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Submitted via regulations.gov

U.S. Environmental Protection Agency,
Office of Air Quality Planning and Standards,
C439-02, Research Triangle Park,
North Carolina 27711

Attention Docket ID #: EPA-HQ-OAR-2019-0587

RE: API Technical Comments on the Cost Estimates in the Regulatory Impact Analysis for the Proposed PM2.5 NAAQS Reconsideration Rule

API thanks the U.S. Environmental Protection Agency ("EPA") for the opportunity to provide comments on the Regulatory Impact Analysis (RIA). We represent all segments of America's oil and natural gas industry. Its more than 600 members produce, process, and distribute most of the nation's energy. The industry supports 11 million U.S. jobs and nearly 8 percent of the U.S. economy. In its first 100 years, API developed more than 800 standards to enhance operational and environmental safety, efficiency, and sustainability.

Many of our members have operations that would be impacted by EPA's range of proposed standards for annual fine particulate matter ($PM_{2.5}$) on the reconsideration of the Agency's 2020 rulemaking. The notice for proposed rulemaking included a RIA with estimates of the costs of control measures intended to meet more stringent standards and the public health benefits of their associated ambient $PM_{2.5}$ reductions.

These cost estimates reflect control measures that produce only a fraction of the emissions reductions that the RIA estimates will be needed for all counties in the U.S. to achieve full attainment for each of the proposed standards it considers (*i.e.,* 29% to 53% nationally, and as little as 0% for some individual counties). As a result, it only provides cost estimates for partial attainment and therefore, limits the RIA's usefulness for decision making or the public understanding of the full potential impacts of the range of proposed standards.

In the analysis attached, we carefully review the modeling inputs and outputs used to produce the RIA's partial cost estimates and demonstrate how to provide a *range* of estimates for the potential cost of full attainment, as well as provide a few highlights here:

- EPA failed to identify sufficient control measures for several areas of the U.S. to attain even the current annual $PM_{2.5}$ NAAQS of 12 µg/m^3
- the estimated potential full attainment costs, even at the low end, are vastly larger than the partial attainment costs that the RIA has reported; for example, for the most stringent proposed standard of 8µg/m^3, we estimate 4 to 13 times more than the RIA's partial cost estimate.
- partial attainment costs provide no indication of either the absolute or relative costs of any of the alternative standards considered.

This full attainment cost analysis, in the attachment below, provides the Agency with some understanding of the regulatory challenges that the various alternative standards may entail.

Again, thanks for the opportunity to comment. If you have any questions regarding the content of these comments, please contact Omobola Mudasiru (MudasiruO@api.org, 202-682-8156) at the American Petroleum Institute

Sincerely,

Mudasiru Omobola

Omobola Mudasiru, Dr.PH

ATTACHMENT

NERA
ECONOMIC CONSULTING

POTENTIAL COSTS OF FULLY ATTAINING PROPOSED LOWER $PM_{2.5}$ NAAQS STANDARDS

Technical Comments on the Cost Estimates in the Regulatory Impact Analysis for the Proposed $PM_{2.5}$ NAAQS Reconsideration Rule

Prepared for:
American Petroleum Institute

For Submission to Docket ID No. EPA-HQ-OAR-2019-0587

March 25, 2023

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About NERA

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This report reflects the research, opinions, and conclusions of its authors, and does not necessarily reflect those of NERA Economic Consulting, its affiliated companies, or any other organization.

Report Qualifications/Assumptions and Limiting Conditions

Information furnished by others, upon which all or portions of this report are based, is believed to be reliable, but has not been independently verified, unless otherwise expressly indicated. Public information and industry and statistical data are from sources we deem to be reliable; however, we make no representation as to the accuracy or completeness of such information. The findings contained in this report may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties including but not limited to free market behavior in the commodity markets. Projected costs of goods and services including liquid fuels (gasoline and diesel), are projected costs of compliance. The cost burden on the consumers will be determined by the competitive dynamics of wholesale and retail goods and fuels markets, including but not limited to supply and demand. NERA Economic Consulting accepts no responsibility for actual results or future events.

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All decisions in connection with the implementation or use of advice or recommendations contained in this report are the sole responsibility of the client. This report does not represent investment advice, nor does it provide an opinion regarding the fairness of any transaction to any and all parties.

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EXECUTIVE SUMMARY

On January 27, 2023, the *Federal Register* published a Notice of Proposed Rulemaking (NPRM) from the Environmental Protection Agency (EPA), seeking comment on a reconsideration of the Agency's 2020 rulemaking on the current annual National Ambient Air Quality Standards (NAAQS) for fine particulate matter ($PM_{2.5}$).[1] The current NAAQS for $PM_{2.5}$ are 12 μg/m^3 for the annual average and 35 μg/m^3 for the daily (24-hour) average.[2] For simplicity of exposition, this combination of annual and daily standards will be referred to herein as "12/35." Upon reconsideration, EPA is proposing to tighten the current annual standard (without modification of the daily standard of 35 μg/m^3) to some level between 10 ug/m^3 and 9 ug/m^3, and is taking comment on a standard of 8 μg/m^3 and of up to 11 ug/m^3.[3] Hereafter, we refer to these three alternative standards by the labels "10/35," "9/35," "8/35," and "11/35." Simultaneously with the NPRM, EPA also publicly released its Regulatory Impact Analysis (RIA) for the proposed revisions.[4] This RIA contains, *inter alia*, estimates of the costs of control measures that form part of the illustrative control strategies intended to meet more stringent standards and the public health benefits of their associated ambient $PM_{2.5}$ reductions. The comment period for both the NRPM and the RIA ends on March 28, 2023.

The technical comments in this report address the RIA's estimates of the potential costs of attaining three of the four alternative annual standards listed above: 10/35, 9/35, and 8/35.[5] Key findings of this report are summarized below, and fully detailed in the main sections and appendices of this report.

Most generally, we find that the RIA's cost estimates are incomplete to the point of having very limited usefulness to decision making or public understanding of the full potential impacts of any of the alternative standards. Specifically, the RIA's cost estimates reflect control measures that produce only a fraction of the emissions reductions that it estimates will be needed for all counties in the U.S. to achieve full attainment of each of the alternative standards (*i.e.,* only 29% to 53% of the required emissions reductions nationally, and as little as 0% for some individual counties). In essence, the cost estimates reported in the RIA are only for "partial attainment."

Partial attainment is not a concept with any basis in economic practice or theory. It is simply the point at which a list of candidate control measures that EPA prepared prior to initiating its cost analysis is

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[1] 88 *Federal Register* 5558, "Reconsideration of the National Ambient Air Quality Standards for Particulate Matter," January 27, 2023.

[2] These are the values that monitor-specific design values may not exceed. The annual average considers 3-year averages of the annual design values. The daily average standard must not be exceeded by the 3-year average of the 98th percentile of a monitor's 24-hour average values.

[3] The NPRM also solicits comments on a possible tightening of the daily standard to 30 μg/m^3 but the focus of these comments is only on analyses related to alternative annual standards discussed in the NPRM.

[4] EPA, 2022, *Regulatory Impact Analysis for the Proposed Reconsideration of the National Ambient Air Quality Standards for Particulate Matter*, EPA-452/P-22-001, December, available at https://www.epa.gov/system/files/documents/2023-01/naaqs-pm_ria_proposed_2022-12.pdf.

[5] The RIA does not explain why it has not provided an evaluation of 11/35 even though it does evaluate 8/35 and a daily standard of 30 μg/m^3 (*i.e.*, 10/30). Lacking any RIA analysis for 11/35, we do not attempt to comment on its costs in this report. While we do not quantitatively evaluate the RIA's cost estimates for 10/30, the comments and concerns we identify for the three alternative annual standards apply equally well to the RIA's estimates of 10/30.

completely used up, or contains only measures that are of a higher cost per ton than EPA has decided to consider,[6] or would be applied to emissions sources that emit fewer tons per year than EPA has decided to consider.[7] The constraints themselves have no foundation in the Clean Air Act nor in states' practices for developing NAAQS implementation plans, and may be unrealistic, given that states face sanctions if they cannot identify and impose controls sufficient to achieve attainment. These cost and size constraints likely play a role in why the RIA produces only partial attainment, but we also find that the list of candidate control measures does not even contain measures that would address a very large fraction of the baseline emissions that need to be reduced in order to achieve full attainment. The omitted potential control measures are inherently more costly than those included. The overall result of the RIA's cost analysis is significant understatement of the full attainment cost of each alternative standard.

There also is no basis in sound RIA practice for reporting only partial attainment costs. In fact, when EPA has run into the problem of partial attainment in its prior RIAs for both $PM_{2.5}$ and ozone NAAQS rulemakings (*e.g.*, EPA, 2012 and 2015), it provided estimates of only full attainment costs in those RIA's executive summaries. EPA treated its partial cost estimates as merely an initial step in the full cost analysis, relegating them to mere analytical details in later chapters of the RIAs. Inspection of the details in those prior RIAs finds that partial attainment costs were most often between 1% and 15% of EPA's respective full attainment cost estimates, and only one case reached as high as 50%.

These two prior NAAQS RIAs show — even by EPA's own calculations — that partial attainment costs are not at all indicative of the likely potential costs of attaining any of the alternative standards. Despite this, the current RIA for the $PM_{2.5}$ NAAQS reconsideration makes no attempt at all to develop cost estimates beyond those of its partial set of illustrative controls and does not even discuss why it has failed to develop full attainment cost estimates.

In this report, we carefully review the modeling inputs and outputs that were used to produce the RIA's partial cost estimates and we demonstrate how to provide a *range* of estimates for the potential cost of full attainment. In developing those full attainment cost estimates, we rely as much as possible on the data and general cost concepts used by EPA despite the fact that many of the cited references for control costs are often small in number and outdated.[8] We explain our approach and assumptions in the main body of this report. The resulting full attainment cost estimates are reported in Table ES-1, which compares them to the RIA's partial attainment costs (from the RIA's Table ES-5).[9]

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[6] In this RIA, the limit allowed is $160,000 per ton removed.

[7] In this RIA, the minimum allowed is 5 tons per year of baseline emissions.

[8] The quality of the available emissions data that must be relied upon is particularly weak for non-point sources of emissions, as EPA has generally conducted less analysis for this category of emissions than for larger point sources. Given the high degree of reliance on non-point source primary $PM_{2.5}$ controls in the RIA for this NAAQS reconsideration, and the high degree of partial attainment that EPA then finds, EPA is effectively considering requiring states to embark on a major regulatory program with significantly less data and more uncertainty on both costs and effectiveness than is typical of past NAAQS RIAs.

[9] The ranges for our estimates of the full cost of attainment of each alternative standard reflect uncertainties in the various input assumptions used in the full attainment portion of the analysis. These ranges do not represent confidence intervals with a probabilistic interpretation. It is our professional judgment, as explained in the main body of this report, that the assumptions defining the lower and upper ends of the range stretch the boundaries of

Table ES-1. Comparison of NERA's Range of Estimates of Annual Cost of Full Attainment to Partial Cost Estimates Reported in RIA (Annual in 2032, millions of 2017$)

Area	10/35			9/35			8/35		
	Partial (RIA)	Full (NERA)		Partial (RIA)	Full (NERA)		Partial (RIA)	Full (NERA)	
		Low	High		Low	High		Low	High
Northeast	$7	$7	$7	$206	$226	$335	$1,100	$2,147	$6,271
Southeast	$4	$4	$4	$69	$202	$605	$437	$1,219	$3,388
West	$19	$74	$238	$34	$272	$905	$122	$769	$2,378
California	$64	$957	$4,055	$85	$1,830	$7,322	$163	$3,097	$11,704
Total	$95	$1,042	$4,305	$393	$2,529	$9,167	$1,822	$7,232	$23,741

As the table shows, the estimated potential full attainment costs, even at the low end, are vastly larger than the partial attainment costs that the RIA has reported. It shows that for the 8/35 standard, the potential full attainment will cost between about $7 billion and $24 billion, which is 4 to 13 times more than the RIA's partial cost estimate of less than $2 billion. Full attainment of 9/35 is projected to potentially cost 6 to 23 times more than the RIA's partial estimate. As for the least stringent alternative standard considered, 10/35, the potential full attainment cost is estimated to be between $1 billion and $4 billion per year, 11 to 45 times more than the RIA's partial estimate.[10]

These comparisons illustrate one of the most important reasons that partial attainment costs are inappropriate to report in an RIA executive summary: partial attainment costs provide no indication of either the absolute or relative costs of any of the alternative standards considered. Their presence in the RIA's executive summary is therefore misleading.

Even if fraught with enormous uncertainty, a concerted effort to characterize the full attainment costs is what is needed. It is not the role of an RIA to determine whether such actions will actually be undertaken, but only what potential types of action and associated costs would be necessary if an alternative standard is to be attained. To the extent that some of the additional control measures we identify as needed to achieve full attainment (as detailed in the main body of this report) might be considered technically, economically, or administratively nonviable, our analysis indicates a situation of long-term extensive nonattainment, nationally in the case of the 8/35 standard, and regionally in the case of the other two alternative standards (serving only to exacerbate a regional situation of perpetual nonattainment). This

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reasonable expectation and thus the true costs of full attainment have a robust chance of falling within the ranges of potential costs that these input assumption sets project.

[10] We note that the ratios of the RIA's partial to their respective full attainment costs are generally similar to those found in the prior $PM_{2.5}$ and ozone NAAQS RIAs (EPA, 2012 and EPA, 2015). This should be viewed as coincidental but perhaps unsurprising. It is coincidental because the approach taken in this study did not follow the extrapolation procedures relied upon in the prior RIAs. As explained in the main body, our approach was more bottom-up in nature, relying on county-specific estimates of remaining tons of primary $PM_{2.5}$ that could still be controlled after adoption of all the allowed control measures in the EPA cost modeling database; in contrast, EPA used more abstract extrapolation formulas. Additionally, the illustrative control strategies in this RIA are based on reductions in primary $PM_{2.5}$ measures, whereas prior RIAs focused on reductions in $PM_{2.5}$ and ozone precursor gases. However, it is perhaps unsurprising given that EPA used the same basic cost modeling tool and an input list of candidate control measures that were inherently among the lowest-cost of the universe of all potential controls to determine its partial attainment costs.

insight from our full attainment cost assessment calls into question the wisdom of setting the annual $PM_{2.5}$ NAAQS at any of the alternative levels, no matter what may appear to be the net benefits of the first few "partial" steps in the direction of attainment identified in the RIA.

Thus, this full attainment cost analysis provides readers with some understanding of the regulatory challenges that the various alternative standards may entail. By failing to even explain the extent of regulatory challenge that is implicit in the analysis and data behind this RIA, EPA does a disservice to the public and policymakers. This report therefore provides important policy-relevant information and insights that the RIA does not. This report also describes some other important anomalies in this RIA compared to established RIA practice, such as EPA's failure to identify sufficient control measures for several areas of the U.S. to attain even the current $PM_{2.5}$ NAAQS of 12/35.

We have focused our analysis on the costs of full attainment as contrasted to "partial attainment" cost estimates. However, readers should be aware of how narrow even a full attainment cost estimate is. For example, RIAs' full attainment cost estimates omit or may otherwise be limited by the following issues:

(1) Costs and/or economic growth losses in *attainment* areas because of heightened difficulties for potential new plants or plant expansions in those clean air areas to demonstrate that they will not cause "significant deterioration" of air quality already meeting the NAAQS.[11]

(2) The economy-wide costs from the ripple effects on related businesses and employment that could be picked up though macroeconomic modeling of the attainment cost estimates (*e.g*., using computable general equilibrium models);

(3) Administrative costs to states, which are likely to be amplified when addressing controls for many smaller sources that have never been regulated;

(4) Potential costs of sanctions — transportation and/or conformity freezes if states cannot submit approvable plans;[12]

(5) The cost of all nonattainment stationary source obligations (*e.g*., NSR, RACM/BACM);

(6) The potential for significant increases in the costs of controls for many source categories given the outdated nature of the referenced source material for the control cost estimates;

(7) EPA's decision to include in its annualized control cost estimates only costs incurred starting in 2032, whereas the technology investments needed to reach attainment by 2032 will need to be incurred well before 2032;

(8) The cost of offsetting emission increases that may perversely occur as the result of the lower standards, such as the recent concerns expressed by the USFS and the Interior Department over

[11] This is more commonly known as the requirement for prevention of significant deterioration (PSD) demonstrations before a proposed new facility can obtain its emissions permit(s).

[12] *See, e.g.*: 87 *Federal Register* 60494, "Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California," October 5, 2022, at 60528.

the effect of the new standards in limiting prescribed fires to manage and prevent higher $PM_{2.5}$ emissions from wildfires.[13]

Item (1) of the above list is becoming a heightened concern as the $PM_{2.5}$ NAAQS starts to near levels typical of most of the attaining U.S. As the Discussion section of this report explains, RIAs' traditional estimates of the costs of implementing emissions control measures in projected nonattainment areas may be becoming a smaller and smaller part of the overall burden that NAAQS rules may entail on the U.S. economy. Specifically, concerns are being expressed that a lowered $PM_{2.5}$ NAAQS may create substantially greater challenges for businesses seeking to pass demonstrations of prevention of significant deterioration (PSD) in order to be allowed to expand even in areas that face no risk of falling into nonattainment with a tightened NAAQS. This issue is explained in more depth in the Discussion section of this report because it suggests that heightened emissions control requirements even in attainment areas could become a substantial new compliance cost that a traditional NAAQS RIA does not consider. This RIA (and future RIAs for tighter NAAQS) should consider expanding their notion of NAAQS compliance costs to include incremental costs likely to be incurred in attaining areas across the U.S. Complicating this issue, however, is the possibility that heightened challenges in passing a PSD demonstration could lead businesses to reduce or forego otherwise desired capacity growth, and thus could hinder the economic growth prospects of attainment areas without any actual dollar expenditures ever being incurred. And in that sense, benefit-cost analyses for NAAQS that are based solely on concepts of spending on control equipment or changes in operational processes may be losing their originally intended policy relevance.

Finally, we note that the fact that these comments evaluate only the RIA's cost estimates does not mean that we do not have significant concerns with the numerical validity of its benefits estimates as well. Those benefits estimates are far more uncertain than any cost estimate because they are the subject of on-going questions regarding both their causal and quantitative interpretation. The epistemological issues for benefits calculations are well documented in the record for the proposed rule;[14] the debate is easily summed up as uncertainty over whether such benefits will be realized. In contrast, there is no debate about the existence of actual compliance costs, and it is important and relevant to policy deliberation to understand their potential full attainment cost — and the associated implied practical or technical challenges — even if that requires acknowledgement of a wide range of numerical uncertainty.

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[13] *See, e.g.*: General Accounting Office, 2023, *Wildfire Smoke Opportunities to Strengthen Federal Efforts to Manage Growing Risk,* March. Available at https://www.gao.gov/assets/gao-23-104723.pdf#page=48&zoom=100,0,789.

[14] *See*, *e.g.*: NCASI (2023); Smith (2019a, 2019b); Smith and Chang (2020); and Gradient (2023).

1. INTRODUCTION

On January 27, 2023, the *Federal Register* published a Notice of Proposed Rulemaking (NPRM) from the Environmental Protection Agency (EPA), seeking comment on a reconsideration of the Agency's 2020 rulemaking on the current annual National Ambient Air Quality Standards (NAAQS) for fine particulate matter ($PM_{2.5}$).[15] The current NAAQS for $PM_{2.5}$ are 12 $\mu g/m^3$ for the annual average and 35 $\mu g/m^3$ for the daily (24-hour) average.[16] For simplicity of exposition, this combination of annual and daily standards will be referred to herein as "12/35." Upon reconsideration, EPA is proposing to tighten the current annual standard (without modification of the daily standard of 35 $\mu g/m^3$) to some level between 10 ug/m^3 and 9 ug/m^3, and is taking comment on a standard of 8 $\mu g/m^3$ and of up to 11 ug/m^3.[17] Hereafter, we refer to these three alternative standards by the labels "10/35," "9/35," "8/35," and "11/35." Simultaneously with the NPRM, EPA also publicly released its Regulatory Impact Analysis (RIA) for the proposed revisions.[18] This RIA contains, *inter alia*, estimates of the costs of control measures that form part of the illustrative control strategies intended to meet more stringent standards and the public health benefits of their associated ambient $PM_{2.5}$ reductions. The comment period for both the NRPM and the RIA ends on March 28, 2023.

The technical comments in this report address the RIA's estimates of the potential costs of attaining three of the four alternative annual standards listed above: 10/35, 9/35, and 8/35.[19] In brief, we conclude that the RIA's cost estimates are incomplete to the point of having very limited usefulness to decision making or public understanding of the full potential impacts of any of the alternative standards. We demonstrate how to provide a range of estimates for the potential cost of full attainment, relying as much as possible on the data and general cost concepts used by EPA.

Our analysis does not attempt to alter the RIA's assumptions about the costs of candidate control measures that the RIA does identify as a potential portion of state attainment strategies, despite the substantial uncertainties that are inevitably associated with such assumptions.[20] Rather, we focus on

[15] 88 *Federal Register* 5558, "Reconsideration of the National Ambient Air Quality Standards for Particulate Matter," January 27, 2023.

[16] These are the values that monitor-specific design values may not exceed. The annual average considers 3-year averages of the annual design values. The daily average standard must not be exceeded by the 3-year average of the 98th percentile of a monitor's 24-hour average values.

[17] The NPRM also solicits comments on a possible tightening of the daily standard to 30 $\mu g/m^3$ but the focus of these comments is only on analyses related to alternative annual standards discussed in the NPRM.

[18] EPA, 2022, *Regulatory Impact Analysis for the Proposed Reconsideration of the National Ambient Air Quality Standards for Particulate Matter*, EPA-452/P-22-001, December, available at https://www.epa.gov/system/files/documents/2023-01/naaqs-pm_ria_proposed_2022-12.pdf.

[19] The RIA does not explain why it has not provided an evaluation of 11/35 even though it does evaluate 8/35 and a daily standard of 30 $\mu g/m3$ (*i.e.*, 10/30). Lacking any RIA analysis for 11/35, we do not attempt to comment on its costs in this report. While we do not quantitatively evaluate the RIA's cost estimates for 10/30, the comments and concerns we identify for the three alternative annual standards apply equally well to the RIA's estimates of 10/30.

[20] The quality of the available emissions data that must be relied upon is particularly weak for non-point sources of emissions, as EPA has generally conducted less analysis for this category of emissions than for larger point sources. In general, the data are supported by a small number of references that are relatively old, and the cost assumptions in the EPA model lack of consideration of location-specific factors. Nevertheless, it is out of NERA's

documenting how profoundly incomplete (and hence understated) are the cost estimates that the RIA reports, and on demonstrating how EPA could have used its own data and evidence to provide readers with a proper and complete understanding of the potential costs of fully attaining each of the alternative standards. Recognizing that computing the cost estimates for full attainment involves some highly uncertain input assumptions about how to make use of the remaining evidence in the EPA control measures data sets, we provide a range of potential cost estimates for fully attaining each alternative standard. This is a more appropriate way to communicate about analytical uncertainties than to simply assume that the most difficult aspects of identifying illustrative attainment strategies will cost nothing, as the RIA has implicitly done.

Although we provide wide ranges of uncertainty in order to produce numerical cost estimates for full attainment, our analysis to develop those estimates indicates that finding sufficient control measures would pose a significant practical challenge for many of the RIA's areas of projected nonattainment. Although our analysis does identify a sufficient number of additional reductions in primary $PM_{2.5}$ emissions for almost all areas to reach full attainment without resorting to "unknown" or "unidentified" control measures, the evidence in EPA's data sets is that they will likely be very costly per ton and in total for the affected nonattainment areas.

It is not the role of an RIA to determine whether such actions will actually be undertaken, but only what types of action and associated costs would be necessary if an alternative standard is to be attained. Nevertheless, to the extent that some of the additional control measures we identify as needed for full attainment might be considered technically, economically, or administratively nonviable, our analysis indicates a situation of long-term extensive nonattainment, nationally in the case of the 8/35 standard, and regionally in the case of the other two alternative standards (serving only to exacerbate a regional situation of perpetual nonattainment). This insight from our full attainment cost assessment calls into question the wisdom of setting the annual $PM_{2.5}$ NAAQS at any of the alternative levels, no matter what may appear to be the net benefits of the first few "partial" steps in the direction of attainment identified in the RIA.

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scope to attempt to remedy weaknesses in the emissions inventory or control technology cost data that the RIA uses. Our analysis also does not attempt to alter the RIA's assumption that attainment strategies will rely entirely on reductions in primary $PM_{2.5}$ emissions that account for the "urban increment" of consistently higher $PM_{2.5}$ concentrations over urban than surrounding areas, which the RIA suggests is the primary driver of the projected areas of nonattainment for annual standards lower than the current standard of 12 $\mu g/m^3$ (RIA, p. 1-2).

2. BACKGROUND ON RIA COST ESTIMATION REQUIREMENTS

Preparation of an RIA is required under executive order of the President for all proposed and final rulemakings of the federal government anticipated to have an annual effect of $100 million or more per year. The expected and required contents of RIAs are varied, but the most central requirement is to provide a thorough evaluation of the costs and benefits of a proposed or final rule, including for alternatives other than the specifically proposed or selected final rule.[21] Even for standards that, by law, cannot directly use evidence on costs or benefit-cost trade-offs in the selection of a standard level, providing this information to both policy makers and the interested public is an important part of creating a transparent understanding of the implications to society of the statutes that such regulations implement. As Professor Kenneth Arrow and other distinguished economists noted:

> *Although formal benefit-cost analysis should not be viewed as either necessary or sufficient for designing sensible public policy, it can provide an exceptionally useful framework for consistently organizing disparate information, and in this way, it can greatly improve the process and, hence, the outcome of policy analysis. If properly done, benefit-cost analysis can be of great help to agencies participating in the development of environment, health, and safety regulations, and it can likewise be useful in evaluating agency decision-making and in shaping statutes.*[22]

In cases where costs and economic impacts can, in fact, be a relevant factor in the regulatory decision, (as in the case of a reconsideration of a NAAQS[23]), it becomes particularly important that the RIA provide a balanced and complete understanding of the potential benefits and potential costs.

NAAQS rules for both $PM_{2.5}$ and ozone have traditionally presented special challenges for the development of robust cost estimates. One complication has been that states that find themselves to have one or more areas that do not attain a NAAQS are responsible for developing their own strategies (to be approved by the EPA) for reducing emissions sufficiently to get into attainment. Known as state implementation plans (SIPs), these documents account for location-specific air quality determinants to identify a set of control measures and other actions that a nonattainment state plans to adopt to achieve attainment. Thus, any RIA prepared by the federal government must attempt to simulate hypothetical or "illustrative" control strategies that are not guaranteed to be the most likely least-cost strategy or SIP

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[21] For background on federal requirements for RIAs and a good synopsis of their additional merits beyond mere estimation of net benefits, *see* Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services, 2016, *Guidelines for Regulatory Impact Analysis*, available at https://aspe.hhs.gov/sites/default/files/private/pdf/242926/HHS_RIAGuidance.pdf. (For example, it states that an RIA "reflects a well-established and widely-used approach for collecting, organizing, and analyzing data on the impacts of policy options, to promote evidence-based decision-making. It provides an objective, unbiased assessment that is an essential component of policy development, considering both quantifiable and unquantifiable impacts.")

[22] K. J. Arrow, M. L. Cropper, *et al*. 1996. "Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation," *Science*, Vol. 272:221-2.

[23] The relevance of costs and economic impacts to a NAAQS reconsideration is expressed in Sunstein (2011).

approach. Heightened lack of precision and accuracy of cost and benefit estimates in federal RIAs for NAAQS is thus an unavoidable and acknowledged feature of results reported in NAAQS RIAs.[24]

Whether "illustrative" or not, a significant complication that EPA has routinely encountered in evaluating attainment strategies in its past $PM_{2.5}$ and ozone NAAQS RIAs is that the Agency has routinely failed to assemble information on a sufficient set of candidate emissions control options to be able to produce a list of control measures that would provide sufficient emissions reductions for all projected nonattainment areas to reach attainment with a specific alternative NAAQS level. Thus, once the maximum set of control measures in the EPA cost analysis datasets are selected, EPA's analyses project that one or more areas of the country will still fail to attain a given standard. This condition is called "partial attainment" in RIAs, and the sum of all the costs associated with the specifically identified list of control measures is reported in the RIAs as the costs of *partial* attainment.

A partial attainment cost estimate is not an analytically proper estimate of the cost of the alternative standard in question, because one or more of the projected nonattainment areas would still need to make emissions reductions (at some cost) to fill the gap between the tons of reduction achieved by the partial list of measures and the total tons of reduction estimated by the air quality modeling to be *needed*. Without a thoughtfully structured effort to estimate that cost of the remaining tons of reduction still needed, the partial cost estimates, on their own, are uninformative regarding total costs and provide only limited insight on the nature of the controls that may be required. Indeed, these partial cost estimates should not even be presented in the RIA's executive summary or other comparisons of costs and benefits, as they completely misrepresent the absolute and relative difficulties of meeting alternative standards. Prior ozone and $PM_{2.5}$ NAAQS RIAs have been careful not to report partial attainment cost estimates in such ways.

Unfortunately, the current RIA for the $PM_{2.5}$ reconsideration not only runs into this common limitation seen in other NAAQS RIAs, but it then reports only the partial attainment costs. This represents its most prominent flaw and is significant enough that this RIA falls well short of meeting the objectives of the federal RIA requirement.[25]

How EPA Has Addressed the Problem of Partial Attainment in Prior RIAs

The past record of NAAQS RIAs makes it clear that EPA has long understood that additional cost estimation is necessary to reflect the cost of filling the gap between tons of emissions reduced under the partial attainment limit of its set of candidate cost measures and the tons of emission reductions needed for full attainment. An estimate of the cost of the still-needed emissions reductions can be added to the

[24] It should be noted that the need to rely on illustrative control strategies creates inaccuracy in the benefits estimates of the RIA as well as in the cost estimates, as benefits estimates depend on the specific locations of emissions reductions that will be implemented, and this will vary the spatial pattern of ambient pollutant reductions that drives the benefits estimates.

[25] EPA's failure to conduct a broader analysis of costs and benefits also thwarts the Agency's ability to fulfill its nondiscretionary statutory obligation under Section 312 of the Clean Air Act to conduct "a comprehensive analysis" of the impact of this chapter (Chapter 85 Air Pollution Prevention and Control) which specifically references, as part of this analysis, 312(a)(1) the issuance of a NAAQS under 109. Additionally, it fails to provide any ranges reflecting the general uncertainty in its estimates, even though OMB's Circular A-4 (OMB, 2004) actually requires a full uncertainty analysis.

partial attainment cost estimate to provide the RIA's estimate of the "full attainment" cost for each alternative standard therein considered. Extrapolation from the costs of a technically detailed but partial list of controls in order to fill the still-needed gap with as-yet unidentified control measures is naturally fraught with even more uncertainty than those associated with estimating the costs of partial attainment. An appropriate analytical response to this uncertainty is to make a range of assumptions, and to represent full attainment costs in the RIA with the resulting wide range of costs for the extrapolated portion of the estimates.

Evidence of EPA's awareness of the need to roughly approximate the control costs for the still-needed tons is directly available in prior RIAs, such as the RIA for the 2015 ozone NAAQS decision (EPA, 2015)[26] and that for the 2012 $PM_{2.5}$ NAAQS decision (EPA, 2012).[27] Those RIAs also ran into the problem of partial attainment, but nevertheless provided a range of estimates for the cost of full attainment by making a range of assumptions about the marginal costs of control measures for filling the gap of still-needed emission reductions. For example, Figure 1 below provides a copy of the first figure in the executive summary of EPA (2012) — the last $PM_{2.5}$ NAAQS RIA before the current one — which shows the analytical steps in the RIA. It describes the distinction between partial and full attainment costs thus:

> *The partial attainment cost analysis reflects the costs associated with applying known controls. Costs for full attainment include estimates for the engineering costs of the additional tons of emissions reductions that are needed beyond identified controls, referred to as extrapolated costs. By definition, no cost data currently exist for the additional emissions reductions needed beyond known controls. We employ two methodologies for estimating the costs of unidentified future controls: a fixed-cost methodology and a hybrid methodology; both approaches assume either that existing technologies can be applied in particular combinations or to specific sources that we currently can't predict or that innovative strategies and new control options make possible the emissions reductions needed for attainment by 2020.*[28]

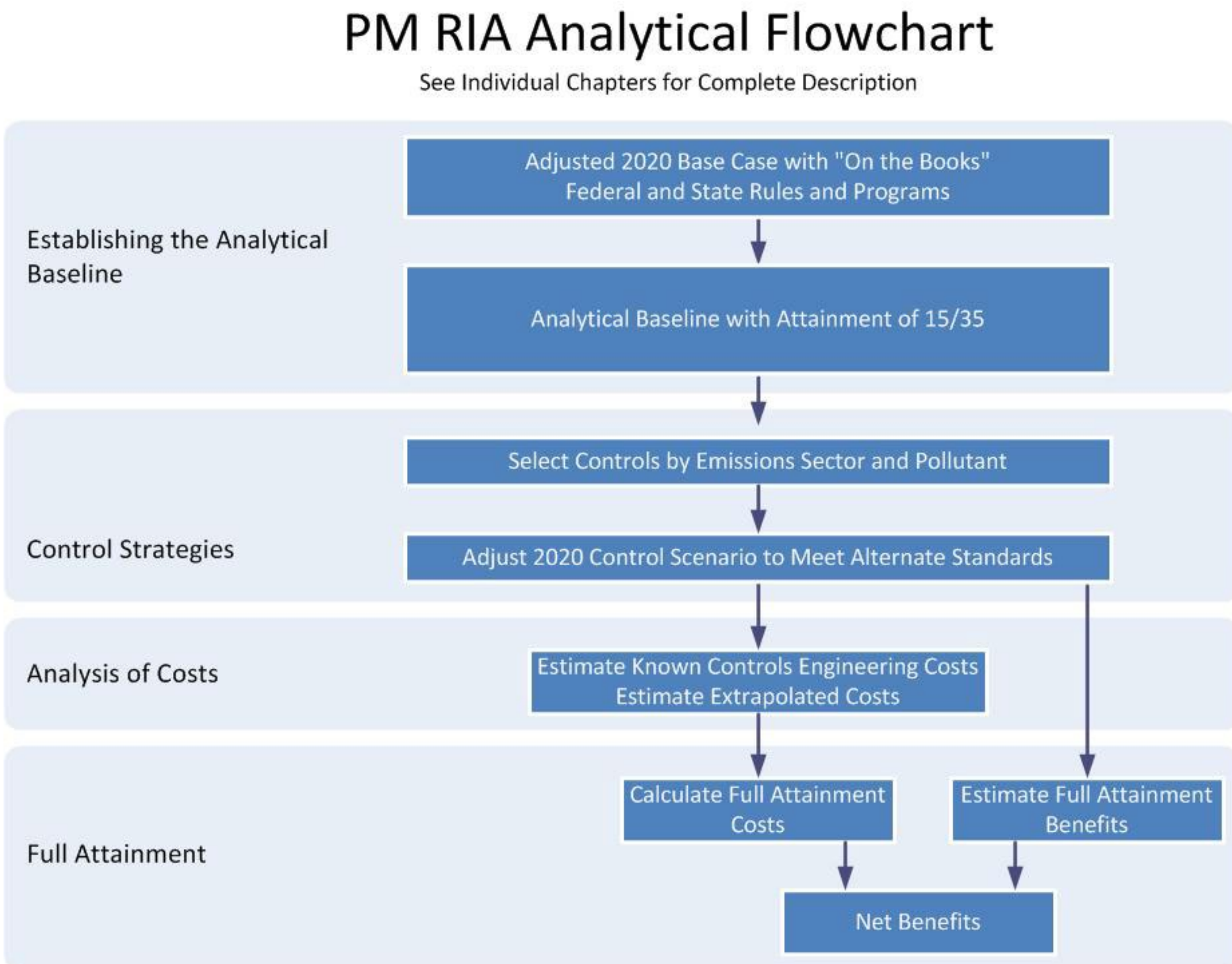
[26] EPA, 2015, *Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone*, EPA-452/R-15-007, September, available at: https://www3.epa.gov/ttnecas1/docs/20151001ria.pdf.

[27] EPA, 2012, *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter*, EPA-452/R-12-005, December, available at: https://www.epa.gov/sites/default/files/2020-07/documents/naaqs-pm_ria_final_2012-12.pdf.

[28] EPA (2012), p. ES-13.

Figure 1. Copy of Figure in 2012 $PM_{2.5}$ RIA Showing Steps Needed to Develop Estimates of Full Attainment Costs

Source: EPA (2012), p. ES-3.



The 2012 RIA's executive summary reports only its estimates of full attainment costs, which include the extrapolated estimates of costs to fill the gap of still-needed emissions reductions after exhausting EPA's list of "known" control measures and getting only a partial attainment cost estimate. And that RIA also makes at least two alternative sets of assumptions for the extrapolation. The result is a range of costs in the executive summary for each of the alternative standards selected. The high end of the range differs from the low end by a factor of 5 to 10, depending on the alternative standard, reflecting the inherent uncertainty in making such extrapolations.[29]

The executive summary of that 2012 RIA for $PM_{2.5}$ does not report its partial attainment costs, but they can be found in the detailed Chapter 7 of that RIA. Notably, it shows that its partial attainment costs are

[29] EPA (2012), Table ES-2, p. ES-15.

only 1% to 10% of the full attainment cost estimates, except for one of the estimated total costs, in which partial attainment accounted for 31% of the full attainment costs.[30]

The 2015 ozone RIA (EPA, 2015) also ran into the problem of achieving only partial attainment; it also estimated full attainment costs using varied extrapolation assumptions. While the methods of extrapolation are different and some of the terminology is different,[31] the key point is that this 2015 RIA also eschewed reporting partial attainment costs in its executive summary.[32] Based on details in that RIA's cost analysis chapters, it can be seen that partial attainment costs accounted for about 50% of the full attainment cost estimate for the less stringent 70 ppb standard evaluated and about 15% for the more stringent 65 ppb alternative standard evaluated.[33]

The Current RIA Deviates from EPA's Past Practices

These two prior NAAQS RIAs show — even by EPA's own calculations — that partial attainment costs are not at all indicative of the likely potential costs of attaining any of the alternative standards. Despite this, the current RIA for the $PM_{2.5}$ NAAQS makes no attempt at all to develop cost estimates beyond those of its partial set of illustrative controls and does not even discuss why it has failed to develop full attainment cost estimates. States do have some flexibility in how they will choose to attain a standard that can differ from an RIA's illustrative strategies, but an RIA should at least identify a justifiable path to get there; this RIA does not. It compounds this flaw by using its executive summary to compare the partial cost estimates to partial benefit estimates. In the logic of benefit-cost analysis, this is a misleading comparison, because the degree of difference between full and partial costs cannot be expected to be similar to the degree of difference between full and partial benefits estimates. This is because marginal costs are expected be rising at greater degrees of control, while the benefits are expected to be rising linearly (under EPA's linear, no-threshold benefits calculation assumptions).

Given the prior evidence that using an extrapolation approach to estimate a range of full attainment costs can completely alter the understanding of the absolute and relative difficulties of meeting alternative NAAQS standards, we consider it paramount to provide our own range of extrapolated cost estimates in response to this RIA.[34]

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[30] EPA (2012), Tables 7-4 and 7-5, pp. 7-14 and 7-15.

[31] For example, EPA (2015) uses the term "identified" and "unidentified" controls to mean the same thing as "known" and "unknown" controls in EPA (2012). Also, EPA (2015) uses the term "total costs" in lieu of "full attainment."

[32] EPA (2015), pp. ES-15 to ES-19. Specifically, the total (full) attainment costs are $1.4b and $16b, respectively, for non-California U.S. in 2025; and $0.8b and $1.5b, respectively, for California "post-2025".

[33] EPA (2015), Table 4-1, p. 4-11.

[34] We also note that OMB Circular A-4, providing guidelines for conducting RIAs, expects Agencies to conduct an uncertainty analysis in addition to an accounting of fully meeting a standard. Specifically, OMB Circular A-4 states: "For rules that exceed the $1 billion annual threshold, a formal quantitative analysis of uncertainty is required. For rules with annual benefits and/or costs in the range from 100 million to $1 billion, you should seek to use more rigorous approaches with higher consequence rules." The RIA should have but does not provide any analysis of uncertainty surrounding its cost estimates. The full attainment cost estimates that we provide in these comments come in the form of ranges that reflect uncertainties in several key input assumptions.

The amount by which full attainment cost estimates can be expected to exceed the Agency's partial attainment cost estimates will depend on the size of the gap, or the number of still-needed tons of emission reductions relative to the number of tons of emissions reduced with the controls selected by EPA in its partial cost modeling. This gap gets larger as the alternative standard under consideration becomes more stringent. Similarly, the range of uncertainty in the extrapolated portion of the cost estimate will widen as the alternative standard under consideration becomes more stringent, but RIAs are not required to present only narrow ranges of cost estimates, if doing so makes them incomplete or not a meaningful indication of regulatory impact. However, the wider the range of the full attainment cost, the more an RIA is suggesting that attainment may not be economically viable. This is policy-relevant information, even if the quantitative values of the cost estimates are speculative and no one knows if the more likely outcome will be towards the higher or lower end of the provided range.

3. THIS RIA'S COST ANALYSIS METHODS AND RESULTING DEGREE OF PARTIAL ATTAINMENT

In developing its lists of identifiable control measures (and their associated annual costs) for attaining each of the alternative standards that the RIA addresses, EPA uses a model called the Control Strategy Tool (CoST), and associated datasets generally referred to as the Control Measures Database (CMDB).[35] Briefly, CoST identifies the least-cost set of control measures to meet a given target of emissions from an input file that identifies a fuller list of candidate control measures by U.S. county. Runs of the CoST model can include additional user-specified constraints on the control measures that can be considered from a full list of candidate measures. Two specific constraints on the CoST model's optimization are explicitly identified in the RIA. These are a ceiling on the estimated cost per ton reduced for a candidate control measure, and a minimum number of tons per year emitted by emissions sources that have candidate control measures listed for them in the main "all controls" input data file. As we discuss below, these are largely arbitrary constraints (whatever value is selected) and may not be supportable even for an illustrative assessment of control strategies, given that states face sanctions if they cannot identify and impose controls sufficient to achieve attainment. However, we also have determined that there are other, more quantitatively significant constraints embedded in the CoST modeling framework that affect its ability to identify full attainment strategies. These too are discussed below. For now, the important point is that the CoST modeling framework has some basic features that cause it to have difficulty in identifying a full attainment illustrative control strategy for many of the projected nonattainment areas.

The RIA finds that full attainment occurs (in a given county projected to otherwise be in nonattainment of the alternative standard of concern) if the CoST run can find a sufficient number of reductions of the targeted emissions species in that county to meet the RIA's specified reduction target for that county. Partial attainment occurs when the entire list of control measures that CoST identifies would produce fewer emissions reductions than the target value. Because the analysis of attainment in this RIA is performed on a county-specific basis, the RIA's summary of partial attainment cost estimates for each alternative standard are a sum of full attainment cost estimates for some of the nonattainment counties and partial cost estimates from others. Because of the latter fact, the aggregate cost estimates reported in the RIA are, by definition, incomplete, and clearly understated.

Specifically, the RIA reports that its partial attainment costs for the 10/35, 9/35, and 8/35 standards are, respectively, $94 million, $393 million, and $1.82 billion (annually).[36] Based on past experience with estimating full attainment costs after first estimating partial attainment costs, those RIA cost estimates cannot be relied upon as an indication of either the absolute or relative cost of the alternative standards. One only knows that they are too low.

The RIA Fails to Identify Sufficient Controls to Attain Even the Current 12/35 Standard

It should be noted before going further that an RIA's estimates of costs for any alternative standard are traditionally reflective of the additional costs of emissions control *incremental* to whatever costs must be incurred to reach full attainment of the existing standards (*i.e.*, 12/35 in this case). Another important

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[35] *See* EPA, "Cost Analysis Models/Tools for Air Pollution Regulations," available at https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-analysis-modelstools-air-pollution.

[36] RIA Table ES-5, p. ES-14.

anomaly in this RIA versus traditional RIA practice is that EPA cannot find sufficient control measures in its CoST model for several areas of the U.S. to attain even the current $PM_{2.5}$ NAAQS of 12/35. Thus, even its starting point for estimating incremental costs of standards tighter than the current one of 12/35 is one of partial attainment in this RIA. This very unusual situation is detailed in Appendix A. Its primary significance for the remainder of this report is:

(1) Several of the major counties for which this RIA projects only partial attainment with the alternative standards actually enter the RIA's cost analysis with zero remaining options in the CoST input data set. The RIA's partial cost analysis therefore estimates that these counties' costs for getting to 10/35, 9/35, or 8/35 are *zero* (*i.e.*, $0 per year). This is a remarkable example of this RIA's incompleteness, given that the RIA's analysis is actually finding that these counties face a huge remaining challenge (and compliance cost) even if the current standard is not tightened at all.

(2) The cost of them first fully attaining 12/35 ought to be estimated and reported in this RIA as well, because it would provide important policy-relevant context regarding how much more difficult it will be for those counties to reach any degree of attainment of standards tighter than 12/35. We provide such cost estimates in Section 5, although these are not included in our ranges of full attainment costs and are provided solely for context.

Evidence of Significant Degree of Partial Attainment in RIA's Set of Identified Control Measures for Alternative Standards

Focusing for the moment on the RIA's evaluation of the 8/35 alternative standard, the RIA identifies 141 counties that will require at least some reductions of primary $PM_{2.5}$ to attain 8/35,[37] for an aggregate reduction need of 86,869 tons.[38] It then runs its CoST model to identify controls of local primary $PM_{2.5}$ emissions sources that are reported to be available and estimated to be cost-effective in meeting each of the 141 counties' emissions reduction needs.[39] In running the CoST model, the RIA applies the following two constraints: (1) that any source undertaking a control measure have at least 5 tons per year of baseline emissions; and (2) that no control measure estimated by CoST input data to cost more than $160,000 per ton reduced will be required. While a total of 86,869 tons of reduction are needed for all these counties to

[37] RIA, Table 2A-14, pp. 2A-60 through 2A-64. The specific number of tons of reduction needed by each county is also shown in this table. This information is also provided in Appendix B of this report.

[38] This is three tons less than the value of 86,872 reported in RIA Table ES-2 at p. ES-9. NERA has confirmed that it is the result of rounding error in the way Table ES-2 was constructed. We will use the more precise values of emissions targets based on the target emissions input files to the CoST model. Discrepancies between what NERA has found in the raw CoST files and what is summarized in the RIA have been frequent but are minor enough not to affect the full attainment cost estimation that we have conducted for this report.

[39] The CoST model also allows counties in the Northeast and Southeast regions to turn to control measures in counties adjacent to them (within their same state) once all of the non-attaining county's identifiable measures have been selected. EPA counts these adjacent-counties' tons of reduction as only one-fourth of a ton towards the direct county's needed tons of reduction. In the following, we will use the term "effective tons" to be equal to the tons from adjacent counties divided by 4, while every ton reduced in a directly nonattaining county is equal to one effective ton.

attain 8/35, the CoST model finds only 46,073 effective tons,[40] with full attainment in only 80 of the initial 141 counties. Thus, another 40,796 effective tons of reduction are needed (in aggregate) to reach full attainment in the remaining 61 of the initial 141 counties.[41] Table 1 summarizes the degree of partial attainment in the RIA for all three alternative standards, showing that partial attainment is also a significant issue even for the less stringent alternative standards of 9/35 and 10/35.[42]

Table 1. Summary of Aggregate Degree of Partial Attainment (in Tons and as % of Total Tons Needed)

	10/35	**9/35**	**8/35**
Emissions Reductions Needed (see Note 1)	12,491	31,911	86,869
"Effective" Emissions Reductions in RIA Partial Attainment Analysis (see Note 2)	3,561 (29%)	13,762 (43%)	46,073 (53%)
"Effective" Emissions Reductions Still Needed	8,930 (71%)	18,149 (57%)	40,796 (47%)

Note 1: RIA Table ES-2 reports slightly different estimates of tons needed than used in this table. NERA concludes that Table ES-2 is subject to rounding error and does not precisely reflect the actual values used in its cost estimation modeling.
Note 2: RIA Table ES-3 reports actual tons reduced in adjacent counties whereas effective tons need to be used when assessing additional tons still needed for full attainment. The values in this row reflect the effective tons reduced, which equals the adjacent actual tons of reduction divided by 4. In the directly nonattaining counties of each region, actual tons are the same as effective tons. Additionally, NERA has found discrepancies between the actual tons reduced reported in Table ES-3 and those in the raw RIA CoST output files. This table uses the values as reported in RIA Table ES-3, as the discrepancies are too small to be material to any full attainment cost estimate.

Appendix B documents the degree of partial attainment in the RIA's analysis on a county-by-county level. When summed, the data in the tables of Appendix B match the information provided in Table 1. We provide the county-specific information because an assessment of full attainment costs requires a county-by-county cost extrapolation. Appendix B's tables reveal how extensive and deep partial attainment is for many individual counties, even while many other counties in the analysis do reach full attainment. Those tables also show that the counties that do reach full attainment in the RIA's partial analysis require, on average, substantially fewer tons of reduction than those that only reach partial attainment. Thus, the control effort to get the RIA's partially attaining counties into full attainment can be expected to be much larger than the cost of full attainment for those counties that do get into attainment.

[40] RIA, Table ES-3, p. ES-11. This is computed by adding the actual tons in the direct counties plus the actual tons in the adjacent counties divided by 4. The total of *actual* tons reported in the table is 61,321, but in terms of effective tons to be compared to the tons needed, it is 46,073.

[41] To the extent that some of these effective tons may need to be obtained by control measures in adjacent counties, the number of *actual* tons still needed would be larger than 40,796.

[42] Although the *percentage* of aggregate tons needed that are found (row 2 of Table 1) increases as the alterative standard tightens, the number of tons still needed (row 3) also increases. This seemingly counterintuitive trend in the percentages occurs because a rapidly increasing number of counties are projected to fall into nonattainment as the standard tightens, but mostly quite marginally (because the added counties *can* attain the next looser alternative standards). Because these additional counties have not yet had to undertake any of the control measures in the CoST data, many of them can get into full attainment even with the RIA's very limited set of candidate control measures. However, the number of counties that remain in partial attainment also continues to grow, and for those that are in partial attainment with one of the looser standards, their *individual* degree of partial attainment gets increasingly large as the alternative standard is tightened. The county-specific attainment percentages can be seen in Appendix B.

The significant shortfall in emissions reductions that the CoST model produces is a highly problematic result for a NAAQS RIA, given that stopping its control efforts at partial attainment is not a viable alternative for a nonattaining state under the Clean Air Act. States must demonstrate a plan for full attainment of each NAAQS within a federally prescribed time period or face a range of sanctions that have economic costs of their own. To the extent that the RIA's partial attainment outcomes are due to the EPA's arbitrary constraints on its CoST model,[43] or due to the CoST model's input file including an insufficiently broad list of candidate control measures, the requirement on states to demonstrate and achieve attainment will force adoption of additional options that the RIA has not identified, many of which will likely violate the limitations that EPA has built into its CoST modeling effort. Given the depth of the shortfall in the RIA analysis, those additional control measures are likely to cost more per ton (on average) than the average cost per ton of the measures selected in the RIA's partial attainment analysis. Thus, the shortfalls in tons reduced in the RIA's partial analysis (summarized in Table 1) most likely understate the degree to which the RIA's partial cost estimates fall short of full attainment costs.

Evidence that Cost of Full Attainment Will Exceed Partial Attainment Cost by Even More Than the Estimated Deficits in Tons of Needed Reductions

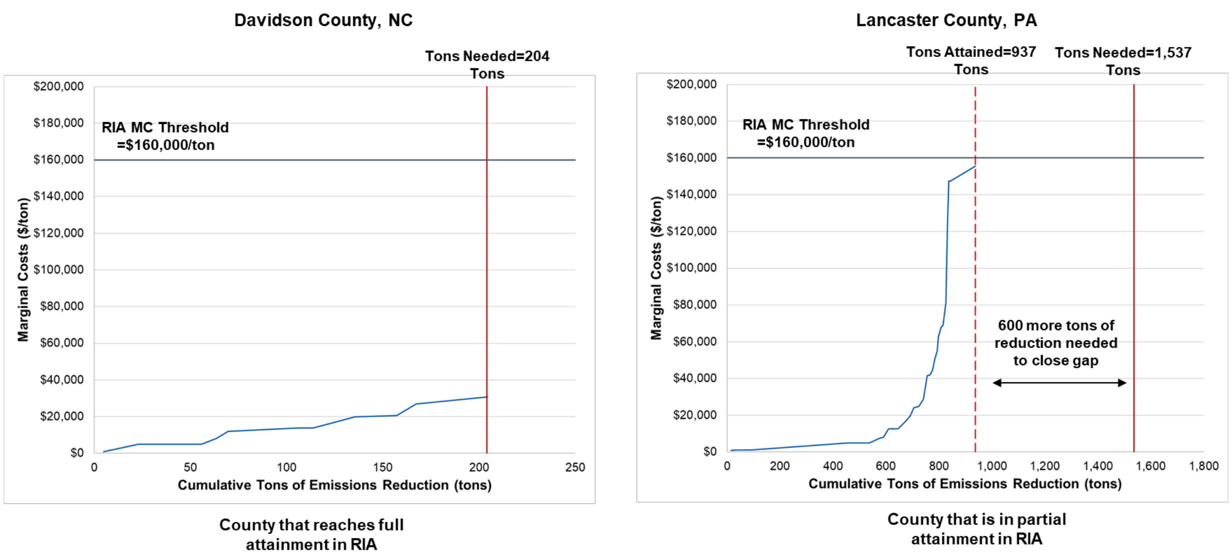
The above section has documented, relying on data that can be found in tables in various parts of the RIA, that the RIA has produced an incomplete evaluation of the costs of attaining each of the alternative standards, and that the deficit in tons of emission reductions that it has costed out is large, both in aggregate and county-specific terms. However, the central issue that this report addresses is how much it will *cost* to eliminate the deficit that we have so far stated only in terms of tons of emission reductions. The basic logic of least-cost analysis (including that reflected in the CoST model and its data) is that the cost per ton of emissions reduction will generally increase as regulators have to make deeper emissions cuts to meet more stringent standards. Thus, the cost of full attainment relative to that which a least-cost modeling exercise has found for partial attainment is likely to be proportionately more than the percentage of full attainment reductions relative to those achieved in the partial attainment analysis. More simply stated, if the tons of emission reductions needed for full attainment are double those reached in the partial attainment case, then the cost of full attainment likely will be more than double the partial attainment cost. The only ways that this basic logic might not hold when evaluating a strategy based solely on primary $PM_{2.5}$ control would be if the partial attainment analysis were either not least-cost in nature, or had failed to include in its list of identifiable candidate control measures some of the most cost-effective control options technically available. Based on an in-depth review of the data in the CoST model input files, we do not consider the latter possibility to have more than a marginal effect on the gap between CoST's project partial attainment and the RIA's projected total emissions reduction needs.[44]

[43] Specifically, these are a $160,000 per ton ceiling on control measures that CoST is allowed to select and a requirement that CoST not select any controls for emissions sources with less than 5 tons per year of baseline emissions.

[44] Another reason this logic might not hold would be if the illustrative strategies were to be broadened to consider more than just local primary $PM_{2.5}$ emissions reductions, such as more regional controls of SO_2, NO_x, and volatile organic gases. The RIA makes its case for assuming that control strategies for a tighter NAAQS will likely focus on primary $PM_{2.5}$ (RIA, p. 1-2). It is out of our scope to alter this RIA assumption but, given the apparent difficulties that states would face in reaching full attainment from primary $PM_{2.5}$ controls alone, the possibility that further controls on precursor emissions might be a necessary part of states' attainment strategies could be viewed as another insight arising from our full attainment cost analysis.

Figure 2 provides a visual summary of how the CoST model's county-specific marginal cost curve, relates to the RIA's county-specific estimate of tons needed for full attainment for two very different situations under the simulation of costs for meeting the 8/35 standard. On the left is the case of a county that is projected to be in nonattainment with 8/35 but which the RIA estimates will reach full attainment with measures available to it in the CoST model. This county (Davidson Co., NC) is projected to need 204 tons of reduction, indicated by the red vertical line.[45] The blue upward sloping line maps out the marginal cost curve in the CoST model for this county, up through the point of finding the full need of 204 tons of reduction.[46] This occurs well below the marginal cost limit of $160,000 per ton applied as a constraint in the CoST model run. The full cost of attainment for Davidson Co., NC is the area under the blue curve, left of the red line, down to the x-axis. It is, per NERA's review of the CoST output files, $3.3 million.[47]

Figure 2. Examples of County-Specific Marginal Cost Curves in RIA (for 8/35) Compared to the Tons of Emissions Reduction Needed for Full Attainment



On the right side of the figure is the case of a county that reaches only partial attainment in the RIA CoST analysis. This county (Lancaster Co., PA) needs 1,537 tons of emission reductions to attain 8/35,[48] but can find only 937 tons (61% of the full need) within the constraints of the CoST model data, resulting in a gap of 600 tons to reach full attainment.[49] Again, the blue line shows the marginal cost curve of the full

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[45] RIA, p, 2A-62.

[46] NERA prepared this graph using the output of control measures selected for the 8/35 case in EPA's CoST run.

[47] It bears mentioning here that this is only the estimated cost (per the CoST model) of implementing the controls that will reduce that county's emissions by 204 tons. Even if it is taken as a sound estimate, it is probably dwarfed by the cost of developing or revising a SIP, much less meet all the additional requirements a state and businesses face under a nonattainment designation. We return to this question of the overall economic burdens of a tighter NAAQS in the Discussion section of this report.

[48] RIA, p. 2A-63.

[49] *See* for example, RIA Table 3-9, which shows 600 tons of emission reductions still needed for 8/35 in Lancaster Co., PA.

set of selected controls for this county in the CoST model output for 8/35. In this case it ends at 937 tons because that is where its control measures reach the RIA's marginal cost limit of $160,000 per ton, and where additional control measures in the CoST database all cost more than $160,000 per ton. The RIA's estimate of the cost incurred under 8/35 for Lancaster Co. is the area under the blue curve, to the left of the red dotted line, down to the x- axis. Per NERA's review of the CoST output file, this is $27.2 million — however, it is clearly only a part of the total costs that would be needed to keep adding more emissions reductions until the gap of 600 tons to full attainment is closed. Indeed, even if all the remaining 600 tons needed could be achieved at a flat $160,000 per ton, the cost of closing that 600-ton gap would be $96 million. In other words, the cost of meeting the first 61% of the attainment need would be only 28% of the full attainment cost, and the cost of full attainment for this county that gets to 100% of its need would be *4.5 times larger* than the reported partial attainment cost.

The big question for estimating the additional cost of full attainment of 8/35 is how much higher the cost per ton will be beyond the $160,000 per ton level for this county and the 60 other counties that reach only partial attainment in the RIA. That requires a county-by-county evaluation of the additional control opportunities in those 61 counties (and their adjacent counties for those in the Northeast and Southeast) individually. The approach we take is described in the next section of this report, and the results from applying that approach in the section thereafter.

However, as a prelude to that cost extrapolation section, we present Table 2 in which we have used EPA's CoST output files to replicate the U.S.-wide estimates of partial attainment costs in 2032 reported in the RIA.[50] Table 2 provides NERA's disaggregation of those costs into costs for all counties that do reach full attainment under the RIA CoST modeling, and costs for all counties that reach only partial attainment. We note that the RIA, when presenting these estimates of what it labels "annualized control costs" does not state clearly that these are only partial attainment costs — *i.e.*, that they are only the costs of control measures identified by the CoST model, with its limited set of candidate control measures and its marginal cost maximum of $160,000 per ton. However, NERA's table below, which was developed by NERA using the RIA's raw output files from the CoST modeling, shows the extent to which the U.S.-wide costs estimates provided in the RIA are predominantly in counties that do not reach full attainment in that RIA CoST analysis.

In our full cost estimation process, described in the next two sections, the cost estimate on the first row of the table will remain unchanged because they represent the portion of the RIA cost estimates that are consistent with full attainment in many of the counties projected to otherwise be in nonattainment, and our analysis makes no changes to the RIA's partial CoST analysis. However, the cost estimates in row 2 are patently incomplete and are subject to the type of cost increase illustrated for Lancaster Co., PA. To the extent that filling the gap of still-needed tons of reduction costs will cost more per ton than the limited set of control measures identified in CoST, Table 2 indicates that even a modest set of extrapolation assumptions can be expected to indicate that full attainment costs are likely substantially larger than the partial attainment costs reported in the RIA for each of the alternative standards.

[50] The RIA's U.S.-wide partial cost estimates are found in Table ES-5 on p. ES-14 of the RIA. They are $94.5 million, $393.3 million, and $1,821.7 million for 10/35, 9/35, and 8/35, respectively (2017$). Note that the RIA's caption to this control cost summary table does not state that these are only partial attainment costs; however, this fact is clear from the text.

Table 2. Disaggregation of RIA's Partial Costs into Counties Reaching Full vs. Partial Attainment in the CoST Model.

	10/35		9/35		8/35	
	Number of Counties	**RIA Costs (million 2017$)**	**Number of Counties**	**RIA Costs (million 2017$)**	**Number of Counties**	**RIA Costs (million 2017$)**
Counties Reaching Full Attainment in RIA's CoST Modeling	9	$11.6	29	$192.1	80	$351.8
Counties Remaining in Nonattainment in RIA's CoST Modeling	15	$82.9	22	$201.2	61	$1,469.9
All Counties in RIA	24	$94.5	51	$393.3	141	$1,821.7

4. NERA'S METHOD FOR ESTIMATING COST OF FILLING THE FULL ATTAINMENT GAPS IN THE RIA'S ANALYSIS

Constraints and Limitations of the CoST Modeling

As we have explained above, the RIA's analysis using the CoST model cannot identify a sufficient list of control measures to meet the estimated reductions in tons of primary $PM_{2.5}$ emissions required for a substantial portion of the counties that its air quality modeling indicates will otherwise fall into nonattainment with one or more of the alternative NAAQS standards. This partial attainment can be largely attributed by several important limitations of the CoST model's data base.

As we have noted in the prior section, EPA decided to limit the control measures that CoST could select to only sources with more than 5 tons per year of baseline emissions and to limit the cost of the selected control measures to not exceed $160,000 per ton relative to baseline controls in place. These are the most widely-discussed of the limitations imposed on the CoST analysis, and as we have noted, there is no basis for them in the Clean Air Act. They have thus received substantial comment and concern. NERA has reviewed the CoST model input and output files and performed several sensitivity runs of CoST in which these constraints are loosened. While projected reductions and costs do vary, it is only by a few percent and thus we conclude that these are not the keys to estimating anything close to full attainment. Appendix C provides more details on these findings.

On the other hand, our review of the CoST model found a much more significant limitation that is not widely known: after allowing for control of the first 25% non-point primary $PM_{2.5}$ sources in each county, the model does not allow any consideration of the possibility of applying control measures for any of the remaining 75%. We find that these remaining non-point source emissions sources are a primary route for identifying substantial quantities of additional needed reductions.

To explain in more detail, the CoST model's input file of candidate control measures contains control options for each of the emissions sources that are reported in the National Emissions Inventory (NEI) as aggregate county-wide sources (*i.e.*, primarily the non-point/area sources). That list of candidate control measures, however, is limited to either 10% or 25% "rule penetration" (RP). In the simplest terms, this means that if it is cost-effective to adopt a particular type of control (such as paving unpaved roads), CoST can only choose to control 10% of the unpaved road baseline emissions or (if more control is needed), to control 25% of that source category's baseline emissions. Options to apply controls addressing more than 25% of any county's road emissions are simply not in the CoST model's input file, even at a higher cost per ton (as higher rule penetration levels would almost certainly entail).[51] The above example is for the unpaved roads area source category, but applies to the majority of the non-point souce catgories in CoST.[52]

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[51] We note that the cost per ton for reducing up to 25% of the unpaved road dusts assumed in CoST is only about half of the RIA's limit of $160,000 per ton (*i.e.*, $89,103 per ton) and thus even if the likely escalation in cost per ton were to be included, at least some additional tons of reduction could have been identified in the RIA even without having to raise its *ad hoc* marginal cost limit of $160,000 per ton.

[52] A few non-point source categories in CoST have candidate controls for which the RP is effectively 100%. The main ones are household burning and open burning, for which the control measure "chipping" is applied to 100%

We consider the latter point to be quite important to the question of how to use evidence-based logic to start to estimate the cost of getting each of the partial-attaining counties into full attainment. It is important because the tons of emission reductions from primary $PM_{2.5}$ controls *remaining* in the non-point source categories such as unpaved roads, paved roads, *etc*., is very large even if one accounts for reductions applied to the first 25% of that county's emissions inventory. In fact, NERA has used the CoST-related data files to estimate that, among the 61 counties that still need tons of reduction to reach full attainment of the 8/35 standard, there *remain* (after accounting for all the controls selected by these counties in the CoST partial attainment modeling of 8/35): about 11,000 effective tons of unpaved road dusts, about 23,000 effective tons of paved road dusts, and about 36,000 effective tons of all other non-point sources in CoST's inventory. [53,54] In aggregate, these 61 counties still need about 40,000 tons to get to full attainment. Reducing even some of these remaining non-point source emissions will almost certainly cost more *per ton* than the first 25% that has already been selected in the partial attainment analysis, but they do represent an *identifiable* path towards full attainment for many of the counties even for the very stringent standard of 8/35.[55]

We recognize, at this point, that these remaining non-point source emissions may not occur close enough to nonattaining monitors to affect their reading. If some or all of these reductions are *ineffective* at the offending monitor's location, then states would be wasting money to control them in pursuit of full

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of the source category, if selected. A very small number of SCCs labelled "generic industrial processes" are treated as non-point in CoST, and the candidate measures for these (fabric filters, electrostatic precipitators, and venturi scrubbers) also would apply to the entire non-point source category, if selected.

[53] "Effective tons" means that remaining tons of emission reductions in counties adjacent to Northeast and Southeast directly nonattaining counties have been divided by four before adding them into the total.

[54] In estimating the remaining tons of emissions that can still be reduced in non-point source categories, we became aware that the CoST input file had not included *any* road or non-road dust emissions in quite a few counties that reach only partial attainment. We found estimates of these counties' road and/or unpaved road dusts with just existing controls in another EPA data file provided with the CoST input files (*see* 2032fj_from_2016_MY_from_afdust_2017NEI_NONPOINT_20200415_05aug2021_v0.csv). We note that the counties for which such emissions inventory data were not included in the CoST input file appear to be those that already report having controlled 25% or more of their road dusts; this implies the marginal cost of further reductions from roads in those counties would be higher than those assumed in CoST for the first 25% (and would likely exceed the *ad hoc* \$160,000 per ton limit that the RIA has employed). Thus, if EPA *had* included these remaining inventories of paved and unpaved road dusts as candidate control measures, its CoST modeling results would likely not have selected them anyway. Nevertheless, for purposes of finding a set of control measures that provides the full need for attainment, without imposing an arbitrary cost per ton limit, we consider these additional tons of emission reductions important to our objective of estimating the complete cost of attaining the alternative standards. We therefore also extracted these NEI emission data for our county-by-county analysis, and they are included in the aggregate totals noted here.

[55] Aggregate comparisons can be misleading because the remaining tons that might be reduced in pursuit of full attainment need to be matched with the still-needed amount on a county-by-county basis. Upon performing the matching, we find that, if they were to be controlled to the maximum control effectiveness possible per the CoST model (*e.g*., 60% reduction of paved roads whose shoulders become paved) these remaining non-point source emissions could get all but eight of the 32 northeast and southeast partial attaining counties into full attainment. We find, however, that even more reductions would be still needed for 20 of the 29 partially attaining counties in California and the West.

attainment.[56] This is a significant remaining source of uncertainty in the analysis of full cost of attainment. If more effective control measures do exist closer to the monitor of concern, they will still have a cost, and that cost is at least proxied in our analysis by an assumption that there is no decline in the *effectiveness* of a ton of emissions reduced from a non-point source if it occurs within the same county as the offending monitor. Obviously, if one were to be able to refine the analysis to include location-specific effectiveness estimates, some of the non-point source emissions controls would not be selected on the basis of cost per *effective* ton — but then some other unidentified measure from another source category would have to be adopted instead, and there is no reason to expect that its cost per ton would be less, even if its cost per *effective* ton were less.

NERA's Use of CoST Modeling Data to Estimate Options for Full Attainment

The basic construct that NERA employs to estimate the cost of filling the gap from partial to full attainment is illustrated in Figure 3. For each county that the RIA leaves in partial attainment with an alternative standard, the marginal costs of its selected identified controls are shown as a stairstep-like curve in the figure (this stairstep is analogous to the blue lines in Figure 2). The cost of partial attainment is equal to the area denoted A in Figure 3. Given an extrapolation of the CoST-derived marginal cost curve, shown as the dotted line sloping upwards, the additional cost of making the still-needed reductions would be equal to the area denoted B.

This figure shows only one point of tons needed (from the baseline of 12/35) to reach attainment. However, there are three lines to consider when evaluating full attainment for 8/35, 9/35, and 10/35. If the line shown in Figure 3 reflects the tons needed for this county to fully attain 10/35, the cost of fully attaining 10/35 would be A+B. However, the tons needed for 9/35 and 8/35 would lie farther to the right on the x-axis, and the equivalent of area B would become larger for 9/35 and larger still for 8/35. Thus, the cost of full attainment becomes larger as the standard being analyzed becomes more stringent, but the concept of developing an extension of the RIA's initial marginal cost curve and then estimating costs under it up to the point of full attainment is the same for all three alternative standards.

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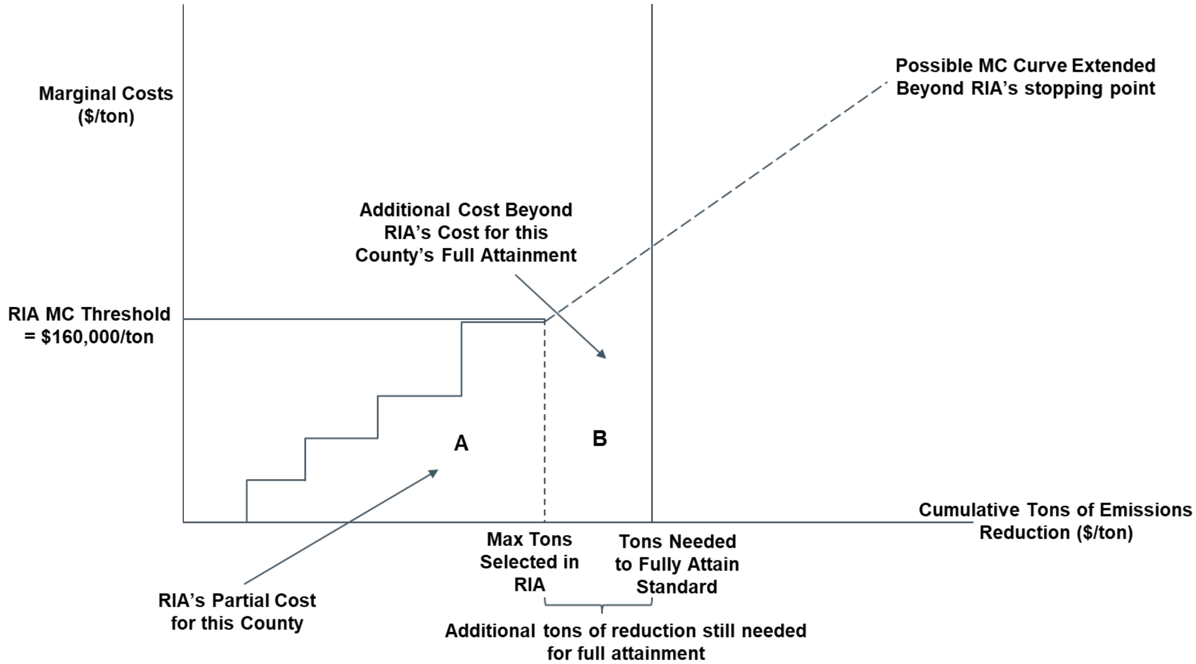
[56] Although this same problem could arise with RPs of 10% or 25%, one can safely assume that counties attempting to rely on controls of any non-point source category for an attainment strategy will attempt to identify the most effective subsets of each category in terms of location relative to the monitor(s) of concern, and intensity of emissions, thus the first few percentage points of RP are the least likely to run into this uncertainty of having effect. We do consider this a significant uncertainty our full attainment cost assumptions for counties that require the most significant amount of non-point source RP to project cost of full attainment. Nevertheless, any estimate of full attainment must make some assumptions about the nature of the sources that will be controlled. To the extent that some counties are projected to require large RPs for all the non-point source categories in its current emissions inventory, if those latter controls become literally ineffective (not just *cost*-ineffective), some other category of emissions that is not a typical target of regulatory controls may become the only effective alternative.

Figure 3. Illustration of Concept in Full Attainment Cost Estimation



The concept may seem simple, but the challenge is in how one might go about extending or extrapolating the first, lowest-cost portion of the marginal cost curve revealed by the CoST analysis (shown as the blue lines in Figure 2, and illustrated as the stairsteps in Figure 3). We take a two-stepped approach for doing this, both steps grounded on the basic approach of the CoST modeling while making use of additional information available in the CoST datasets.

Step 1: Additional Point Source Controls

In the first step, we considered extensions of the constraints EPA selected for its CoST runs. We considered the separate and combined effect of both the 5 ton per year baseline emissions constraint and the $160,000 per ton control cost constraint. As we explain in Appendix C, the results of these sensitivity analyses generally had little impact to either reduction of partial attainment or estimates of attainment costs (either partial or full). At the same time, as we also explain in Appendix C, we concluded that loosening the constraint of 5 tons of baseline emissions per year appeared to tap into a specious portion of the CoST data, causing us to decide that the CoST model was being pressed beyond its range of usefulness. Ultimately, the only way in which we decided to use additional controls from within the CoST list of candidate measures was to identify and include point source controls that cost more than $160,000 per ton (while retaining the 5 ton per year constraint).

The result of our Step 1 identified 66 additional or more stringent control measures on point sources in the 61 counties still needing controls to fully attain 8/35. All of these additional controls were in the Northeast and Southeast regions; none were identified in the partially attaining counties in the West and California. The aggregate net increase in effective tons of control over the RIA was 465 tons at an additional aggregate annual cost of $205.6 million. Since none of the additional point source controls was found to cost more than $685,000 per ton, we did not elect to choose another (also *ad hoc*) cost limit below $685,000 per ton. This step produced no additional controls for the 10/35 standard and only 19 tons of control at an added cost of $5.3 million per year for the 9/35 standard. A listing of the additional point source controls included as a result of Step 1 is available on request.

Clearly, this effort to find more controls with a reasonable overall appearance of reliability by relaxing EPA's two explicit CoST modelling constraints made very little difference to the gap of about 40,000 additional tons of reduction needed. Thus, it is apparent that the only way to make a meaningful dent in the remaining 39,900, 18,160, and 8,930 tons of reductions needed to fully attain 8/35, 9/35, and 10/35, respectively, would be to include options for the partially attaining counties to resort to significant amounts of additional tons of reduction from their remaining non-point source emissions. As these deeper cuts were not even candidate control measures in the CoST data base, we incorporated them "off-line" as described in Step 2.

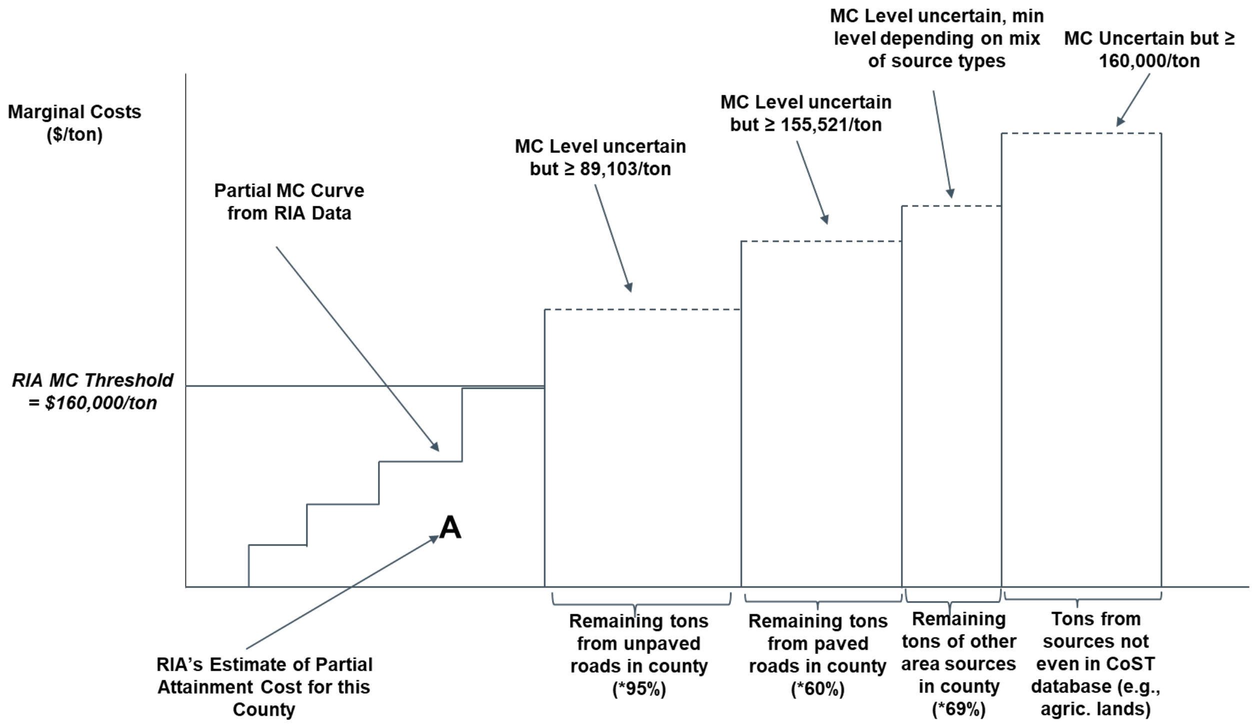
Step 2: Additional Non-point Source Controls

Our second step for extension of the county-specific marginal cost curves is grounded in making deeper reductions in the non-point source controls than the maximal 25% control allowed for by the CoST model assumptions. Figure 4 illustrates the basic building blocks of this approach. Once the CoST controls have been exhausted (as they will have been in any partial-attainment county) and any additional controls from Step 1 are included, Step 2 starts to apply additional controls to the *remaining* tons in the county's database from three general source categories, represented by the next three "stairsteps" that start at the end of the partial marginal cost curve. These three steps are to be taken in their cost-effectiveness order until they have yielded the full amount of still-needed tons of reduction. Since the RIA's marginal cost for controlling 25% of each category is $89,103 per ton for unpaved roads, $155,521 per ton for shoulder paving, and starts at $471,406 for construction site water sprinkling, the figure shows that order for the stairsteps.

The total quantity of potential reduction from each category (*i.e.*, the width of each block) is 95% times the remaining tons of unpaved road dusts (which is the CoST model's assumption about the control effectiveness of paving a road), 60% times the remaining tons of paved road dusts (*i.e.*, the control effectiveness of paving shoulders in CoST) and 68.6% times the amount of other non-point source emissions (which is the control effectiveness for sprinkling water at construction sites). A listing of the remaining tons of non-point source emissions for the 61 partially-attaining counties is available on request.

The height of each of the three added stairsteps reflects an estimate of the cost per ton of controlling each category beyond the 25% RP level assumed in the CoST portion of the marginal cost curve. This is highly uncertain and we estimate alternative cost per ton levels for each of the three blocks, while not letting the paved and unpaved categories fall below the cost per ton levels used by CoST for the first 25% of controls. By varying these three categories' marginal costs, selecting from them in cost-effectiveness order, and stopping when a sufficient number of additional effective tons of reduction have been selected to reach full attainment in each affected county, we add the additional costs under that extended part of the curve to the costs from the RIA and Step 1 (*i.e.*, the area labelled A). For purposes of developing regional and national totals, we make no changes to the RIA's cost estimates for nonattaining counties that the RIA does project to reach full attainment (*i.e.,* for those counties identified in Appendix B as attaining "100%" of their emissions reduction need in the RIA CoST analysis).

Figure 4. Illustration of Building Blocks for Extending Marginal Cost Curves Through Deeper Cuts in Remaining Primary $PM_{2.5}$ Emissions from Non-point Sources



A fourth and last stairstep is applied only in the counties with the most extreme partial attainment situation, which occurs if even 100% RP for all of the first three blocks (that are rooted in CoST non-point source emissions inventory data) is insufficient to meet the full attainment needs of some counties.[57] Here is where the full cost analysis must rely on assumptions that cannot be traced to any of the data in the EPA RIA datasets. Since nearly maximal control has, by this point, been extracted from the sources listed in the CoST database, the controls that this block would account for would likely be from source categories not even listed in the CoST database – agricultural dusts would be an example. Here, any assumed marginal cost will have a wide range of uncertainty because this last block falls into the category that we might call "truly unidentifed" at this point.

One might take the reliance on this last block of the extrapolated cost curve in the 8/35 case as an indication that the 8/35 standard may be unattainable as a practical matter, rather than just very high cost. It could also be viewed as an indication that the decision to develop illustrative control strategies solely on controls of primary $PM_{2.5}$ was ill-advised, and that further controls of precursor emissions (which are

[57] Our analysis finds that eight of the 32 northeast and Southeast partial attaining counties and 20 of the 29 partially attaining counties in California and the West end up relying on Block 4 for the 8/35 standard.

widely understood to be increasingly expensive after decades of controls) will in fact become an essential part of full attainment.

Key Attributes of Our Approach and Objectives

The approach we have described above was designed to rely as much as possible on data about controls and reduction potential in EPA's own databases. We are aware of many concerns various parties have raised about the reliability of the CoST control cost assumptions, their cost-effectiveness, emissions inventory, estimates of tons needed for attainment, *etc.*[58] In our own explorations of CoST sensitivity runs, some of these became apparent to us directly. We have noted how some of these data issues caused us not to rely heavily on adjustment of the two overt CoST model constraints in estimating costs of full attainment (see Appendix C). We choose not to engage in in-depth criticisms of specific numerical assumptions in the RIA, and we do not attempt to replace any numerical assumptions of the RIA analysis used in its partial portion of its calculations. However, we acknowledge here that some of these concerns are real and that, if they could be addressed better, might alter the results of our analysis (as well as those of the RIA).

Instead, our focus is on demonstrating that the partial attainment costs in the RIA are not informative about either the absolute or relative cost of the three alternative standards. Our approach relies on the standard economists' concepts of extrapolating the "identified" marginal cost curve that even EPA has used in its prior $PM_{2.5}$ and ozone NAAQS RIA rather that boldly report only partial attainment cost estimates. That is the fundamental criticism that we level at this RIA, and we consider it a very serious flaw for the utility of this RIA. We find it deeply concerning if its partial cost estimates should be allowed to stand as a precedent for bad practices in future RIAs.

[58] Uncertainties are not just inherent in the cost modeling efforts of the RIA; it also exists in the PM modeling itself, since the model performance evaluation criteria accept inaccuracies of as much as +/- 50 percent.

5. FULL ATTAINMENT COST RESULTS SUMMARY

Input Assumptions Used to Define a Range of Full Attainment Costs for Each County

Our approach to assessing the full cost of attainment is to provide a range of cost estimates for each alternative standard to reflect the great degree of uncertainty in the underlying assumptions it requires. Table 3 presents the costs per ton that we assume for each of the four blocks illustrated in Figure 4 to estimate costs at the lowest and highest end of those full attainment cost ranges. The reasoning behind each value in the table is summarized below.

Table 3. Range of Assumptions Used About the Average Cost per Ton of Reduction in Each of the Four Blocks of the Extrapolation Calculation

Block	Lowest	Highest
Block 1: Paving remaining unpaved roads after first 25%	$89,103	$356,412
Block 2: Paving shoulders of remaining paved roads after first 25%	$155,521	$622,084
Block 3: Controls on remaining emissions in all other non-point sources included in CoST database	$20,000	$471,406
Block 4: Truly unknown controls after exhausting 100% controls on all non-point sources in the CoST model	$166, 667	$500,000

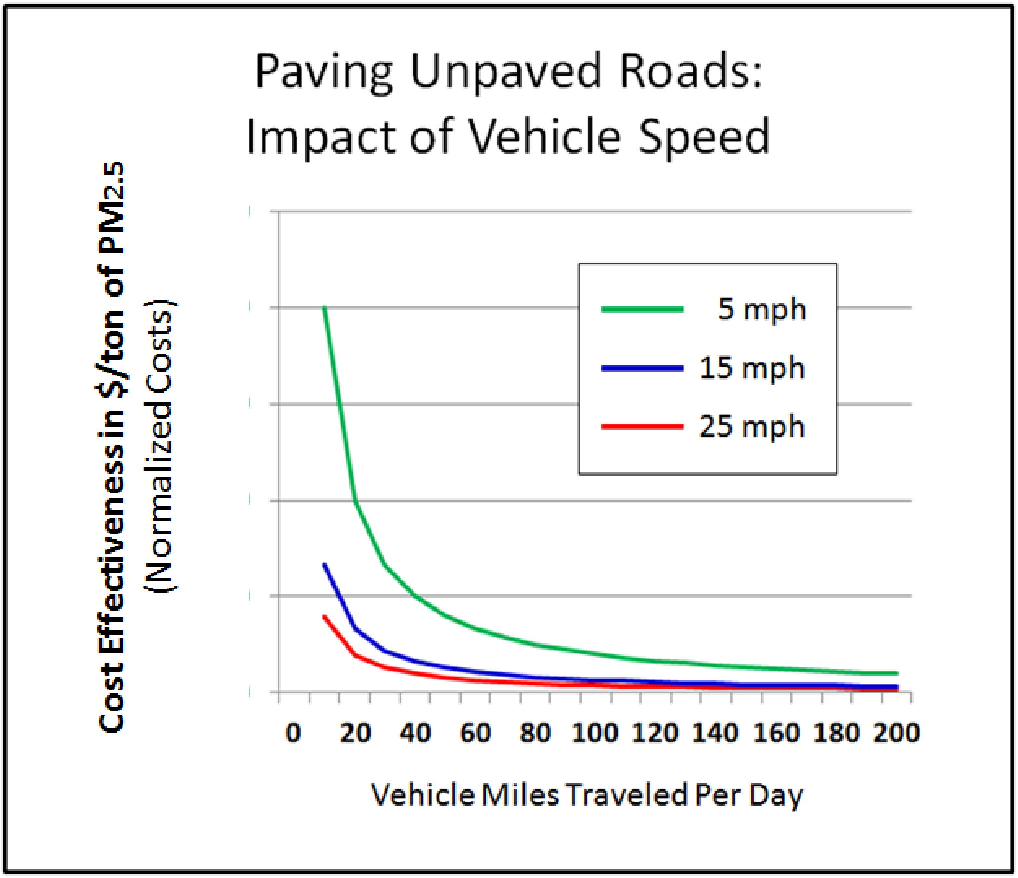
For the lowest assumptions for Blocks 1 and 2, we assume that the marginal cost assumed for the first 25% of rule penetration would not increase for the remaining 75% of rule penetration. We consider this to be an extremely low estimate, given that the source document for the non-point CoST assumptions provides graphs indicating very steep rises in those sources' costs per ton as the road segments being addressed are less intensively used.[59] A copy of one of those figures is provided in Figure 5. It shows a rapid increase in the estimated cost per ton reduced as the vehicle miles travelled (VMT) on a 1-mile segment of road to be paved falls below 30 miles per day (which is the VMT level assumed in the CoST model's cost per ton for RPs of 10% and 25%), and also as the speed of travel on that road falls below 25 mph (which is the approximate speed assumed in the CoST model's cost per ton for RPs of 10% and 25%). If equally well-located with respect to an offending monitor, a SIP planner would choose to pave road segments with the highest average VMT, mpg, and vehicle weights.[60] Based on figures in HARC (2015), such as the example provided in Figure 5, it would be entirely plausible to assume that the last percentiles of currently unpaved roads to be paved (*i.e.,* as a SIP planner needs to start paving roads with lower vehicle travelling attributes) could be at least ten times more costly per ton reduced than the CoST model assumes for the RPs of 10% and 25%. In contrast, our high-end assumptions are only four times

[59] Houston Advanced Research Center and Texas Environmental Research Consortium (HARC), 2015, *Fine Particulate Matter in Harris County*, report prepared for Harris County, April 30, Figures 4-7, pp. 18-21. Available at: https://pm25.harcresearch.org/assets/FinalReport.pdf.

[60] These are the three key road characteristics that are used in the HARC (2015) formula for estimating the cost per ton reduced from paving a 1-mile road segment. The estimate in CoST of $89,103 per ton for paving an unpaved road is taken from HARC (2015) and assumes, per Appendix C of HARC (2015) at p.2, a daily VMT per mile of road of 30 miles, vehicle speed of 25.9 mpg, and vehicle weight of 1.8 tons.

the CoST assumption, which we consider a quite modest assumption for a possible high end. The use of a multiple of only four is taken to recognize that this assumption is an *average* cost per ton over the entire range from the 26th percent to a 100% rule penetration of the most cost-effective of the CoST model's road control measures.

Figure 5. Copy of Figure 7 from HARC (2015) Showing Cost per Ton Reduced by Paving Unpaved Roads as Function of Vehicle Miles Travelled per Day on a 1-Mile Segment to be Paved and the Speed (mpg) of Vehicles on the Segment.[61]



For Block 3, we use an extremely wide range because this category of remaining tons is a combination of all the other non-point source categories' tons, which creates substantial uncertainty and county-to-county variation in the primary sources of emissions in the block. At the low end, we assume only $20,000 per ton, which is roughly consistent with assuming that most of the remaining tons are either from residential wood combustion or from commercial cooking, and that the remaining tons (after measures have been applied in CoST) will cost, on average, about two times the marginal cost assumed in CoST for the first 25% of rule penetration. On the high end, we use the marginal cost per ton for the most cost-effective of the construction dust control measures ("soil moisture/sprinkler") in CoST's candidate measures input file for the first 25% of that sector's emissions (*i.e.,* RP of 25%). Because even this control measure exceeds the $160,000 per ton limit EPA has applied to its CoST modeling, the RIA applies no construction dust

[61] Note: The y-axis on this figure is for "normalized costs" and does not provide a numerical scale, so that a reader can only infer the *relative* cost impact of changing the assumptions on the graph.

controls at all in its partial attainment analysis. Thus, Block 3 effectively allows even some construction dust controls to start to be applied for full attainment.

For Block 4, there is no evidentiary basis in the EPA modeling data sets for estimating what these controls would be, what sources they would apply to, or what their average cost per ton might be. Clearly, not being even considered as candidates for control in CoST suggests these emissions come from sources that are either considered very high cost to control (or to control *further* than they might already be) or are considered uncontrollable for one or more possible reasons. Not knowing what they might, practically speaking, cost to control, but assuming they are inherently problematic to control, we have applied a wide range of costs per ton. We selected a high-end cost of $500,000 per ton, which is roughly consistent with the high-end cost of other blocks that are at least identifiable and thus somewhat evidence-based. For the low end, we took one-third of the high-end assumption, noting that it is approximately at the level of the cost limit that the RIA's CoST modeling chose to apply.

Resulting Ranges of Estimates for Cost of Full Attainment

The full attainment cost estimates associated with simultaneously applying all four of the low-end cost per ton estimates in Table 3, and those associated with simultaneously applying all four of the high-end estimates are presented in Table 4. These ranges do not represent confidence intervals with a probabilistic interpretation. Rather, the lower ends of the ranges reflect the potential costs when one assumes the simultaneous combination of the lowest marginal cost estimates for the average cost per ton for reductions; the higher end values reflect the estimated costs when one assumes the simultaneous combination of our highest assumptions regarding the average cost per ton for the necessary number of tons of reduction in each of those four blocks. It is our professional judgment that both sets of input assumptions, *when taken simultaneously*, stretch the boundaries of reasonable expectation and thus the true costs for finding the RIA's estimated tons of reduction still needed have a robust chance of falling within the ranges of potential costs that these input assumption sets project. This judgment applies most strongly to the ranges for *total* full attainment costs (*i.e.*, the sum of costs estimated for all counties, shown in the bottom row of Table 4) than to ranges of cost estimates for any single county that lie beneath these totals.

The RIA's own estimates of costs for counties that it projects will reach full attainment are included in the "Full" cost ranges of Table 4 without any alteration by NERA. Because the RIA's cost estimates for those counties are just point estimates, the same values are included in the low and high ends for the "Full" cost ranges for each alternative standard, respectively.

The estimated potential full attainment costs, even at the low end, are vastly larger than the partial attainment costs that the RIA has reported (*e.g.*, in its Table ES-5). The RIA's partial attainment cost estimates are presented next to this study's range of full attainment cost estimates in the table. It shows that for the 8/35 standard, the potential full attainment will cost between about $7 billion and $24 billion, which is 4 to 13 times more than the RIA's partial cost estimate of less than $2 billion. Full attainment of 9/35 is projected to potentially cost 6 to 23 times more than the RIA's partial estimate. As for the least stringent alternative standard considered, 10/35, the potential full attainment cost is estimated to be between $1 billion and $4 billion per year, 11 to 45 times more than the RIA's partial estimate.

Table 4. Comparison of NERA's Range of Estimates of Annual Cost of Full Attainment to Partial Cost Estimates Reported in RIA (Annual in 2032, millions of 2017$)

Area	10/35			9/35			8/35		
	Partial (RIA)	Full (NERA)		Partial (RIA)	Full (NERA)		Partial (RIA)	Full (NERA)	
		Low	High		Low	High		Low	High
Northeast	$7	$7	$7	$206	$226	$335	$1,100	$2,147	$6,271
Southeast	$4	$4	$4	$69	$202	$605	$437	$1,219	$3,388
West	$19	$74	$238	$34	$272	$905	$122	$769	$2,378
California	$64	$957	$4,055	$85	$1,830	$7,322	$163	$3,097	$11,704
Total	$95	$1,042	$4,305	$393	$2,529	$9,167	$1,822	$7,232	$23,741

We also calculated full attainment cost estimates for all the possible combinations of the high and low average cost per ton assumptions for each block. This exercise produced a nearly uniform distribution of cost estimates between the low and high values, indicating that no single one of the four average cost per ton assumptions in Table 4 has a dominant effect on whether the full attainment cost estimate will be closer to the low end or to the high end.

For those who might view the above cost estimates as overstated, take note of the reasons they could be understated, especially at the lower end of the ranges.

- The low ends of the ranges assume that the marginal cost of obtaining additional reductions of non-point source controls is no higher than the CoST model assumes is the cost per ton from controlling the first 10% to 25% of emissions in each respective source category, despite extensive evidence in the reports that developed those costs per ton that costs per ton rapidly increase across the full source category. Review of EPA's CoST model input and related source data files indicate that EPA itself recognizes that as the fraction of road dusts already controlled increases, the marginal cost of reducing dusts on another fraction of the roads in that county increases. Apparently because this increased marginal cost estimate rises above $160,000 per ton, EPA elected to not include any candidate road dust control measures in counties indicating they have already controlled road dusts on 25% or more of their roads. Thus, our low-end assumption that all remaining 75% of the road dusts not controlled in the CoST run can be controlled at the CoST model's marginal cost for the first 25% appears to be lower than even EPA would have assumed, had it included such higher RP options in its CoST input file at all.

- The low ends of the ranges make no assumptions that the *effectiveness* of each incremental ton of reduction (with respect to reducing ambient concentrations at the specific location of offending monitors) declines as one reaches towards a 100% RP level in each partial-attaining county, even though this will almost certainly occur as well.

California's Challenge in Meeting the *Current* $PM_{2.5}$ Standard Exceeds the Challenge That Most Other Counties Would Face Under an 8/35 Standard

The peculiar situation in this RIA of finding only partial attainment of the *current* standard of 12/35 in a number of counties further supports the notion that full attainment of any *tighter* standard will necessarily involve cost per ton assumptions higher than those assumed at the lower ends of each of our full attainment cost ranges. For example, most of the higher cost of full attainment in the case of the loosest of the alternative standards (*i.e.*, 10/35) is projected to occur in the California and the West. This reflects the fact that a number of the California and West region counties exhaust all of the candidate controls available to them in the CoST data even before attaining the current standard of 12/35 — and so the RIA's partial attainment costs for these counties is reported to be *zero* dollars per year, rather than a much higher cost per ton needed than is assumed for other counties that have not exhausted their available control options in CoST to attain 12/35. While Table 4 suggests that California's incremental costs of attaining 10/35 will be about $1 billion to $4 billion (compared to the $0.06 billion reported in the RIA), we have used our extrapolation logic to estimate the cost of first getting the seven California counties that enter the analysis for 10/35 still in partial attainment of even 12/35 into full attainment with the *current* $PM_{2.5}$ NAAQS (*i.e.,* 12/35). The potential additional cost (above and beyond the point where the CoST-based control measures are exhausted) is estimated to be between $0.4 billion and $1.5 billion if those controls are to be based solely on local primary $PM_{2.5}$ controls, as the RIA has assumed.[62]

In undertaking these additional costs to first attain fully 12/35, the California counties would effectively be using up a large portion the remaining options for reducing non-point emissions that our estimates of full attainment costs presented in Table 4 have assumed would still be available once they have attained 12/35. Thus, our full attainment cost estimates for reaching any of the alternative standards in Table 4 should be viewed as understated in the case of the California region because we start the analysis of full attainment control options for meeting the alternative standards without first removing the portion of remaining tons that would need to be reduced to first attain 12/35; nor do we attempt to assign a higher cost per ton to reducing those remaining emissions to reflect that California counties will be well beyond the first 25% of rule penetration for those control measures.

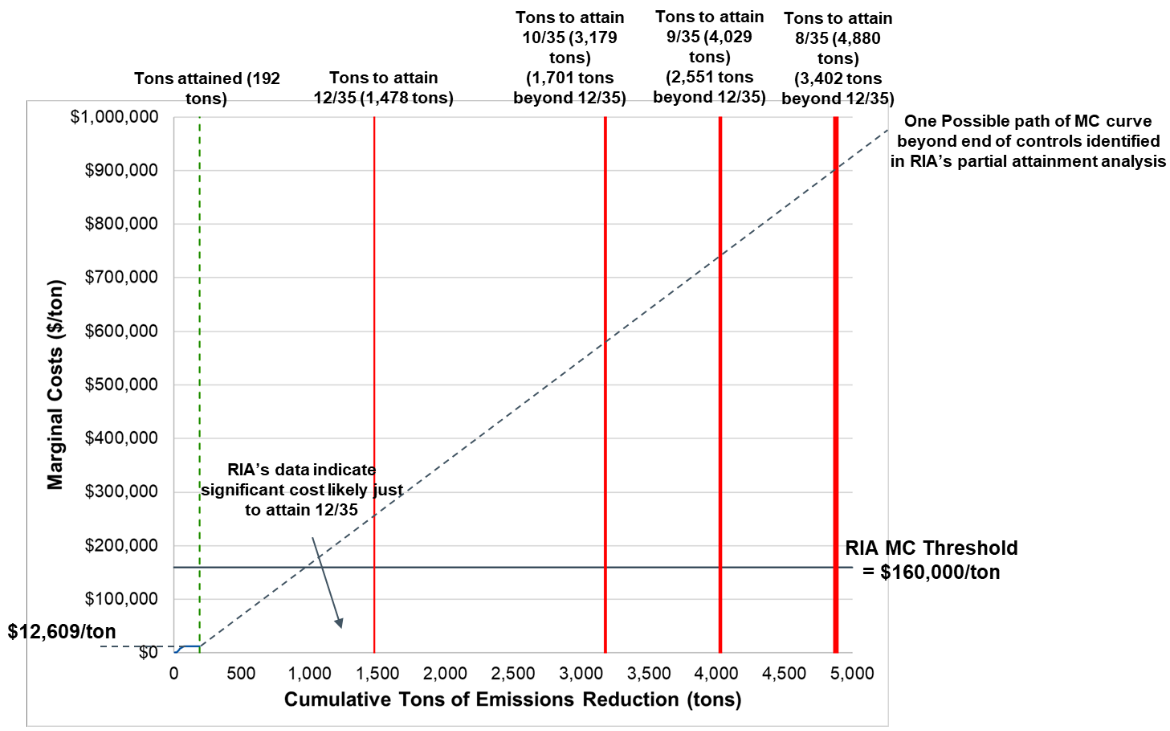
Although this analysis of first getting California into attainment of 12/35 indicates that our full attainment costs for California in Table 4 are systematically understated, they more broadly demonstrate the exceptional technical challenge that the current standard of 12/35 itself still presents. To visualize the degree of challenge that these California counties face in simply attaining the 12/35 standard, consider the information in Figure 6, which shows what the RIA's analysis finds for Riverside Co., CA. In the figure, the leftmost red vertical line shows the tons of primary $PM_{2.5}$ the RIA estimates Riverside Co. will need to reduce just to get to attainment with the current 12/35 standard.[63] The amount of reduction that the CoST model finds for this county is difficult to even see on this scale but ends at the dotted green line (192 tons). Relative to the 192 tons that the CoST modeling can identify for Riverside Co., the still-needed tons just to get to full attainment of 12/35 is 1,286 tons — a reduction larger than is required by most of the 141 counties needing to attain 8/35 (see Appendix B). Since the CoST model cannot find even those tons, this county (and another six counties identified in Appendix A) are projected in the RIA partial cost

[62] The cost of getting to full attainment of 12/35 for those California counties might be less if California has more cost-effective control measures available to it from precursor emissions sources, and/or more controls than assumed in the analytical baseline from mobile sources. It is out of NERA's scope to determine that, but it should be noted that the RIA analysis did control NO_x emissions by an additional 75% relative to projected emissions in 2032 under all existing regulations before estimating the tons of primary $PM_{2.5}$ reductions still needed to reach 12/35 or any of the alternative standards (RIA, pp. 2A-50 to 2A-53).

[63] Note that these estimates of the requirements for full attainment using primary $PM_{2.5}$ emissions reductions are computed *after* the RIA modeling has imposed a 75% reduction in California NO_x relative to the projected 2032 NO_x levels in its 2032 all-measures CMAQ run (*i.e.*, the result of "Step 1" described on p. 2-1 of the RIA).

analysis to undertake zero additional measures to close the ever-growing gap to 10/35, 9/35, or 8/35 — the size of those gaps being illustrated by the three other vertical red bars.

Figure 6. Illustration of the Full Attainment Challenge Faced by Riverside County, CA Based on Data from the RIA CoST Analysis.



Additional reasons why the full attainment cost estimates in Table 4 should not be considered an overstatement of the overall economic burden of meeting the tighter NAAQS alternatives are discussed in the next section of this report.

6. DISCUSSION

This report has made the case that it is inappropriate and highly misleading for an RIA to provide only partial attainment cost estimates. The ranges of full attainment cost estimates in the prior section demonstrate just how misleading partial attainment estimates can be of either the absolute or relative costs of alternative tighter NAAQS standards.

- For example, the RIA's partial attainment costs for 8/35 are 19 times higher than those for 10/35, while the respective full attainment cost estimates are only 5 to 6 times higher. This tells us that the partial attainment cost estimates for the least stringent alternative standard appear to be understated even more than those for the most stringent alternative — a finding that is not possible to anticipate just by observing the way the partial attainment cost estimates differ.
- In absolute terms, one could readily anticipate that the full attainment cost estimates would be higher, but not how much higher based on the partial attainment cost estimate levels. In the case of this set of alternative NAAQS standards, we find that the partial attainment costs are only about 2% to 9% of the full attainment costs for 10/35, about 4% to 16% of full attainment costs for 9/35, and about 8% to 25% of full attainment costs for 8/35.

Such large differences between CoST-based partial attainment cost estimates and the full cost estimate range are completely consistent with EPA's own record of prior $PM_{2.5}$ and ozone NAAQS cost estimates. As noted in Section 2, CoST model-based partial attainment costs in the 2012 $PM_{2.5}$ NAAQS RIA were only 1% to 31% of EPA's own full attainment cost estimates.[64] It is not possible to simply apply a multiplier to any given set of partial attainment costs: there is no pattern observable in the past record of partial *versus* full attainment cost estimates to predict the magnitude of the understatement as a function of the type or stringency of the alternative standard. Nevertheless, this study, combined with past EPA RIA analyses, indicates that the difference can be very large — large enough to be of importance to policy deliberations, and thus essential information for a reliable RIA.

This report also makes the point that full attainment cost estimates must be provided as quantitative ranges to help communicate to readers of the RIA the degree of uncertainty about what types of options will be used to achieve attainment once the (very) short list of candidate control measures that EPA has assembled for its CoST model is used up. The more that one can base the extrapolation to full attainment on control actions that can at least be named and partially quantified, the more reliable the resulting full attainment cost estimates may be, but this does not necessarily help narrow the uncertainty range. For example, in this study, the full attainment cost estimates are at least based on named non-point sources and the set of known options for limiting their emissions. As they involve far greater rule penetration than the CoST model accounts for, the cost per ton of those additional measures is still a critical uncertainty. We suggest, however, that a full cost estimation process that broadly identifies the most likely types and sources of additional control measures can produce a more confidence-inspiring cost range than a process that simply assumes a particular shape of a marginal cost curve (*e.g.*, flat, rising linearly, or rising exponentially) of unknown, unnamed, unidentified control measures that might fill the gap after the end of the CoST model's marginal cost curves. This study has taken the former approach, whereas the EPA's prior RIAs containing full attainment cost estimates have taken the latter approach.

[64] EPA (2012), Tables 7-4 and 7-5, pp. 7-14 and 7-15.

We have focused our analysis on the costs of full attainment as contrasted to "partial attainment" cost estimates only. Readers should be aware of how narrow even the full attainment cost estimate is. For example, these cost estimates omit or may otherwise be limited by the following issues:

(1) Costs and/or economic growth losses in *attainment* areas because of heightened difficulties for potential new plants or plant expansions in those clean air areas to demonstrate that they will not cause "significant deterioration" of air quality already meeting the NAAQS; [65]

(2) The economy-wide costs from the ripple effects on related businesses and employment that could be picked up though macroeconomic modeling of the attainment cost estimates (*e.g.*, using computable general equilibrium models);

(3) Administrative costs to states, which are likely to be amplified when addressing controls for many smaller sources that have never been regulated;

(4) Potential costs of sanctions — transportation and/or conformity freezes if states cannot submit approvable plans;[66]

(5) The cost of all nonattainment stationary source obligations (*e.g.*, NSR, RACM/BACM);

(6) The potential for significant increases in the costs of controls for many source categories given the outdated nature of the referenced source material for the control cost estimates;

(7) EPA's decision to include in its annualized control cost estimates only costs incurred starting in 2032, whereas the technology investments needed to reach attainment by 2032 will need to be incurred well before 2032;

(8) The cost of offsetting emission increases that may perversely occur as the result of the lower standards, such as the recent concerns expressed by the USFS and the Interior Department over the effect of the new standards in limiting prescribed fires to manage and prevent higher $PM_{2.5}$ emissions from wildfires.[67]

Item (1) in the list above merits some detailed discussion, as it raises the possibility of a tighter NAAQS resulting in incremental costs even in areas that remain in attainment with a tightened NAAQS. The numerical analyses in this report have focused solely on the costs of reducing criteria pollutant emissions to the degree estimated by the RIA to be needed to bring nonattainment areas into full attainment. That is the traditional focus of RIAs. However, as NAAQS regulations start to be driven down to levels close to those in relatively clean areas of the U.S. that do not face any risk of falling into nonattainment, RIA's estimates of the costs of implementing emissions control measures (even for full attainment) may be

[65] This is more commonly known as the requirement for prevention of significant deterioration (PSD) demonstrations before a proposed new facility can obtain its emissions permit(s).

[66] *See, e.g.*: 87 *Federal Register* 60494, "Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California," October 5, 2022, at 60528.

[67] *See, e.g.*: General Accounting Office, 2023, *Wildfire Smoke Opportunities to Strengthen Federal Efforts to Manage Growing Risk,* March. Available at https://www.gao.gov/assets/gao-23-104723.pdf#page=48&zoom=100,0,789.

becoming a smaller and smaller part of the overall burden that NAAQS rules may entail on the U.S. economy at large, for reasons explained below.

Typically, RIAs acknowledge that there is an array of administrative costs for state governments to comply with SIPs and other implementation measures. Traditionally, it has been assumed that these costs are minor relative to the technical control measures themselves. That may still be the case. However, a tighter NAAQS also triggers increases in the challenges for businesses to demonstrate that any new or expanded major emissions source in attaining areas across the country will not result in new nonattainment or exacerbate any existing nonattainment. Known as the Clean Air Act's requirement for prevention of significant deterioration (PSD), "PSD demonstrations" are required of emitting manufacturing and industrial sources across the U.S. before they receive an air permit for a new or significantly expanded facility. There is nothing new about the PSD requirement, but as a NAAQS is tightened to levels increasingly close to the average ambient levels in areas that have no risk of nonattainment themselves, the chance that an increment in emissions from a new or expanded facility will exceed the allowable local air quality margin (called "headroom") becomes greater. If so, a detailed air quality modeling effort must be undertaken to demonstrate no significant deterioration would occur. To ensure passing that demonstration may require that proposed new sources agree to be built with emissions controls that are more expensive than is normally required outside of nonattainment areas.

Heightened emissions control requirements even in attainment areas could thus be an added cost that a traditional NAAQS RIA never considers, and could result in spending that is not insubstantial compared to the more narrowly defined costs of achieving attainment. For example, an analysis of additional costs due to additional controls on the wood and paper products industry that might become required in attaining areas if the PM2.5 NAAQS were tightened to 8/35 could cost over $4 billion in capital costs for that sector alone.[68] The paper suggests that if its analysis is representative of impacts to other U.S. manufacturing sectors, the overall increase in capital costs could be on the order of $20 billion. Although these costs are not directly comparable to the annualized costs estimated in the RIA, we estimate that, once annualized, they exceed the RIA's annual partial attainment costs for 8/35, and that they could be as much as 10% to 25% of our estimates of the full attainment costs of 8/35. Although these are rough estimates, they seem significant enough that this RIA (and future RIAs for tighter NAAQS) should start to consider expanding their notion of costs to include heightened costs in attaining areas across the U.S. in addition to the costs of eliminating projected nonattainment.

We also note that the PSD demonstration concern is not just that costs of manufacturing may increase more broadly than just in nonattainment areas. We also note that the heightened challenges in passing a PSD demonstration in many otherwise "clean" areas of the U.S. *could hinder their economic growth prospects without any actual dollar expenditures ever being incurred*. And in that sense in particular, benefit-cost analyses for NAAQS that are based solely on concepts of spending on control equipment or changes in operational processes may be losing their originally intended policy relevance. Consideration should be given to broadening the types of cost and economic impacts that future NAAQS RIAs should start to include.

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[68] American Forest and Paper Association and American Wood Council, 2023, "Impacts of a Lower Annual $PM_{2.5}$ Ambient Air Quality Standard on the Forest Products Industry, February. To be submitted to the $PM_{2.5}$ Reconciliation docket EPA-HQ-OAR-2015-0072 as part of comments by the NR3 Coalition.

The analysis in this set of technical comments on the current $PM_{2.5}$ RIA is solely on the question of full attainment cost estimation to replace the misleading partial attainment costs in the RIA. The fact that we do not critique the RIA's estimates of benefits does not mean that we do not have significant concerns with their numerical validity as well. In fact, we note that those benefits estimates are far more uncertain than any cost estimate because they are the subject of on-going questions regarding both their causal and quantitative interpretation. Even if there is acceptance of a causal relationship reflected in the epidemiological associations on which RIA benefits are based, there is no evidence that the numerical values of those associations can be interpreted as unbiased quantitative predictors of the responses of public health to changes in concentrations in different locations, under different baseline exposures, and for different demographics than the original study. These epistemological issues for benefits calculations are well documented in comments on the rationale for the proposed rule;[69] the debate is easily summed up as uncertainty over whether such benefits will be realized. In contrast, there is no debate about the existence of actual compliance costs, and it is important and relevant to policy deliberation to understand their potential full attainment cost — and the associated implied practical or technical challenges — even if that requires acknowledgement of a wide range of numerical uncertainty.

[69] *See*, *e.g.*: NCASI (2023); Smith (2019a, 2019b); Smith and Chang (2020); and Gradient (2023).

7. CONCLUSION

In summary, the current RIA's cost estimates are inappropriately based on an undefined concept it calls "partial attainment." It is undefined because the "stopping point" at which control measures (and their costs) for getting closer to attainment stop being identified and are treated implicitly as zero cost; this is totally arbitrary and even differs in its degree of incompleteness with the location projected to be in nonattainment. Setting aside its ill-defined nature, partial attainment costs are inappropriate to report in an RIA executive summary because they bear no relationship whatsoever to the challenges, both technically and economically, of adopting a tighter standard or regulation, even though that sort of insight is one of the most important objectives of an RIA. Their presence in the executive summary is therefore misleading.

Even if fraught with enormous uncertainty, a concerted effort to characterize the full attainment costs is what is needed. If readers decide that the resulting cost ranges are too wide to be useful, the associated analysis to estimate those costs still provides readers with some understanding of the regulatory challenges that the various alternative standards may entail. By failing to even explain the extent of regulatory challenge that is implicit in the analysis and data behind this RIA, EPA does a disservice to the public and policymakers. This report provides important policy-relevant information and insights that the current RIA does not.

8. REFERENCES

American Forest and Paper Association and American Wood Council. 2023. "Impacts of a Lower Annual $PM_{2.5}$ Ambient Air Quality Standard on the Forest Products Industry, February. To be submitted to the $PM_{2.5}$ Reconciliation docket EPA-HQ-OAR-2015-0072 as part of comments by the NR3 Coalition.

Arrow, K. J., Cropper, M. L. *et al*. 1996. "Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation," *Science*, Vol. 272:221-2.

EPA, "Cost Analysis Models/Tools for Air Pollution Regulations," available at https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-analysis-modelstools-air-pollution (accessed 3/13/23).

EPA. 2022. Regulatory Impact Analysis for the Proposed Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, EPA-452/P-22-001, December, available at https://www.epa.gov/system/files/documents/2023-01/naaqs-pm_ria_proposed_2022-12.pdf.

EPA. 2015. Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone, EPA-452/R-15-007, September, available at: https://www3.epa.gov/ttnecas1/docs/20151001ria.pdf.

EPA. 2012. Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter, EPA-452/R-12-005, December, available at: https://www.epa.gov/sites/default/files/2020-07/documents/naaqs-pm_ria_final_2012-12.pdf.

87 *Federal Register* 60494, "Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California," October 5, 2022.

88 *Federal Register* 5558, "Reconsideration of the National Ambient Air Quality Standards for Particulate Matter," January 27, 2023.

General Accounting Office. 2023. Wildfire Smoke Opportunities to Strengthen Federal Efforts to Manage Growing Risk, March, available at https://www.gao.gov/assets/gao-23-104723.pdf#page=48&zoom=100,0,789.

Gradient. 2023. "Comments on US EPA's Proposed Rule for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter. Docket ID No. EPA-HQ-OAR-2015-0072." March 21. Submitted to docket EPA-HQ-OAR-2015-0072 (Comment Tracking Number: lfk-4z5n-amf4).

Houston Advanced Research Center and Texas Environmental Research Consortium. 2015. *Fine Particulate Matter in Harris County*, report prepared for Harris County, April 30, available at: https://pm25.harcresearch.org/assets/FinalReport.pdf.

Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services. 2016. *Guidelines for Regulatory Impact Analysis*, available at https://aspe.hhs.gov/sites/default/files/private/pdf/242926/HHS_RIAGuidance.pdf.

Office of Management and Budget (OMB). 2003. *Regulatory Analysis*, Circular A-4, September 17, available at https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf.

NCASI. 2023. "RE: Reconsideration of the National Ambient Air Quality Standards for Particulate Matter: Docket ID No. EPA-HQ-OAR-2015-0072." March 16. Submitted to docket EPA-HQ-OAR-2015-0072 (Comment Tracking Number: lfb-dmdh-3ax8).

Smith, A. E. 2019a. "Comments to CASAC on the Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft." October 21. Available at: file:///C:/Users/ANNE~1.SMI/AppData/Local/Temp/MicrosoftEdgeDownloads/aa26b030-21a1-43ac-adc9-9bdfeac0feb2/Smith%20Comments%20to%20CASAC%20on%20DraftPA_submitted_102119.pdf.

Smith, A. E. 2019b. "Oral Statement to CASAC on the Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft." October 22. Available at: file:///C:/Users/ANNE~1.SMI/AppData/Local/Temp/MicrosoftEdgeDownloads/edb52cec-d35e-452b-a6c4-5918e493ba60/Smith%20Oral%20Statement.pdf.

Smith A. E. and Chang, W. 2020. "Exposure Window Uncertainty in Chronic Effects Associations of $PM_{2.5}$ and Health Risks." Submitted as Attachment 4 to comment of the NAAQS Regulatory Review & Rulemaking Coalition to the docket for the 2020 $PM_{2.5}$ NAAQS Proposed Rule, Docket reference number EPA-HQ-OAR-2015-0072-0915, June 28. Available at: file:///C:/Users/anne.smith/Downloads/EPA-HQ-OAR-2015-0072-0915_attachment_5.pdf.

Sunstein, C. R. 2011. Return Letter from Administrator of the Office of Regulatory Information and Affairs, Office of Management and Budget to EPA Administrator Jackson returning the draft final rule "Reconsideration of the 2008 Ozone Primary and Secondary National Ambient Air Quality Standards." September 2. Available at: https://www.reginfo.gov/public/return/EPA_Return_Letter_9-2-2011.pdf.

APPENDIX A. EVIDENCE IN THE RIA OF THE INABILITY OF SOME AREAS TO ATTAIN THE CURRENT STANDARD OF 12/35

Before evaluating any of the alternative standards, this RIA first makes estimates of design values in 2032 (the assumed first year of full attainment) at existing monitors across the U.S. based on an assumption of implementation of all existing regulations, plus assumptions about economic growth through 2032. In this RIA, this 2032 projection indicates that, after imposition of all those current and future regulatory requirements, eight counties (all in California) are projected to still fail to attain the current *annual* standard of 12 $\mu g/m^3$.[70] These eight counties are identified in Table A-1.

The RIA analysis then applies a 75% reduction in NO_x emissions projected to remain by 2032 in South Coast and San Joaquin Valley counties.[71] (Plumas Co. is the only one in the table below that is not in either the South Coast or San Joaquin Valley.) After accounting for the effects on the 2032 design values of this large additional NO_x reduction, the RIA estimates the number of tons of primary $PM_{2.5}$ reduction that those California counties will still need to first attain the current 12/35 standard. Those additional tons of primary $PM_{2.5}$ estimated to be needed, and the tons that EPA finds for them using its CoST model are shown in Table A-1. Only one of the eight counties (Los Angeles Co.) is projected by the CoST model to have sufficient control options available to it to reach full attainment of the current 12/35 standard.

Table A-1. California Counties in Partial Attainment of Current 12/35 Standard

California County Not Attaining Annual Standard of 12 ug/m^3 by 2032	Emissions Reductions in Primary $PM_{2.5}$ Needed to Attain 12/35 (tons)	Primary $PM_{2.5}$ Reductions Identified by CoST Model Before Reaching Its Limit (tons and % of tons needed)	Primary $PM_{2.5}$ Emissions Reductions Still Needed for Attaining 12/35 in the "Partial" Analytical Baseline (tons)
Imperial	349	92 (26%)	257 (74%)
Kern	791	563 (71%)	228 (29%)
Kings	104	43 (41%)	61 (59%)
Los Angeles	313	313 (100%)	0 (0%)
Plumas	1,244	108 (9%)	1,136 (91%)
Riverside	1,478	192 (13%)	1,286 (87%)
San Bernadino	2,209	2,139 (97%)	70 (3%)
Tulare	230	177 (77%)	53 (23%)

The remaining seven counties in California enter the RIA's analysis of costs of meeting alternative standards (tighter than 12/35) still in partial attainment with 12/35 and lacking any further options in the CoST model to rely on. As one can infer from the last column of Table A-1, they still need a combined total of 3,091 tons. Clearly these are the counties of the U.S. that face the highest additional costs to attain even tighter standards than 12/35; but because they are already out of candidate control measures in

70 RIA, Table 2A-13. Fresno Co., CA and another nine counties in the RIA's West region are projected to still fail to meet the current *daily* standard of 35 $\mu g/m^3$. These are not discussed here, as we are focused on attainment of alternative annual standards only.

71 *See* RIA, pp. 2A-50 to 2A-53 for a description of its assumptions regarding additional NO_x reductions prior to estimating the need for reductions in primary $PM_{2.5}$ emissions in California counties.

EPA's CoST dataset, the RIA analysis of partial attainment implies that these seven counties will do *nothing* as the standard tightens — and that their assessed partial attainment cost reported in the RIA is *zero* dollars.

Several of the counties not attaining the daily standard in the 2032 baseline also exhaust their full set of controls in the CoST model and enter the main cost analysis in partial attainment of the daily standard, as well as show no cost (because they have no identified controls left) when they face one or more of the tighter alternative annual standards. These are Lemhi Co., ID, Shoshone Co., ID, and Yakima Co., WA.

APPENDIX B. COUNTY-BY-COUNTY ATTAINMENT OUTCOMES IN THE RIA PARTIAL ANALYSIS (TONS)

The tables below summarize the degree of severity of the partial attainment outcome of the RIA CoST analysis for every county that the RIA projects will have a nonattainment status under a given alternative standard. These tables also include the counties for which the RIA's CoST analysis does find sufficient control measures to get into full attainment (*i.e.*, for which the last column indicates "100%".) Table B-1 reflects the results for the 141 counties that are projected to be in nonattainment for the 8/35 standard. Table B-2 reflects the RIA's results for the 51 counties that are projected to be in nonattainment for the 9/35 standard. Table B-3 reflects the RIA's results for the 22 counties that are projected to be in nonattainment for the 9/35 standard. Obviously, the 22 counties are a subset of the 51 counties, which are in turn are a subset of the 141 counties. Also, any county that reaches only partial attainment of a less stringent standard will also be in partial attainment of any of the more stringent standards, and the depth of their partial attainment will increase with the tighter alternative standards.

Table B-1. Degree of Attainment in RIA Analysis Results for 141 Counties Projected to Face Nonattainment for the Alternative Standard of 8/35 (continued next page)

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Northeast				
Jefferson County, OH	893	213	680	24%
Camden County, NJ	856	248	608	29%
Delaware County, PA	1,405	435	970	31%
Lebanon County, PA	776	253	523	33%
Brooke County, WV	271	152	119	56%
St. Joseph County, IN	498	291	207	58%
Marshall County, WV	307	183	124	60%
New York County, NY	666	400	266	60%
Lancaster County, PA	1,537	937	600	61%
Marion County, IN	1,149	759	390	66%
St. Louis City County, MO	234	157	77	67%
Armstrong County, PA	907	613	294	68%
Butler County, OH	1,303	893	410	69%
Cuyahoga County, OH	1,603	1,167	436	73%
Vigo County, IN	315	252	63	80%
Wayne County, MI	1,478	1,192	286	81%
Union County, NJ	424	348	76	82%
Cambria County, PA	761	632	129	83%
Allegheny County, PA	2,305	1,923	382	83%
Hamilton County, OH	637	601	36	94%

Table B-1. (continued-2) Degree of Attainment in RIA Analysis Results for 141 Counties Projected to Face Nonattainment for the Alternative Standard of 8/35 (continued next page)

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Philadelphia County, PA	1,251	1,200	51	96%
Saint Clair County, IL	695	682	13	98%
New Castle County, DE	73	73	0	100%
Cook County, IL	1,017	1,017	0	100%
Madison County, IL	724	724	0	100%
Allen County, IN	44	44	0	100%
Clark County, IN	395	395	0	100%
Elkhart County, IN	241	241	0	100%
Floyd County, IN	29	29	0	100%
Lake County, IN	644	644	0	100%
Vanderburgh County, IN	263	263	0	100%
Jefferson County, KY	593	593	0	100%
Howard County, MD	124	124	0	100%
Baltimore (City) County, MD	95	95	0	100%
Kent County, MI	329	329	0	100%
Buchanan County, MO	80	80	0	100%
Jackson County, MO	37	37	0	100%
Jefferson County, MO	344	344	0	100%
Saint Louis County, MO	571	571	0	100%
Franklin County, OH	95	95	0	100%
Lucas County, OH	483	483	0	100%
Mahoning County, OH	117	117	0	100%
Stark County, OH	644	644	0	100%
Summit County, OH	498	498	0	100%
Beaver County, PA	293	293	0	100%
Berks County, PA	102	102	0	100%
Chester County, PA	681	681	0	100%
Dauphin County, PA	241	241	0	100%
Lackawanna County, PA	22	22	0	100%
Lehigh County, PA	95	95	0	100%
Mercer County, PA	278	278	0	100%
Washington County, PA	241	241	0	100%
York County, PA	381	381	0	100%
Providence County, RI	168	168	0	100%
Davidson County, TN	95	95	0	100%
Knox County, TN	410	410	0	100%
Berkeley County, WV	124	124	0	100%

Table B-1. (continued-3) Degree of Attainment in RIA Analysis Results for 141 Counties Projected to Face Nonattainment for the Alternative Standard of 8/35 (continued next page)

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Southeast				
Cameron County, TX	1,398	154	1,244	11%
Hidalgo County, TX	1,840	455	1,385	25%
El Paso County, TX	850	247	603	29%
Clayton County, GA	433	129	304	30%
Muscogee County, GA	523	258	265	49%
Fulton County, GA	1,161	765	396	66%
Caddo Parish, LA	1,145	786	359	69%
Bibb County, GA	621	467	154	75%
West Baton Rouge Parish, LA	515	460	55	89%
Floyd County, GA	556	541	15	97%
Jefferson County, AL	1,488	1,488	0	100%
Talladega County, AL	131	131	0	100%
Pulaski County, AR	777	777	0	100%
Union County, AR	65	65	0	100%
District of Columbia	139	139	0	100%
Cobb County, GA	41	41	0	100%
DeKalb County, GA	33	33	0	100%
Dougherty County, GA	278	278	0	100%
Gwinnett County, GA	16	16	0	100%
Richmond County, GA	409	409	0	100%
Wilkinson County, GA	760	760	0	100%
Wyandotte County, KS	90	90	0	100%
East Baton Rouge Parish, LA	531	531	0	100%
Iberville Parish, LA	16	16	0	100%
St. Bernard Parish, LA	57	57	0	100%
Hinds County, MS	33	33	0	100%
Davidson County, NC	204	204	0	100%
Mecklenburg County, NC	90	90	0	100%
Wake County, NC	65	65	0	100%
Tulsa County, OK	74	74	0	100%
Greenville County, SC	98	98	0	100%
Dallas County, TX	33	33	0	100%
Harris County, TX	1,905	1,905	0	100%
Nueces County, TX	809	809	0	100%
Travis County, TX	842	842	0	100%

Table B-1. (continued-4) Degree of Attainment in RIA Analysis Results for 141 Counties Projected to Face Nonattainment for the Alternative Standard of 8/35 (continued next page)

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
West				
Lemhi County, ID	939	0	939	0%
Shoshone County, ID	1,265	0	1,265	0%
Santa Cruz County, AZ	444	13	431	3%
Lincoln County, MT	1,422	225	1,197	16%
Benewah County, ID	734	133	601	18%
Denver County, CO	468	145	323	31%
Silver Bow County, MT	281	133	148	47%
Harney County, OR	267	148	119	55%
Maricopa County, AZ	669	669	0	100%
Pinal County, AZ	56	56	0	100%
Weld County, CO	47	47	0	100%
Canyon County, ID	383	383	0	100%
Missoula County, MT	697	697	0	100%
Ravalli County, MT	33	33	0	100%
Douglas County, NE	19	19	0	100%
Sarpy County, NE	28	28	0	100%
Clark County, NV	561	561	0	100%
Dona Ana County, NM	248	248	0	100%
Crook County, OR	105	105	0	100%
Jackson County, OR	533	533	0	100%
Klamath County, OR	281	281	0	100%
Lane County, OR	37	37	0	100%
King County, WA	126	126	0	100%
Spokane County, WA	65	65	0	100%
California				
Imperial County, CA	3,402	0	3,402	0%
Kern County, CA	1,268	0	1,268	0%
Kings County, CA	1,268	0	1,268	0%
Plumas County, CA	810	0	810	0%
Riverside County, CA	3,402	0	3,402	0%
San Bernardino County, CA	3,402	0	3,402	0%
Tulare County, CA	1,268	0	1,268	0%
Napa County, CA	650	33	617	5%
Merced County, CA	871	101	770	12%
Stanislaus County, CA	965	113	852	12%
Madera County, CA	813	111	702	14%

Table B-1. (continued-5) Degree of Attainment in RIA Analysis Results for 141 Counties Projected to Face Nonattainment for the Alternative Standard of 8/35

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Ventura County, CA	1,012	229	783	23%
Fresno County, CA	1,074	248	826	23%
San Luis Obispo County, CA	504	128	376	25%
San Joaquin County, CA	646	168	478	26%
Los Angeles County, CA	3,402	1,159	2,243	34%
Solano County, CA	317	150	167	47%
Sacramento County, CA	396	228	168	58%
San Diego County, CA	953	616	337	65%
Alameda County, CA	666	491	175	74%
Sutter County, CA	247	191	56	77%
Butte County, CA	76	76	0	100%
Contra Costa County, CA	355	355	0	100%
Marin County, CA	44	44	0	100%
Santa Clara County, CA	482	482	0	100%

Table B-2. Degree of Attainment in RIA Analysis Results for 51 Counties Projected to Face Nonattainment for the Alternative Standard of 9/35 (continued next page)

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Northeast				
Delaware County, PA	673	435	238	65%
Jefferson County, OH	161	161	0	100%
Camden County, NJ	124	124	0	100%
Lebanon County, PA	44	44	0	100%
Lancaster County, PA	805	805	0	100%
Marion County, IN	417	417	0	100%
Armstrong County, PA	176	176	0	100%
Butler County, OH	571	571	0	100%
Cuyahoga County, OH	871	871	0	100%
Wayne County, MI	746	746	0	100%
Cambria County, PA	29	29	0	100%
Allegheny County, PA	1,573	1,573	0	100%
Philadelphia County, PA	520	520	0	100%
Cook County, IL	285	285	0	100%
Southeast				
Cameron County, TX	581	154	427	27%
Hidalgo County, TX	1,022	455	567	45%
El Paso County, TX	33	33	0	100%
Fulton County, GA	343	343	0	100%
Caddo Parish, LA	327	327	0	100%
Jefferson County, AL	670	670	0	100%
Harris County, TX	1,087	1,087	0	100%
Travis County, TX	25	25	0	100%
West				
Lemhi County, ID	471	0	471	0%
Shoshone County, ID	797	0	797	0%
Lincoln County, MT	954	224	730	23%
Benewah County, ID	267	133	134	50%
Maricopa County, AZ	201	201	0	100%
Missoula County, MT	229	229	0	100%
Clark County, NV	94	94	0	100%
Jackson County, OR	65	65	0	100%
California				
Imperial County, CA	2,551	0	2,551	0%
Kern County, CA	951	0	951	0%
Kings County, CA	951	0	951	0%

Table B-2. (continued-2) Degree of Attainment in RIA Analysis Results for 51 Counties Projected to Face Nonattainment for the Alternative Standard of 9/35

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Plumas County, CA	493	0	493	0%
Riverside County, CA	2,551	0	2,551	0%
San Bernardino County, CA	2,551	0	2,551	0%
Tulare County, CA	951	0	951	0%
Napa County, CA	333	33	300	10%
Stanislaus County, CA	648	113	535	17%
Merced County, CA	554	101	453	18%
Madera County, CA	496	112	384	23%
Fresno County, CA	757	248	509	33%
Los Angeles County, CA	2,551	1,158	1,393	45%
San Joaquin County, CA	329	168	161	51%
San Luis Obispo County, CA	187	128	59	68%
Ventura County, CA	162	162	0	100%
Sacramento County, CA	79	79	0	100%
San Diego County, CA	102	102	0	100%
Alameda County, CA	349	349	0	100%
Contra Costa County, CA	38	38	0	100%
Santa Clara County, CA	165	165	0	100%

Table B-3. Degree of Attainment in RIA Analysis Results for 24 Counties Projected to Face Nonattainment for the Alternative Standard of 10/35

	(1) **Reductions Needed (Tons)** (Source: RIA Table 2A-14)	(2) **Reductions Achieved (Tons)** (1)-(3)	(3) **Reductions Still Needed (Tons)** (Source: RIA Table 3-9)	(4) **Percent of Emissions Reductions Needed That Are Achieved in RIA CoST Analysis (%)** (2)/(1)
Northeast				
Lancaster County, PA	73	73	0	100%
Cuyahoga County, OH	139	139	0	100%
Wayne County, MI	15	15	0	100%
Allegheny County, PA	842	842	0	100%
Southeast				
Hidalgo County, TX	204	204	0	100%
Harris County, TX	270	270	0	100%
West			0	
Lemhi County, ID	3	0	3	0%
Shoshone County, ID	330	0	330	0%
Lincoln County, MT	486	224	262	46%
California				
Imperial County, CA	1,701	0	1,701	0%
Kern County, CA	634	0	634	0%
Kings County, CA	634	0	634	0%
Plumas County, CA	176	0	176	0%
Riverside County, CA	1,701	0	1,701	0%
San Bernardino County, CA	1,701	0	1,701	0%
Tulare County, CA	634	0	634	0%
Stanislaus County, CA	331	113	218	34%
Merced County, CA	237	101	136	43%
Fresno County, CA	440	248	192	56%
Madera County, CA	179	112	67	63%
Los Angeles County, CA	1,701	1,159	542	68%
Napa County, CA	16	16	0	100%
San Joaquin County, CA	12	12	0	100%
Alameda County, CA	32	32	0	100%

APPENDIX C. QUANTITATIVE IMPLICATIONS OF LOOSENING COST PER TON AND TON PER YEAR CONSTRAINTS

In this study, efforts were made to determine whether the two constraints that EPA applied to its CoST model runs could be a significant cause of the extensive degree of partial attainment in the RIA cost analysis. NERA re-ran the EPA CoST model with loosened constraint levels. As explained below, these sensitivity cases showed that few additional controls could be found within the CoST input data, and many of the additional controls identified in these runs appeared to be using unreliable cost assumptions. Below we summarize more details of these findings and explain why we decided not to rely on many of the resulting selected control measures for our estimates of full attainment costs.

With regard to the 5 ton per year limit:

We first note that the 5 ton per year limit has only minimal effect on CoST's ability to select control measures for *non-point* or area sources. Although area sources, such as restaurants, are individually likely to be smaller than 5 tons per year, they are not represented individually in the NEI, nor in the CoST model. Rather, for each separate category of area sources (defined in NEI by their SCC codes, such as types of commercial cooking equipment), NEI estimates the total emissions from all such sources within a county. This total emissions estimate is what CoST's constraint requires to be more than 5 tons per year. While some counties may have so few individual sources within an SCC that they do not aggregate to at least 5 tons per year, we find that this is not a widespread phenomenon. The CoST model run with the 5 ton per year limit does identify and select controls for the various categories of non-point sources in a large fraction of the counties analyzed.

Our sensitivity run of CoST that reduced the 5 ton per year constraint to 1 ton per year identified only 157 more net effective tons of control from *non-point* sources across all of the potential nonattainment areas compared to the EPA run.[72] In general, and *because* these were very small missing control options to start with, the reduction in the gap to full attainment was at most a few tons for a few of the partially attaining counties. Given the effort of tailoring a full attainment estimate to capture these few additional tons, we elected not to manually incorporate them into our analysis. We found that the more important constraint for non-point sources in CoST is that it only provides control measures for the first 10% or 25% of any non-point source category's estimated emissions. We do address this constraint in the main part of our full attainment cost estimation (called "Step 2" in Section 4).

The effect of reducing the 5 ton per year limit to 1 ton per year was somewhat larger in the case of *point* source controls. We found that lowering this constraint identifies additional net reductions of 1,727 effective tons in the 61 counties that only partially attain 8/35. While this is a more substantial reduction of those counties' gap than that for non-point sources, when we reviewed the additional set of control measures selected for the point sources, we became uncomfortable with relying upon them. We noticed

[72] By "net" we mean total effective tons of increased reduction, and by "effective" we mean that tons reduced in adjacent counties are counted only as 0.25 tons of control for purposes of comparison to the estimate of tons of reduction needed to reach full attainment. In gross terms, the model identified additional measures summing to 179 tons of reduction in the nonattaining counties, and 59 effective tons among the various adjacent counties. However, these 238 additional effective tons were offset by about 81 fewer effective tons when various less cost-effective measures in the original EPA CoST run were no longer needed. (such off-setting would only occur in counties that can reach full attainment without exhausting all of their available control options).

that about three-fourths of these extra reductions were assigned the same cost per ton regardless of the size of the point source. In other words, point sources with the same SCC code that emit, for example, 200 tons per year apply these control measures at the same cost *per ton* as point sources that emit only 1 or 2 tons per year. We do not know the size basis that was used to estimate that single cost per ton that could be applied to *any* point source of any annual emissions size, but it is extremely unlikely that the estimate would have been viewed as appropriate for point sources emitting less than 5 tons per year. In fact, we wonder whether these size-invariant marginal cost estimates in CoST may also be inappropriate for application to sources in the 5 ton per year range. (Any alterations to the assumptions in the CoST model that EPA did elect to rely on are beyond NERA's scope, and we make this statement only as an observation worthy of future study regarding the general reliability of the current CoST dataset.)

The other one-quarter of the added reductions did show a well-defined size-dependent marginal cost assumption that continued as the annual tons were reduced below 5 tons per year. For each of the various control measures that were in this category, the cost per ton for a source of about 5 tons per year averaged nine times higher than the cost per ton for the same type of control measure on a source with 50 tons per year.[73]

While the latter subset of the control measure cost data did not appear unreasonable, those measures consistently had very high marginal costs (*e.g.,* greater than $70,000 per ton), while contributing little overall to reduction in the gap towards full attainment. Rather than attempt to pick and choose which subset of control measures in the less than 5 ton per year segment could be deemed reliable and which not, we decided not to include any controls with less than 5 tons per year. This decision has little impact on the approximately 40,000 of additional tons of reduction needed, nor, therefore, to our ultimate full attainment cost estimate. The sensitivity analysis was useful in revealing some of the potentially problematic assumptions even in the RIA cost estimates of partial attainment; correcting those was out of our scope.

<u>With regard to the $160,000 per ton limit:</u>

The $160,000 per ton constraint might appear even more *ad hoc* than that of the size constraint, given that there is no obvious "limit" at which it implies a technical impracticality.[74] Indeed, the RIA indicates that EPA selected this cost constraint value just so that some paved road dust controls would become part of

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[73] When the cost limit of $160,000 per ton is also removed, point source control measures' marginal costs for sources of 2 tons per year were on average about five times higher than the same respective measures applied to facilities with about 5 tons per year baseline emissions. Because of the marginal cost escalation, we also noticed that over 80% of the point source control measures that *do* have a size-dependent marginal cost estimate in CoST and which emit less than 5 tons per year already have marginal costs greater than $160,000. Thus, it appears that the 5 ton per year limit, on its own, has almost the same effect as setting a $160,000 per ton limit on point source control measures.

[74] Indeed, the RIA analysis does not even respect this limit in adjacent counties. That is, a ton of reduction in an adjacent county costs the same (*e.g.*, $155,521 per ton for paving existing shoulders), but that ton of physical reduction counts towards the direct county's attainment need as only 0.25 tons. Thus, the marginal cost of control for any tons reduced in any adjacent county is four times higher per effective ton than in the directly nonattaining county that relies on such reductions. For example, the selection of paving shoulders in adjacent counties actually costs $622,084 per ton — and yet such controls are indeed selected in the RIA CoST modeling.

the identified control measures.[75] Notably, $160,000 is the nearest round number larger than the lowest cost-per-ton option for paved road controls, which is to pave existing shoulders at $155,521 per ton for the first 10% or 25% the paved road emissions of each county. We found that this cost limit had the merit of enabling the most cost-effective of the paved and unpaved road measures in the list of candidate control measures of CoST, while not allowing any further increase in controls from other sources, particularly point sources.

We realized, upon inspection of the control options available to non-point sources above the $160,000 per ton cost level, that it would likely be more cost-effective overall to allow counties to control the remaining tons in the various non-point source categories beyond the 25% RP mark using the most cost-effective control measures for those sources than to retain the 25% RP limit in CoST and force CoST to then adopt much higher cost-per-ton measures for just those first 25% of each source category's overall emissions. We therefore ran a sensitivity case in which the CoST limit of $160,000 per ton was lifted for point sources only. The initial sensitivity run raised the cost limit to $5 million, just to see how extreme the options might appear to be for point sources. That run (which retained the 5 ton per year limit) selected 66 additional control options within the 61 partial-attaining counties for 8/35. The average cost per ton of these additional measures was about $440,000 and the maximum cost per ton of the 66 extra controls was $685,000. As these additional point source controls did not appear to include any unreasonable-seeming outliers, we elected to include them in the set of control measures used as part of the effort of partial-attaining counties to reach full attainment. In aggregate, they have relatively little impact on closing that gap: an additional net reduction of 465 tons compared to the overall aggregate still-needed reductions of over 40,000 tons, adding $206 million to the RIA's original partial attainment cost for 8/35 of $1,822 million. These added control measures were found only in the Northeast and southeast regions.

[75] RIA, p. 3-11. ("We selected the $160,000/ton marginal cost threshold because it is around that cost level that (i) road paving controls get selected and applied (as seen by the slight uptick in the curves), and (ii) opportunities for additional emissions reductions diminish (as seen by the flattening of the curve around that cost threshold.")

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