - 1.34%)	0.63% (0.15% - 1.11%)
New York, NY	0.36% (-0.21% - 0.92%)	0.3% (-0.17% - 0.76%)	0.29% (-0.17% - 0.74%)	0.27% (-0.16% - 0.68%)	0.25% (-0.15% - 0.65%)	0.21% (-0.12% - 0.54%)
Philadelphia, PA	0.36% (-0.21% - 0.93%)	0.33% (-0.2% - 0.86%)	0.31% (-0.18% - 0.8%)	0.29% (-0.17% - 0.74%)	0.29% (-0.17% - 0.74%)	0.24% (-0.14% - 0.61%)
Phoenix, AZ	0.93% (0.22% - 1.64%)	0.93% (0.22% - 1.64%)	0.93% (0.22% - 1.64%)	0.89% (0.21% - 1.56%)	0.87% (0.2% - 1.54%)	0.73% (0.17% - 1.28%)
Pittsburgh, PA	0.47% (-0.28% - 1.21%)	0.27% (-0.16% - 0.7%)	0.27% (-0.16% - 0.7%)	0.27% (-0.16% - 0.7%)	0.23% (-0.14% - 0.6%)	0.19% (-0.11% - 0.5%)
Salt Lake City, UT	1.01% (0.24% - 1.77%)	0.64% (0.15% - 1.12%)	0.64% (0.15% - 1.12%)	0.64% (0.15% - 1.12%)	0.54% (0.13% - 0.96%)	0.45% (0.11% - 0.79%)
St. Louis, MO	0.42% (-0.25% - 1.07%)	0.37% (-0.22% - 0.96%)	0.32% (-0.19% - 0.83%)	0.3% (-0.17% - 0.76%)	0.32% (-0.19% - 0.82%)	0.26% (-0.16% - 0.68%)
Tacoma, WA	0.2% (-2.72% - 2.97%)	0.16% (-2.19% - 2.41%)	0.16% (-2.19% - 2.41%)	0.16% (-2.19% - 2.41%)	0.14% (-1.87% - 2.07%)	0.11% (-1.54% - 1.72%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-113. Estimated Percent of Total Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.47% (-0.6% - 1.53%)	0.43% (-0.55% - 1.4%)	0.37% (-0.46% - 1.19%)	0.34% (-0.42% - 1.09%)	0.37% (-0.46% - 1.19%)	0.33% (-0.42% - 1.07%)
Baltimore, MD	0.38% (-0.22% - 0.98%)	0.36% (-0.21% - 0.93%)	0.31% (-0.19% - 0.81%)	0.29% (-0.17% - 0.74%)	0.31% (-0.18% - 0.79%)	0.26% (-0.15% - 0.66%)
Birmingham, AL	0.54% (-0.69% - 1.76%)	0.43% (-0.54% - 1.38%)	0.36% (-0.46% - 1.17%)	0.33% (-0.42% - 1.07%)	0.36% (-0.46% - 1.17%)	0.3% (-0.38% - 0.97%)
Dallas, TX	0.32% (-0.4% - 1.03%)	0.32% (-0.4% - 1.03%)	0.32% (-0.4% - 1.03%)	0.29% (-0.37% - 0.95%)	0.32% (-0.4% - 1.03%)	0.29% (-0.37% - 0.95%)
Detroit, MI	0.35% (-0.21% - 0.9%)	0.28% (-0.17% - 0.73%)	0.26% (-0.15% - 0.67%)	0.24% (-0.14% - 0.62%)	0.24% (-0.14% - 0.62%)	0.2% (-0.12% - 0.52%)
Fresno, CA	1.49% (0.35% - 2.61%)	0.82% (0.19% - 1.45%)	0.82% (0.19% - 1.45%)	0.82% (0.19% - 1.45%)	0.7% (0.16% - 1.24%)	0.58% (0.14% - 1.03%)
Houston, TX	0.47% (-0.59% - 1.51%)	0.44% (-0.56% - 1.43%)	0.38% (-0.47% - 1.22%)	0.34% (-0.43% - 1.11%)	0.38% (-0.47% - 1.22%)	0.34% (-0.43% - 1.11%)
Los Angeles, CA	1.3% (0.3% - 2.29%)	0.82% (0.19% - 1.45%)	0.82% (0.19% - 1.45%)	0.78% (0.18% - 1.37%)	0.7% (0.16% - 1.24%)	0.58% (0.14% - 1.03%)
New York, NY	0.32% (-0.19% - 0.84%)	0.27% (-0.16% - 0.7%)	0.26% (-0.15% - 0.68%)	0.24% (-0.14% - 0.62%)	0.23% (-0.14% - 0.59%)	0.19% (-0.11% - 0.49%)
Philadelphia, PA	0.36% (-0.21% - 0.92%)	0.33% (-0.19% - 0.85%)	0.31% (-0.18% - 0.8%)	0.28% (-0.17% - 0.73%)	0.28% (-0.17% - 0.73%)	0.23% (-0.14% - 0.6%)
Phoenix, AZ	0.96% (0.22% - 1.68%)	0.96% (0.22% - 1.68%)	0.96% (0.22% - 1.68%)	0.91% (0.21% - 1.6%)	0.9% (0.21% - 1.58%)	0.74% (0.17% - 1.31%)
Pittsburgh, PA	0.43% (-0.25% - 1.1%)	0.25% (-0.15% - 0.64%)	0.25% (-0.15% - 0.64%)	0.25% (-0.15% - 0.64%)	0.21% (-0.12% - 0.54%)	0.17% (-0.1% - 0.45%)
Salt Lake City, UT	0.9% (0.21% - 1.58%)	0.57% (0.13% - 1%)	0.57% (0.13% - 1%)	0.57% (0.13% - 1%)	0.48% (0.11% - 0.85%)	0.4% (0.09% - 0.71%)
St. Louis, MO	0.36% (-0.21% - 0.92%)	0.32% (-0.19% - 0.82%)	0.28% (-0.16% - 0.71%)	0.25% (-0.15% - 0.65%)	0.27% (-0.16% - 0.7%)	0.22% (-0.13% - 0.58%)
Tacoma, WA	0.16% (-2.18% - 2.39%)	0.13% (-1.76% - 1.94%)	0.13% (-1.76% - 1.94%)	0.13% (-1.76% - 1.94%)	0.11% (-1.49% - 1.66%)	0.09% (-1.23% - 1.38%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-114. Estimated Percent of Total Annual Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent of Total Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	0.48% (-0.6% - 1.54%)	0.44% (-0.55% - 1.42%)	0.37% (-0.47% - 1.21%)	0.34% (-0.43% - 1.1%)	0.37% (-0.47% - 1.21%)	0.33% (-0.42% - 1.08%)
Baltimore, MD	0.37% (-0.22% - 0.94%)	0.35% (-0.2% - 0.89%)	0.3% (-0.18% - 0.78%)	0.28% (-0.16% - 0.72%)	0.3% (-0.17% - 0.76%)	0.25% (-0.14% - 0.63%)
Birmingham, AL	0.54% (-0.68% - 1.73%)	0.42% (-0.53% - 1.36%)	0.36% (-0.45% - 1.15%)	0.32% (-0.41% - 1.05%)	0.36% (-0.45% - 1.15%)	0.3% (-0.37% - 0.96%)
Dallas, TX	0.33% (-0.42% - 1.08%)	0.33% (-0.42% - 1.08%)	0.33% (-0.42% - 1.08%)	0.31% (-0.39% - 1%)	0.33% (-0.42% - 1.08%)	0.31% (-0.39% - 1%)
Detroit, MI	0.34% (-0.2% - 0.87%)	0.27% (-0.16% - 0.7%)	0.25% (-0.15% - 0.65%)	0.23% (-0.14% - 0.59%)	0.23% (-0.14% - 0.6%)	0.19% (-0.11% - 0.5%)
Fresno, CA	1.6% (0.38% - 2.79%)	0.89% (0.21% - 1.55%)	0.89% (0.21% - 1.55%)	0.89% (0.21% - 1.55%)	0.76% (0.18% - 1.33%)	0.63% (0.15% - 1.1%)
Houston, TX	0.46% (-0.57% - 1.47%)	0.43% (-0.54% - 1.39%)	0.37% (-0.46% - 1.18%)	0.33% (-0.42% - 1.08%)	0.37% (-0.46% - 1.18%)	0.33% (-0.42% - 1.08%)
Los Angeles, CA	1.32% (0.31% - 2.31%)	0.83% (0.19% - 1.47%)	0.83% (0.19% - 1.47%)	0.79% (0.18% - 1.38%)	0.71% (0.17% - 1.25%)	0.59% (0.14% - 1.04%)
New York, NY	0.33% (-0.19% - 0.84%)	0.27% (-0.16% - 0.7%)	0.26% (-0.16% - 0.68%)	0.24% (-0.14% - 0.63%)	0.23% (-0.14% - 0.6%)	0.19% (-0.11% - 0.5%)
Philadelphia, PA	0.36% (-0.21% - 0.92%)	0.33% (-0.19% - 0.84%)	0.31% (-0.18% - 0.79%)	0.28% (-0.17% - 0.73%)	0.28% (-0.16% - 0.72%)	0.23% (-0.14% - 0.6%)
Phoenix, AZ	0.88% (0.21% - 1.55%)	0.88% (0.21% - 1.55%)	0.88% (0.21% - 1.55%)	0.84% (0.2% - 1.47%)	0.83% (0.19% - 1.45%)	0.69% (0.16% - 1.21%)
Pittsburgh, PA	0.43% (-0.26% - 1.11%)	0.25% (-0.15% - 0.64%)	0.25% (-0.15% - 0.64%)	0.25% (-0.15% - 0.64%)	0.21% (-0.13% - 0.55%)	0.18% (-0.1% - 0.46%)
Salt Lake City, UT	1.06% (0.25% - 1.86%)	0.67% (0.16% - 1.18%)	0.67% (0.16% - 1.18%)	0.67% (0.16% - 1.18%)	0.57% (0.13% - 1.01%)	0.47% (0.11% - 0.83%)
St. Louis, MO	0.37% (-0.22% - 0.94%)	0.33% (-0.19% - 0.85%)	0.28% (-0.17% - 0.73%)	0.26% (-0.15% - 0.67%)	0.28% (-0.16% - 0.72%)	0.23% (-0.14% - 0.6%)
Tacoma, WA	0.17% (-2.32% - 2.52%)	0.14% (-1.87% - 2.05%)	0.14% (-1.87% - 2.05%)	0.14% (-1.87% - 2.05%)	0.12% (-1.59% - 1.76%)	0.1% (-1.31% - 1.46%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-115. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	11% (10% - 11%)	15% (15% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	15% (15% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-73% (-73% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Percents are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-116. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	11% (11% - 11%)	15% (15% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	15% (15% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-73% (-73% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Percents are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

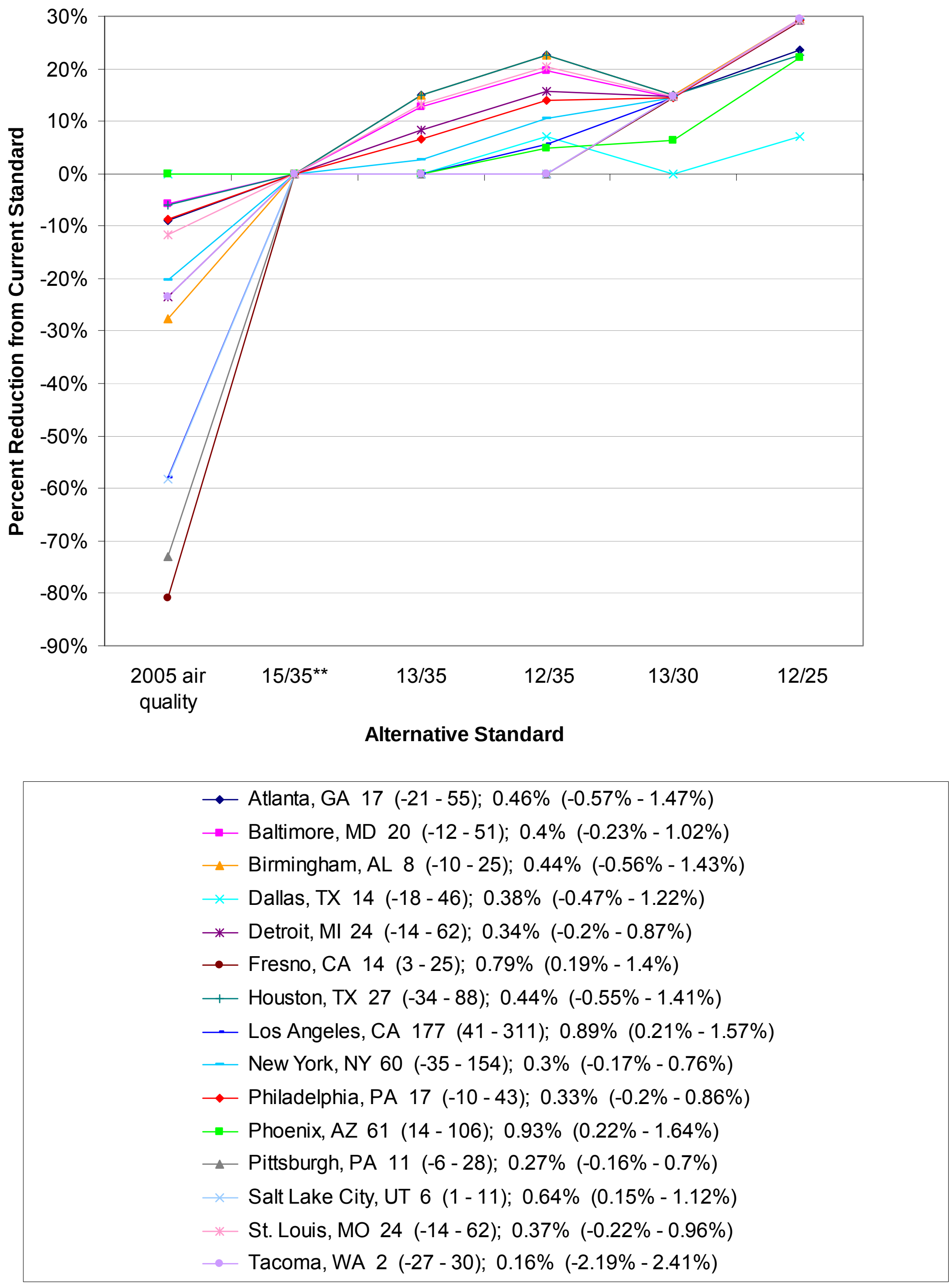
Table E-117. Percent Reduction from the Current Standards: Estimated Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Risk Assessment Location	Percent Reduction from the Current Standards: Annual Incidence of Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Atlanta, GA	-9% (-9% - -9%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	24% (24% - 24%)
Baltimore, MD	-6% (-6% - -6%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Birmingham, AL	-28% (-28% - -28%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	30% (29% - 30%)
Dallas, TX	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	7% (7% - 7%)	0% (0% - 0%)	7% (7% - 7%)
Detroit, MI	-23% (-23% - -23%)	0% (0% - 0%)	8% (8% - 8%)	16% (16% - 16%)	15% (15% - 15%)	29% (29% - 29%)
Fresno, CA	-81% (-80% - -82%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 29%)
Houston, TX	-6% (-6% - -6%)	0% (0% - 0%)	15% (15% - 15%)	23% (22% - 23%)	15% (15% - 15%)	23% (22% - 23%)
Los Angeles, CA	-58% (-58% - -58%)	0% (0% - 0%)	0% (0% - 0%)	6% (6% - 6%)	15% (15% - 15%)	29% (29% - 29%)
New York, NY	-20% (-20% - -20%)	0% (0% - 0%)	3% (3% - 3%)	11% (11% - 11%)	15% (15% - 15%)	29% (29% - 29%)
Philadelphia, PA	-9% (-9% - -9%)	0% (0% - 0%)	6% (6% - 7%)	14% (14% - 14%)	15% (15% - 15%)	29% (29% - 29%)
Phoenix, AZ	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	5% (5% - 5%)	6% (6% - 6%)	22% (22% - 22%)
Pittsburgh, PA	-73% (-73% - -73%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
Salt Lake City, UT	-58% (-58% - -59%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (15% - 15%)	29% (29% - 29%)
St. Louis, MO	-12% (-12% - -12%)	0% (0% - 0%)	13% (13% - 13%)	20% (20% - 20%)	15% (15% - 15%)	29% (29% - 29%)
Tacoma, WA	-23% (-23% - -24%)	0% (0% - 0%)	0% (0% - 0%)	0% (0% - 0%)	15% (14% - 15%)	29% (29% - 30%)

[1]Estimates were calculated using the appropriate regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Percents are rounded to the nearest whole number.

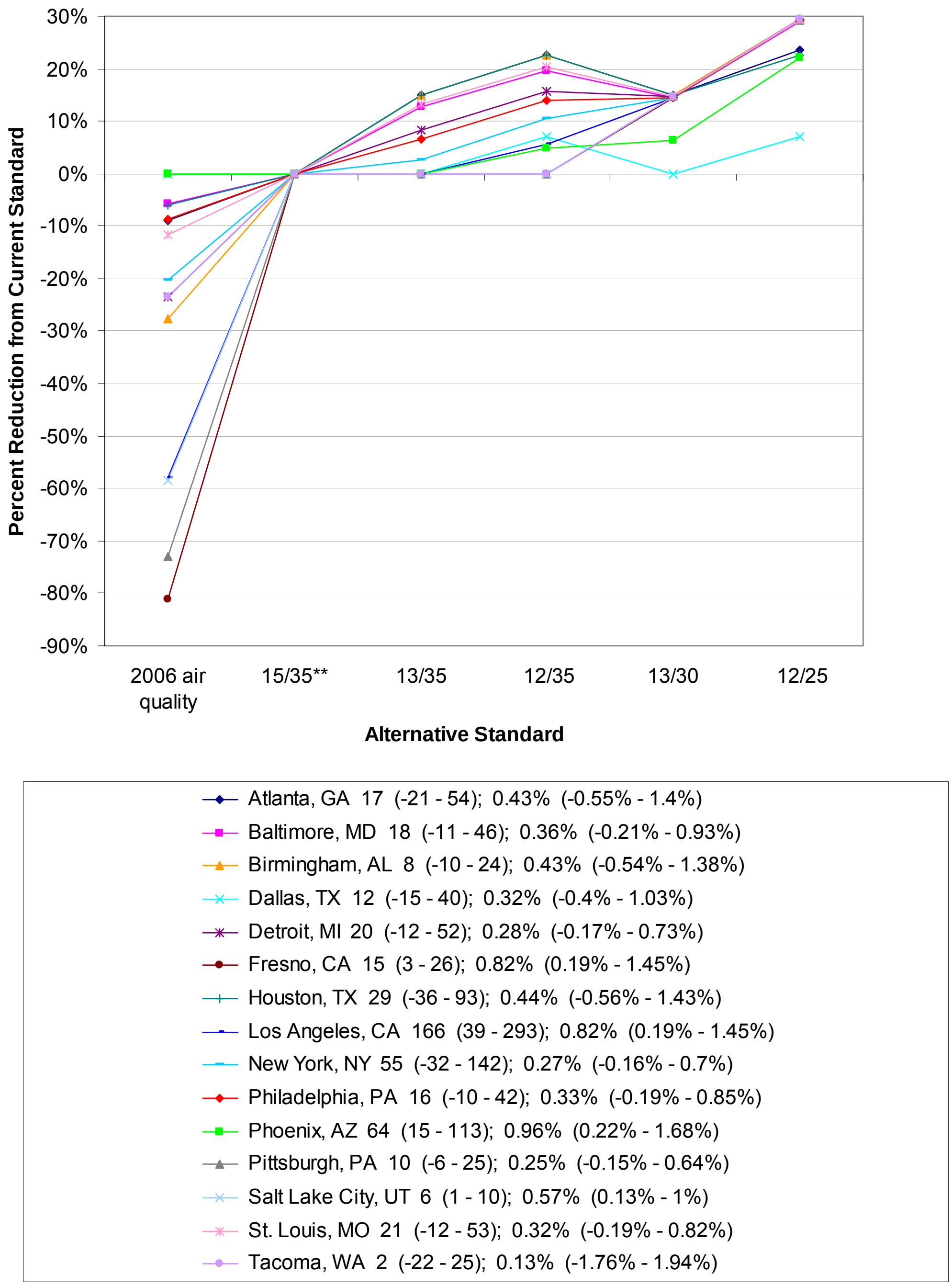
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Figure E-37. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2005 Air Quality Data*



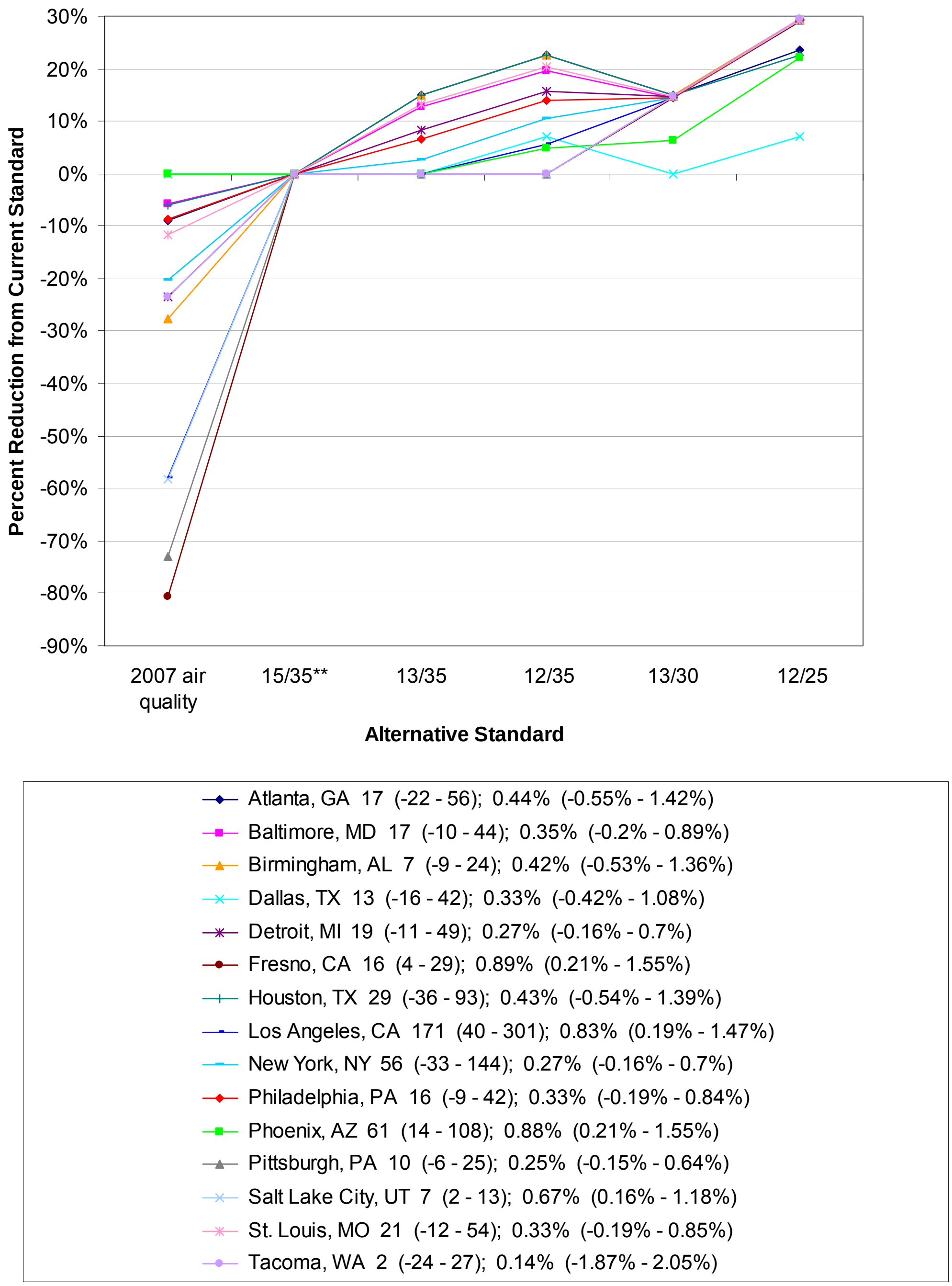
*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 µg/m^3 and a daily standard of 35 µg/m^3. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-38. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2006 Air Quality Data*



*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Figure E-39. Estimated Percent Reductions From the Current Standard to Alternative Standards in Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$: Based on 2007 Air Quality Data*



*Based on Bell et al. (2008). The legend contains, for each urban area, the incidence estimate (and 95% CI) and the estimate of percent of total incidence (and 95% CI) under the current standards.
**The current standards consist of an annual standard of 15 $\mu g/m^3$ and a daily standard of 35 $\mu g/m^3$. Combinations of an annual standard (n) and a daily standard (m) are denoted n/m in this figure.

Table E-118. Estimated Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	215 (-302 - 722)	197 (-277 - 663)	167 (-235 - 564)	153 (-214 - 514)	167 (-235 - 564)	150 (-211 - 507)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	808 (-811 - 2400)	741 (-743 - 2203)	630 (-631 - 1875)	574 (-575 - 1710)	630 (-631 - 1875)	566 (-566 - 1685)
Ito et al. (2007)	New York, NY	Asthma	1162 (743 - 1567)	971 (620 - 1314)	947 (604 - 1281)	872 (556 - 1181)	834 (531 - 1130)	695 (442 - 943)

[1]Numbers rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-119. Estimated Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	212 (-298 - 713)	195 (-274 - 655)	165 (-232 - 557)	151 (-212 - 508)	165 (-232 - 557)	149 (-208 - 501)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	798 (-800 - 2373)	732 (-734 - 2178)	622 (-623 - 1853)	567 (-568 - 1690)	622 (-623 - 1853)	559 (-559 - 1665)
Ito et al. (2007)	New York, NY	Asthma	991 (633 - 1340)	828 (528 - 1122)	807 (515 - 1094)	743 (473 - 1008)	711 (452 - 964)	592 (376 - 804)

[1]Numbers rounded to the nearest whole number.
[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-120. Estimated Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	220 (-310 - 739)	202 (-284 - 678)	171 (-241 - 577)	156 (-219 - 527)	171 (-241 - 577)	154 (-216 - 519)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	827 (-830 - 2457)	759 (-761 - 2256)	645 (-646 - 1920)	588 (-589 - 1751)	645 (-646 - 1920)	580 (-580 - 1726)
Ito et al. (2007)	New York, NY	Asthma	1114 (712 - 1504)	931 (594 - 1260)	907 (579 - 1229)	836 (532 - 1133)	799 (509 - 1083)	665 (423 - 904)

[1]Numbers rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-121. Estimated Percent of Total Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Percent of Total Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	0.6% (-0.9% - 2.2%)	0.6% (-0.8% - 2%)	0.5% (-0.7% - 1.7%)	0.5% (-0.6% - 1.5%)	0.5% (-0.7% - 1.7%)	0.5% (-0.6% - 1.5%)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	0.6% (-0.6% - 1.9%)	0.6% (-0.6% - 1.8%)	0.5% (-0.5% - 1.5%)	0.5% (-0.5% - 1.4%)	0.5% (-0.5% - 1.5%)	0.5% (-0.5% - 1.3%)
Ito et al. (2007)	New York, NY	Asthma	6.5% (4.2% - 8.8%)	5.5% (3.5% - 7.4%)	5.3% (3.4% - 7.2%)	4.9% (3.1% - 6.7%)	4.7% (3% - 6.4%)	3.9% (2.5% - 5.3%)

[1]Percents rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-122. Estimated Percent of Total Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Percent of Total Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	0.6% (-0.9% - 2.1%)	0.6% (-0.8% - 1.9%)	0.5% (-0.7% - 1.6%)	0.4% (-0.6% - 1.5%)	0.5% (-0.7% - 1.6%)	0.4% (-0.6% - 1.5%)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	0.6% (-0.6% - 1.8%)	0.6% (-0.6% - 1.7%)	0.5% (-0.5% - 1.4%)	0.4% (-0.4% - 1.3%)	0.5% (-0.5% - 1.4%)	0.4% (-0.4% - 1.3%)
Ito et al. (2007)	New York, NY	Asthma	5.6% (3.6% - 7.5%)	4.7% (3% - 6.3%)	4.5% (2.9% - 6.1%)	4.2% (2.7% - 5.7%)	4% (2.5% - 5.4%)	3.3% (2.1% - 4.5%)

[1]Percents rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table E-123. Estimated Percent of Total Annual Incidence of Emergency Room (ER) Visits Associated with Short-Term Exposure to Ambient $PM_{2.5}$ Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Study	Location	ER Visit for:	Percent of Total Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
			Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Tolbert et al. (2007)	Atlanta, GA	Cardiovascular illness	0.6% (-0.9% - 2.1%)	0.6% (-0.8% - 1.9%)	0.5% (-0.7% - 1.6%)	0.4% (-0.6% - 1.5%)	0.5% (-0.7% - 1.6%)	0.4% (-0.6% - 1.5%)
Tolbert et al. (2007)	Atlanta, GA	Respiratory illness	0.6% (-0.6% - 1.8%)	0.6% (-0.6% - 1.7%)	0.5% (-0.5% - 1.4%)	0.4% (-0.4% - 1.3%)	0.5% (-0.5% - 1.4%)	0.4% (-0.4% - 1.3%)
Ito et al. (2007)	New York, NY	Asthma	6.2% (4% - 8.4%)	5.2% (3.3% - 7%)	5.1% (3.2% - 6.9%)	4.7% (3% - 6.3%)	4.5% (2.8% - 6.1%)	3.7% (2.4% - 5%)

[1]Percents rounded to the nearest tenth.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

APPENDIX F: SENSITIVITY ANALYSIS RESULTS

Appendix F. Sensitivity Analysis Results

This Appendix provides detailed results of the single- and multi-factor sensitivity analyses completed as part of this risk analysis. For additional detail on the sensitivity analysis results completed for this analysis, as well as the types of results generated, see section 4.3.

We have identified an error in the approach used to simulate ambient $PM_{2.5}$ levels for the Pittsburgh study area for the scenarios involving just meeting the current and alternative sets of standards. Sensitivity analyses involving the Pittsburgh study area (focusing on the impact of using the alternative hybrid rollback approach – see section 3.5.4) involved the current and alternative sets of standard levels and consequently, these sensitivity analyses results are impacted. However, there was insufficient time after identifying this error to either generate corrected risk estimates or remove the erroneous risk estimates from the summary tables presented in this Appendix. We will correct this error and release updated results for the Pittsburgh study area as soon as is practicable and will include the corrected results in the next version of this document. Note, that this error does not impact sensitivity analysis results for any of the other urban study areas.

Table F-1. Sensitivity Analysis: Impact of Using Different Model Choices to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]			Percent Difference [6]	
	Standard Fixed Effects Log-Linear (Cox Proportional Hazard) Model[3]	Random Effects Log-Linear Model [4]	Random Effects Log-Log Model [5]	Fixed Effects vs. Random Effects Log-Linear Models	Random Effects Log-Linear vs. Log-Log Models
Los Angeles, CA					
All Cause Mortality	1432 (911 - 1948)	1767 (824 - 2694)	3526 (2179 - 4841)	23%	146%
Cardiopulmonary Mortality	1626 (1270 - 1977)	--- [7]	2694 (1794 - 3563)	---	66%
Ischemic Heart Disease Mortality	1330 (1083 - 1572)	1486 (903 - 2044)	2652 (1878 - 3376)	12%	99%
Lung Cancer Mortality	174 (76 - 269)	---	322 (168 - 467)	---	85%
Philadelphia, PA					
All Cause Mortality	547 (349 - 743)	674 (316 - 1023)	1201 (745 - 1641)	23%	120%
Cardiopulmonary Mortality	512 (401 - 620)	---	757 (507 - 996)	---	48%
Ischemic Heart Disease Mortality	347 (284 - 409)	387 (238 - 527)	614 (439 - 774)	12%	77%
Lung Cancer Mortality	83 (37 - 127)	---	137 (72 - 196)	---	65%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in the study (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 9. Autocorrelation at MSA and ZCA levels; MSA & DIFF, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[5]Estimates based on Table 11, "MSA and DIFF" rows, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[6]Calculated as (core analysis model estimate - alternative model estimate)/(core analysis model estimate.)

[7]Estimates for cardiopulmonary mortality and lung cancer mortality were not available for the random effects log-linear model.

Table F-2. Sensitivity Analysis: Impact of Using Different Model Choices to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]			Percent Difference [6]	
	Standard Fixed Effects Log-Linear (Cox Proportional Hazard) Model[3]	Random Effects Log-Linear Model [4]	Random Effects Log-Log Model [5]	Fixed Effects vs. Random Effects Log-Linear Models	Random Effects Log-Linear vs. Log-Log Models
Los Angeles, CA					
All Cause Mortality	1221 (776 - 1662)	1507 (702 - 2300)	3130 (1931 - 4303)	23%	156%
Cardiopulmonary Mortality	1390 (1084 - 1692)	--- [7]	2396 (1592 - 3176)	---	72%
Ischemic Heart Disease Mortality	1140 (927 - 1349)	1275 (772 - 1760)	2374 (1675 - 3034)	12%	108%
Lung Cancer Mortality	149 (65 - 231)	---	286 (149 - 417)	---	92%
Philadelphia, PA					
All Cause Mortality	536 (341 - 727)	660 (309 - 1002)	1182 (733 - 1617)	23%	121%
Cardiopulmonary Mortality	501 (393 - 608)	---	746 (500 - 982)	---	49%
Ischemic Heart Disease Mortality	340 (279 - 401)	380 (233 - 517)	606 (433 - 764)	12%	78%
Lung Cancer Mortality	81 (36 - 125)	---	134 (71 - 194)	---	65%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in the study (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 9. Autocorrelation at MSA and ZCA levels; MSA & DIFF, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[5]Estimates based on Table 11, "MSA and DIFF" rows, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[6]Calculated as (core analysis model estimate - alternative model estimate)/(core analysis model estimate.)

[7]Estimates for cardiopulmonary mortality and lung cancer mortality were not available for the random effects log-linear model.

Table F-3. Sensitivity Analysis: Impact of Using Different Model Choices to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]			Percent Difference [6]	
	Standard Fixed Effects Log-Linear (Cox Proportional Hazard) Model[3]	Random Effects Log-Linear Model [4]	Random Effects Log-Log Model [5]	Fixed Effects vs. Random Effects Log-Linear Models	Random Effects Log-Linear vs. Log-Log Models
Los Angeles, CA					
All Cause Mortality	1257 (799 - 1711)	1552 (723 - 2368)	3206 (1979 - 4407)	23%	155%
Cardiopulmonary Mortality	1431 (1116 - 1741)	--- [7]	2454 (1631 - 3251)	---	71%
Ischemic Heart Disease Mortality	1173 (954 - 1388)	1312 (795 - 1810)	2429 (1715 - 3102)	12%	107%
Lung Cancer Mortality	153 (67 - 238)	---	293 (153 - 427)	---	92%
Philadelphia, PA					
All Cause Mortality	530 (338 - 719)	653 (305 - 991)	1174 (728 - 1605)	23%	122%
Cardiopulmonary Mortality	496 (388 - 601)	---	741 (496 - 975)	---	49%
Ischemic Heart Disease Mortality	337 (276 - 397)	376 (230 - 512)	602 (430 - 759)	12%	79%
Lung Cancer Mortality	80 (35 - 123)	---	134 (70 - 192)	---	68%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in the study (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 9. Autocorrelation at MSA and ZCA levels; MSA & DIFF, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[5]Estimates based on Table 11, "MSA and DIFF" rows, in Krewski et al. (2009) -- exposure period from 1999 - 2000.

[6]Calculated as (core analysis model estimate - alternative model estimate)/(core analysis model estimate.)

[7]Estimates for cardiopulmonary mortality and lung cancer mortality were not available for the random effects log-linear model.

Table F-4. Sensitivity Analysis: Impact of Limiting Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards to the Lowest Measured Level in the Study vs. to PRB, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1, 2]

Risk Assessment Location	Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Measured Down to:		Percent Difference[3]
	Lowest Measured Level in Study (5.8 ug/m3)	Estimated PRB	
Atlanta, GA	732 (468 - 992)	1053 (676 - 1421)	44%
Baltimore, MD	696 (444 - 942)	1067 (685 - 1437)	53%
Birmingham, AL	451 (288 - 611)	660 (423 - 891)	46%
Dallas, TX	469 (299 - 637)	746 (477 - 1009)	59%
Detroit, MI	697 (445 - 946)	1160 (744 - 1566)	66%
Fresno, CA	110 (70 - 150)	258 (165 - 350)	135%
Houston, TX	849 (542 - 1151)	1247 (800 - 1683)	47%
Los Angeles, CA	1432 (911 - 1948)	2934 (1876 - 3972)	105%
New York, NY	1600 (1019 - 2174)	3012 (1928 - 4073)	88%
Philadelphia, PA	547 (349 - 743)	935 (599 - 1262)	71%
Phoenix, AZ	611 (389 - 831)	1247 (797 - 1687)	104%
Pittsburgh, PA	366 (233 - 498)	732 (468 - 991)	100%
Salt Lake City, UT	54 (34 - 74)	177 (113 - 240)	228%
St. Louis, MO	857 (547 - 1161)	1342 (861 - 1810)	57%
Tacoma, WA	101 (64 - 138)	232 (148 - 314)	130%

[1]Estimates based on Table 33 in Krewski et al. (2009) -- exposure period from 1999 - 2000, follow-up through 2000, models with 44 individual and 7 ecological covariates.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality estimated down to PRB - mortality estimated down to LML)/(mortality estimated down to LML).

Table F-5. Sensitivity Analysis: Impact of Limiting Estimated Annual Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards to the Lowest Measured Level in the Study vs. to PRB, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1, 2]

Risk Assessment Location	Incidence of Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Measured Down to:		Percent Difference[3]
	Lowest Measured Level in Study (5.8 ug/m^3)	Estimated PRB	
Atlanta, GA	269 (221 - 315)	383 (317 - 446)	42%
Baltimore, MD	399 (327 - 468)	622 (515 - 723)	56%
Birmingham, AL	190 (156 - 223)	274 (227 - 319)	44%
Dallas, TX	220 (179 - 260)	382 (314 - 447)	74%
Detroit, MI	447 (365 - 528)	827 (681 - 967)	85%
Fresno, CA	91 (74 - 108)	198 (162 - 232)	118%
Houston, TX	534 (438 - 626)	754 (624 - 877)	41%
Los Angeles, CA	1140 (927 - 1349)	2459 (2020 - 2882)	116%
New York, NY	1785 (1454 - 2110)	3546 (2918 - 4149)	99%
Philadelphia, PA	340 (279 - 401)	564 (466 - 657)	66%
Phoenix, AZ	479 (391 - 566)	915 (753 - 1069)	91%
Pittsburgh, PA	224 (183 - 266)	482 (396 - 565)	115%
Salt Lake City, UT	14 (11 - 17)	63 (51 - 74)	350%
St. Louis, MO	507 (415 - 597)	858 (708 - 1001)	69%
Tacoma, WA	43 (35 - 51)	140 (114 - 165)	226%

[1]Estimates based on Table 33 in Krewski et al. (2009) -- exposure period from 1999 - 2000, follow-up through 2000, models with 44 individual and 7 ecological covariates.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (IHD mortality estimated down to PRB - IHD mortality estimated down to LML)/(IHD mortality estimated down to LML).

Table F-6. Sensitivity Analysis: Impact of Limiting Estimated Annual Incidence of All-Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards to the Lowest Measured Level in the Study vs. to PRB, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1, 2]

Risk Assessment Location	Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Measured Down to:		Percent Difference[3]
	Lowest Measured Level in Study (5.8 ug/m3)	Estimated PRB	
Atlanta, GA	731 (467 - 990)	1071 (687 - 1446)	47%
Baltimore, MD	563 (359 - 764)	937 (601 - 1265)	66%
Birmingham, AL	429 (274 - 581)	643 (412 - 869)	50%
Dallas, TX	399 (254 - 542)	689 (440 - 932)	73%
Detroit, MI	469 (299 - 638)	934 (598 - 1265)	99%
Fresno, CA	144 (92 - 196)	296 (189 - 401)	106%
Houston, TX	880 (562 - 1193)	1300 (834 - 1755)	48%
Los Angeles, CA	1257 (799 - 1711)	2783 (1778 - 3770)	121%
New York, NY	1370 (871 - 1863)	2813 (1799 - 3807)	105%
Philadelphia, PA	530 (338 - 719)	917 (588 - 1239)	73%
Phoenix, AZ	580 (369 - 789)	1262 (807 - 1709)	118%
Pittsburgh, PA	303 (193 - 413)	667 (426 - 904)	120%
Salt Lake City, UT	67 (43 - 91)	197 (126 - 268)	194%
St. Louis, MO	698 (445 - 948)	1191 (763 - 1609)	71%
Tacoma, WA	69 (44 - 94)	205 (131 - 278)	197%

[1]Estimates based on Table 33 in Krewski et al. (2009) -- exposure period from 1999 - 2000, follow-up through 2000, models with 44 individual and 7 ecological covariates.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality estimated down to PRB - mortality estimated down to LML)/(mortality estimated down to LML).

Table F-7. Sensitivity Analysis: Impact of Using a Different Study to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]		Percent Difference[5]
	Krewski et al. (2009)[3]	Krewski et al. (2000)[4]	
Los Angeles, CA			
All Cause Mortality	1432 (911 - 1948)	1072 (-1096 - 3160)	-25%
Cardiopulmonary Mortality	1626 (1270 - 1977)	718 (-726 - 2089)	-56%
Lung Cancer Mortality	174 (76 - 269)	-162 (-604 - 227)	-193%
Philadelphia, PA			
All Cause Mortality	547 (349 - 743)	410 (-423 - 1198)	-25%
Cardiopulmonary Mortality	512 (401 - 620)	228 (-233 - 655)	-55%
Lung Cancer Mortality	83 (37 - 127)	-79 (-306 - 107)	-195%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in Krewski et al., 2009 (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 21b in Krewski et al. (2000) [reanalysis of Six Cities Study].

[5]Calculated as (Krewski et al. (2000) estimate - Krewski et al. (2009) estimate)/(Krewski et al. (2009) estimate).

Table F-8. Sensitivity Analysis: Impact of Using a Different Study to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]		Percent Difference[5]
	Krewski et al. (2009)[3]	Krewski et al. (2000)[4]	
Los Angeles, CA			
All Cause Mortality	1221 (776 - 1662)	914 (-931 - 2700)	-25%
Cardiopulmonary Mortality	1390 (1084 - 1692)	612 (-616 - 1787)	-56%
Lung Cancer Mortality	149 (65 - 231)	-137 (-507 - 194)	-192%
Philadelphia, PA			
All Cause Mortality	536 (341 - 727)	402 (-414 - 1173)	-25%
Cardiopulmonary Mortality	501 (393 - 608)	223 (-228 - 641)	-55%
Lung Cancer Mortality	81 (36 - 125)	-77 (-299 - 105)	-195%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in Krewski et al., 2009 (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 21b in Krewski et al. (2000) [reanalysis of Six Cities Study].

[5]Calculated as (Krewski et al. (2000) estimate - Krewski et al. (2009) estimate)/(Krewski et al. (2009) estimate).

Table F-9. Sensitivity Analysis: Impact of Using a Different Study to Estimate the Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Endpoint	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]		Percent Difference[5]
	Krewski et al. (2009)[3]	Krewski et al. (2000)[4]	
Los Angeles, CA			
All Cause Mortality	1257 (799 - 1711)	941 (-959 - 2780)	-25%
Cardiopulmonary Mortality	1431 (1116 - 1741)	630 (-635 - 1840)	-56%
Lung Cancer Mortality	153 (67 - 238)	-141 (-523 - 200)	-192%
Philadelphia, PA			
All Cause Mortality	530 (338 - 719)	397 (-410 - 1160)	-25%
Cardiopulmonary Mortality	496 (388 - 601)	221 (-226 - 635)	-55%
Lung Cancer Mortality	80 (35 - 123)	-76 (-295 - 104)	-195%

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Mortality incidence was estimated for $PM_{2.5}$ concentrations down to the lowest measured level in Krewski et al., 2009 (5.8 ug/m^3).

[3]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[4]Estimates based on Table 21b in Krewski et al. (2000) [reanalysis of Six Cities Study].

[5]Calculated as (Krewski et al. (2000) estimate - Krewski et al. (2009) estimate)/(Krewski et al. (2009) estimate).

Table F-10. Sensitivity Analysis: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	696 (444 - 942)	561 (358 - 761)	485 (309 - 659)	541 (345 - 734)	384 (245 - 522)
	Hybrid	687 (439 - 931)	586 (374 - 795)	508 (324 - 690)	534 (340 - 724)	378 (241 - 514)
	Percent Difference [3]	-1%	4%	5%	-1%	-2%
Birmingham, AL	Proportional	451 (288 - 611)	352 (224 - 478)	302 (193 - 411)	352 (224 - 478)	256 (163 - 348)
	Hybrid	452 (289 - 613)	353 (225 - 480)	304 (193 - 412)	353 (225 - 480)	268 (170 - 364)
	Percent Difference	0%	0%	1%	0%	5%
Detroit, MI	Proportional	697 (445 - 946)	601 (383 - 817)	514 (327 - 698)	528 (336 - 717)	356 (226 - 485)
	Hybrid	738 (471 - 1001)	716 (457 - 972)	620 (395 - 841)	563 (358 - 765)	386 (245 - 525)
	Percent Difference	6%	19%	21%	7%	8%
Los Angeles, CA	Proportional	1432 (911 - 1948)	1432 (911 - 1948)	1265 (804 - 1722)	1001 (636 - 1363)	566 (359 - 772)
	Hybrid	1775 (1131 - 2412)	1698 (1081 - 2308)	1435 (913 - 1952)	1296 (824 - 1764)	812 (516 - 1107)
	Percent Difference	24%	19%	13%	29%	43%
New York, NY	Proportional	1600 (1019 - 2174)	1521 (969 - 2068)	1282 (815 - 1744)	1159 (737 - 1578)	714 (454 - 974)
	Hybrid	1650 (1051 - 2242)	1518 (966 - 2063)	1278 (813 - 1739)	1202 (765 - 1637)	751 (477 - 1023)
	Percent Difference	3%	0%	0%	4%	5%
Pittsburgh, PA	Proportional	366 (233 - 498)	366 (233 - 498)	366 (233 - 498)	259 (164 - 352)	150 (95 - 205)
	Hybrid	518 (330 - 703)	487 (310 - 661)	417 (266 - 567)	389 (248 - 530)	259 (165 - 353)
	Percent Difference	42%	33%	14%	50%	73%
St. Louis, MO	Proportional	857 (547 - 1161)	679 (433 - 922)	583 (371 - 792)	661 (421 - 897)	463 (295 - 630)
	Hybrid	930 (594 - 1260)	732 (467 - 993)	631 (402 - 858)	732 (467 - 993)	529 (337 - 720)
	Percent Difference	9%	8%	8%	11%	14%

[1]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-11. Sensitivity Analysis: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	603 (385 - 817)	479 (305 - 651)	409 (261 - 557)	460 (293 - 626)	317 (201 - 431)
	Hybrid	594 (379 - 806)	501 (320 - 681)	430 (274 - 584)	453 (289 - 616)	311 (198 - 423)
	Percent Difference [3]	-1%	5%	5%	-2%	-2%
Birmingham, AL	Proportional	434 (277 - 589)	337 (215 - 458)	289 (184 - 392)	337 (215 - 458)	243 (155 - 331)
	Hybrid	434 (277 - 589)	337 (215 - 458)	289 (184 - 392)	337 (215 - 458)	253 (161 - 345)
	Percent Difference	0%	0%	0%	0%	4%
Detroit, MI	Proportional	508 (323 - 690)	427 (271 - 581)	353 (224 - 480)	364 (232 - 496)	220 (140 - 300)
	Hybrid	541 (344 - 735)	523 (333 - 710)	441 (280 - 600)	393 (250 - 535)	244 (155 - 332)
	Percent Difference	6%	22%	25%	8%	11%
Los Angeles, CA	Proportional	1221 (776 - 1662)	1221 (776 - 1662)	1064 (676 - 1450)	817 (519 - 1114)	411 (261 - 561)
	Hybrid	1540 (980 - 2094)	1468 (934 - 1996)	1222 (777 - 1664)	1092 (694 - 1487)	640 (406 - 873)
	Percent Difference	26%	20%	15%	34%	56%
New York, NY	Proportional	1345 (855 - 1829)	1272 (809 - 1731)	1050 (668 - 1430)	937 (595 - 1277)	526 (334 - 718)
	Hybrid	1389 (884 - 1889)	1267 (806 - 1724)	1045 (664 - 1424)	975 (620 - 1329)	558 (354 - 762)
	Percent Difference	3%	0%	0%	4%	6%
Pittsburgh, PA	Proportional	297 (189 - 404)	297 (189 - 404)	297 (189 - 404)	199 (126 - 272)	101 (64 - 138)
	Hybrid	430 (274 - 584)	402 (256 - 546)	339 (215 - 461)	314 (200 - 427)	197 (125 - 268)
	Percent Difference	45%	35%	14%	58%	95%
St. Louis, MO	Proportional	652 (415 - 885)	500 (318 - 680)	417 (265 - 568)	484 (308 - 659)	315 (200 - 429)
	Hybrid	714 (455 - 969)	543 (346 - 739)	458 (291 - 623)	543 (346 - 739)	370 (235 - 504)
	Percent Difference	10%	9%	10%	12%	17%

[1]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-12. Sensitivity Analysis: Estimated Annual Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of All Cause Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	563 (359 - 764)	444 (283 - 604)	377 (240 - 513)	426 (271 - 579)	288 (183 - 393)
	Hybrid	555 (354 - 555)	465 (296 - 465)	397 (252 - 397)	419 (267 - 419)	282 (179 - 282)
	Percent Difference [3]	-1%	5%	5%	-2%	-2%
Birmingham, AL	Proportional	429 (274 - 581)	332 (212 - 452)	284 (181 - 386)	332 (212 - 452)	239 (152 - 325)
	Hybrid	429 (274 - 429)	333 (212 - 333)	284 (181 - 284)	333 (212 - 333)	249 (159 - 249)
	Percent Difference	0%	0%	0%	0%	4%
Detroit, MI	Proportional	469 (299 - 638)	392 (249 - 533)	321 (204 - 437)	332 (211 - 452)	193 (123 - 264)
	Hybrid	502 (319 - 502)	484 (308 - 484)	406 (258 - 406)	360 (229 - 360)	217 (138 - 217)
	Percent Difference	7%	23%	26%	8%	12%
Los Angeles, CA	Proportional	1257 (799 - 1711)	1257 (799 - 1711)	1098 (698 - 1496)	847 (538 - 1155)	434 (275 - 593)
	Hybrid	1582 (1007 - 1582)	1508 (960 - 1508)	1259 (800 - 1259)	1126 (716 - 1126)	668 (424 - 668)
	Percent Difference	26%	20%	15%	33%	54%
New York, NY	Proportional	1370 (871 - 1863)	1296 (824 - 1764)	1072 (681 - 1459)	957 (608 - 1304)	541 (343 - 739)
	Hybrid	1415 (900 - 1415)	1291 (821 - 1291)	1067 (678 - 1067)	996 (633 - 996)	574 (364 - 574)
	Percent Difference	3%	0%	0%	4%	6%
Pittsburgh, PA	Proportional	303 (193 - 413)	303 (193 - 413)	303 (193 - 413)	205 (130 - 280)	106 (67 - 145)
	Hybrid	437 (278 - 437)	408 (260 - 408)	345 (219 - 345)	320 (203 - 320)	202 (128 - 202)
	Percent Difference	44%	35%	14%	56%	91%
St. Louis, MO	Proportional	698 (445 - 948)	540 (344 - 735)	455 (289 - 619)	524 (334 - 713)	348 (221 - 474)
	Hybrid	766 (489 - 766)	589 (375 - 589)	500 (318 - 500)	589 (375 - 589)	408 (260 - 408)
	Percent Difference	10%	9%	10%	12%	17%

[1]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000, using models with 44 individual and 7 ecological covariates (see Table 33 in Krewski et al., 2009).

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-13. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	53 (8 - 97)	52 (3 - 99)	43 (-15 - 101)	33 (-17 - 83)	181 --- [4]	175 (33 - 316)	3%
Baltimore, MD	67 (9 - 124)	47 (1 - 93)	59 (-7 - 123)	49 (7 - 91)	222 ---	256 (104 - 406)	-13%
Birmingham, AL	21 (-5 - 47)	28 (-3 - 59)	18 (-23 - 59)	11 (-24 - 45)	78 ---	38 (-60 - 135)	105%
Dallas, TX	30 (-5 - 64)	28 (-8 - 64)	41 (-3 - 85)	44 (6 - 82)	143 ---	151 (36 - 264)	-5%
Detroit, MI	-6 (-81 - 67)	76 (19 - 132)	53 (-32 - 136)	30 (-28 - 86)	153 ---	141 (-25 - 305)	9%
Fresno, CA	0 (-34 - 34)	15 (-1 - 32)	3 (-14 - 21)	11 (-12 - 34)	29 ---	44 (6 - 82)	-34%
Houston, TX	49 (-5 - 102)	64 (5 - 123)	56 (-14 - 125)	59 (-10 - 127)	228 ---	232 (47 - 414)	-2%
Los Angeles, CA	17 (-86 - 120)	66 (-35 - 167)	-109 (-271 - 50)	-2 (-96 - 90)	-28 ---	85 (-121 - 289)	-133%
New York, NY	264 (97 - 428)	142 (1 - 281)	122 (-49 - 289)	189 (82 - 295)	717 ---	714 (419 - 1007)	0%
Philadelphia, PA	90 (19 - 159)	29 (-33 - 89)	33 (-47 - 110)	63 (16 - 110)	215 ---	211 (78 - 342)	2%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	240 (40 - 438)	---
Pittsburgh, PA	39 (-4 - 80)	56 (10 - 101)	36 (-19 - 91)	20 (-23 - 62)	151 ---	135 (40 - 230)	12%
Salt Lake City, UT	17 (-2 - 35)	7 (-2 - 16)	7 (-6 - 19)	9 (-4 - 21)	40 ---	33 (7 - 59)	21%
St. Louis, MO	36 (-36 - 106)	70 (13 - 126)	67 (-6 - 138)	70 (12 - 126)	243 ---	252 (73 - 429)	-4%
Tacoma, WA	1 (-53 - 53)	9 (-7 - 25)	4 (-9 - 17)	14 (-10 - 37)	28 ---	48 (8 - 87)	-42%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-14. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	47 (7 - 86)	54 (3 - 105)	49 (-17 - 113)	28 (-14 - 69)	178 --- [4]	172 (33 - 310)	3%
Baltimore, MD	55 (7 - 102)	42 (1 - 82)	56 (-6 - 118)	49 (7 - 91)	202 ---	234 (95 - 372)	-14%
Birmingham, AL	22 (-5 - 49)	31 (-3 - 64)	19 (-24 - 61)	9 (-19 - 36)	81 ---	38 (-59 - 132)	113%
Dallas, TX	23 (-4 - 50)	29 (-9 - 66)	36 (-3 - 75)	33 (4 - 61)	121 ---	129 (31 - 226)	-6%
Detroit, MI	-4 (-59 - 50)	75 (19 - 130)	42 (-25 - 107)	26 (-24 - 76)	139 ---	117 (-21 - 254)	19%
Fresno, CA	1 (-37 - 37)	15 (-1 - 30)	4 (-15 - 23)	11 (-12 - 34)	31 ---	46 (7 - 86)	-33%
Houston, TX	49 (-5 - 103)	82 (6 - 156)	61 (-15 - 135)	51 (-8 - 109)	243 ---	243 (50 - 434)	0%
Los Angeles, CA	18 (-88 - 123)	57 (-30 - 144)	-102 (-252 - 47)	-2 (-83 - 79)	-29 ---	78 (-112 - 267)	-137%
New York, NY	230 (84 - 374)	126 (1 - 250)	113 (-45 - 268)	187 (81 - 292)	656 ---	654 (384 - 922)	0%
Philadelphia, PA	78 (16 - 139)	27 (-31 - 84)	33 (-47 - 111)	72 (18 - 125)	210 ---	208 (77 - 337)	1%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	255 (42 - 466)	---
Pittsburgh, PA	34 (-3 - 71)	52 (9 - 94)	35 (-18 - 88)	16 (-19 - 50)	137 ---	122 (36 - 208)	12%
Salt Lake City, UT	13 (-2 - 28)	7 (-2 - 16)	7 (-7 - 21)	8 (-3 - 19)	35 ---	30 (6 - 54)	17%
St. Louis, MO	27 (-27 - 79)	65 (12 - 118)	57 (-5 - 118)	60 (10 - 110)	209 ---	214 (62 - 364)	-2%
Tacoma, WA	1 (-36 - 36)	10 (-8 - 26)	4 (-10 - 19)	12 (-8 - 31)	27 ---	39 (7 - 71)	-31%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-15. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	47 (7 - 86)	70 (4 - 134)	53 (-18 - 122)	31 (-16 - 77)	201 --- [4]	177 (34 - 319)	14%
Baltimore, MD	55 (7 - 102)	44 (1 - 87)	57 (-6 - 118)	50 (7 - 92)	206 ---	225 (91 - 357)	-8%
Birmingham, AL	23 (-5 - 50)	50 (-6 - 104)	22 (-28 - 70)	11 (-23 - 43)	106 ---	37 (-58 - 131)	186%
Dallas, TX	28 (-5 - 60)	25 (-8 - 57)	38 (-3 - 79)	39 (5 - 72)	130 ---	137 (33 - 240)	-5%
Detroit, MI	-5 (-76 - 63)	71 (18 - 124)	43 (-26 - 109)	39 (-37 - 113)	148 ---	112 (-20 - 242)	32%
Fresno, CA	1 (-84 - 80)	26 (-2 - 53)	6 (-24 - 34)	23 (-24 - 68)	56 ---	51 (7 - 94)	10%
Houston, TX	58 (-6 - 121)	73 (6 - 140)	65 (-16 - 146)	55 (-9 - 118)	251 ---	240 (49 - 429)	5%
Los Angeles, CA	23 (-115 - 160)	117 (-62 - 294)	-148 (-369 - 68)	-3 (-145 - 136)	-11 ---	79 (-113 - 270)	-114%
New York, NY	269 (98 - 436)	161 (1 - 319)	133 (-54 - 316)	234 (102 - 365)	797 ---	659 (387 - 930)	21%
Philadelphia, PA	87 (18 - 155)	31 (-35 - 95)	34 (-49 - 115)	76 (19 - 132)	228 ---	206 (76 - 334)	11%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	242 (40 - 441)	---
Pittsburgh, PA	54 (-5 - 112)	89 (16 - 160)	59 (-31 - 146)	32 (-37 - 99)	234 ---	123 (36 - 209)	90%
Salt Lake City, UT	29 (-3 - 60)	13 (-4 - 29)	12 (-10 - 33)	14 (-6 - 34)	68 ---	36 (7 - 65)	89%
St. Louis, MO	31 (-32 - 93)	80 (15 - 144)	64 (-6 - 132)	69 (12 - 124)	244 ---	222 (64 - 378)	10%
Tacoma, WA	1 (-47 - 46)	12 (-9 - 32)	4 (-9 - 16)	20 (-14 - 52)	37 ---	42 (7 - 76)	-12%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-16. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	14 (-20 - 46)	9 (-32 - 47)	9 (-32 - 47)	-2 (-37 - 31)	30 --- [4]	32 (-32 - 94)	-6%
Baltimore, MD	16 (-31 - 60)	10 (-32 - 49)	11 (-44 - 63)	32 (-2 - 64)	69 ---	70 (-5 - 142)	-1%
Birmingham, AL	5 (-18 - 27)	1 (-27 - 28)	0 (-32 - 29)	-18 (-46 - 10)	-12 ---	-1 (-48 - 45)	1100%
Dallas, TX	10 (-18 - 36)	11 (-19 - 40)	12 (-24 - 47)	-2 (-32 - 27)	31 ---	31 (-21 - 82)	0%
Detroit, MI	-1 (-47 - 42)	25 (-7 - 56)	28 (-21 - 74)	32 (0 - 63)	84 ---	70 (-9 - 147)	20%
Fresno, CA	-2 (-13 - 8)	1 (-3 - 5)	0 (-4 - 4)	3 (-4 - 9)	2 ---	11 (-8 - 30)	-82%
Houston, TX	9 (-37 - 53)	2 (-49 - 50)	30 (-24 - 81)	8 (-44 - 58)	49 ---	51 (-34 - 134)	-4%
Los Angeles, CA	-7 (-55 - 40)	3 (-45 - 50)	-46 (-111 - 18)	0 (-46 - 46)	-50 ---	-33 (-146 - 79)	52%
New York, NY	141 (33 - 246)	116 (26 - 204)	143 (27 - 256)	92 (21 - 160)	492 ---	460 (268 - 649)	7%
Philadelphia, PA	27 (-5 - 58)	16 (-15 - 46)	26 (-12 - 63)	27 (4 - 49)	96 ---	85 (22 - 147)	13%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	83 (-4 - 169)	---
Pittsburgh, PA	13 (-9 - 34)	26 (2 - 48)	11 (-19 - 39)	4 (-17 - 24)	54 ---	40 (-8 - 88)	35%
Salt Lake City, UT [5]	--- ---	--- ---	--- ---	--- ---	--- ---	9 (-2 - 19)	---
St. Louis, MO	-3 (-66 - 57)	44 (-2 - 88)	38 (-18 - 91)	41 (-4 - 84)	120 ---	118 (26 - 208)	2%
Tacoma, WA	0 (-12 - 13)	0 (-3 - 4)	0 (-2 - 3)	2 (-4 - 7)	2 ---	12 (-7 - 31)	-83%

[1] Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2] The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-17. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	12 (-18 - 41)	9 (-33 - 50)	10 (-36 - 53)	-2 (-31 - 26)	29 --- [4]	31 (-32 - 93)	-6%
Baltimore, MD	13 (-25 - 50)	9 (-28 - 43)	11 (-42 - 60)	32 (-2 - 64)	65 ---	64 (-4 - 130)	2%
Birmingham, AL	5 (-19 - 28)	1 (-29 - 31)	0 (-33 - 30)	-14 (-36 - 8)	-8 ---	-1 (-47 - 44)	700%
Dallas, TX	8 (-14 - 28)	11 (-20 - 41)	11 (-21 - 41)	-1 (-23 - 20)	29 ---	27 (-18 - 71)	7%
Detroit, MI	-1 (-34 - 31)	25 (-7 - 55)	22 (-16 - 58)	28 (0 - 56)	74 ---	58 (-7 - 122)	28%
Fresno, CA	-2 (-14 - 9)	1 (-3 - 5)	0 (-4 - 5)	3 (-4 - 9)	2 ---	12 (-8 - 32)	-83%
Houston, TX	9 (-37 - 53)	2 (-63 - 64)	32 (-26 - 87)	7 (-38 - 50)	50 ---	53 (-36 - 140)	-6%
Los Angeles, CA	-8 (-57 - 41)	2 (-39 - 43)	-43 (-103 - 17)	0 (-40 - 40)	-49 ---	-30 (-134 - 73)	63%
New York, NY	123 (29 - 215)	103 (23 - 182)	133 (25 - 237)	90 (21 - 158)	449 ---	421 (246 - 595)	7%
Philadelphia, PA	23 (-5 - 51)	15 (-14 - 43)	27 (-13 - 63)	31 (5 - 56)	96 ---	84 (22 - 144)	14%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	88 (-4 - 179)	---
Pittsburgh, PA	11 (-8 - 30)	24 (2 - 45)	10 (-18 - 38)	3 (-14 - 20)	48 ---	36 (-7 - 80)	33%
Salt Lake City, UT [5]	--- ---	--- ---	--- ---	--- ---	--- ---	8 (-2 - 18)	---
St. Louis, MO	-2 (-49 - 43)	41 (-2 - 83)	33 (-15 - 79)	36 (-3 - 73)	108 ---	101 (22 - 177)	7%
Tacoma, WA	0 (-9 - 9)	0 (-3 - 4)	0 (-2 - 3)	1 (-3 - 6)	1 ---	10 (-5 - 26)	-90%

[1] Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2] The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-18. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	11 (-16 - 38)	11 (-40 - 58)	10 (-35 - 52)	-2 (-31 - 27)	30 --- [4]	32 (-33 - 95)	-6%
Baltimore, MD	12 (-24 - 47)	9 (-28 - 44)	10 (-40 - 57)	31 (-2 - 62)	62 ---	61 (-4 - 125)	2%
Birmingham, AL	4 (-15 - 23)	2 (-38 - 39)	0 (-30 - 27)	-13 (-34 - 7)	-7 ---	-1 (-46 - 44)	600%
Dallas, TX	9 (-16 - 34)	10 (-17 - 36)	11 (-22 - 44)	-2 (-28 - 24)	28 ---	29 (-19 - 75)	-3%
Detroit, MI	-1 (-36 - 33)	19 (-5 - 43)	18 (-13 - 48)	34 (0 - 67)	70 ---	55 (-7 - 117)	27%
Fresno, CA	-3 (-17 - 11)	1 (-3 - 5)	0 (-3 - 4)	3 (-4 - 10)	1 ---	13 (-9 - 35)	-92%
Houston, TX	10 (-42 - 59)	2 (-53 - 54)	33 (-26 - 89)	7 (-39 - 51)	52 ---	52 (-36 - 139)	0%
Los Angeles, CA	-6 (-47 - 34)	3 (-50 - 55)	-39 (-94 - 15)	0 (-44 - 43)	-42 ---	-30 (-136 - 74)	40%
New York, NY	120 (28 - 209)	109 (24 - 193)	130 (25 - 233)	94 (22 - 165)	453 ---	425 (248 - 600)	7%
Philadelphia, PA	24 (-5 - 52)	16 (-14 - 45)	25 (-12 - 60)	30 (4 - 54)	95 ---	83 (22 - 143)	14%
Phoenix, AZ [5]	--- ---	--- ---	--- ---	--- ---	--- ---	84 (-4 - 170)	---
Pittsburgh, PA	10 (-7 - 28)	24 (2 - 45)	10 (-18 - 37)	4 (-16 - 23)	48 ---	37 (-7 - 80)	30%
Salt Lake City, UT [5]	--- ---	--- ---	--- ---	--- ---	--- ---	10 (-2 - 21)	---
St. Louis, MO	-2 (-52 - 45)	45 (-2 - 91)	33 (-15 - 79)	36 (-3 - 74)	112 ---	104 (23 - 184)	8%
Tacoma, WA	0 (-9 - 9)	0 (-3 - 4)	0 (-2 - 2)	2 (-5 - 8)	2 ---	11 (-6 - 27)	-82%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

[5] Season-specific coefficient estimates were not available from Zanobetti and Schwartz (2009) for this location.

Table F-19. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	4 (-6 - 13)	1 (-8 - 11)	3 (-7 - 13)	3 (-5 - 11)	11 --- [4]	19 (-8 - 46)	-42%
Baltimore, MD	5 (-6 - 16)	6 (-4 - 15)	6 (-6 - 17)	3 (-4 - 10)	20 ---	35 (7 - 63)	-43%
Birmingham, AL	1 (-4 - 6)	2 (-4 - 8)	-1 (-9 - 7)	4 (-2 - 10)	6 ---	10 (-8 - 29)	-40%
Dallas, TX	1 (-6 - 9)	3 (-4 - 9)	2 (-5 - 9)	1 (-5 - 7)	7 ---	11 (-10 - 31)	-36%
Detroit, MI	5 (-6 - 16)	9 (-1 - 18)	10 (0 - 19)	8 (0 - 16)	32 ---	27 (1 - 52)	19%
Fresno, CA	-1 (-11 - 9)	4 (-1 - 9)	1 (-2 - 4)	1 (-6 - 8)	5 ---	9 (0 - 17)	-44%
Houston, TX	6 (-4 - 16)	5 (-4 - 14)	4 (-6 - 14)	5 (-7 - 16)	20 ---	36 (6 - 66)	-44%
Los Angeles, CA	27 (-3 - 57)	28 (-2 - 56)	-16 (-61 - 27)	0 (-24 - 23)	39 ---	59 (6 - 112)	-34%
New York, NY	48 (18 - 78)	16 (-5 - 37)	20 (-9 - 47)	20 (1 - 39)	104 ---	97 (34 - 159)	7%
Philadelphia, PA	10 (-1 - 21)	7 (-1 - 15)	7 (-3 - 16)	5 (-2 - 11)	29 ---	23 (-2 - 46)	26%
Phoenix, AZ	27 (-28 - 77)	30 (-8 - 66)	21 (-3 - 45)	41 (14 - 67)	119 ---	47 (4 - 89)	153%
Pittsburgh, PA	4 (-3 - 10)	6 (-1 - 13)	6 (-2 - 14)	6 (0 - 12)	22 ---	17 (-2 - 35)	29%
Salt Lake City, UT	4 (-1 - 10)	2 (-2 - 6)	-2 (-7 - 3)	-1 (-6 - 4)	3 ---	6 (1 - 11)	-50%
St. Louis, MO	1 (-14 - 16)	7 (-6 - 19)	4 (-10 - 17)	6 (-5 - 18)	18 ---	30 (-8 - 67)	-40%
Tacoma, WA	0 (-15 - 13)	2 (-2 - 6)	1 (-2 - 3)	1 (-4 - 6)	4 ---	7 (0 - 15)	-43%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-20. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	3 (-5 - 11)	1 (-9 - 11)	4 (-8 - 15)	3 (-4 - 9)	11 --- [4]	19 (-8 - 45)	-42%
Baltimore, MD	4 (-5 - 13)	5 (-4 - 13)	5 (-6 - 16)	3 (-4 - 10)	17 ---	32 (6 - 58)	-47%
Birmingham, AL	1 (-4 - 6)	2 (-5 - 9)	-1 (-9 - 7)	3 (-2 - 8)	5 ---	10 (-8 - 28)	-50%
Dallas, TX	1 (-5 - 7)	3 (-4 - 10)	2 (-5 - 8)	1 (-4 - 5)	7 ---	9 (-9 - 27)	-22%
Detroit, MI	4 (-5 - 12)	8 (-1 - 17)	8 (0 - 15)	7 (0 - 14)	27 ---	23 (1 - 44)	17%
Fresno, CA	-1 (-12 - 10)	4 (-1 - 9)	1 (-2 - 5)	1 (-6 - 8)	5 ---	9 (0 - 18)	-44%
Houston, TX	6 (-4 - 16)	6 (-6 - 18)	5 (-7 - 15)	4 (-6 - 14)	21 ---	38 (6 - 69)	-45%
Los Angeles, CA	28 (-3 - 59)	24 (-2 - 49)	-15 (-57 - 26)	0 (-21 - 20)	37 ---	55 (5 - 104)	-33%
New York, NY	42 (16 - 68)	14 (-5 - 33)	18 (-8 - 44)	20 (1 - 38)	94 ---	89 (31 - 145)	6%
Philadelphia, PA	9 (-1 - 18)	7 (-1 - 14)	7 (-3 - 16)	5 (-2 - 12)	28 ---	22 (-2 - 46)	27%
Phoenix, AZ	31 (-33 - 89)	30 (-8 - 66)	22 (-3 - 46)	41 (14 - 67)	124 ---	50 (4 - 95)	148%
Pittsburgh, PA	3 (-3 - 9)	6 (-1 - 12)	6 (-2 - 14)	5 (0 - 10)	20 ---	15 (-2 - 32)	33%
Salt Lake City, UT	4 (-1 - 8)	2 (-2 - 6)	-2 (-7 - 3)	-1 (-5 - 3)	3 ---	5 (1 - 10)	-40%
St. Louis, MO	1 (-11 - 12)	6 (-6 - 18)	3 (-9 - 14)	5 (-5 - 15)	15 ---	26 (-7 - 57)	-42%
Tacoma, WA	0 (-10 - 9)	2 (-2 - 6)	1 (-2 - 4)	1 (-3 - 5)	4 ---	6 (0 - 12)	-33%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-21. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	3 (-5 - 10)	2 (-10 - 13)	4 (-8 - 15)	3 (-4 - 9)	12 --- [4]	20 (-8 - 47)	-40%
Baltimore, MD	4 (-5 - 12)	5 (-4 - 14)	5 (-5 - 15)	3 (-4 - 10)	17 ---	31 (6 - 56)	-45%
Birmingham, AL	1 (-4 - 5)	3 (-6 - 11)	-1 (-8 - 7)	3 (-2 - 7)	6 ---	10 (-8 - 28)	-40%
Dallas, TX	1 (-6 - 8)	3 (-3 - 9)	2 (-5 - 8)	1 (-5 - 6)	7 ---	10 (-9 - 29)	-30%
Detroit, MI	4 (-5 - 12)	7 (0 - 13)	7 (0 - 13)	9 (0 - 17)	27 ---	22 (1 - 42)	23%
Fresno, CA	-1 (-14 - 12)	4 (-1 - 8)	1 (-2 - 4)	2 (-6 - 9)	6 ---	10 (0 - 19)	-40%
Houston, TX	6 (-5 - 18)	5 (-5 - 15)	5 (-7 - 15)	4 (-6 - 14)	20 ---	38 (6 - 68)	-47%
Los Angeles, CA	23 (-2 - 48)	31 (-2 - 63)	-14 (-52 - 23)	0 (-23 - 21)	40 ---	56 (5 - 105)	-29%
New York, NY	41 (15 - 66)	15 (-5 - 35)	18 (-8 - 43)	21 (1 - 40)	95 ---	90 (32 - 147)	6%
Philadelphia, PA	9 (-1 - 18)	7 (-1 - 15)	7 (-3 - 15)	5 (-2 - 12)	28 ---	22 (-2 - 45)	27%
Phoenix, AZ	24 (-25 - 69)	29 (-8 - 63)	25 (-4 - 51)	45 (15 - 73)	123 ---	47 (4 - 90)	162%
Pittsburgh, PA	3 (-2 - 8)	6 (-1 - 12)	6 (-2 - 13)	5 (0 - 11)	20 ---	16 (-2 - 32)	25%
Salt Lake City, UT	5 (-2 - 11)	2 (-3 - 7)	-2 (-7 - 3)	-1 (-6 - 4)	4 ---	6 (1 - 12)	-33%
St. Louis, MO	1 (-11 - 13)	7 (-6 - 19)	3 (-9 - 14)	6 (-5 - 15)	17 ---	27 (-7 - 59)	-37%
Tacoma, WA	0 (-11 - 10)	2 (-2 - 6)	1 (-1 - 3)	1 (-5 - 7)	4 ---	6 (0 - 13)	-33%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons mortality - all-year mortality)/(all-year mortality).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-22. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	29 (-2 - 59)	24 (-8 - 55)	-29 (-70 - 11)	6 (-27 - 39)	30 --- [4]	40 (-26 - 105)	-25%
Baltimore, MD	131 (92 - 171)	46 (16 - 76)	39 (6 - 72)	47 (22 - 72)	263 ---	247 (182 - 313)	6%
Birmingham, AL	12 (-1 - 24)	11 (-4 - 25)	-14 (-34 - 5)	3 (-13 - 19)	12 ---	18 (-12 - 48)	-33%
Dallas, TX	24 (-2 - 49)	18 (-6 - 42)	-20 (-49 - 8)	4 (-19 - 27)	26 ---	30 (-19 - 78)	-13%
Detroit, MI	149 (104 - 193)	54 (18 - 88)	40 (6 - 73)	50 (24 - 77)	293 ---	269 (198 - 340)	9%
Fresno, CA	14 (-5 - 32)	11 (-5 - 27)	-7 (-29 - 15)	3 (-11 - 17)	21 ---	21 (0 - 42)	0%
Houston, TX	48 (-3 - 98)	36 (-13 - 85)	-39 (-94 - 15)	10 (-44 - 64)	55 ---	61 (-40 - 161)	-10%
Los Angeles, CA	106 (-36 - 247)	196 (-99 - 481)	-152 (-647 - 322)	44 (-147 - 232)	194 ---	274 (3 - 543)	-29%
New York, NY	370 (258 - 481)	144 (49 - 238)	117 (17 - 216)	133 (63 - 203)	764 ---	724 (532 - 915)	6%
Philadelphia, PA	114 (79 - 148)	39 (13 - 64)	34 (5 - 63)	38 (18 - 58)	225 ---	210 (154 - 265)	7%
Phoenix, AZ	57 (-19 - 132)	82 (-41 - 202)	-47 (-198 - 99)	14 (-47 - 75)	106 ---	107 (1 - 212)	-1%
Pittsburgh, PA	52 (36 - 68)	27 (9 - 44)	23 (3 - 43)	31 (14 - 47)	133 ---	134 (98 - 169)	-1%
Salt Lake City, UT	6 (-2 - 14)	4 (-2 - 11)	-4 (-17 - 8)	1 (-4 - 6)	7 ---	9 (0 - 17)	-22%
St. Louis, MO	100 (70 - 130)	41 (14 - 67)	30 (4 - 55)	41 (19 - 63)	212 ---	200 (147 - 253)	6%
Tacoma, WA	12 (-65 - 82)	0 (-61 - 55)	-5 (-56 - 42)	-5 (-53 - 40)	2 ---	21 (-52 - 92)	-90%

[1]Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-23. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	26 (-2 - 53)	25 (-9 - 58)	-32 (-78 - 13)	5 (-23 - 33)	24 --- [4]	39 (-26 - 103)	-38%
Baltimore, MD	107 (75 - 139)	41 (14 - 67)	37 (6 - 69)	47 (22 - 72)	232 ---	224 (165 - 284)	4%
Birmingham, AL	12 (-1 - 24)	12 (-4 - 27)	-14 (-34 - 6)	2 (-10 - 15)	12 ---	18 (-12 - 47)	-33%
Dallas, TX	19 (-1 - 39)	19 (-7 - 44)	-18 (-43 - 7)	3 (-14 - 21)	23 ---	25 (-17 - 67)	-8%
Detroit, MI	110 (77 - 144)	53 (18 - 87)	31 (5 - 57)	45 (21 - 68)	239 ---	224 (165 - 284)	7%
Fresno, CA	15 (-5 - 35)	10 (-5 - 26)	-7 (-32 - 16)	3 (-11 - 17)	21 ---	22 (0 - 44)	-5%
Houston, TX	48 (-3 - 100)	46 (-17 - 108)	-42 (-102 - 16)	9 (-38 - 55)	61 ---	64 (-42 - 170)	-5%
Los Angeles, CA	111 (-38 - 258)	172 (-86 - 424)	-144 (-612 - 306)	39 (-129 - 205)	178 ---	258 (3 - 511)	-31%
New York, NY	325 (227 - 422)	129 (44 - 213)	109 (16 - 201)	132 (62 - 202)	695 ---	666 (489 - 843)	4%
Philadelphia, PA	98 (69 - 128)	36 (12 - 60)	34 (5 - 63)	43 (20 - 65)	211 ---	204 (150 - 258)	3%
Phoenix, AZ	66 (-22 - 153)	81 (-41 - 199)	-48 (-205 - 103)	14 (-47 - 75)	113 ---	113 (1 - 225)	0%
Pittsburgh, PA	46 (32 - 60)	25 (8 - 41)	22 (3 - 41)	25 (12 - 38)	118 ---	120 (88 - 152)	-2%
Salt Lake City, UT	5 (-2 - 11)	5 (-2 - 12)	-4 (-19 - 9)	1 (-3 - 5)	7 ---	8 (0 - 16)	-13%
St. Louis, MO	76 (53 - 98)	38 (13 - 63)	26 (4 - 48)	36 (17 - 55)	176 ---	171 (125 - 216)	3%
Tacoma, WA	9 (-45 - 57)	0 (-64 - 59)	-6 (-61 - 46)	-4 (-43 - 33)	-1 ---	18 (-43 - 76)	-106%

[1]Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-24. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Cardiovascular Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	24 (-2 - 49)	30 (-11 - 69)	-33 (-79 - 13)	5 (-23 - 34)	26 --- [4]	41 (-27 - 108)	-37%
Baltimore, MD	101 (70 - 131)	41 (14 - 67)	35 (5 - 65)	45 (21 - 69)	222 ---	215 (158 - 271)	3%
Birmingham, AL	10 (-1 - 20)	15 (-5 - 35)	-13 (-31 - 5)	2 (-10 - 14)	14 ---	17 (-11 - 46)	-18%
Dallas, TX	23 (-2 - 47)	16 (-6 - 38)	-19 (-46 - 7)	4 (-17 - 25)	24 ---	27 (-18 - 72)	-11%
Detroit, MI	115 (81 - 150)	41 (14 - 68)	26 (4 - 48)	54 (26 - 83)	236 ---	215 (158 - 272)	10%
Fresno, CA	18 (-6 - 42)	10 (-5 - 25)	-6 (-27 - 13)	4 (-12 - 19)	26 ---	24 (0 - 48)	8%
Houston, TX	55 (-4 - 112)	40 (-14 - 93)	-43 (-105 - 17)	9 (-39 - 57)	61 ---	64 (-42 - 169)	-5%
Los Angeles, CA	93 (-32 - 217)	226 (-114 - 556)	-135 (-571 - 286)	44 (-144 - 228)	228 ---	265 (3 - 526)	-14%
New York, NY	318 (222 - 413)	137 (47 - 227)	108 (16 - 199)	139 (65 - 212)	702 ---	676 (496 - 855)	4%
Philadelphia, PA	100 (70 - 130)	37 (13 - 62)	32 (5 - 59)	41 (19 - 63)	210 ---	201 (148 - 254)	4%
Phoenix, AZ	51 (-17 - 118)	78 (-39 - 192)	-54 (-228 - 114)	16 (-52 - 82)	91 ---	108 (1 - 215)	-16%
Pittsburgh, PA	42 (29 - 54)	24 (8 - 40)	21 (3 - 39)	28 (13 - 43)	115 ---	120 (88 - 152)	-4%
Salt Lake City, UT	7 (-2 - 15)	5 (-3 - 13)	-4 (-19 - 10)	1 (-4 - 6)	9 ---	10 (0 - 20)	-10%
St. Louis, MO	79 (55 - 103)	41 (14 - 69)	26 (4 - 47)	36 (17 - 55)	182 ---	176 (129 - 222)	3%
Tacoma, WA	9 (-48 - 59)	0 (-64 - 59)	-4 (-43 - 33)	-6 (-63 - 47)	-1 ---	19 (-46 - 82)	-105%

[1]Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-25. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	6 (-20 - 31)	9 (-10 - 27)	-6 (-25 - 12)	1 (-13 - 15)	10 --- [4]	17 (-21 - 55)	-41%
Baltimore, MD	18 (-5 - 41)	1 (-14 - 15)	14 (0 - 28)	2 (-12 - 15)	35 ---	20 (-12 - 51)	75%
Birmingham, AL	2 (-8 - 12)	4 (-5 - 13)	-3 (-12 - 6)	1 (-6 - 7)	4 ---	8 (-10 - 25)	-50%
Dallas, TX	4 (-17 - 25)	7 (-8 - 21)	-5 (-20 - 10)	1 (-13 - 15)	7 ---	14 (-18 - 46)	-50%
Detroit, MI	23 (-6 - 51)	1 (-18 - 20)	17 (0 - 35)	2 (-12 - 16)	43 ---	24 (-14 - 62)	79%
Fresno, CA	10 (-1 - 21)	3 (-6 - 11)	4 (-4 - 12)	3 (-5 - 11)	20 ---	14 (3 - 25)	43%
Houston, TX	8 (-30 - 45)	13 (-14 - 40)	-9 (-37 - 18)	3 (-29 - 35)	15 ---	27 (-34 - 88)	-44%
Los Angeles, CA	73 (-6 - 151)	46 (-98 - 184)	90 (-103 - 273)	44 (-64 - 149)	253 ---	177 (41 - 311)	43%
New York, NY	54 (-15 - 122)	2 (-46 - 50)	44 (-1 - 88)	4 (-31 - 39)	104 ---	60 (-35 - 154)	73%
Philadelphia, PA	16 (-4 - 36)	1 (-12 - 13)	12 (0 - 24)	1 (-9 - 12)	30 ---	17 (-10 - 43)	76%
Phoenix, AZ	34 (-3 - 70)	17 (-36 - 68)	23 (-26 - 70)	13 (-18 - 43)	87 ---	61 (14 - 106)	43%
Pittsburgh, PA	7 (-2 - 16)	0 (-9 - 9)	8 (0 - 16)	1 (-8 - 10)	16 ---	11 (-6 - 28)	45%
Salt Lake City, UT	4 (0 - 9)	1 (-3 - 5)	3 (-3 - 8)	1 (-2 - 4)	9 ---	6 (1 - 11)	50%
St. Louis, MO	23 (-6 - 51)	1 (-18 - 19)	15 (0 - 29)	2 (-15 - 19)	41 ---	24 (-14 - 62)	71%
Tacoma, WA	0 (-50 - 43)	4 (-27 - 32)	1 (-19 - 19)	-2 (-25 - 18)	3 ---	2 (-27 - 30)	50%

[1] Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2] The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-26. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	5 (-18 - 27)	9 (-11 - 29)	-7 (-29 - 14)	1 (-11 - 13)	8 --- [4]	17 (-21 - 54)	-53%
Baltimore, MD	15 (-4 - 34)	1 (-12 - 13)	13 (0 - 26)	2 (-12 - 15)	31 ---	18 (-11 - 46)	72%
Birmingham, AL	2 (-8 - 13)	4 (-5 - 14)	-3 (-13 - 6)	0 (-5 - 6)	3 ---	8 (-10 - 24)	-63%
Dallas, TX	4 (-13 - 20)	7 (-8 - 22)	-4 (-18 - 9)	1 (-10 - 11)	8 ---	12 (-15 - 40)	-33%
Detroit, MI	17 (-5 - 38)	1 (-18 - 19)	14 (0 - 27)	2 (-11 - 14)	34 ---	20 (-12 - 52)	70%
Fresno, CA	11 (-1 - 23)	3 (-5 - 10)	4 (-5 - 13)	3 (-5 - 11)	21 ---	15 (3 - 26)	40%
Houston, TX	8 (-30 - 45)	17 (-19 - 51)	-10 (-40 - 20)	3 (-25 - 30)	18 ---	29 (-36 - 93)	-38%
Los Angeles, CA	77 (-7 - 158)	40 (-86 - 162)	86 (-98 - 261)	39 (-56 - 132)	242 ---	166 (39 - 293)	46%
New York, NY	48 (-13 - 107)	2 (-41 - 45)	41 (-1 - 82)	4 (-30 - 39)	95 ---	55 (-32 - 142)	73%
Philadelphia, PA	14 (-4 - 31)	0 (-11 - 12)	12 (0 - 24)	2 (-10 - 13)	28 ---	16 (-10 - 42)	75%
Phoenix, AZ	40 (-3 - 82)	17 (-36 - 67)	24 (-27 - 73)	13 (-18 - 43)	94 ---	64 (15 - 113)	47%
Pittsburgh, PA	6 (-2 - 14)	0 (-8 - 9)	7 (0 - 15)	1 (-6 - 8)	14 ---	10 (-6 - 25)	40%
Salt Lake City, UT	3 (0 - 7)	1 (-3 - 5)	3 (-3 - 9)	1 (-2 - 4)	8 ---	6 (1 - 10)	33%
St. Louis, MO	17 (-5 - 39)	1 (-17 - 18)	13 (0 - 25)	2 (-13 - 16)	33 ---	21 (-12 - 53)	57%
Tacoma, WA	0 (-35 - 29)	4 (-29 - 34)	1 (-21 - 20)	-1 (-20 - 15)	4 ---	2 (-22 - 25)	100%

[1]Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-27. Sensitivity Analysis: Impact of Using Season-Specific Concentration-Response Functions vs. an Annual Concentration-Response Function to Estimate the Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Risk Assessment Location	Estimated Incidence of Hospital Admissions for Respiratory Illness Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards						Percent Difference [3]
	Winter	Spring	Summer	Fall	Sum of Four Seasons	All Year	
Atlanta, GA	5 (-17 - 25)	11 (-13 - 34)	-7 (-29 - 14)	1 (-11 - 13)	10 --- [4]	17 (-22 - 56)	-41%
Baltimore, MD	14 (-4 - 32)	1 (-12 - 13)	12 (0 - 25)	2 (-11 - 14)	29 ---	17 (-10 - 44)	71%
Birmingham, AL	2 (-7 - 10)	6 (-6 - 17)	-3 (-11 - 6)	0 (-4 - 5)	5 ---	7 (-9 - 24)	-29%
Dallas, TX	4 (-16 - 24)	6 (-7 - 20)	-5 (-19 - 9)	1 (-11 - 14)	6 ---	13 (-16 - 42)	-54%
Detroit, MI	18 (-5 - 40)	1 (-14 - 15)	11 (0 - 23)	2 (-13 - 17)	32 ---	19 (-11 - 49)	68%
Fresno, CA	13 (-1 - 28)	2 (-5 - 10)	4 (-4 - 11)	4 (-6 - 13)	23 ---	16 (4 - 29)	44%
Houston, TX	9 (-34 - 51)	14 (-16 - 44)	-10 (-41 - 20)	3 (-26 - 31)	16 ---	29 (-36 - 93)	-45%
Los Angeles, CA	64 (-6 - 133)	53 (-113 - 213)	80 (-92 - 245)	44 (-63 - 146)	241 ---	171 (40 - 301)	41%
New York, NY	46 (-12 - 105)	2 (-44 - 48)	41 (-1 - 81)	5 (-32 - 40)	94 ---	56 (-33 - 144)	68%
Philadelphia, PA	14 (-4 - 31)	1 (-11 - 12)	11 (0 - 23)	1 (-10 - 13)	27 ---	16 (-9 - 42)	69%
Phoenix, AZ	31 (-3 - 63)	16 (-34 - 65)	27 (-30 - 81)	14 (-20 - 47)	88 ---	61 (14 - 108)	44%
Pittsburgh, PA	6 (-2 - 13)	0 (-8 - 9)	7 (0 - 14)	1 (-7 - 9)	14 ---	10 (-6 - 25)	40%
Salt Lake City, UT	5 (0 - 10)	1 (-3 - 6)	3 (-3 - 9)	1 (-2 - 5)	10 ---	7 (2 - 13)	43%
St. Louis, MO	18 (-5 - 40)	1 (-18 - 20)	13 (0 - 25)	2 (-13 - 16)	34 ---	21 (-12 - 54)	62%
Tacoma, WA	0 (-37 - 31)	4 (-29 - 34)	1 (-15 - 15)	-2 (-29 - 22)	3 ---	2 (-24 - 27)	50%

[1]Incidence estimates were calculated using the appropriate season-specific or all-year regional concentration-response function estimates from models with a 2-day lag for respiratory hospital admissions reported in Table 2 of Bell et al. (2008). Location-specific C-R function estimates were not available from this study. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (sum-of-4-seasons hospital admissions - all-year hospital admissions)/(all-year hospital admissions).

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-28. Sensitivity Analysis: Impact of Using an Annual Concentration-Response Function vs. a Seasonal Function (for April - August) Applied Only to that Period to Estimate the Incidence of Emergency Room Visits for Asthma Associated with Short-Term Exposure to Concentrations in a Recent Year (2005) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards in New York City, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Concentration-Response (C-R) Function and Period to Which Applied:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentration	15/35[2]	13/35	12/35	13/30	12/25
Annual C-R Function Applied to the Whole Year	1162 (743 - 1567)	971 (620 - 1314)	947 (604 - 1281)	872 (556 - 1181)	834 (531 - 1130)	695 (442 - 943)
Seasonal C-R Function for April - August Applied Only to that Period:	737 (485 - 977)	620 (406 - 824)	605 (396 - 805)	558 (364 - 744)	534 (349 - 713)	447 (291 - 598)

[1]Based on Ito et al. (2007). New York City in this study consisted only of Manhattan.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table F-29. Sensitivity Analysis: Impact of Using an Annual Concentration-Response Function vs. a Seasonal Function (for April - August) Applied Only to that Period to Estimate the Incidence of Emergency Room Visits for Asthma Associated with Short-Term Exposure to Concentrations in a Recent Year (2006) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards in New York City, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Concentration-Response (C-R) Function and Period to Which Applied:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentration	15/35[2]	13/35	12/35	13/30	12/25
Annual C-R Function Applied to the Whole Year	991 (633 - 1340)	828 (528 - 1122)	807 (515 - 1094)	743 (473 - 1008)	711 (452 - 964)	592 (376 - 804)
Seasonal C-R Function for April - August Applied Only to that Period:	627 (411 - 832)	526 (344 - 702)	513 (335 - 685)	474 (309 - 632)	453 (295 - 606)	379 (246 - 508)

[1]Based on Ito et al. (2007). New York City in this study consisted only of Manhattan.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table F-30. Sensitivity Analysis: Impact of Using an Annual Concentration-Response Function vs. a Seasonal Function (for April - August) Applied Only to that Period to Estimate the Incidence of Emergency Room Visits for Asthma Associated with Short-Term Exposure to Concentrations in a Recent Year (2007) and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards in New York City, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Concentration-Response (C-R) Function and Period to Which Applied:	Incidence of ER Visits Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations in a Recent Year and $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):					
	Recent $PM_{2.5}$ Concentrations	15/35[2]	13/35	12/35	13/30	12/25
Annual C-R Function Applied to the Whole Year	1114 (712 - 1504)	931 (594 - 1260)	907 (579 - 1229)	836 (532 - 1133)	799 (509 - 1083)	665 (423 - 904)
Seasonal C-R Function for April - August Applied Only to that Period:	684 (449 - 908)	575 (376 - 766)	561 (366 - 747)	517 (337 - 691)	495 (323 - 661)	414 (269 - 554)

[1]Based on Ito et al. (2007). New York City in this study consisted only of Manhattan.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

Table F-31. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure:							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	286 (-36 - 606)	Max. positive est. = 312	85 (-121 - 289)	236%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	312 (0 - 622)	Min. positive est. = 201		267%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	2 day	none	201 (-100 - 501)	**Percent diff. = 55%**		136%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	3 day	none	-80 (-388 - 226)			-194%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	4 day	none	-48 (-342 - 244)			-156%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	5 day	none	-299 (-616 - 16)			-452%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	286 (-36 - 606)	Max. positive est. = 286	85 (-121 - 289)	236%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	0 day	none	212 (-181 - 601)	Min. positive est. = 159		149%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	0 day	none	170 (-120 - 457)	**Percent diff. = 80%**		100%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	0 day	none	159 (-227 - 542)			87%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	312 (0 - 622)	Max. positive est. = 312	85 (-121 - 289)	267%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	1 day	none	291 (-90 - 669)	Min. positive est. = 53		242%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	none	53 (-245 - 349)	**Percent diff. = 489%**		-38%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	none	-5 (-530 - 512)			-106%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	CO	-283 (-703 - 133)		85 (-121 - 289)	-433%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	CO	-176 (-561 - 206)			-307%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	CO	-176 (-627 - 270)			-307%

Table F-31 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	178 (17 - 336)	Max. positive est. = 178	-33 (-146 - 79)	109%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	174 (25 - 322)	Min. positive est. = 174		105%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	none	174 (-4 - 350)	**Percent diff. = 2%**		105%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	1 day	none	185 (27 - 341)	Max. positive est. = 185	-33 (-146 - 79)	118%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	none	144 (-6 - 292)	Min. positive est. = 124		69%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	none	124 (-58 - 304)	**Percent diff. = 49%**		46%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	318 (135 - 499)	Max. positive est. = 336	-33 (-146 - 79)	274%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	CO	336 (120 - 548)	Min. positive est. = 163		295%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	CO	163 (-23 - 347)	**Percent diff. = 106%**		92%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	CO	163 (-63 - 386)			92%
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	0 day	none	-15 (-83 - 51)		--- [5]	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	none	-39 (-106 - 26)			---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	0 day	none	-33 (-114 - 44)			---
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	10 (-58 - 76)	Max. positive est. = 23	---	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	23 (-44 - 88)	Min. positive est. = 5		---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	5 (-78 - 86)	**Percent diff. = 360%**		---

Table F-31 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	824 (474 - 1170)	Max. positive est. = 824	274 (3 - 543)	869%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	606 (264 - 946)	Min. positive est. = 606		613%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	none	658 (235 - 1077)	**Percent diff. = 36%**		674%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	725 (361 - 1087)	Max. positive est. = 725	274 (3 - 543)	753%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	591 (243 - 935)	Min. positive est. = 591		595%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	627 (201 - 1048)	**Percent diff. = 23%**		638%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	205 (-233 - 638)	Max. positive est. = 304	274 (3 - 543)	141%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	304 (-216 - 818)	Min. positive est. = 126		258%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	126 (-342 - 589)	**Percent diff. = 141%**		48%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	142 (-396 - 672)			67%
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	348 (143 - 551)	Max. positive est. = 348	---	---
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	288 (108 - 466)	Min. positive est. = 288		---
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	311 (86 - 533)	**Percent diff. = 21%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	249 (47 - 448)	Max. positive est. = 249	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	157 (-23 - 336)	Min. positive est. = 157		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	161 (-57 - 377)	**Percent diff. = 59%**		---

Table F-31 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 2-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	2 day	none	385 (172 - 595)	Max. positive est. = 385	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	none	238 (45 - 430)	Min. positive est. = 216		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	2 day	none	216 (-25 - 452)	**Percent diff. = 78%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure, with a Copollutant Model							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	NO2	88 (-192 - 364)	Max. positive est. = 88	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	NO2	-8 (-342 - 319)	Min. positive est. = 74		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	NO2	74 (-217 - 359)	**Percent diff. = 19%**		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	3 day	NO2	-231 (-510 - 43)			---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3. Results are based on Moolgavkar (2003) [reanalysis of Moolgavkar (2000a, 2000b, and 2000c)].

[2]The core analysis estimates for non-accidental mortality and cardiovascular mortality associated with short-term exposure to PM2.5 are from Zanobetti and Schwartz (2009). The core analysis estimates for cardiovascular hospital admissions associated with short-term exposure to PM2.5 are from Bell et al. (2008).

[3]Calculated as (maximum positive estimate - minimum positive estimate)/(minimum positive estimate).

[4]Calculated as (Moolgavkar (2003) estimate - core analysis estimate)/(core analysis estimate).

[5]Because "respiratory illness" was much more broadly defined in both Zanobetti and Schwartz (2009) and Bell et al. (2008) than in Moolgavkar (2003), a comparison between the Moolgavkar (2003) estimates and the corresponding core analysis estimates is not shown.

Table F-32. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure:							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	265 (-34 - 561)	Max. positive est. = 289 Min. positive est. = 186 **Percent diff. = 55%**	78 (-112 - 267)	240%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	289 (0 - 576)			271%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	2 day	none	186 (-93 - 464)			138%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	3 day	none	-74 (-358 - 209)			-195%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	4 day	none	-44 (-316 - 226)			-156%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	5 day	none	-276 (-569 - 15)			-454%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	265 (-34 - 561)	Max. positive est. = 265 Min. positive est. = 147 **Percent diff. = 80%**	78 (-112 - 267)	240%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	0 day	none	196 (-167 - 556)			151%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	0 day	none	157 (-111 - 423)			101%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	0 day	none	147 (-210 - 501)			88%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	289 (0 - 576)	Max. positive est. = 289 Min. positive est. = 49 **Percent diff. = 490%**	78 (-112 - 267)	271%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	1 day	none	269 (-83 - 619)			245%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	none	49 (-227 - 323)			-37%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	none	-5 (-489 - 474)			-106%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	CO	-261 (-649 - 123)		78 (-112 - 267)	-435%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	CO	-162 (-518 - 191)			-308%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	CO	-162 (-579 - 250)			-308%

Table F-32 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	165 (16 - 312)	Max. positive est. = 165	-30 (-134 - 73)	112%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	161 (23 - 298)	Min. positive est. = 161		106%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	none	161 (-3 - 324)	**Percent diff. = 2%**		106%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	1 day	none	171 (25 - 315)	Max. positive est. = 171	-30 (-134 - 73)	119%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	none	133 (-6 - 271)	Min. positive est. = 115		71%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	none	115 (-53 - 281)	**Percent diff. = 49%**		47%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	294 (125 - 462)	Max. positive est. = 311	-30 (-134 - 73)	277%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	CO	311 (111 - 508)	Min. positive est. = 151		299%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	CO	151 (-21 - 322)	**Percent diff. = 106%**		94%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	CO	151 (-58 - 358)			94%
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	0 day	none	-14 (-77 - 47)		--- [5]	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	none	-36 (-98 - 24)			---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	0 day	none	-31 (-105 - 41)			---
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	10 (-54 - 71)	Max. positive est. = 22	---	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	22 (-40 - 82)	Min. positive est. = 5		---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	5 (-72 - 79)	**Percent diff. = 340%**		---

Table F-32 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	775 (446 - 1102)	Max. positive est. = 775	258 (3 - 511)	894%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	570 (248 - 890)	Min. positive est. = 570		631%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	none	619 (221 - 1014)	**Percent diff. = 36%**		694%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, cardiovascular	log-linear, GAM (stringent), 30 df	1 day	none	683 (339 - 1024)	Max. positive est. = 683	258 (3 - 511)	776%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	1 day	none	556 (229 - 881)	Min. positive est. = 556		613%
HA, cardiovascular	log-linear, GLM, 100 df	1 day	none	590 (189 - 987)	**Percent diff. = 23%**		656%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	193 (-219 - 600)	Max. positive est. = 286	258 (3 - 511)	147%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	286 (-203 - 770)	Min. positive est. = 119		267%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	1 day	CO	119 (-322 - 555)	**Percent diff. = 140%**		53%
HA, cardiovascular	log-linear, GLM, 100 df	1 day	CO	133 (-372 - 633)			71%
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	0 day	none	322 (132 - 510)	Max. positive est. = 322	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	none	267 (100 - 432)	Min. positive est. = 267		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	0 day	none	288 (79 - 494)	**Percent diff. = 21%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	230 (43 - 415)	Max. positive est. = 230	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	146 (-21 - 311)	Min. positive est. = 146		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	149 (-53 - 349)	**Percent diff. = 58%**		---

Table F-32 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 2-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	2 day	none	357 (160 - 552)	Max. positive est. = 357	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	none	221 (41 - 398)	Min. positive est. = 200		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	2 day	none	200 (-23 - 419)	**Percent diff. = 79%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure, with a Copollutant Model							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	NO2	82 (-178 - 337)	Max. positive est. = 82	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	NO2	-8 (-316 - 295)	Min. positive est. = 68		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	NO2	68 (-200 - 332)	**Percent diff. = 21%**		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	3 day	NO2	-214 (-471 - 40)			---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3. Results are based on Moolgavkar (2003) [reanalysis of Moolgavkar (2000a, 2000b, and 2000c)].

[2]The core analysis estimates for non-accidental mortality and cardiovascular mortality associated with short-term exposure to PM2.5 are from Zanobetti and Schwartz (2009). The core analysis estimates for cardiovascular hospital admissions associated with short-term exposure to PM2.5 are from Bell et al. (2008).

[3]Calculated as (maximum positive estimate - minimum positive estimate)/(minimum positive estimate).

[4]Calculated as (Moolgavkar (2003) estimate - core analysis estimate)/(core analysis estimate).

[5]Because "respiratory illness" was much more broadly defined in both Zanobetti and Schwartz (2009) and Bell et al. (2008) than in Moolgavkar (2003), a comparison between the Moolgavkar (2003) estimates and the corresponding core analysis estimates is not shown.

Table F-33. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure:							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	267 (-34 - 566)	Max. positive est. = 292 Min. positive est. = 188 **Percent diff. = 55%**	79 (-113 - 270)	238%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	292 (0 - 582)			270%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	2 day	none	188 (-94 - 468)			138%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	3 day	none	-75 (-362 - 211)			-195%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	4 day	none	-45 (-320 - 228)			-157%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	5 day	none	-279 (-575 - 15)			-453%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	0 day	none	267 (-34 - 566)	Max. positive est. = 267 Min. positive est. = 149 **Percent diff. = 79%**	79 (-113 - 270)	238%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	0 day	none	198 (-169 - 562)			151%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	0 day	none	159 (-112 - 427)			101%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	0 day	none	149 (-212 - 506)			89%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	none	292 (0 - 582)	Max. positive est. = 292 Min. positive est. = 50 **Percent diff. = 484%**	79 (-113 - 270)	270%
Mortality, short-term non-accidental	log-linear, GLM, 30 df	1 day	none	272 (-84 - 625)			244%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	none	50 (-229 - 326)			-37%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	none	-5 (-494 - 479)			-106%
Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term non-accidental	log-linear, GAM (stringent), 30 df	1 day	CO	-264 (-656 - 124)		79 (-113 - 270)	-434%
Mortality, short-term non-accidental	log-linear, GAM (stringent), 100 df	1 day	CO	-164 (-524 - 192)			-308%
Mortality, short-term non-accidental	log-linear, GLM, 100 df	1 day	CO	-164 (-585 - 252)			-308%

Table F-33 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	166 (16 - 314)	Max. positive est. = 166	-30 (-136 - 74)	110%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	163 (24 - 301)	Min. positive est. = 163		106%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	none	163 (-3 - 327)	**Percent diff. = 2%**		106%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 30 df	1 day	none	173 (26 - 318)	Max. positive est. = 173	-30 (-136 - 74)	119%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	none	134 (-6 - 273)	Min. positive est. = 116		70%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	none	116 (-54 - 284)	**Percent diff. = 49%**		47%
Cardiovascular Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	297 (126 - 466)	Max. positive est. = 314	-30 (-136 - 74)	276%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	0 day	CO	314 (112 - 512)	Min. positive est. = 153		297%
Mortality, short-term cardiovascular	log-linear, GAM (stringent), 100 df	1 day	CO	153 (-21 - 325)	**Percent diff. = 105%**		94%
Mortality, short-term cardiovascular	log-linear, GLM, 100 df	1 day	CO	153 (-59 - 361)			94%
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	0 day	none	-14 (-78 - 47)		--- [5]	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	none	-36 (-99 - 24)			---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	0 day	none	-31 (-106 - 41)			---
Respiratory Mortality Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	10 (-54 - 71)	Max. positive est. = 22	---	---
Mortality, short-term respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	22 (-41 - 82)	Min. positive est. = 5		---
Mortality, short-term respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	5 (-73 - 80)	**Percent diff. = 340%**		---

Table F-33 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, cardiovascular	log-linear, GAM (stringent), 30 df	0 day	none	798 (459 - 1134)	Max. positive est. = 798	265 (3 - 526)	910%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	none	587 (256 - 916)	Min. positive est. = 587		643%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	none	637 (228 - 1043)	**Percent diff. = 36%**		706%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, cardiovascular	log-linear, GAM (stringent), 30 df	1 day	none	703 (349 - 1053)	Max. positive est. = 703	265 (3 - 526)	790%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	1 day	none	572 (235 - 906)	Min. positive est. = 572		624%
HA, cardiovascular	log-linear, GLM, 100 df	1 day	none	607 (195 - 1015)	**Percent diff. = 23%**		668%
Cardiovascular Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of a Copollutant Model							
HA, cardiovascular	log-linear, GAM (stringent), 100 df	0 day	CO	198 (-225 - 618)	Max. positive est. = 295	265 (3 - 526)	151%
HA, cardiovascular	log-linear, GLM, 100 df	0 day	CO	295 (-209 - 792)	Min. positive est. = 122		273%
HA, cardiovascular	log-linear, GAM (stringent), 100 df	1 day	CO	122 (-331 - 571)	**Percent diff. = 142%**		54%
HA, cardiovascular	log-linear, GLM, 100 df	1 day	CO	137 (-383 - 651)			73%
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 0-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	0 day	none	325 (134 - 515)	Max. positive est. = 325	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	none	269 (101 - 436)	Min. positive est. = 269		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	0 day	none	291 (80 - 498)	**Percent diff. = 21%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 1-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	1 day	none	233 (44 - 419)	Max. positive est. = 233	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	none	147 (-22 - 314)	Min. positive est. = 147		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	1 day	none	151 (-53 - 353)	**Percent diff. = 59%**		---

Table F-33 cont'd. Sensitivity Analysis: Estimated Annual Incidence and Percent of Total Incidence of Mortality in Los Angeles, CA Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Health Effects	Model	Lag	Other Pollutants in Model	Incidence Associated with $PM_{2.5}$ Above Policy Relevant Background	Range of Positive Estimates and Percent Difference Between Maximum and Minimum [2]	Incidence Estimate Using Core Analysis Model [3]	Percent Difference (Compared to Core Analysis Model) [4]
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Type of Model, with a 2-Day Lag							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 30 df	2 day	none	360 (161 - 557)	Max. positive est. = 360	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	none	223 (42 - 402)	Min. positive est. = 201		---
HA, respiratory (COPD+)	log-linear, GLM, 100 df	2 day	none	201 (-23 - 423)	**Percent diff. = 79%**		---
Respiratory Hospital Admissions Associated with Short-Term Exposure to $PM_{2.5}$ -- Impact of Changing the Lag Structure, with a Copollutant Model							
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	0 day	NO2	82 (-180 - 340)	Max. positive est. = 82	---	---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	1 day	NO2	-8 (-320 - 298)	Min. positive est. = 69		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	2 day	NO2	69 (-202 - 335)	**Percent diff. = 19%**		---
HA, respiratory (COPD+)	log-linear, GAM (stringent), 100 df	3 day	NO2	-216 (-476 - 40)			---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3. Results are based on Moolgavkar (2003) [reanalysis of Moolgavkar (2000a, 2000b, and 2000c)].

[2]The core analysis estimates for non-accidental mortality and cardiovascular mortality associated with short-term exposure to PM2.5 are from Zanobetti and Schwartz (2009). The core analysis estimates for cardiovascular hospital admissions associated with short-term exposure to PM2.5 are from Bell et al. (2008).

[3]Calculated as (maximum positive estimate - minimum positive estimate)/(minimum positive estimate).

[4]Calculated as (Moolgavkar (2003) estimate - core analysis estimate)/(core analysis estimate).

[5]Because "respiratory illness" was much more broadly defined in both Zanobetti and Schwartz (2009) and Bell et al. (2008) than in Moolgavkar (2003), a comparison between the Moolgavkar (2003) estimates and the corresponding core analysis estimates is not shown.

Table F-34. Sensitivity Analysis: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	256 (104 - 406)	224 (91 - 355)	206 (84 - 327)	219 (89 - 348)	182 (74 - 289)
	Hybrid	254 (103 - 403)	230 (93 - 365)	211 (86 - 335)	217 (88 - 345)	181 (73 - 287)
	Percent Difference [3]	-1%	3%	2%	-1%	-1%
Birmingham, AL	Proportional	38 (-60 - 135)	33 (-51 - 115)	30 (-46 - 105)	33 (-51 - 115)	27 (-42 - 96)
	Hybrid	39 (-60 - 136)	33 (-51 - 115)	30 (-46 - 105)	33 (-51 - 115)	28 (-43 - 98)
	Percent Difference	3%	0%	0%	0%	4%
Detroit, MI	Proportional	141 (-25 - 305)	129 (-23 - 280)	119 (-21 - 257)	121 (-21 - 260)	100 (-18 - 216)
	Hybrid	146 (-26 - 315)	143 (-25 - 310)	132 (-23 - 284)	125 (-22 - 270)	103 (-18 - 224)
	Percent Difference	4%	11%	11%	3%	3%
Los Angeles, CA	Proportional	85 (-121 - 289)	85 (-121 - 289)	80 (-114 - 273)	72 (-103 - 247)	60 (-86 - 205)
	Hybrid	94 (-135 - 323)	92 (-132 - 315)	85 (-121 - 289)	81 (-116 - 276)	67 (-96 - 229)
	Percent Difference	11%	8%	6%	13%	12%
New York, NY	Proportional	714 (419 - 1007)	696 (408 - 981)	639 (375 - 902)	611 (358 - 861)	507 (297 - 716)
	Hybrid	726 (426 - 1023)	695 (408 - 979)	638 (375 - 900)	621 (364 - 876)	515 (302 - 727)
	Percent Difference	2%	0%	0%	2%	2%
Pittsburgh, PA	Proportional	135 (40 - 230)	135 (40 - 230)	135 (40 - 230)	116 (34 - 197)	96 (28 - 163)
	Hybrid	163 (48 - 277)	158 (46 - 268)	145 (43 - 246)	140 (41 - 237)	116 (34 - 197)
	Percent Difference	21%	17%	7%	21%	21%
St. Louis, MO	Proportional	252 (73 - 429)	219 (63 - 373)	201 (58 - 342)	215 (62 - 367)	179 (51 - 305)
	Hybrid	266 (77 - 452)	228 (66 - 389)	210 (61 - 357)	228 (66 - 389)	191 (55 - 325)
	Percent Difference	6%	4%	4%	6%	7%

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-35. Sensitivity Analysis: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	234 (95 - 372)	205 (83 - 325)	188 (76 - 299)	201 (81 - 318)	167 (68 - 265)
	Hybrid	233 (94 - 369)	210 (85 - 334)	193 (78 - 307)	199 (81 - 316)	165 (67 - 263)
	Percent Difference [3]	0%	2%	3%	-1%	-1%
Birmingham, AL	Proportional	38 (-59 - 132)	32 (-50 - 113)	29 (-45 - 103)	32 (-50 - 113)	26 (-41 - 94)
	Hybrid	38 (-59 - 132)	32 (-50 - 113)	29 (-45 - 103)	32 (-50 - 113)	27 (-42 - 96)
	Percent Difference	0%	0%	0%	0%	4%
Detroit, MI	Proportional	117 (-21 - 254)	108 (-19 - 233)	99 (-17 - 214)	100 (-18 - 217)	83 (-15 - 180)
	Hybrid	121 (-21 - 262)	119 (-21 - 258)	109 (-19 - 237)	104 (-18 - 224)	86 (-15 - 186)
	Percent Difference	3%	10%	10%	4%	4%
Los Angeles, CA	Proportional	78 (-112 - 267)	78 (-112 - 267)	74 (-106 - 252)	67 (-96 - 228)	55 (-79 - 189)
	Hybrid	87 (-125 - 299)	85 (-122 - 291)	78 (-112 - 268)	74 (-107 - 255)	62 (-88 - 211)
	Percent Difference	12%	9%	5%	10%	13%
New York, NY	Proportional	654 (384 - 922)	637 (374 - 898)	585 (343 - 826)	559 (328 - 789)	464 (272 - 655)
	Hybrid	664 (390 - 936)	635 (373 - 896)	584 (343 - 824)	568 (333 - 801)	471 (276 - 665)
	Percent Difference	2%	0%	0%	2%	2%
Pittsburgh, PA	Proportional	122 (36 - 208)	122 (36 - 208)	122 (36 - 208)	104 (31 - 177)	87 (25 - 147)
	Hybrid	147 (43 - 249)	141 (41 - 240)	130 (38 - 221)	125 (37 - 213)	104 (30 - 177)
	Percent Difference	20%	16%	7%	20%	20%
St. Louis, MO	Proportional	214 (62 - 364)	185 (53 - 316)	170 (49 - 290)	183 (53 - 311)	151 (44 - 258)
	Hybrid	225 (65 - 384)	194 (56 - 330)	178 (51 - 303)	194 (56 - 330)	162 (47 - 276)
	Percent Difference	5%	5%	5%	6%	7%

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-36. Sensitivity Analysis: Estimated Annual Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations: Comparison of Proportional and Hybrid Rollback Methods[1]

Risk Assessment Location	Type of Rollback	Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current and Alternative Combinations of Annual (n) and Daily (m) Standards (Standard Combination Denoted n/m):				
		15/35 [2]	13/35	12/35	13/30	12/25
Baltimore, MD	Proportional	225 (91 - 357)	197 (80 - 312)	181 (73 - 287)	192 (78 - 306)	160 (65 - 254)
	Hybrid	223 (90 - 354)	202 (82 - 320)	185 (75 - 294)	191 (77 - 303)	158 (64 - 252)
	Percent Difference [3]	-1%	3%	2%	-1%	-1%
Birmingham, AL	Proportional	37 (-58 - 131)	32 (-49 - 112)	29 (-45 - 102)	32 (-49 - 112)	26 (-41 - 93)
	Hybrid	37 (-58 - 132)	32 (-49 - 112)	29 (-45 - 102)	32 (-49 - 112)	27 (-42 - 95)
	Percent Difference	0%	0%	0%	0%	4%
Detroit, MI	Proportional	112 (-20 - 242)	102 (-18 - 222)	94 (-16 - 204)	95 (-17 - 207)	79 (-14 - 171)
	Hybrid	116 (-20 - 250)	113 (-20 - 245)	104 (-18 - 225)	99 (-17 - 214)	82 (-14 - 177)
	Percent Difference	4%	11%	11%	4%	4%
Los Angeles, CA	Proportional	79 (-113 - 270)	79 (-113 - 270)	74 (-107 - 255)	67 (-97 - 231)	56 (-80 - 191)
	Hybrid	88 (-126 - 302)	86 (-123 - 294)	79 (-113 - 270)	75 (-108 - 258)	62 (-89 - 213)
	Percent Difference	11%	9%	7%	12%	11%
New York, NY	Proportional	659 (387 - 930)	642 (377 - 906)	590 (346 - 833)	564 (331 - 795)	468 (274 - 661)
	Hybrid	670 (393 - 944)	641 (376 - 904)	589 (346 - 831)	573 (336 - 808)	476 (279 - 671)
	Percent Difference	2%	0%	0%	2%	2%
Pittsburgh, PA	Proportional	123 (36 - 209)	123 (36 - 209)	123 (36 - 209)	105 (31 - 179)	87 (26 - 148)
	Hybrid	147 (43 - 250)	142 (42 - 242)	131 (38 - 222)	126 (37 - 214)	104 (31 - 178)
	Percent Difference	20%	15%	7%	20%	20%
St. Louis, MO	Proportional	222 (64 - 378)	193 (56 - 328)	177 (51 - 301)	190 (55 - 323)	157 (45 - 268)
	Hybrid	234 (68 - 399)	201 (58 - 343)	185 (53 - 315)	201 (58 - 343)	168 (48 - 287)
	Percent Difference	5%	4%	5%	6%	7%

[1]Based on location-specific single pollutant concentration-response function estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. "Shrunken" coefficient estimates and their standard errors were sent to EPA by A. Zanobetti via email. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Calculated as (mortality based on hybrid rollbacks - mortality based on proportional rollbacks)/(mortality based on proportional rollbacks).

Table F-37. Multi-Factor Sensitivity Analysis: Impact of Using a Log-Linear vs. a Log-Log Model, Estimating Incidence Down to the Lowest Measured Level (LML) in the Study vs. PRB, and Using a Proportional vs. a Hybrid Rollback to Estimate the Incidence of All Cause and Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations[1]

Modeling Choices:	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]							
Fixed Effects (FE) Log-linear vs. Random Effects (RE) log-log model	**FE Log-Linear**	**FE Log-Linear**	**FE Log-Linear**	**FE Log-Linear**	**RE Log-Log**	**RE Log-Log**	**RE Log-Log**	**RE Log-Log**
Down to LML (5.8 ug/m^3) vs. PRB	**LML**	**LML**	**PRB**	**PRB**	**LML**	**LML**	**PRB**	**PRB**
Proportional vs. hybrid rollback	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**
	Los Angeles, CA							
All Cause Mortality	1432 (911 - 1948)	1775 (1131 - 2412)	2934 (1876 - 3972)	3268 (2091 - 4418)	3526 (2179 - 4841)	4121 (2551 - 5644)	13713 (8814 - 18111)	14193 (9141 - 18709)
Percent Difference: [3]	---	24%	105%	128%	146%	188%	858%	891%
Ischemic Heart Disease Mortality	1330 (1083 - 1572)	1634 (1334 - 1927)	2621 (2156 - 3067)	2894 (2386 - 3380)	2652 (1878 - 3376)	3061 (2180 - 3877)	8336 (6475 - 9736)	8540 (6662 - 9937)
Percent Difference:	---	23%	97%	118%	99%	130%	527%	542%
	Philadelphia, PA							
All Cause Mortality	547 (349 - 743)	--- [4]	732 (468 - 991)	---	1201 (745 - 1641)	---	3896 (2520 - 5116)	---
Percent Difference:	---	---	34%	---	120%	---	612%	---
Ischemic Heart Disease Mortality	347 (284 - 409)	---	571 (472 - 665)	---	614 (439 - 774)	---	1599 (1258 - 1846)	---
Percent Difference	---	---	65%	---	77%	---	361%	---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000. The fixed effects log-linear estimates are from Table 33, using models with 44 individual and 7 ecological covariates; the random effects log-log estimates are from Table 11, "MSA and DIFF" rows.

[3] Percent differences are calculated relative to the model selections used in the core analysis (fixed effects log-linear model; LML, and proportional rollbacks). So, for example, the percent difference in estimated all cause mortality in Los Angeles resulting from changing from the core analysis input selections to instead using (1) a fixed effects log-linear model, (2) PRB, and (3) hybrid rollbacks is (3099 - 1257)/1257 = 147%.

[4] Philadelphia was not among the risk assessment urban areas for which hybrid rollbacks were calculated.

Table F-38. Multi-Factor Sensitivity Analysis: Impact of Using a Log-Linear vs. a Log-Log Model, Estimating Incidence Down to the Lowest Measured Level (LML) in the Study vs. PRB, and Using a Proportional vs. a Hybrid Rollback to Estimate the Incidence of All Cause and Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations[1]

Modeling Choices:	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]							
Fixed Effects (FE) Log-linear vs. Random Effects (RE) log-log model	**FE Log-Linear**	**FE Log-Linear**	**FE Log-Linear**	**FE Log-Linear**	**RE Log-Log**	**RE Log-Log**	**RE Log-Log**	**RE Log-Log**
Down to LML (5.8 ug/m^3) vs. PRB	**LML**	**LML**	**PRB**	**PRB**	**LML**	**LML**	**PRB**	**PRB**
Proportional vs. hybrid rollback	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**	**Proportional**	**Hybrid**
	Los Angeles, CA							
All Cause Mortality	1221 (776 - 1662)	1540 (980 - 2094)	2738 (1749 - 3709)	3048 (1949 - 4125)	3130 (1931 - 4303)	3726 (2304 - 5112)	13459 (8639 - 17800)	13941 (8966 - 18402)
Percent Difference: [3]	---	26%	124%	150%	156%	205%	1002%	1042%
Ischemic Heart Disease Mortality	1140 (927 - 1349)	1426 (1163 - 1685)	2459 (2020 - 2882)	2716 (2236 - 3177)	2374 (1675 - 3034)	2792 (1981 - 3549)	8241 (6382 - 9651)	8449 (6571 - 9857)
Percent Difference:	---	25%	116%	138%	108%	145%	623%	641%
	Philadelphia, PA							
All Cause Mortality	536 (341 - 727)	--- [4]	923 (591 - 1246)	---	1182 (733 - 1617)	---	3875 (2506 - 5089)	---
Percent Difference:	---	---	72%	---	121%	---	623%	---
Ischemic Heart Disease Mortality	340 (279 - 401)	---	564 (466 - 657)	---	606 (433 - 764)	---	1592 (1252 - 1839)	---
Percent Difference	---	---	66%	---	78%	---	368%	---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000. The fixed effects log-linear estimates are from Table 33, using models with 44 individual and 7 ecological covariates; the random effects log-log estimates are from Table 11, "MSA and DIFF" rows.

[3] Percent differences are calculated relative to the model selections used in the core analysis (fixed effects log-linear model; LML, and proportional rollbacks). So, for example, the percent difference in estimated all cause mortality in Los Angeles resulting from changing from the core analysis input selections to instead using (1) a fixed effects log-linear model, (2) PRB, and (3) hybrid rollbacks is (3099 - 1257)/1257 = 147%.

[4] Philadelphia was not among the risk assessment urban areas for which hybrid rollbacks were calculated.

Table F-39. Multi-Factor Sensitivity Analysis: Impact of Using a Log-Linear vs. a Log-Log Model, Estimating Incidence Down to the Lowest Measured Level (LML) in the Study vs. PRB, and Using a Proportional vs. a Hybrid Rollback to Estimate the Incidence of All Cause and Ischemic Heart Disease Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations[1]

Modeling Choices:	Incidence of Mortality Associated with Long-Term Exposure to $PM_{2.5}$ Concentrations Using:[2]							
Fixed Effects (FE) Log-linear vs. Random Effects (RE) log-log model	FE Log-Linear	FE Log-Linear	FE Log-Linear	FE Log-Linear	RE Log-Log	RE Log-Log	RE Log-Log	RE Log-Log
Down to LML (5.8 ug/m^3) vs. PRB	LML	LML	PRB	PRB	LML	LML	PRB	PRB
Proportional vs. hybrid rollback	Proportional	Hybrid	Proportional	Hybrid	Proportional	Hybrid	Proportional	Hybrid
	Los Angeles, CA							
All Cause Mortality	1257 (799 - 1711)	1582 (1007 - 1582)	2783 (1778 - 3770)	3099 (1982 - 4193)	3206 (1979 - 4407)	3807 (2354 - 5221)	13590 (8725 - 17970)	14076 (9054 - 18576)
Percent Difference:[3]	---	26%	121%	147%	155%	203%	981%	1020%
Ischemic Heart Disease Mortality	1173 (954 - 1388)	1464 (1193 - 1464)	2498 (2053 - 2927)	2759 (2272 - 3227)	2429 (1715 - 3102)	2849 (2022 - 3620)	8313 (6440 - 9732)	8523 (6631 - 9939)
Percent Difference:	---	25%	113%	135%	107%	143%	609%	627%
	Philadelphia, PA							
All Cause Mortality	530 (338 - 719)	---[4] ---	917 (588 - 1239)	--- ---	1174 (728 - 1605)	--- ---	3870 (2502 - 5083)	--- ---
Percent Difference:	---	---	73%	---	122%	---	630%	---
Ischemic Heart Disease Mortality	337 (276 - 397)	--- ---	561 (464 - 654)	--- ---	602 (430 - 759)	--- ---	1591 (1251 - 1838)	--- ---
Percent Difference	---	---	66%	---	79%	---	372%	---

[1]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[2]Estimates Based on Krewski et al. (2009), exposure period from 1999 - 2000. The fixed effects log-linear estimates are from Table 33, using models with 44 individual and 7 ecological covariates; the random effects log-log estimates are from Table 11, "MSA and DIFF" rows.

[3] Percent differences are calculated relative to the model selections used in the core analysis (fixed effects log-linear model; LML, and proportional rollbacks). So, for example, the percent difference in estimated all cause mortality in Los Angeles resulting from changing from the core analysis input selections to instead using (1) a fixed effects log-linear model, (2) PRB, and (3) hybrid rollbacks is (3099 - 1257)/1257 = 147%.

[4] Philadelphia was not among the risk assessment urban areas for which hybrid rollbacks were calculated.

Table F-40. Sensitivity Analysis: Impact of Using Season-Specific vs. Annual Concentration-Response Functions and Proportional vs. Hybrid Rollbacks to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2005 $PM_{2.5}$ Concentrations [1, 2]

Modeling Choices:	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards			
Seasonal C-R Functions vs. an All-Year Function	All Year	All Year	Sum of Four Seasons	Sum of Four Seasons
Proportional vs. Hybrid Rollback	Proportional	Hybrid	Proportional	Hybrid
Baltimore, MD	256 (104 - 406)	254 (103 - 403)	222 --- [4]	222 ---
Percent Difference [3]	---	-1%	-13%	-13%
Birmingham, AL	38 (-60 - 135)	39 (-60 - 136)	78 ---	78 ---
Percent Difference	---	3%	105%	105%
Detroit, MI	141 (-25 - 305)	146 (-26 - 315)	153 ---	159 ---
Percent Difference	---	4%	9%	13%
Los Angeles, CA	85 (-121 - 289)	94 (-135 - 323)	-28 ---	-32 ---
Percent Difference	---	11%	-133%	-138%
New York, NY	714 (419 - 1007)	726 (426 - 1023)	717 ---	728 ---
Percent Difference	---	2%	0%	2%
Pittsburgh, PA	135 (40 - 230)	163 (48 - 277)	151 ---	182 ---
Percent Difference	---	21%	12%	35%
St. Louis, MO	252 (73 - 429)	266 (77 - 452)	243 ---	256 ---
Percent Difference	---	6%	-4%	2%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Percent differences are calculated relative to the model selections used in the core analysis (all-year C-R function and proportional rollback). So, for example, the percent difference in estimated non-accidental mortality in Baltimore resulting from changing from the core analysis input selections to instead using the sum of four season-specific mortality estimates and hybrid rollbacks is (192 - 225)/225 = -15%.

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-41. Sensitivity Analysis: Impact of Using Season-Specific vs. Annual Concentration-Response Functions and Proportional vs. Hybrid Rollbacks to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2006 $PM_{2.5}$ Concentrations [1, 2]

Modeling Choices:	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards			
Seasonal C-R Functions vs. an All-Year Function	All Year	All Year	Sum of Four Seasons	Sum of Four Seasons
Proportional vs. Hybrid Rollback	Proportional	Hybrid	Proportional	Hybrid
Baltimore, MD	234 (95 - 372)	233 (94 - 369)	202 --- [4]	201 ---
Percent Difference [3]	---	0%	-14%	-14%
Birmingham, AL	38 (-59 - 132)	38 (-59 - 132)	81 ---	80 ---
Percent Difference	---	0%	113%	111%
Detroit, MI	117 (-21 - 254)	121 (-21 - 262)	139 ---	143 ---
Percent Difference	---	3%	19%	22%
Los Angeles, CA	78 (-112 - 267)	87 (-125 - 299)	-29 ---	-32 ---
Percent Difference	---	12%	-137%	-141%
New York, NY	654 (384 - 922)	664 (390 - 936)	656 ---	667 ---
Percent Difference	---	2%	0%	2%
Pittsburgh, PA	122 (36 - 208)	147 (43 - 249)	137 ---	164 ---
Percent Difference	---	20%	12%	34%
St. Louis, MO	214 (62 - 364)	225 (65 - 384)	209 ---	221 ---
Percent Difference	---	5%	-2%	3%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Percent differences are calculated relative to the model selections used in the core analysis (all-year C-R function and proportional rollback). So, for example, the percent difference in estimated non-accidental mortality in Baltimore resulting from changing from the core analysis input selections to instead using the sum of four season-specific mortality estimates and hybrid rollbacks is (192 - 225)/225 = -15%.

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

Table F-42. Sensitivity Analysis: Impact of Using Season-Specific vs. Annual Concentration-Response Functions and Proportional vs. Hybrid Rollbacks to Estimate the Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards, Based on Adjusting 2007 $PM_{2.5}$ Concentrations [1, 2]

Modeling Choices:	Estimated Incidence of Non-Accidental Mortality Associated with Short-Term Exposure to $PM_{2.5}$ Concentrations that Just Meet the Current Standards			
Seasonal C-R Functions vs. an All-Year Function	All Year	All Year	Sum of Four Seasons	Sum of Four Seasons
Proportional vs. Hybrid Rollback	Proportional	Hybrid	Proportional	Hybrid
Baltimore, MD	225 (91 - 357)	223 (90 - 354)	206 --- [4]	192 ---
Percent Difference [3]	---	-1%	-8%	-15%
Birmingham, AL	37 (-58 - 131)	37 (-58 - 132)	106 ---	81 ---
Percent Difference	---	0%	186%	119%
Detroit, MI	112 (-20 - 242)	116 (-20 - 250)	148 ---	124 ---
Percent Difference	---	4%	32%	11%
Los Angeles, CA	79 (-113 - 270)	88 (-126 - 302)	-11 ---	-7 ---
Percent Difference	---	11%	-114%	-109%
New York, NY	659 (387 - 930)	670 (393 - 944)	797 ---	674 ---
Percent Difference	---	2%	21%	2%
Pittsburgh, PA	123 (36 - 209)	147 (43 - 250)	234 ---	162 ---
Percent Difference	---	20%	90%	32%
St. Louis, MO	222 (64 - 378)	234 (68 - 399)	244 ---	231 ---
Percent Difference	---	5%	10%	4%

[1]Based on season-specific and all-year location-specific coefficient estimates from Zanobetti and Schwartz (2009) that have been "shrunken" towards the appropriate regional means. Numbers are rounded to the nearest whole number.

[2]The current primary $PM_{2.5}$ standards include an annual standard set at 15 ug/m^3 and a daily standard set at 35 ug/m^3.

[3] Percent differences are calculated relative to the model selections used in the core analysis (all-year C-R function and proportional rollback). So, for example, the percent difference in estimated non-accidental mortality in Baltimore resulting from changing from the core analysis input selections to instead using the sum of four season-specific mortality estimates and hybrid rollbacks is (192 - 225)/225 = -15%.

[4] It was not possible to calculate the 2.5th and 97.5th percentile estimates of the sum of the season-specific incidences because the variance-covariance matrix for the season-specific coefficient estimators was not available.

APPENDIX G: SUPPLEMEMNT TO THE NATIONAL-SCALE ASSESSMENT OF LONG-TERM MORTALITY RELATED TO $PM_{2.5}$ EXPOSURE

Appendix G National-Scale Assessment Of Long-Term Mortality Related To $PM_{2.5}$ Exposure (additional technical detail regarding inputs used in the analysis)

This technical appendix includes additional details regarding the inputs to the national-scale current conditions health impact analysis. Below we present air quality modeling, exposure and risk information.

Air Quality Modeled Inputs

The Community Model for Air Quality (CMAQ) model was used to estimate annual $PM_{2.5}$ concentrations for the year 2005 for the continental US. These data were then combined with ambient monitored $PM_{2.5}$ measurements to create "fused" spatial surfaces supplied to BenMAP.

CMAQ Model Application and Evaluation

CMAQ is a non-proprietary computer model that simulates the formation and fate of photochemical oxidants, including $PM_{2.5}$ and ozone, for given input sets of meteorological conditions and emissions. This analysis employed a version of CMAQ based on the latest publicly released version (i.e. CMAQ version 4.7[2]).

Model Domain and Grid Resolution

The CMAQ modeling analyses were performed for two domains covering the continental United States, as shown in Figure 4-1. These domains consist of a horizontal grid of 36 km covering the entire continental US and a finer-scale 12-km grid covering the Eastern U.S. The model extends vertically from the surface to 100 millibars (approximately 15 km) using a sigma-pressure coordinate system. The 36-km grid was used to establish the incoming air quality concentrations along the boundaries of the 12-km grids. Table G-1 provides some basic geographic information regarding the CMAQ domains. The 36-km and both 12-km CMAQ modeling domains were modeled for the entire year of 2005. All 365 model days were used in the annual average levels of $PM_{2.5}$.

[2]CMAQ version 4.7 was released on December 1, 2008. It is available from the Community Modeling and Analysis System (CMAS) at: http://www.cmascenter.org.

Table G-1. Geographic Information for Modeling Domains

	CMAQ Modeling Configuration	
	National Grid	**Eastern U.S. Fine Grid**
Map Projection	Lambert Conformal Projection	
Grid Resolution	36 km	12 km
Coordinate Center	97 W, 40 N	
True Latitudes	33 and 45 N	
Dimensions	148 x 112 x 24	279 x 240 x 24
Vertical extent	24 Layers: Surface to 100 mb level	

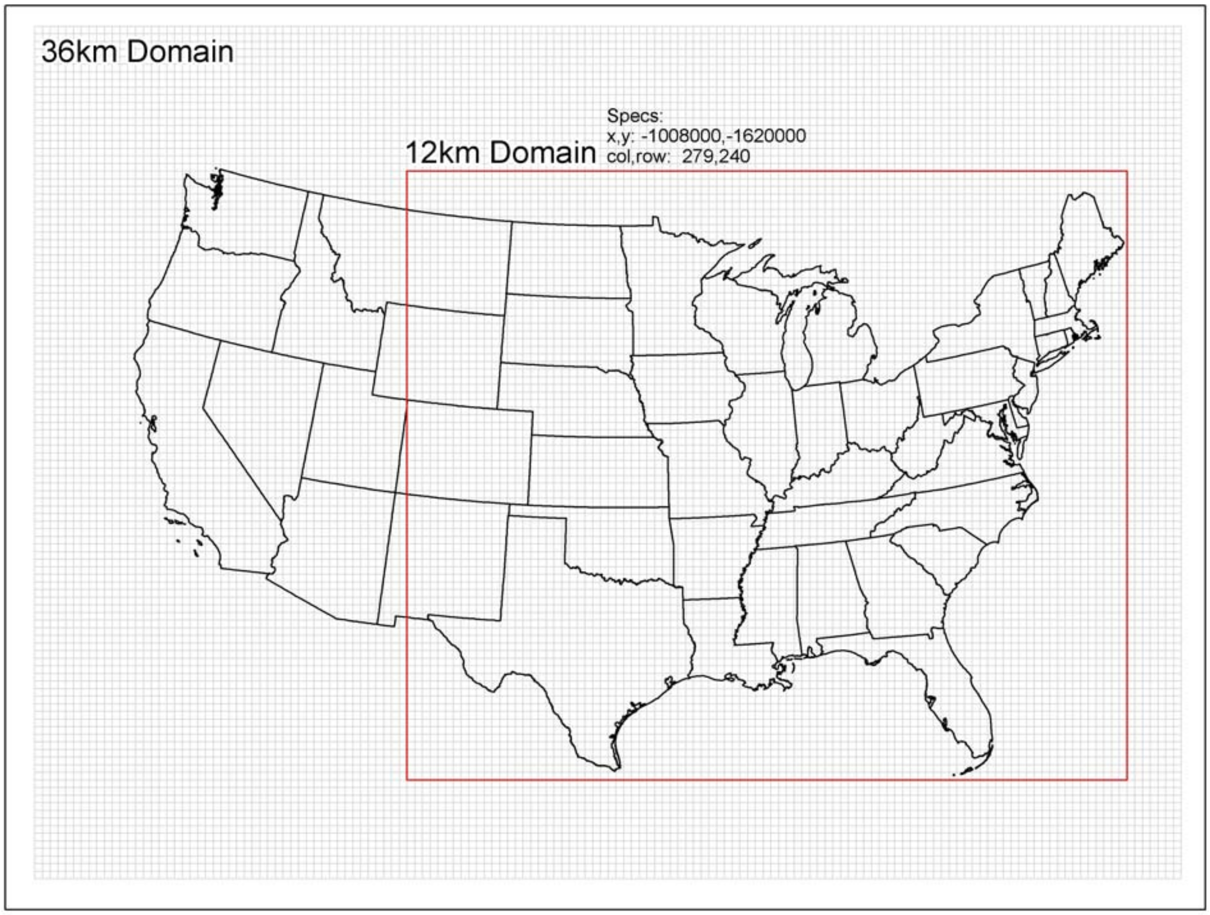


Figure G-1. Map of the CMAQ Modeling Domain (Note, the black outer box denotes the 36-km national modeling domain; the red inner box is the 12-km Eastern U.S. fine grid).

CMAQ Model Inputs

Emissions:

The 2005 emissions inputs to CMAQ included five source sectors: a) Electric Generating Units (EGUs); b) Other Stationary Sources (Point and Nonpoint); c) Onroad and Nonroad Mobile Sources; d) Biogenic Emissions; and e) Fires. The fires portion of the inventory included emissions from wildfires and prescribed burning computed as hour-specific point sources.

Electric Generating Units (EGUs)

Annual emissions estimates for EGUs for all National Emissions Inventory (NEI) air pollutants for 2005 were developed using data reported to the USEPA's Clean Air Marketing Division's (CAMD) Acid Rain database. The Acid Rain database contains hourly emissions for

SO2 and NOx emissions plus hourly heat input amounts. These three values are reported to the database by the largest electric generating facilities, usually based upon Continuous Emissions Monitors (CEMs). For all pollutants except the directly monitored SO2 and NOx, the ratio of the Acid Rain heat input for 2005 to the Acid Rain heat input for 2002 was used as the adjusting ratio to estimate the 2005 emissions.

Other Stationary Sources (Point and Nonpoint)

Emission estimates for other stationary sources including both point and nonpoint stationary sources were held constant at the level in Version 3 of the 2002 NEI. The only exception to this was that some information on plants that closed after 2002 was incorporated into the emissions modeled. Emissions for plants that closed were set to zero. U.S. EPA, 2008c provides complete documentation on the development of the 2002 NEI.

Onroad and Nonroad Mobile Sources

Emission estimates for all pollutants were developed using EPA's National Mobile Inventory Model (NMIM), which uses MOBILE6 to calculate onroad emission factors. A full VMT database at the county, roadway type, and vehicle type level of detail was developed from Federal Highway Administration (FHWA) information. However, state and local agencies had the opportunity to provide model inputs (vehicle populations, fuel characteristics, VMT, etc) for 2002 and 2005. If the state or local area submitted 2005 VMT estimates, these data were used. However, if the state or local area only provided 2002 VMT estimates that were incorporated in the 2002 NEI, the 2002 NEI VMT data were grown to 2005 using growth factors developed from the FHWA data, and these grown VMT data replaced the baseline FHWA-based VMT data. Otherwise, the FHWA-based VMT data were used.

Emission estimates for NONROAD model engines were developed using EPA's National Mobile Inventory Model (NMIM), which incorporates NONROAD2005. Where states provided alternate nonroad inputs, these data replaced EPA default inputs, as described above. For more information on how NMIM is run, refer to the 2005 NEI documentation posted at ftp://ftp.epa.gov/EmisInventory/2005_nei/mobile/2005_mobile_nei_version_2_report.pdf.

Fires

Fires in the 2005 emissions inventory were modeled with the same methodology as used for the 2002 NEI (U.S. EPA, 2008). However, as described in Raffuse et al., 2008, the wildland fire emission inventories for 2005 were produced using the BlueSky framework for the conterminous United States, which used the Satellite Mapping Automatic Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) as the fire information source. SMARTFIRE is an algorithm and database system designed to reconcile these disparate fire information sources to produce daily fire location and size information (Sullivan et al., 2008).

Biogenic Emissions

Biogenic emissions were computed for CMAQ based on 2005 meteorology data using the BEIS3.13 model (Schwede, et. al, 2005) from the Sparse Matrix Operator Kernel Emissions (SMOKE). The BEIS3.13 model creates gridded, hourly, model-species emissions from vegetation and soils. It estimates CO, VOC, and NOX emissions for the U.S., Mexico, and Canada. The inputs to BEIS include:

- temperature data at 10 meters which were obtained from the CMAQ meteorological input files, and
- land-use data from the Biogenic Emissions Landuse Database, version 3 (BELD3), which provides data on the 230 vegetation classes at 1 km resolution over most of North America.

Meteorological Input Data:

The gridded meteorological input data for the entire year of 2005 were derived from simulations of the Pennsylvania State University / National Center for Atmospheric Research Mesoscale Model. This model, commonly referred to as MM5, is a limited-area, nonhydrostatic, terrain-following system that solves for the full set of physical and thermodynamic equations which govern atmospheric motions (Grell et al., 1994). Meteorological model input fields were prepared separately for both of the domains shown in Figure G-1 using MM5 version 3.7.4. The MM5 simulations were run on the same map projection as CMAQ.

Both meteorological model runs were configured similarly. The selections for key MM5 physics options are shown below:

- Pleim-Xiu PBL and land surface schemes
- Kain-Fritsh 2 cumulus parameterization
- Reisner 2 mixed phase moisture scheme
- RRTM longwave radiation scheme
- Dudhia shortwave radiation scheme

Three dimensional analysis nudging for temperature and moisture was applied above the boundary layer only. Analysis nudging for the wind field was applied above and below the boundary layer. The 36 km domain nudging weighting factors were 3.0 x 10^4 for wind fields and temperatures and 1.0 x 10^5 for moisture fields. The 12 km domain nudging weighting factors were 1.0 x 10^4 for wind fields and temperatures and 1.0 x 10^5 for moisture fields.

All model runs were conducted in 5.5 day segments with 12 hours of overlap for spin-up purposes. Both domains contained 34 vertical layers with an approximately 38 m deep surface layer and a 100 millibar top. The MM5 and CMAQ vertical structures are shown in Table G-2 and do not vary by horizontal grid resolution.

Table G-2. Vertical Layer Structure for MM5 and CMAQ (heights are layer top).

CMAQ Layers	MM5 Layers	Sigma P	Approximate Height (m)	Approximate Pressure (mb)
0	0	1	0	1000
1	1	0.995	38	995
2	2	0.99	77	991
3	3	0.985	115	987
	4	0.98	154	982
4	5	0.97	232	973
5	6	0.96	310	964
6	7	0.95	389	955
	8	0.94	469	946
7	9	0.93	550	937
	10	0.92	631	928
8	11	0.91	712	919
	12	0.9	794	910
9	13	0.88	961	892
10	14	0.86	1,130	874
11	15	0.84	1,303	856
12	16	0.82	1,478	838
13	17	0.8	1,657	820
14	18	0.77	1,930	793
15	19	0.74	2,212	766
16	20	0.7	2,600	730
17	21	0.65	3,108	685
18	22	0.6	3,644	640
19	23	0.55	4,212	595
	24	0.5	4,816	550
20	25	0.45	5,461	505

CMAQ Layers	MM5 Layers	Sigma P	Approximate Height (m)	Approximate Pressure (mb)
	26	0.4	6,153	460
21	27	0.35	6,903	415
	28	0.3	7,720	370
22	29	0.25	8,621	325
	30	0.2	9,625	280
23	31	0.15	10,764	235
	32	0.1	12,085	190
24	33	0.05	13,670	145
	34	0	15,674	100

The meteorological outputs from the MM5 sets were processed to create model-ready inputs for CMAQ using the Meteorology-Chemistry Interface Processor (MCIP), version 3.4, to derive the specific inputs to CMAQ.

Before initiating the air quality simulations, it was important to identify the biases and errors associated with the meteorological modeling inputs. The 2005 MM5 model performance evaluations used an approach which included a combination of qualitative and quantitative analyses to assess the adequacy of the MM5 simulated fields. The qualitative aspects involved comparisons of the model-estimated synoptic patterns against observed patterns from historical weather chart archives. Additionally, the evaluations compared spatial patterns of monthly average rainfall and monthly maximum planetary boundary layer (PBL) heights. Qualitatively, the model fields closely matched the observed synoptic patterns, which is not unexpected given the use of nudging. The operational evaluation included statistical comparisons of model/observed pairs (e.g., mean normalized bias, mean normalized error, index of agreement, root mean square errors, etc.) for multiple meteorological parameters, including temperature, humidity, shortwave downward radiation, wind speed, and wind direction (Baker and Dolwick, 2009a, Baker and Dolwick, 2009b). It was ultimately determined that the bias and error values associated with the 2005 meteorological data were generally within the range of past meteorological modeling results that have been used for air quality applications.

Initial and Boundary Conditions:

The lateral boundary and initial species concentrations are provided by a three-dimensional global atmospheric chemistry model, the GEOS-CHEM model (Yantosca, 2004). The global GEOS-CHEM model simulates atmospheric chemical and physical processes driven by assimilated meteorological observations from the NASA's Goddard Earth Observing System (GEOS). This model was run for 2002 with a grid resolution of 2.0 degrees x 2.5 degrees (latitude-longitude) and 24 vertical layers. The 2005 CMAQ 36km simulation used non-year specific GEOS-CHEM data, which was created by taking the median value for each month in each individual grid cell of the 2002 GEOS-CHEM data described above. The predictions were used to provide one-way dynamic boundary conditions and an initial concentration field for the CMAQ simulations. More information is available about the GEOS-CHEM model and other applications using this tool at: http://www-as.harvard.edu/chemistry/trop/geos.

CMAQ Model Performance Evaluation

An operational model performance evaluation for $PM_{2.5}$ and its related speciated components was conducted for 2005 using state/local monitoring sites data in order to estimate the ability of the CMAQ modeling system to replicate the concentrations for the 12-km Eastern domain and 36-km domain in the west. The principal evaluation statistics used to evaluate CMAQ performance included two bias metrics, normalized mean bias and fractional bias; and two error metrics, normalized mean error and fractional error. For the 12-km Eastern domain, performance evaluation statistics were computed for the entire domain as well as its subregions. For the 36-km domain, evaluation focuses on the parts of the US not covered by the 12-km Eastern domain by computing performance evaluation statistics for the states included in the Western Regional Air Partnership (WRAP).

The $PM_{2.5}$ evaluation focuses on $PM_{2.5}$ total mass and its components, including sulfate (SO4), nitrate (NO3), total nitrate (TNO3 = NO3 + HNO3), ammonium (NH4), elemental carbon (EC), and organic carbon (OC). PM2.5 ambient measurements for 2005 were obtained from the following networks for model evaluation: Speciation Trends Network (STN), Interagency Monitoring of PROtected Visual Environments (IMPROVE), and Clean Air Status and Trends Network (CASTNET). For PM2.5 species that are measured by more than one network, we calculated separate sets of statistics for each network. Table G-3 provides annual model performance statistics for $PM_{2.5}$ and its component species. Based on the bias and error values associated with the 2005 CMAQ-modeled $PM_{2.5}$ concentration data, it was determined that the annual average $PM_{2.5}$ data were generally within the range of past modeling results used for air quality applications and are applicable to be used for this national-scale current conditions analysis.

Table G-3. CMAQ modeled performance evaluation statistics for PM2.5 for 2005.

CMAQ 2005 Annual			No. of Obs.	NMB (%)	NME (%)	FB (%)	FE (%)
PM2.5 Total Mass	STN	12-km EUS	11622	-2.2	39.1	-4.7	40.3
		Northeast	2795	4.2	41.3	3.4	39.5

CMAQ 2005 Annual			No. of Obs.	NMB (%)	NME (%)	FB (%)	FE (%)
		Midwest	2318	4.3	35.2	5.0	34.1
		Southeast	2960	-13.0	37.5	-15.9	41.1
		Central	2523	-2.2	43.1	-8.4	45.6
		36-km West WRAP	3082	-35.1	50.7	-40.3	57.4
	IMPROVE	12-km EUS	10534	-9.4	44.3	-13.8	48.6
		Northeast	2464	5.3	48.6	2.3	46.2
		Midwest	668	-4.6	38.2	-7.3	40.8
		Southeast	1963	-20.8	42.8	-25.9	51.3
		Central	2768	-10.5	42.8	-12.9	47.7
		36-km West WRAP	10,122	-21.0	56.0	-24.4	57.6
Sulfate	STN	12-km EUS	13317	-17.1	34.0	-13.5	37.0
		Northeast	3247	-13.7	32.4	-9.4	34.3
		Midwest	2495	-10.9	33.9	-4.4	34.9
		Southeast	3499	-19.2	32.8	-16.8	35.8
		Central	2944	-25.7	38.7	-23.1	43.5
		36-km West WRAP	3450	-21.9	46.4	-15.0	46.5
	IMPROVE	12-km EUS	10164	-21.8	36.4	-13.2	41.1
		Northeast	2393	-14.6	35.5	-6.6	38.6
		Midwest	622	-19.0	34.5	-9.4	36.7
		Southeast	1990	-25.2	35.9	-22.3	41.1
		Central	2640	-27.9	38.0	-22.0	42.4
		36-km West WRAP	9693	-5.2	45.2	9.6	47.6
	CASTNet	12-km EUS	3170	-16.5	22.9	-15.6	26.0
		Northeast	786	-11.7	20.5	-9.8	22.6
		Midwest	615	-13.6	21.4	-11.2	22.2
		Southeast	1099	-18.4	22.9	-19.6	25.7
		Central	300	-29.4	32.5	-30.3	36.1
		36-km West WRAP	1112	-12.6	34.5	-3.2	36.7
Nitrate	STN	12-km EUS	12186	20.1	67.8	-10.1	76.3
		Northeast	3248	28.7	70.2	-3.7	74.1

CMAQ 2005 Annual			No. of Obs.	NMB (%)	NME (%)	FB (%)	FE (%)
		Midwest	2495	20.2	61.0	9.2	63.0
		Southeast	3499	23.5	84.0	-25.0	87.2
		Central	1812	8.1	60.2	-5.9	72.4
		36-km West WRAP	15,533	15.2	79.3	-15.6	85.9
	IMPROVE	12-km EUS	10157	30.1	85.2	-32.5	99.1
		Northeast	2388	67.0	108.9	0.5	93.4
		Midwest	622	14.0	67.9	-24.1	88.9
		Southeast	1990	37.4	104.6	-46.2	105.9
		Central	2640	17.3	70.8	-19.3	89.6
		36-km West WRAP	17,452	33.1	99.1	-41.9	109.9
Total Nitrate (NO_3+HNO_3)	CASTNet	12-km EUS	3170	24.6	39.7	17.8	38.0
		Northeast	786	36.5	43.0	30.3	40.6
		Midwest	615	23.3	36.5	23.9	33.2
		Southeast	1099	23.6	42.2	12.8	40.5
		Central	300	10.6	35.5	5.0	35.0
		36-km West WRAP	4065	37.7	51.9	24.2	45.1
Ammonium	STN	12-km EUS	13317	1.8	41.9	8.3	45.6
		Northeast	3247	7.1	42.9	18.9	45.7
		Midwest	2495	7.1	40.5	16.4	41.4
		Southeast	3499	-2.1	40.5	2.9	43.3
		Central	2944	-7.6	44.0	-4.0	51.4
		36-km West WRAP	16,680	8.1	47.2	12.8	48.9
	CASTNet	12-km EUS	3170	2.2	35.4	3.1	36.5
		Northeast	786	9.2	38.1	13.3	36.6
		Midwest	615	10.9	35.3	14.8	33.7
		Southeast	1099	-9.2	33.3	-9.7	37.6
		Central	300	1.5	36.9	3.0	40.2
		36-km West WRAP	4065	12.8	39.6	13.0	40.1
Elemental Carbon	STN	12-km EUS	13460	19.7	63.5	11.9	53.9
		Northeast	3230	20.8	61.9	14.6	52.0

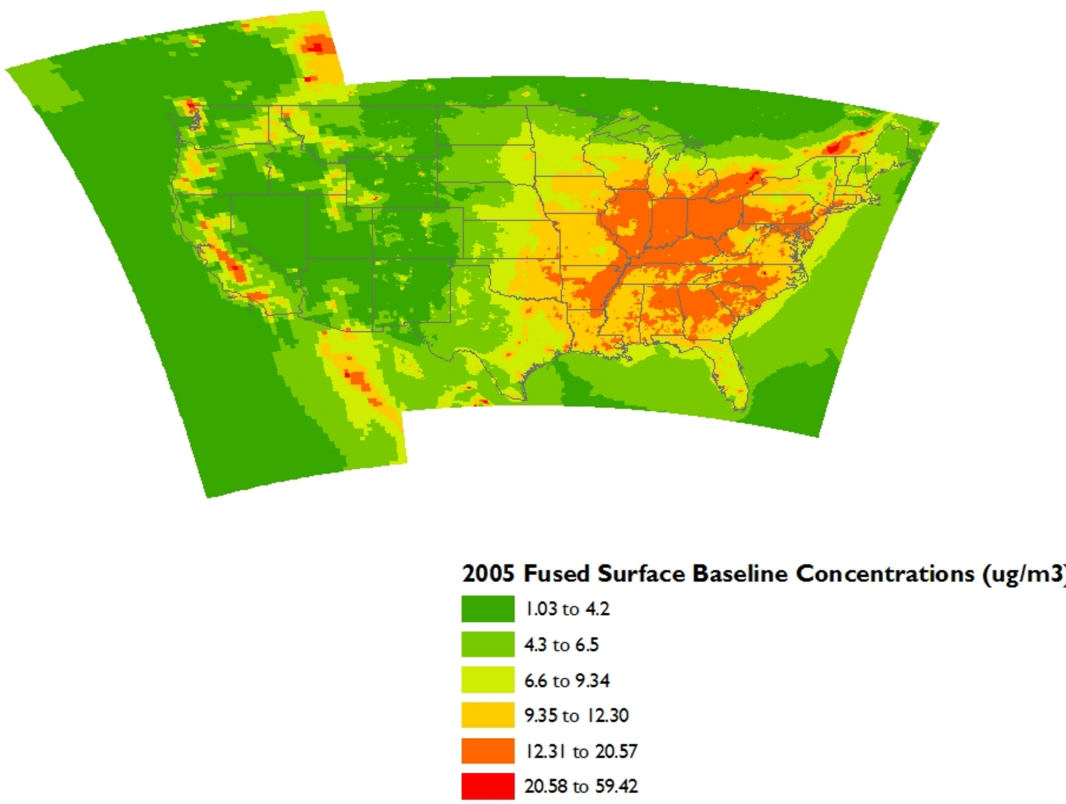
CMAQ 2005 Annual			No. of Obs.	NMB (%)	NME (%)	FB (%)	FE (%)
		Midwest	2502	7.3	46.1	10.8	44.9
		Southeast	3495	10.2	60.2	3.0	50.6
		Central	3107	47.6	88.2	23.0	64.9
		36-km West WRAP	16,700	2.6	56.7	2.6	55.0
	IMPROVE	12-km EUS	10244	-29.0	49.7	-39.1	61.3
		Northeast	2341	-17.8	49.2	-25.6	57.7
		Midwest	696	-26.7	41.9	-39.6	55.7
		Southeast	1995	-45.6	53.3	-58.5	69.8
		Central	2626	-22.9	49.2	-31.3	56.8
		36-km West WRAP	17,289	-16.6	53.4	-23.4	60.2
Organic Carbon	STN	12-km EUS	12118	-36.5	53.6	-40.6	66.5
		Northeast	3083	-29.1	53.1	-27.6	64.2
		Midwest	2385	-42.5	52.6	-41.7	65.3
		Southeast	3442	-42.6	53.5	-55.6	70.2
		Central	2164	-30.6	57.7	-39.6	66.5
		36-km West WRAP	15,397	-41.2	56.1	-45.7	69.2
	IMPROVE	12-km EUS	10210	-34.7	53.7	-53.0	70.0
		Northeast	2336	-21.0	52.2	-29.2	58.4
		Midwest	696	-41.3	47.6	-55.7	63.6
		Southeast	1993	-40.4	53.7	-64.0	74.2
		Central	2622	-34.1	52.8	-52.7	68.1
		36-km West WRAP	17,295	-22.5	57.5	-40.8	67.6

“Fused” Spatial Surfaces

Spatial surfaces of the 2005 data were created by fusing CMAQ-modeled annual average PM2.5 concentrations with total $PM_{2.5}$ data from STN, IMPROVE, and CASTNET monitoring sites for the two domains shown in Figure 1. We used the EPA’s Model Attainment Test Software (MATS) (Abt, 2009) which employees the Voronoi Neighbor Averaging (VNA) interpolation technique (Abt, 2008). This technique identifies the set of monitors that are nearest to the center of each grid cell, and then takes an inverse distance squared weighted average of the monitor concentrations. The “fused” spatial fields are calculated by adjusting the interpolated ambient data (in each grid cell) up or down by a multiplicative factor calculated as the ratio of the modeled concentration at the grid cell divided by the modeled concentration at the nearest neighbor monitor locations (weighted by distance).

To create the spatial surfaces for use in BenMAP, the 2005 CMAQ-modeled annual average $PM_{2.5}$ concentrations were “fused” with 2005 total $PM_{2.5}$ ambient monitoring data from STN, IMPROVE, and CASTNET sites. This was done for both the 36km national domain and the 12km eastern US domain. The spatial surface of annual average PM2.5 air quality concentrations produced by this technique is shown in Figure G-2 for the continental U.S. Where available, the 12km spatial surface was used to supply BenMAP with annual average $PM_{2.5}$ concentrations. In the western part of the U.S., annual average $PM_{2.5}$ concentrations were supplied from the 36km domain.

Figure G-2: 2005 Predicted Annual Mean $PM_{2.5}$ Levels



Advantages and Limitations

As compared to using monitored data alone, an advantage of using the CMAQ model output for comparing with health outcomes is that it has the potential to provide more complete spatial and temporal coverage. In addition, "fusing" the CMAQ data with ambient monitoring data allows for an improvement over non-fused fields (Timin et al., 2009). Doing so allows for a combination of the advantages of both sets of data: better spatial coverage and more accurate air quality estimates. Of course, the more accurate the model estimates of $PM_{2.5}$, the better the performance of the "fused" spatial fields. Therefore, it is important to use model outputs that have adequate $PM_{2.5}$ performance. As discussed above, we believe that the 2005 CMAQ-modeled $PM_{2.5}$ concentration data showed adequate model performance to be used for this national-scale current conditions analysis.

As with any model estimate of air quality, there are limitations. For example, the emissions and meteorological data used in CMAQ can each have large uncertainties, in particular for unusual emission or meteorological events. There are also uncertainties associated with the chemical transformation and fate process algorithms used in air quality models. For these reasons, CMAQ predicts best on longer time scale bases (e.g., synoptic, monthly, and annual scales). These limitations have led us to use modeled air quality estimates in this analysis that are "fused" with measured ambient data and averaged over an annual scale.

Air Quality Estimates

Figures G-3 through G-6 below illustrate the spatial distribution of air quality impacts. Figure 1 illustrates the modeled 2005 $PM_{2.5}$ air quality levels across the U.S. Figures 2 and 3 display the PM2.5 air quality levels after being adjusted so that the maximum level is no higher than the LML reported in the Krewski et al. (2009) and Laden et al. (2006) studies. Figure G-4 displays the PRB by region of the county.

Figure G-3: 2005 Predicted Annual Mean $PM_{2.5}$ Levels

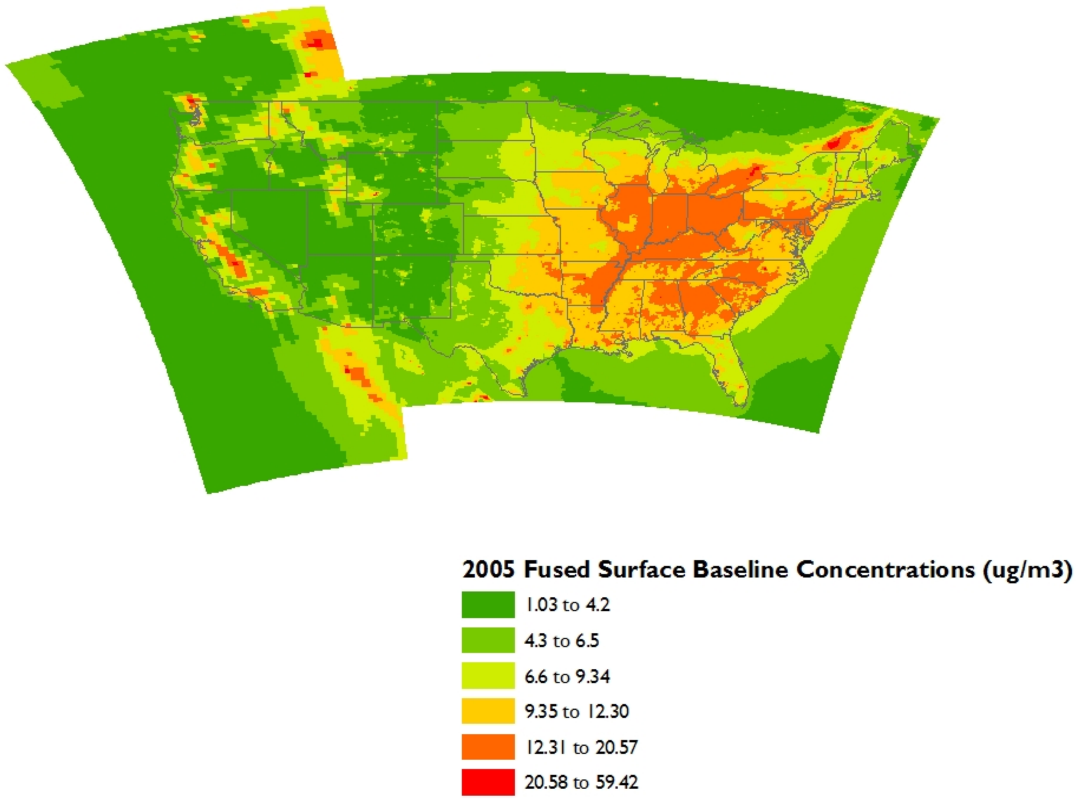


Figure G-4: 2005 Predicted Annual Mean $PM_{2.5}$ Levels Adjusted for LML of the Krewski et al. (2009) study

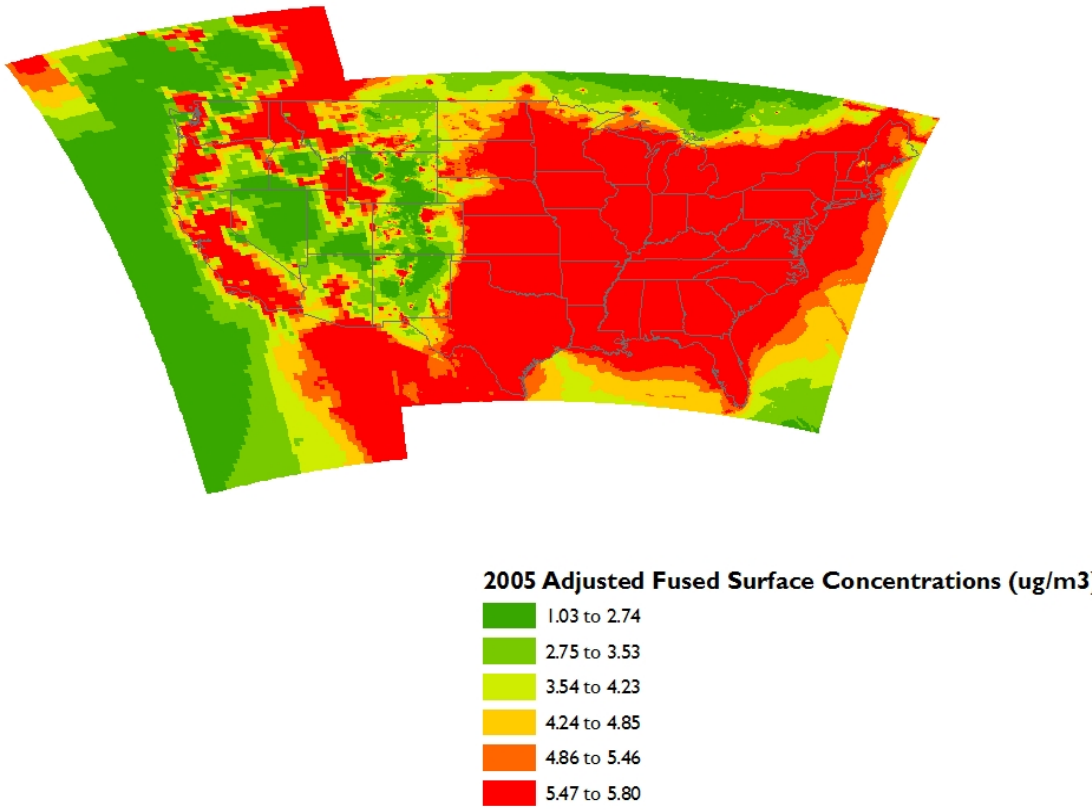


Figure G-5: 2005 Predicted Annual Mean $PM_{2.5}$ Levels Adjusted for LML of the Laden et al. (2006) study

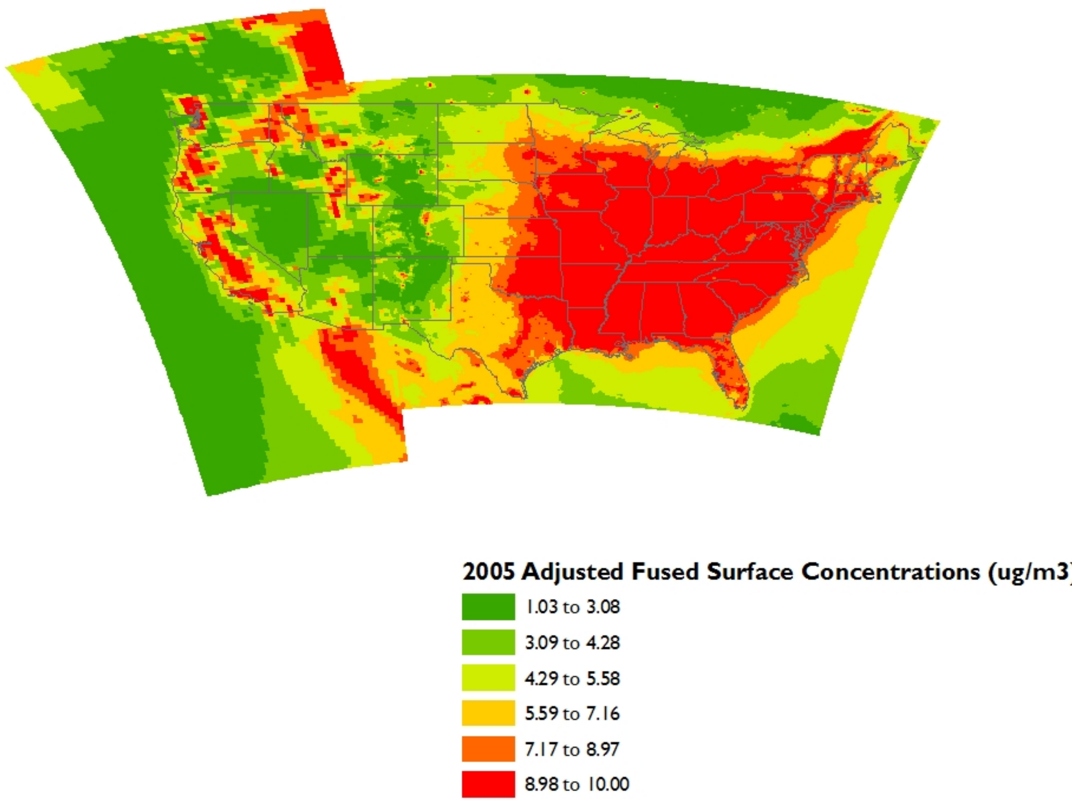


Figure G-6: PRB by Geographic Area in the U.S.

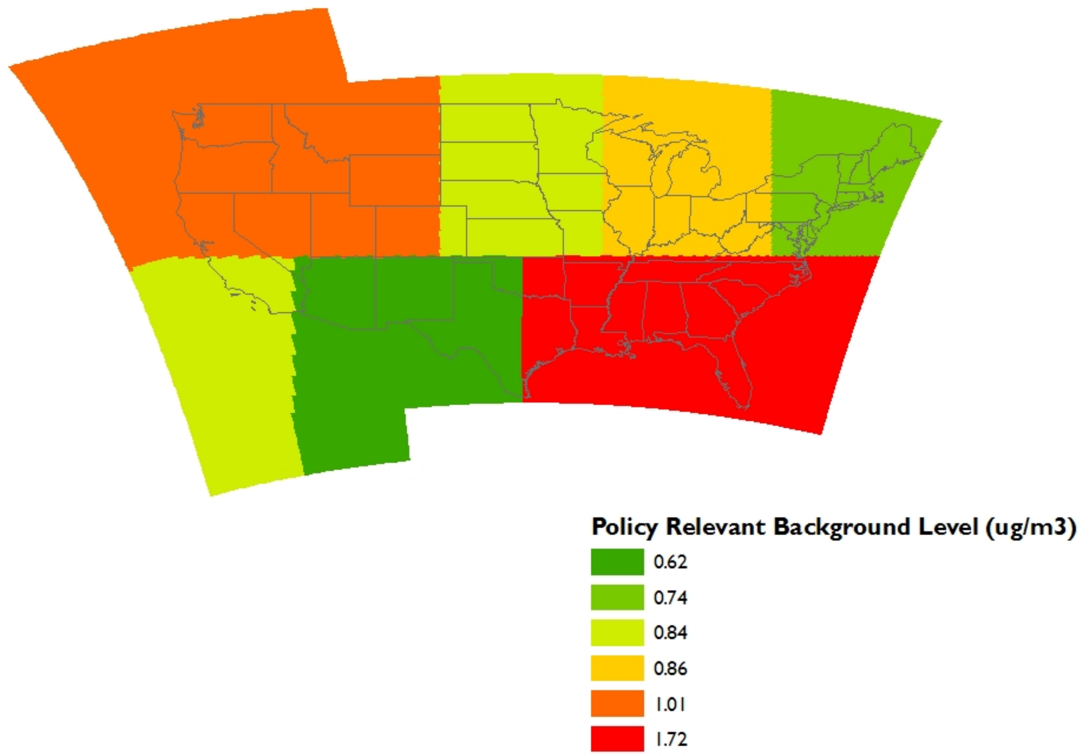


Figure G-7 displays the distribution of grid cells at different baseline $PM_{2.5}$ air quality levels. Figures G-8 through G-10 displays the distribution of grid cells according to the incremental change in $PM_{2.5}$ air quality for each of three scenarios: current conditions to 10 µg/m3, current conditions to 5.8 µg/m3 and current conditions to PRB.

Figure G-7: The Number of Grid Cells at Each Level of $PM_{2.5}$ Concentration in 2005 Current Conditions Air Quality Modeling Run

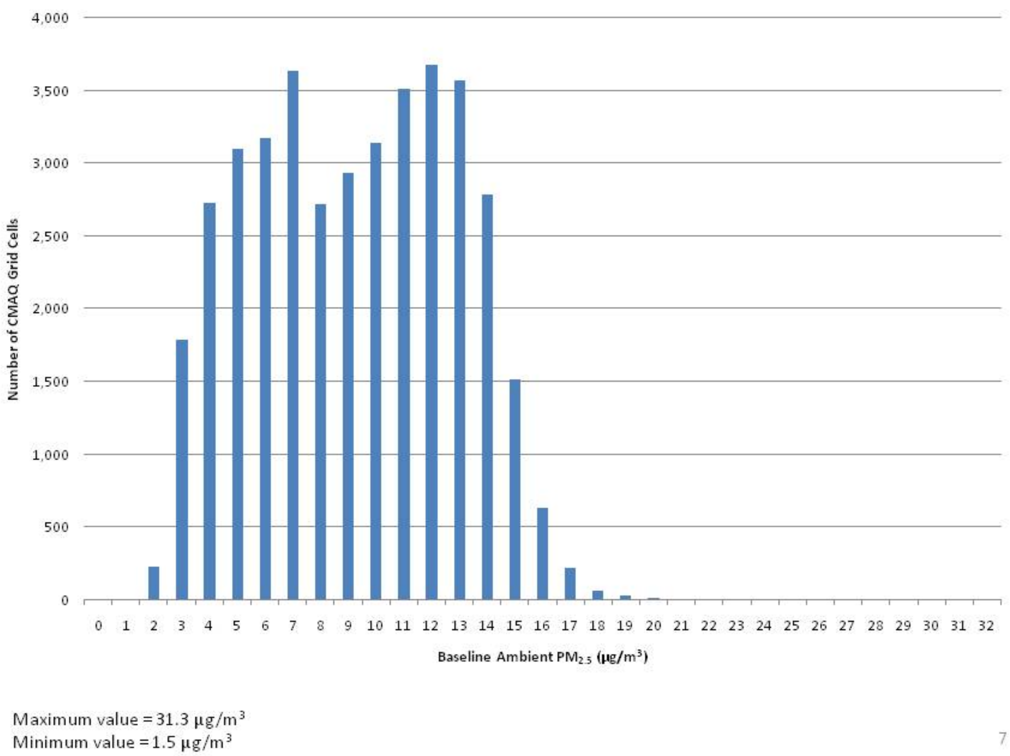


Figure G-8: The Number of CMAQ Grid Cells Experiencing an Incremental Change in Annual Mean PM2.5 (µg/m^3) (Current Conditions – 10 µg/m^3)

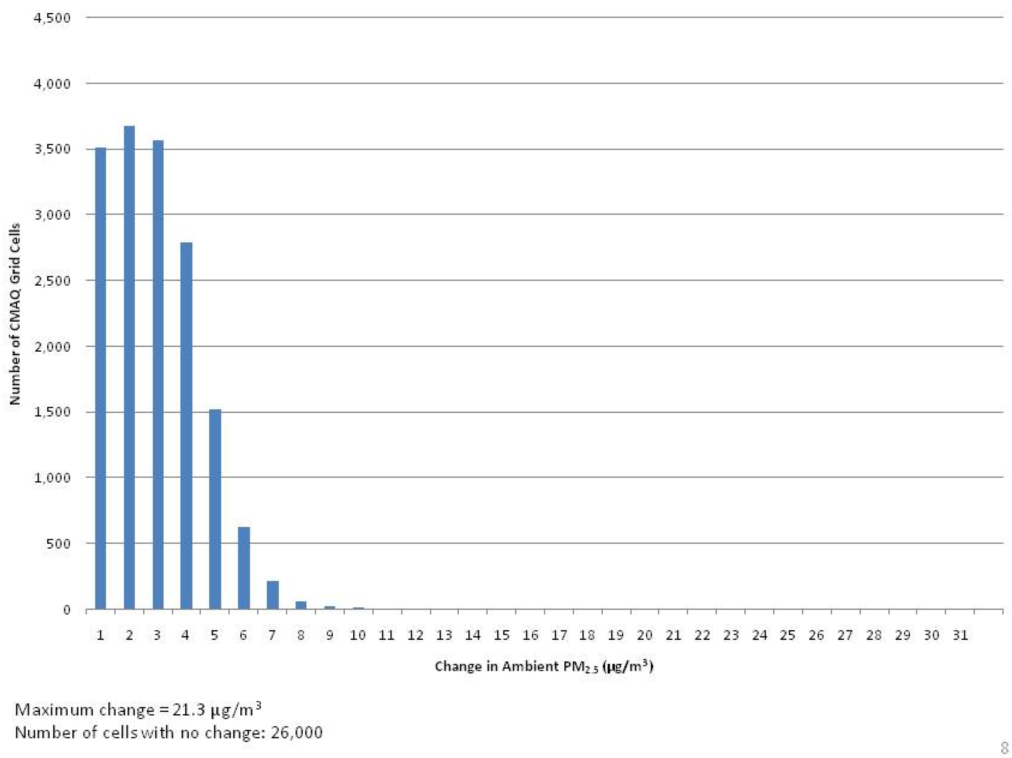


Figure G-9: The Number of CMAQ Grid Cells Experiencing an Incremental Change in Annual Mean $PM_{2.5}$ (µg/m^3) (Current Conditions – 5.8 µg/m^3)

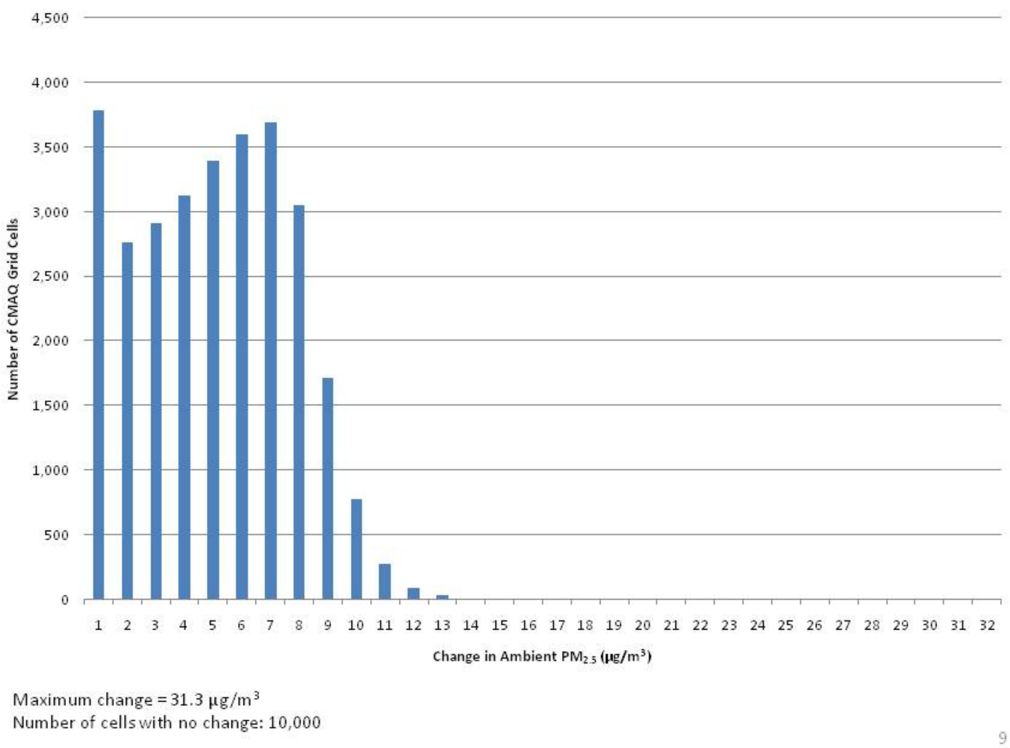


Figure G-10: The Number of CMAQ Grid Cells Experiencing an Incremental Change in Annual Mean $PM_{2.5}$ (μg/m^3) (Current Conditions – Policy Relevant Background)

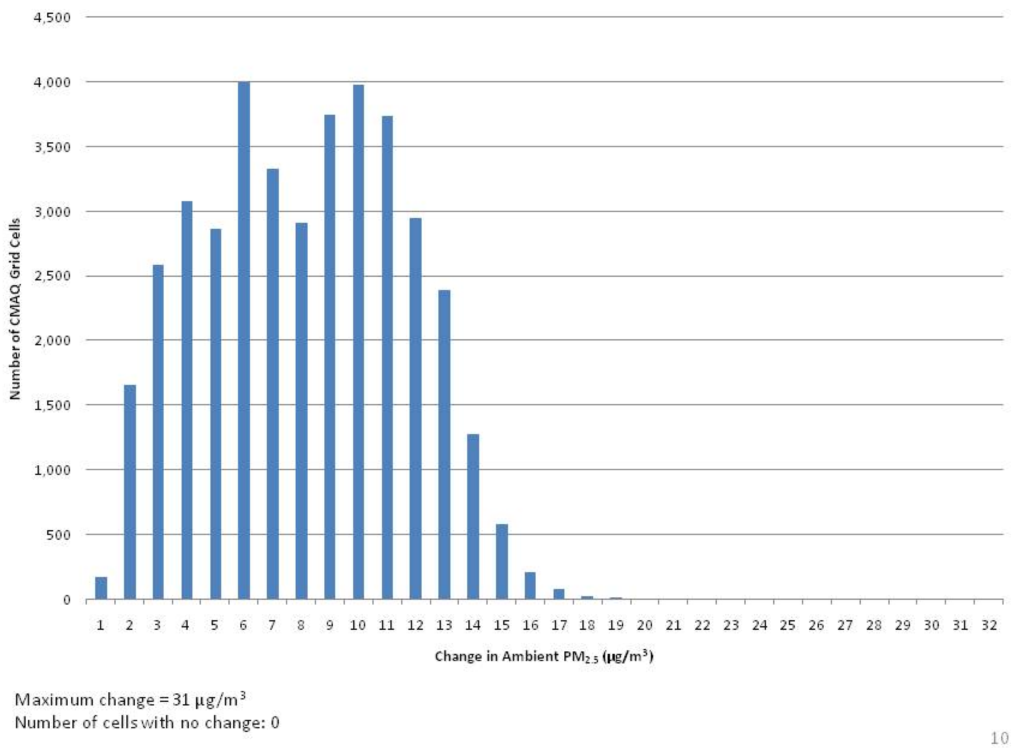


Figure G-11 displays the cumulative distribution of grid cells at each baseline concentration. Figures G-12 through G-14 display the cumulative distribution of grid cells experiencing an incremental air quality change.

Figure G-11: Cumulative Distribution of Baseline $PM_{2.5}$ Concentrations ($\mu g/m^3$)

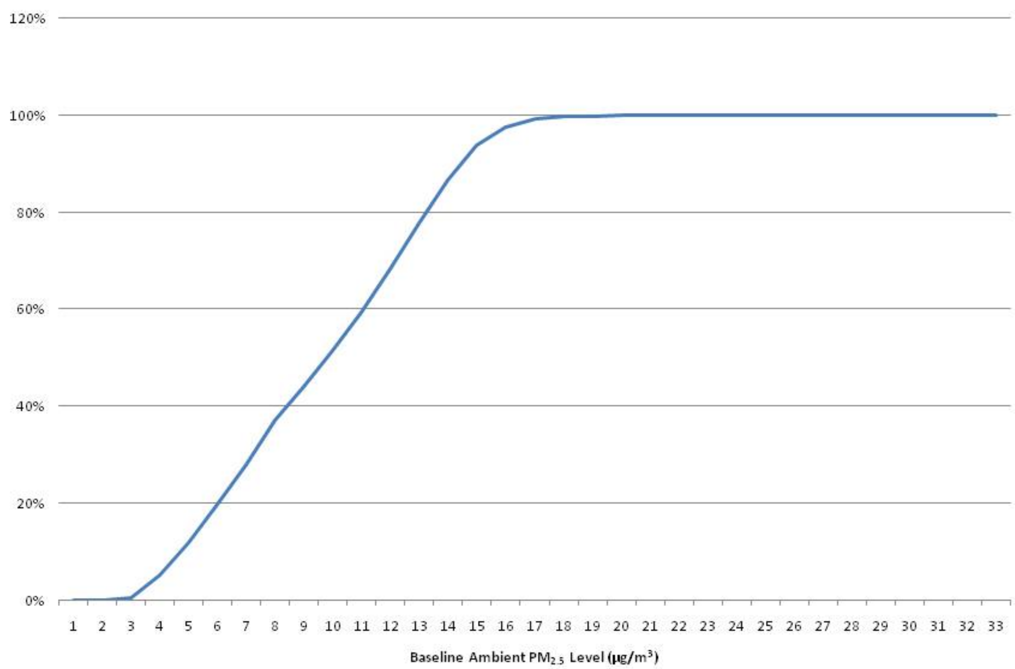
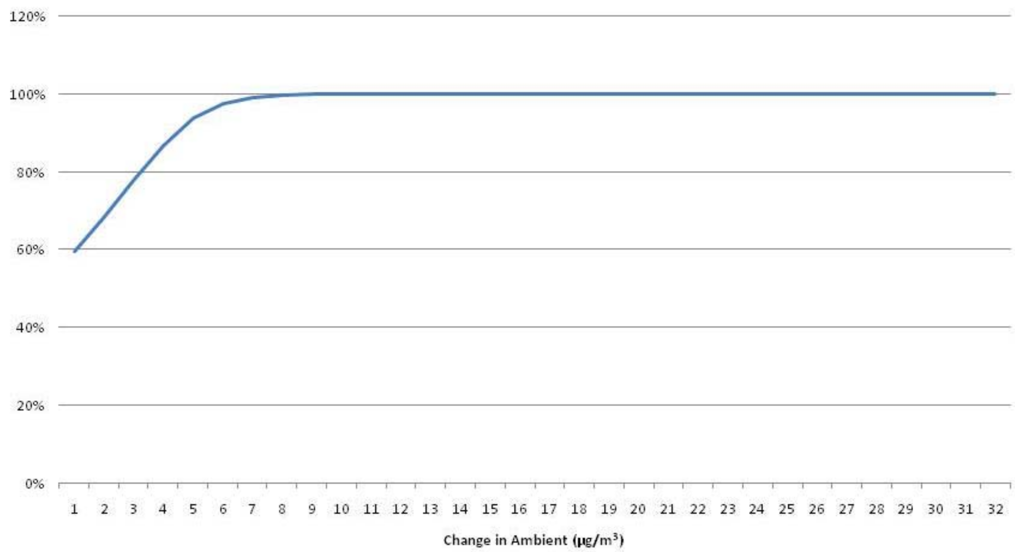


Figure G-12: Cumulative Distribution of $PM_{2.5}$ ($\mu g/m^3$) Changes (Baseline – 10 $\mu g/m^3$)



*10 µg/m³ represents the lowest measured level in the 6-cities cohort

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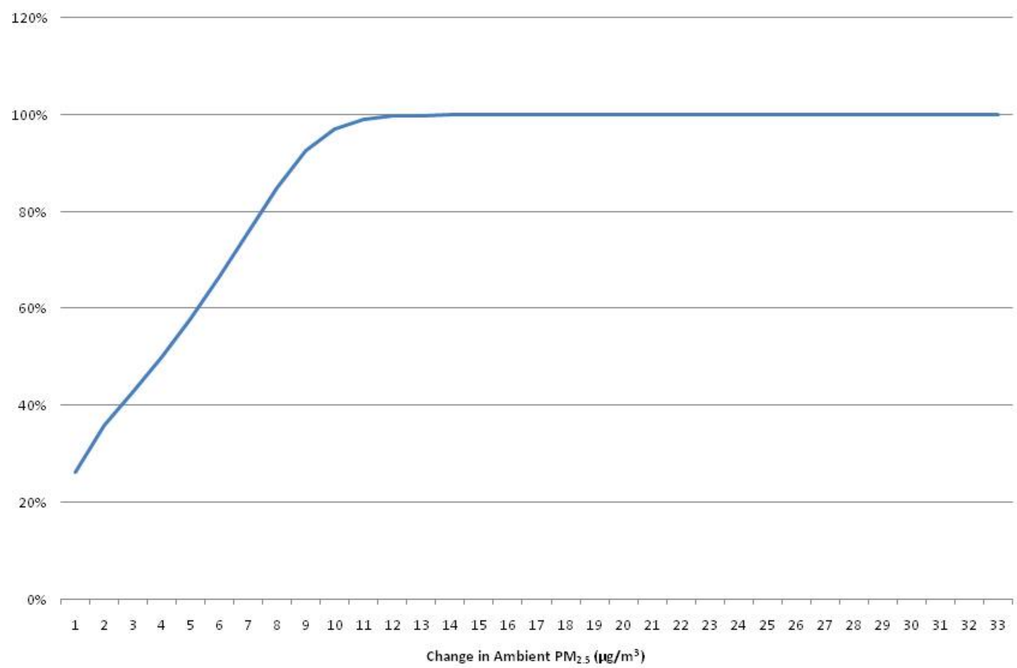
Figure G-13: Cumulative Distribution of $PM_{2.5}$ ($\mu g/m^3$) Changes (Baseline – 5.8 $\mu g/m^3$)



*5.8 µg/m3 represents the lowest measured level in the ACS cohort

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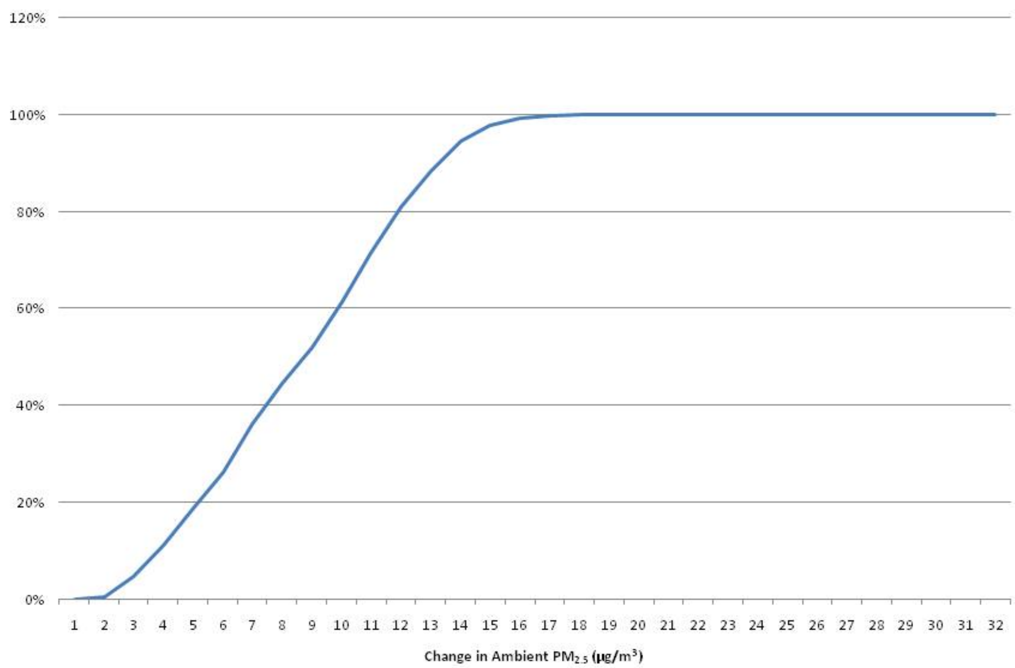
Figure G-14: Cumulative Distribution of $PM_{2.5}$ (µg/m^3) (Baseline – Policy Relevant Background)



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<u>Exposure Estimates</u>

Below we provide additional details regarding the estimated exposure changes occurring as a result of each of the air quality changes assumed in each of the three health impact assessments: current conditions incremental to 10 µg/m3, 5.8 µg/m3 and PRB. Table G-4 summarizes the population-weighted air quality change occurring among populations 30-99 (the age range considered in the ACS cohort) for each scenario.

Population-weighted air quality change is the average per-person change in $PM_{2.5}$. It is estimated by calculating the summation of the population in each grid cell multiplied against the change in annual mean $PM_{2.5}$ concentration in that grid cell and then dividing by the total population.

Table G-4. Estimated Change in Annual Mean Population-Weighted $PM_{2.5}$ by Model Scenario

Model scenario	Population-weighted air quality change or baseline
Current conditions to 10 μg/m^3	2.6 μg/m^3
Current conditions to 5.8 μg/m^3	6.3 μg/m^3
Current conditions to PRB	11 μg/m^3
Current conditions	12 μg/m^3

Health Impact Estimates

Figure G-15 through G-17 illustrate the distribution of total mortality attributable to $PM_{2.5}$ exposure for each of three scenarios: current conditions to 10 μg/m^3, 5.8 μg/m^3 and PRB.

Figure G-15: The Percentage of Total Mortality Attributable to PM2.5 Exposure: Baseline – 10 μg/m^3

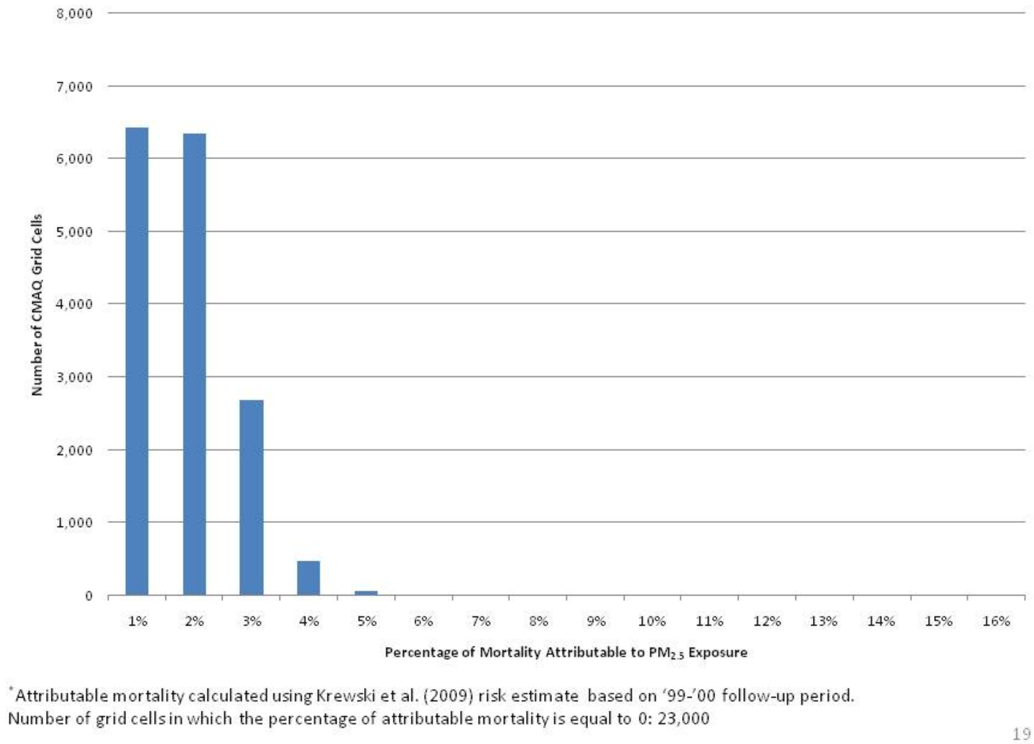
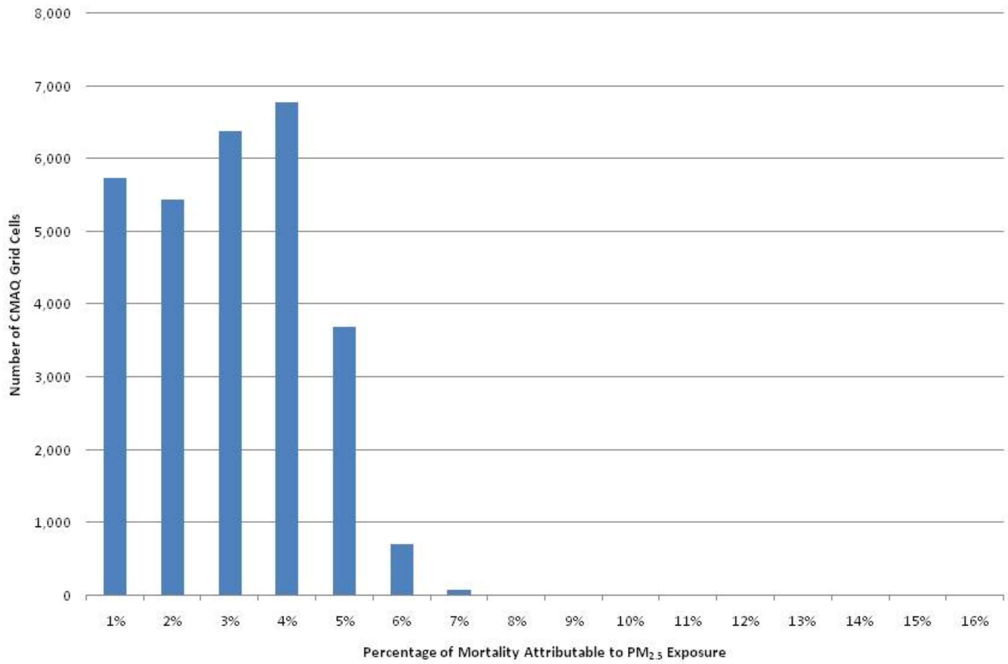


Figure G-16: The Percentage of Total Mortality Attributable to $PM_{2.5}$ Exposure: Baseline – 5.8 μg/m^3



*Attributable mortality calculated using Krewski et al. (2009) risk estimate based on '99-'00 follow-up period.
Number of grid cells in which the percentage of attributable mortality is equal to 0: 11,000

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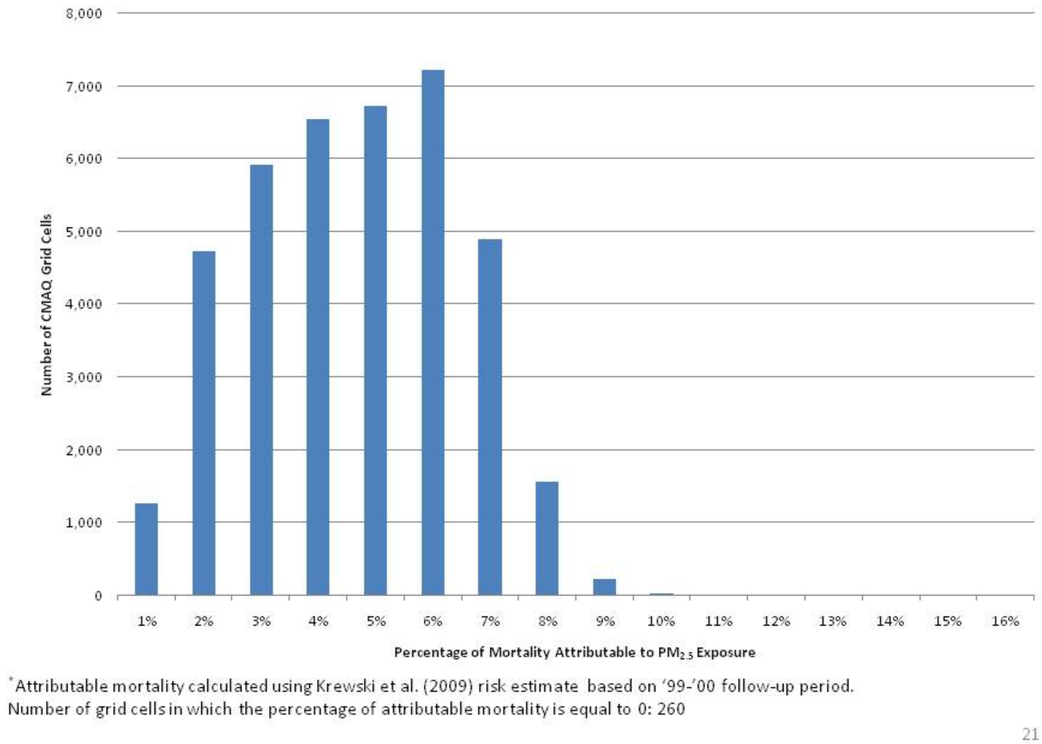
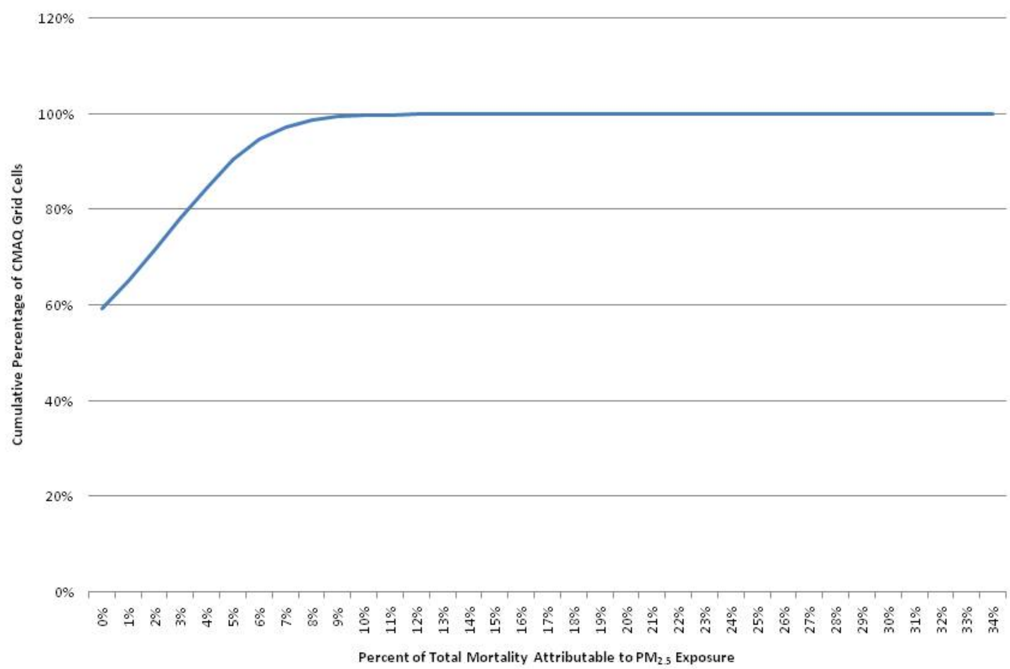
Figure G-17: The Percentage of Total Mortality Attributable to $PM_{2.5}$ Exposure: Baseline – Policy Relevant Background



Figures G-18 through G-20 illustrate the cumulative distribution of total mortality attributable to $PM_{2.5}$ exposure for each of three scenarios: current conditions to 10 $\mu g/m^3$, 5.8 $\mu g/m^3$ and PRB.

Figure G-18: The Cumulative Distribution of the Percentage of Total Mortality Attributable to $PM_{2.5}$ Exposure: Baseline – 10 µg/m^3



*Attributable mortality calculated using Krewski et al. (2009) risk estimate based on '99-'00 follow-up period.

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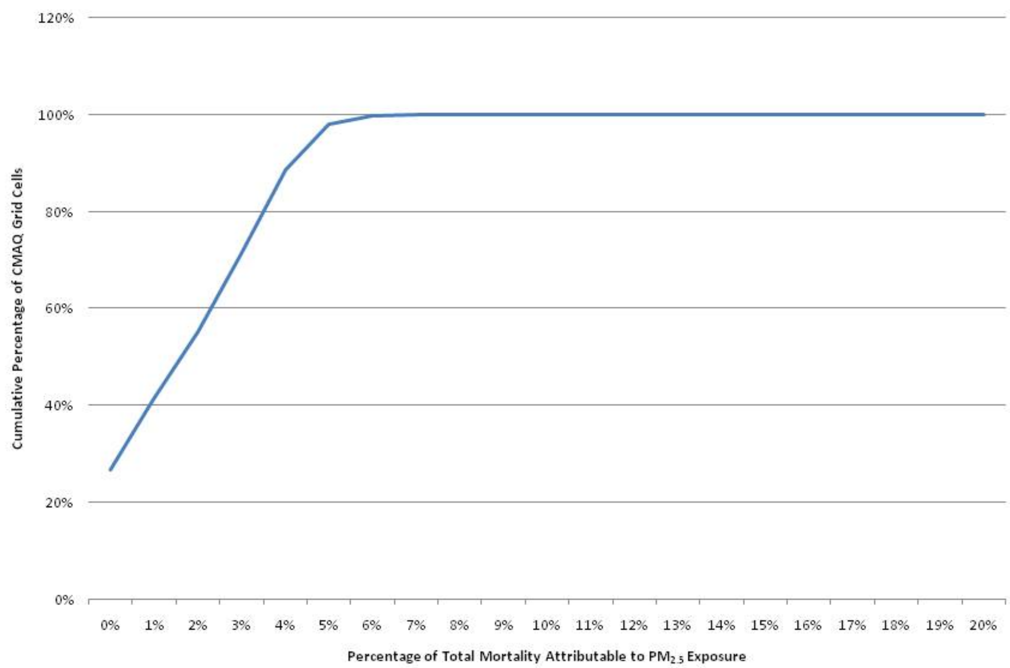
Figure G-19: The Cumulative Distribution of the Percentage of Total Mortality Attributable to PM2.5 Exposure: Baseline – 5.8 µg/m^3



*Attributable mortality calculated using Krewski et al. (2009) risk estimate based on '99-'00 follow-up period.

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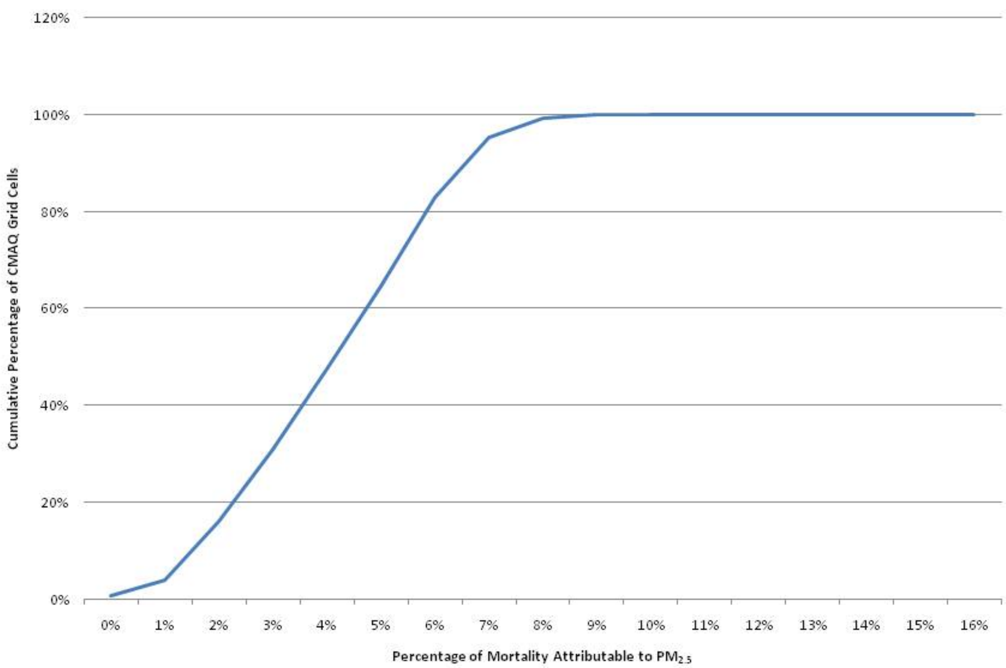
Figure G-20: The Cumulative Distribution of the Percentage of Total Mortality Attributable to $PM_{2.5}$ Exposure: Baseline – Policy Relevant Background



*Attributable mortality calculated using Krewski et al. (2009) risk estimate based on '99-'00 follow-up period.

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