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S. HRG. 114–915

OPPORTUNITY DENIED: HOW OVERREGULATION HARMS MINORITIES

HEARING

BEFORE THE

SUBCOMMITTEE ON OVERSIGHT, AGENCY ACTION, FEDERAL RIGHTS AND FEDERAL COURTS

OF THE

COMMITTEE ON THE JUDICIARY UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

OCTOBER 6, 2015

Serial No. J–114–32

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OPPORTUNITY DENIED: HOW OVERREGULATION HARMS MINORITIES

TUESDAY, OCTOBER 6, 2015

UNITED STATES SENATE,
SUBCOMMITTEE ON OVERSIGHT, AGENCY ACTION, FEDERAL RIGHTS, AND FEDERAL COURTS
COMMITTEE ON THE JUDICIARY,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:23 p.m., in Room 226, Dirksen Senate Office Building, Hon. Ted Cruz, Chairman of the Subcommittee, presiding.

Present: Senators Cruz [presiding], Hatch, Coons, and Klobuchar.

OPENING STATEMENT OF HON. TED CRUZ, A U.S. SENATOR FROM THE STATE OF TEXAS

Chairman CRUZ. This hearing will come to order. Good afternoon. Welcome. I would like to welcome our distinguished panel of witnesses for joining us today. Very glad to have you.

In his very first inaugural address, President Thomas Jefferson defined good government as one that "shall restrain men from injuring one another" and "shall leave them otherwise free to regulate their own pursuits of industry and improvement." This pro-liberty standard embraced by our Founding Fathers and the Constitution has served us well.

Today, the United States stands as the most powerful and prosperous Nation in history, a beacon of hope to people throughout the world. There is a growing sense among many that our Nation is in decline.

We have now seen years of sluggish economic growth, stagnant household income, the largest percentage of Americans not working since 1977, far too many people who have simply given up any hope of having a job, of starting a business, of having a future. Entrepreneurship, truly one of America's defining traits, is hurting badly. It is a tough time to own a small business in America today.

The last several decades have seen a dramatic decline in the rate of business formation. Business deaths now outpace business births. That is a deeply troubling trend in our Nation, one that stands in direct opposition to the promise of America as a land where anyone can start with nothing and achieve anything.

On top of that, the United States now ranks 46th in the world when it comes to the ease of starting a new business—46th. That is hard to imagine. Why is that? What has gone wrong?

We are here today to discuss a major part of the problem: Government overregulation. It is axiomatic that the larger and more intrusive Government becomes, the smaller and more docile we, the people, are forced to become. There is no greater obstacle to growth, to opportunity, and prosperity for all Americans than an invasive and bloated Government. Ronald Reagan understood this. "It is no coincidence," he said, "that our present troubles parallel and are proportionate to the intervention and intrusion in the lives that result from unnecessary and excessive growth of Government."

The Federal Government and, sadly, many States no longer adhere to the Jeffersonian standard of leaving the people free to regulate their own pursuits of industry and improvement. Instead, they now seemingly regulate everything under the Sun.

Fifty-five years ago, there were 13 regulatory Federal Government agencies. Today, there are over 70. Fifty-five years ago, the Code of Federal Regulations contained 23,000 pages—a sizable amount. Today, the Code of Federal Regulations takes up an astounding 175,000 pages and 235 volumes, all incredibly small print. Somehow the American people are expected to comply with 175,000 pages of regulations that no one person can even begin to understand.

This figure dwarfs the number of statutes actually enacted by Congress, the body that the Constitution entrusted with making our laws. Federal statutes today take up over 40 volumes and 50,000 pages—about a quarter the length of the Federal Regulations.

Although an inexact science, estimates of Federal regulations are estimated to increase costs up to possibly $2 trillion a year. Is it any wonder we have the economic stagnation, so many millions hurting, when the Federal Government is putting $2 trillion a year of cost on small businesses, on those trying to create jobs and opportunity?

Unfortunately, the media far too often writes off overregulation as a trifling issue because they believe it only concerns giant corporations, not everyday people. This hearing is about shining the light on the true people paying the price for Government overregulation.

Truth be told, overregulation harms everyone, but it especially harms those who do not have the resources or political connections to get a special exemption, to have a lobbyist, to get a favor from Government, and far too often those are minorities—African Americans, Hispanics, single moms, people who are struggling but want to start a small business, want to stand on their own feet, want to provide for their family. The burden of Federal regulation makes it harder and harder and harder to do exactly that.

Peter Kirsanow is the longest-serving member of the United States Civil Rights Commission. He is an African-American, and at a hearing very much like this, held 20 years ago, Commissioner Kirsanow said this: "Regulations affect all businesses, but they have a particularly pernicious effect on small businesses, on businesses that are marginally capitalized, are labor-intensive, or are perceived as being credit risks. A disproportionate share of those businesses are owned by minorities and by Black Americans."

Unfortunately, 20 years later, overregulation remains and has become an even bigger obstacle to the success and prosperity of those who are struggling to achieve the American dream.

Revenues for minority-owned small businesses still, unfortunately, lag behind revenues for nonminority-owned businesses. Yet minority-owned businesses must absorb regulatory costs of roughly $7,000 to $10,000 per employee, just like any other small business. What this means is that regulatory costs have a more severe impact on the bottom line of minority businesses than other businesses, making it more difficult for minority businesses to grow and hire more employees.

The regulation epidemic in this country certainly has not translated into more jobs and prosperity for minorities, especially since President Obama has taken office. The median household income for African Americans and Hispanics, for instance, has remained virtually unchanged since President Obama was elected, meaning that there has been no recovery since the 2008 crash, and poverty rates for African Americans have gone up. African-American unemployment remains almost double that of nonminorities, as it has for over 50 years. There are together roughly a million fewer working-age African Americans and Hispanics employed today than when the President took office.

Let me repeat that statistic. There are together roughly 1 million fewer working-age African Americans and Hispanics employed today than when the President took office. That is roughly 1 million lives impacted, plus their children, plus their families, people who want to work, want to provide for their families, and yet are being denied that opportunity.

It is estimated that for every additional $1 million that the Government spends enforcing its regulations, the economy loses 420 private sector jobs.

Of course, it does not have to be this way. Curbing excessive Government regulation should not be a partisan issue. We should be able to find a way to stem the tide of red tape, to loosen the burdens on small businesses that are struggling to create opportunities, without weakening essential protections for our society. Not all regulations are bad. A wall of regulations descending from Washington on small businesses and crushing job creation is making it harder and harder for people who are struggling to achieve the American dream.

I want to thank each of you for being here, and I look forward to your testimony. We have today seven witnesses.

The first witness, Mr. Michael Barrera, a Kansas City-based attorney with over 30 years of business, legal, nonprofit, and Government experience. A graduate of Kansas State and the Texas Law School, he serves as the national economic prosperity manager for The LIBRE Institute, a nonprofit that promotes economic freedom in the U.S. Hispanic community. Before joining LIBRE, Mr. Barrera served as the president and CEO of the U.S. Hispanic Chamber of Commerce and prior to that as the National Ombudsman for the U.S. Small Business Administration.

Our second witness is Amit Narang, an expert on the Federal regulatory process. A graduate of the University of Pennsylvania and the American University Washington College of Law, Mr.

Narang is a regulatory policy advocate for Public Citizen, a nonprofit public interest organization founded by Ralph Nader.

Timothy Sandefur is an Arizona-based attorney who specializes in economic liberty and constitutional law. A graduate of Hillsdale College and Chapman Law School, Mr. Sandefur currently serves as the principal attorney for the Pacific Legal Foundation, where he is the lead attorney in the PLF's Economic Liberty Project.

William Scott is the CEO of Tristatz, LLC, a community and economic development consulting company in Selma, Alabama. Educated at Alabama State University and Troy University-Montgomery, Mr. Scott is a former mayor and council member of the town of Mosses, Alabama, and a veteran of the United States Army. Thank you, Mr. Scott, for your service.

Sabrina Loving is a Chicago-based small business owner. A graduate of Robert Morris College and Roosevelt University, Ms. Loving runs Loving Tax Services, Incorporated, a tax preparation service she started 5 years ago to assist individual and small business clients with their tax returns.

Aaron Mair is the 57th president of the Sierra Club, one of the Nation's premier environmental organizations. He became a member in 1999 and has held numerous leadership positions within the organization since 2002.

Henry Alford is a DC-based business leader. A former Wisconsin football player and Army officer—thank you for your service as well—Mr. Alford currently serves as president and CEO of the National Black Chamber of Commerce, which he founded with his wife, Kay, over 20 years ago. Prior to founding NBCC, Mr. Alford worked for several Fortune 100 companies.

We will now have an opening statement from Mr. Coons.

OPENING STATEMENT OF HON. CHRISTOPHER A. COONS, A U.S. SENATOR FROM THE STATE OF DELAWARE

Senator COONS. Thank you, Chairman Cruz, and thank you for calling this hearing.

The foundational principle underlying this hearing, that regulations are inherently harmful to business and our prosperity, I think is highly dubious. A previous Senate Judiciary Committee hearing in this very Congress examined this point, and evidence presented by the OMB suggests that major Federal regulations have a net benefit to our economy of between $130 and $800 billion measured over 10 years. That should not be surprising because, since 1981, every economically significant regulation is required to undergo a searching cost-benefit analysis before being put into effect.

Rulemaking is also governed by the APA, the Administrative Procedures Act, which guarantees all stakeholders the opportunity to be heard, and courts have not been shy about striking down regulations that run afoul of rulemaking procedures or organic statutes, as evidenced by the Court's decision last term in *Michigan v. EPA*.

Turning, though, to the precise topic of today's hearing, of this hearing, the impact of regulations on racial minorities, I would observe that the argument against regulation is too narrowly focused on looking at the acute costs of regulation and not sufficiently fo-

cused on the wide-ranging benefits of regulating some private behavior to minimize injustice and to defuse externalities.

The Civil Rights Act of 1964, for example, is thought of as civil rights legislation, which, of course, it is, but also a powerful piece of economic regulation because, prior to its enactment, businesses were free to exercise their economic liberty to refuse to do business with or hire minorities in much of the country, and many businesses did just that.

Under the Voting Rights Act of 1965, the Department of Justice served as regulator for 48 years, using that law to block the implementation of some roughly 2,400 proposed discriminatory voting changes. When the Supreme Court struck down a key component of that law, doing away with much of the relevant Federal regulatory framework, unfortunately, several States then moved fairly quickly to enact their own regulations that have the effect widely of disenfranchising voters of color. Anti-equality voting regulations have been enacted to shorten voter registration, early voting periods, implement photo I.D. laws, and purge voter rolls of eligible minority voters.

I am proud to cosponsor bipartisan legislation in this Senate, the Voting Rights Advancement Act, which would restore these critical Federal regulations in order to protect the rights of minorities to vote.

Federal regulation then prevents discrimination in lending, housing, and education against minorities. In each area, regulation has improved the economic opportunities of African Americans and other racial minorities in America, notwithstanding the claims of civil rights opponents who stated they would interfere with economic liberty.

In addition to these transformative laws, there is a host of other Federal regulatory structures outside the civil rights context that have, nevertheless, benefited the health, the safety, and the economic opportunities currently available to Americans of color.

The Affordable Care Act, for example, has improved access to private health insurance for nearly eight million African Americans and four million Latinos who have gained coverage since passage of the law, decreasing the uninsured rate in the Hispanic community by roughly 27 percent. Thanks to the ACA, all Americans are today free from discrimination due to pre-existing conditions or lifetime caps and fees associated with routine screenings.

These improvements will ensure that the chronic rates of disease in minority communities, diseases like diabetes, heart disease, obesity, will have access to affordable and comprehensive health care coverage to address these challenges.

Environmental regulations, which are often held up as prime examples of overregulation of business, protect us all, but are especially crucial to minority communities. Due to the vestiges of housing discrimination and a lack of economic opportunities, many minorities have no choice but to live in areas with very high levels of industrial and atmospheric pollution. In the South Bronx, for example, which is overwhelmingly Hispanic and African-American, asthma rates are four times the national average due to a heavy concentration of air pollution.

A number of studies suggest minorities face 40 percent more exposure to a variety of toxic air pollution components—sulfates, nickel, silicon, vanadium—which are linked to deaths from cardiovascular and lung disease. They are also exposed to much higher levels of other air toxics like aluminum, which is associated with low birth weight.

Instead of asking if environmental regulations go too far, perhaps we should be asking in these circumstances and for these particular communities if they go far enough.

The case that regulation harms minorities turns a blind eye to the manifold ways in which regulations have been used to promote equality and justice in health care and the environment, as I have already mentioned, but we could also consider workplace safety and payrolls, the ability to fight back as a consumer against unfair trade practices, and indeed in economic terms by producing a level playing field for all businesses.

I look forward to a robust and sustained exchange of views. I join the Chairman in welcoming all the witnesses and thanking you for your service to our Nation in several cases and for being here today. You have a broad range of relevant experiences, and I look forward to that informing our discussion.

If I might, I would like to briefly offer a special welcome to Mr. Scott on behalf of your Representative in Congress and my friend, Congresswoman Terri Sewell, who has also joined us here today. I understand, Mr. Scott, you are a former staffer to Ms. Sewell and are currently a business leader in the Black Belt region. I join in stating that we can and must do more together to provide the minority business community with the tools necessary to succeed, and I look forward to a vigorous debate as to the role of regulations in doing so.

Thank you, Mr. Chairman.

Chairman CRUZ. Thank you, Senator Coons.

I would ask each of the witnesses to please rise. If you would raise your right hand. Do you affirm that the testimony you are about to give before this Committee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. BARRERA. I do.

Mr. NARANG. I do.

Mr. SANDEFUR. I do.

Mr. SCOTT. I do.

Ms. LOVING. I do.

Mr. MAIR. I do.

Mr. ALFORD. I do.

[Witnesses are sworn in.]

Chairman CRUZ. You may be seated. Mr. Barrera, you may begin.

STATEMENT OF MICHAEL BARRERA, NATIONAL ECONOMIC PROSPERITY MANAGER, THE LIBRE INSTITUTE, KANSAS CITY, MISSOURI

Mr. BARRERA. Thank you, Senator. Mr. Chairman and Members of the Committee and my fellow panelists, my name is Michael Barrera, national manager of Economic Prosperity for The LIBRE Institute, a nonpartisan, nonprofit organization that educates His-

panics on the importance of economic freedom. Thank you for your invitation to testify regarding the impact of Federal regulations on the minority community. I will focus my comments on the impact on small businesses and the Hispanic community.

Americans are suffering under the crushing burden of overregulation, and I stress "overregulation." In 2014, Federal regulations cost nearly $2 trillion through higher prices and lost productivity. In a 2008 report, the Small Business Administration found that small businesses, those with fewer than 20 employees, bore the largest burden of complying with Federal regulations, facing an annual cost of over $10,000 per employee. This is 36 percent higher than large firms of more than 500 employees. It should be noted these were the costs 7 years ago and do not include the cost of compliance with the Affordable Care Act and Dodd-Frank. Federal regulations continue to grow as the number of pages in the Federal Register, as was pointed out, grew from 23,000 in 1960 to over 175,000 today.

Additionally, the NFIB reported that for 65 straight months, small business owners cited regulations as a top impediment to conducting business. Also, 21 percent of small businesses cite regulations as their single most important problem.

The U.S. is also losing leadership in business startups as the growth of regulations contributed to the U.S. falling out of the top 10 worldwide rankings in the ease of starting a business. In fact, the World Bank found that it is easier to start a new business in Portugal, Romania, Panama, Hungary, and Belarus than in the U.S.

One of the most disturbing statistics we found is that business failures now outpace business startups. From 1977 to 2008, the number of new startups outpaced the number of failing businesses by about $100,000 a year. Startups lag behind closures. These trends concern the Hispanic community and our 4 million businesses, many of which are family owned. Nationally, family owned businesses account for 50 percent of the U.S. GDP, 60 percent of the country's employment, and 78 percent of all new jobs.

Family—family business is also important in our community. Mass Mutual reports that 89 percent of Hispanic entrepreneurs started their business in order to provide financially for their family and 70 percent of Hispanic business owners plan to pass that business down to their family members. Additionally, 31 percent of Hispanic entrepreneurs hire extended family, people like their siblings, their parents, their cousins, their aunts, and their uncles. As such, the impact of Federal regulations affect both business and family lives. As Federal regulations grow, so does the cost of doing business. This forces entrepreneurs and their families to make difficult choices. Do I spend my time and money complying with Federal and local mandates? Or, do I spend it managing and marketing my business, hiring new employees, or working to increase their wages?

This testimony is not a blanket rejection of regulation. It is about overregulation. Elected and unelected officials must rededicate themselves to weighing the costs and benefits of each proposed rule before proceeding. This is the law. The burden of proof should be on the regulator to prove that a rule is necessary and will benefit

our lives and help businesses to prosper, not on small businesses to prove otherwise.

Sadly, something is truly amiss when unelected agency officials pass 16 new regulations for every law passed by you, our elected officials.

In conclusion, small businesses employ close to two-thirds of American workers and must be more than a convenient talking point when policymakers discuss reviving our economy. Unfortunately, the vast majority of Americans and entrepreneurs, including Hispanics, will tell you Government rules and regulations are confusing, complex, time-consuming, and expensive. Moreover, many of our businesses are hesitant to contest, complain, unable to defend or advocate for themselves due to the expense, time, and in some cases the intimidation formed by Federal regulators.

It is very important—I heard a great story in North Carolina where a small business talked about, "Mr. Barrera, I cannot reproduce myself. The time I spend complying with Federal rules and regulations, I could be spending that personal time"—he is a personal trainer—"with my customers, researching new ways to help people become healthy. I spend time with Federal regulation."

Polls consistently show the economy and jobs are a top priority—in other words, how to achieve prosperity. I heard another story in Colorado from a business leader. He talked about Government and entrepreneurs' attitude. He summed it up this way: "When elected officials talk about laws that they pass, that is all nice and good. I would rather they talk about the rules and regulations that they eliminated to make it easier to do business and to live my life."

We believe economic freedom, the rule of law, the free market, and a constitutionally limited Government—not excessive regulation or Government cronyism—are the pathway to prosper and the best way for each person to achieve their American dream. Thank you.

[The prepared statement of Mr. Barrera appears as a submission for the record.]

Chairman CRUZ. Thank you, sir. Mr. Narang.

STATEMENT OF AMIT NARANG, REGULATORY POLICY ADVOCATE, PUBLIC CITIZEN, WASHINGTON, DC

Mr. NARANG. Thank you. Chairman Cruz, Ranking Member Coons, and Members of the Subcommittee, thank you for the opportunity to testify today. I am Amit Narang, regulatory policy advocate at Public Citizen's Congress Watch. Public Citizen is a national public interest organization with more than 400,000 members and supporters. For more than 40 years, we have successfully advocated for stronger health, safety, consumer protection, and other rules, as well as for a robust regulatory system that curtails corporate wrongdoing and advances the public interest.

Regulation which has been adopted to protect the public has been among the greatest public policy success stories in our country's history. Regulations have made our air far less polluted and our water much cleaner. They have made our food and drugs safer. They have made our workplace less dangerous. They have made our financial system more stable when they have been in place.

They have protected consumers from unsafe products and from predatory lending practices, and they have made our cars safer.

For minorities in particular, regulations have made our society more equal and fair by outlawing discrimination in many contexts, by giving traditionally disenfranchised minorities the opportunity to vote and participate in our democracy, and by combating policies that expose minority populations to higher rates of pollution and environmental toxins.

Indeed, the premise of this hearing has it exactly backward. Regulations have been crucial in providing basis rights and opportunities to minority that otherwise would not have existed. The story of regulation should not only be celebrated but also emulated going forward. While regulators deserve credit for these successes, the true credit goes to Congress who passed landmark legislation such as the Clean Air Act, the Clean Water Act, the Occupational Safety and Health Act, the Consumer Product Safety Act, the Civil Rights Act, and the Fair Housing Act, laws which gave regulators the authority to protect the public and make our country more equal and fair.

On the other hand, when regulatory safeguards have not been in place, regulatory failure has occurred, and our country and economy has suffered. Deregulation of the financial industry led to the greatest recession since the Great Depression, costing our country $13 trillion and throwing millions out of work and their homes. A lack of adequate offshore drilling safety measures led to the British Petroleum oil spill in the Gulf of Mexico, one of the greatest ecological disasters in our country's history.

Tainted food scandals, derailing and exploding oil trains, unsafe children's toys leading to injuries and recalls, chemical spills in critical waterways, oil and gas pipeline ruptures all share a common theme: underregulation of dangerous and unfair business practices due to a misplaced faith in industry's self-regulation.

While it is true that we have made much progress as a country and that regulation has been critical to that progress, it is also clear that there is much progress to be made. This is why it is so important for Congress to avoid making the problem of underregulation worse and instead actively engage in efforts to fix what I agree is a broken regulatory system, a regulatory system that is broken in three ways, and the public, including minorities, is paying the price.

First, our regulatory process moves far too slow when implementing new laws intended to protect the public. The examples of regulatory delay touch virtually every area of public protection. The new food safety regulations were finalized over 4 years ago—over 4 years after Congress demanded them. Up to a third of the new Wall Street reforms intended to prevent the next financial crisis still have not been put into place almost 7 years after the financial crash. Five years after the BP oil spill, and we still do not have safety measures in place to fix one of the primary causes of the oil rig explosion that led to the disaster. These delays are the status quo, not the exception, and are a concern across party lines and ideologies.

This summer, the R Street Institute, a libertarian, free market-oriented think tank, looked back over the past 20 years to see how

often regulators were able to meet deadlines established by Congress. The results were deeply troubling. Regulators missed congressional deadlines a shocking 50 percent of the time. Regulatory delay is central to the problem of underregulation.

Second, our regulatory system does not have the authority and resources to effectively enforce violation of regulations by bad actors, leading to undercriminalization of white-collar crime. The public is deeply dissatisfied, and rightly so, that virtually no individuals or bank executives have been prosecuted in the aftermath of the financial crisis. Similar situations have unfolded in the wake of the General Motors ignition switch scandal. While GM has paid a fine, no individuals were held accountable, and the lead prosecutor even admitted that quote, "there are gaps in the law", unquote that made it difficult to prosecute individuals.

Fines that are no more than the cost of doing business will not deter future illegal behavior that costs lives and costs our economy, and they will surely do nothing to change corporate cultures that lead to this wrongdoing.

Finally, our regulatory system must adopt approaches to regulating that are precautionary in nature and seek to prevent threats to the public safety or our economy rather than simply reacting when something goes wrong. Here, Congress has taken promising steps in this direction, although more can be done.

For example, the Food Safety Modernization Act shifted our food safety regulatory structure from trying to mitigate tainted food outbreaks once they occurred to actually preventing those tainted food outbreaks in the first place. In some respects, the Wall Street reform law, Dodd-Frank, adopts the same approach by requiring banks to be better capitalized and preventing them from engaging in risky activity. When passing new laws intended to protect the public, often in response to crises created by underregulation, Congress should be mindful of adopting laws that are designed to prevent crises, not just react to them.

Unfortunately, Congress is considering legislation that would make the problems I just outlined worse. So-called regulatory reform legislation, better termed, "deregulatory reform legislation," would further slow down the rulemaking process by adding numerous redundant and unfunded legal and analytical requirements, likely paralyzing rulemaking as a result. In certain instances, legislation will force the least costly rule to regulated industries, and we saw with the Wall Street crash that the least costly rules to Wall Street were the most costly to the public and small businesses.

In terms of enforcement, the imposition of new mens rea and criminal intent standards will make it even harder and surely not easier to prosecute Wall Street and corporate executives for future crimes.

Public Citizen stands ready to work with lawmakers across the aisle to make our regulatory system work effectively and efficiently for consumers, minorities, working families, and small businesses. Thank you.

[The prepared statement of Mr. Narang appears as a submission for the record.]

Chairman CRUZ. Thank you very much. Mr. Sandefur.

STATEMENT OF TIMOTHY SANDEFUR, PRINCIPAL ATTORNEY, PACIFIC LEGAL FOUNDATION, SACRAMENTO, CALIFORNIA

Mr. SANDEFUR. Thank you, Senator. I believe economic freedom is the greatest hope for the poor, for immigrants, and for members of minority groups who seek independence and success for themselves and their families. Whenever I think about this subject, I think of the story of Frederick Douglass who described in his autobiography what it was like to escape from slavery to New Bedford, Massachusetts, on the Underground Railroad. He said quote, "The fifth day after my arrival, I went in search of work. On my way down Union Street, I saw a large pile of coal in front of a house. I went to the kitchen door and asked the privilege of bringing in and putting away this coal. I was not long in accomplishing the job, when the dear lady put into my hand two silver half-dollars. To understand the emotion which swelled my heart as I clasped this money, realizing that it was mine—that my hands were my own, and could earn more of the precious coin—one must have been in some sense himself a slave. I was not only a free man, but a free working man, and no master stood ready at the end of the week to seize my hard earnings", unquote.

Sadly, overregulation at the Federal, State, and local levels today deprive many Americans of this fundamental human right to economic liberty. I will give just two examples.

Occupational licensing laws often force people to satisfy expensive and time-consuming educational requirements before they may pursue their trade. Florida, for example, requires people to have a college degree before they can work as an interior designer. In other words, it is illegal for someone to advise me on what color drapes to hang in my living room unless that person has spent two years in college at the cost of perhaps tens of thousands of dollars. Since Black and Hispanic Floridians are about a third less likely to have a college degree, this restriction makes it much harder for members of these groups to enter this trade.

It may not sound like much to you and me to take an exam to get a license, but remember that, in addition to the degree requirement, exams are only administered a few times a year, sometimes far away from where people live, so they have to get transportation and a hotel room and pay the licensing fees. All of this helps make entry-level jobs off limits to those who need them the most. Minority entrepreneurs are less likely to have a license than their white counterparts, and licensing laws drive them into the underground economy where they cannot get loans or insurance or are subject to police harassment, cannot advertise openly, and in general are less likely to succeed.

Yet licensing laws are on the increase. The White House reported in August, in a very thorough and long overdue report, that nearly a third of all jobs in America—that is, a third of the American dream—is now off limits without some form of Government permission.

My second example is much worse. A certain kind of licensing law called a, "certificate of public convenience and necessity", or a "competitor's veto law," which has nothing to do with whether a person is qualified or skilled or honest, but simply forbids people

from operating a business unless they first get permission from the companies already operating. This sounds absurd, and it is. It is the law in most States and most major cities. These competitor's veto laws apply to a wide range of businesses, everything from taxicab and limo companies to moving companies, liquor stores, car dealerships, and hospitals. In all these industries, it is illegal to start a new business unless you first get permission from your own competition. Obviously, these laws create a cartel that can be very hard for members of minority groups to break into.

Take my client, Maurice Underwood, for example. Maurice lives in Reno, Nevada, where he wants to start a moving company. Nevada has the most anticompetitive licensing laws in the Nation. There the law says that even if you are fully qualified and have a squeaky clean record, you cannot run a moving company unless you first prove that you would not compete against the existing moving companies in the State. To get a license, Maurice would have to provide detailed statements from potential customers, hire a lawyer, attend a hearing before the Nevada Transportation Authority, and prove to State bureaucrats that there is a public need for a new moving company, and that a new moving company would quote, "foster sound economic conditions," end of quote—whatever that means. Under such vague and anticompetitive restrictions, it is little wonder that people like Maurice find it hard to break into the old-boy network.

We at Pacific Legal Foundation challenged that law, and that case is still pending in court. Federal courts today typically ignore violations of the right to earn a living. Although Supreme Court Justice William Douglas called it the, "most precious liberty that man possesses," courts today typically refuse to enforce that right and allow Federal, State, and local governments to restrict economic opportunity virtually without limit.

This should not be a Republican-Democrat issue. I mentioned Justice Douglas endorsing this right, and he was about as a liberal as a Justice can get. Another liberal Supreme Court Justice, John Paul Stevens, warned in the 1980s of the danger of businesses using licensing laws to prevent competition against themselves.

Like all restrictions on economic freedom, these laws have a disproportionate impact on members of minority groups because they lack the political influence necessary to get the Government to do their will. They turn to courts to protect their rights, and thanks to the theory of judicial restraint, courts typically cover their eyes and ignore these violations. That is what happened in Florida when courts refused to protect the rights of entrepreneurs who wanted to be interior designers and upheld that State's power to impose absurd and unnecessary licensing laws.

In my written testimony, I have suggested ways Congress could, at today to protect the rights of America's wealth-creating entrepreneurs. Most restrictions on economic liberty are at the State and local levels, and the 14th Amendment gives Congress the power to protect people against State governments violating their rights. Congress should forbid States from imposing unnecessary, burdensome licensing requirements on interior designers, for example, and abolish competitor's veto laws across the board. We would never tolerate such laws when it comes to freedom of speech or

freedom of religion, and yet we tolerate them when it comes to the right to earn a living without unreasonable Government interference, the most precious liberty that man possesses.

[The prepared statement of Mr. Sandefur appears as a submission for the record.]

Chairman CRUZ. Thank you, sir. Mr. Scott.

STATEMENT OF WILLIAM C. SCOTT, SENIOR CONSULTANT, EMERGING CHANGEMAKERS, AND CHIEF EXECUTIVE OFFICER, TRISTATZ, LLC, MOSSES, ALABAMA

Mr. SCOTT. Good afternoon, Chairman Cruz, Ranking Member Coons, and distinguished Members of the Judiciary Subcommittee on Oversight, Agency Action, Federal Rights, and Federal Courts. I am William Scott, and I serve as the president and CEO of Tristatz, a community and economic development businesses. We provide services to mid-tier and small businesses who provide service solutions to Federal, State, and local government, nonprofits, and commercial markets. I thank you on their behalf for giving me the opportunity to speak and appear before you about the organizations and their opportunities in America.

I would be remiss to not acknowledge Hon. Terri Sewell of the 7th Congressional District of Alabama, who is my Congresswoman. For almost 11 years, I have focused my career on providing economic development and resources to small business. I am the host of the top-rated "Small Business Radio Show", and my name is "The Business Doctor", that reaches over 150,000 people and the former mayor and councilmember of the town of Mosses in Lowndes County, Alabama. Over the years, I have worked for the United States Department of Commerce as a partnership specialist and as a Black Belt Outreach Coordinator for The Honorable Congresswoman Terri Sewell of the 7th Congressional District of Alabama.

I have completed 12 years of dedicated and decorated service in the United States Army. Helping people and providing quality service is my primary goal in life. My diverse experience allows me to understand issues from multiple perspectives.

Though I work with small businesses in economically distressed communities with majority Black populations, it is not just these entrepreneurs in Alabama that I represent. According to Fortune, the number of businesses owned by African-American women grew 322 percent since 1997, making Black females the fastest growing group of entrepreneurs in the United States.

While some politicians say that Federal regulations are stifling small business growth, the statistics and I am here to tell you that that is not the case. A national poll conducted for the American Sustainable Business Council found that "lack of demand"—and not regulation—is the biggest problem that small businesses face. Small business owners see regulations as a necessary part of a modern economy, 86 percent, and believe they can live with regulations if they are fair and reasonable, 93 percent.

I understand firsthand needs of Black entrepreneurs in our community, and I can tell you that regulations play an important role

in meeting the needs of our businesses and protecting our communities.

I am also the senior consultant for Emerging ChangeMakers Network in Alabama. Emerging ChangeMakers worked in the areas of leadership and social entrepreneur building among historically marginalized communities. We provide professional business consultation to developing and growing small business owners and to owners who believe that you do not have to choose between growing businesses and social and environmental protection.

In fact, our businesses in Alabama understand that we do better because of these protections because they create a level playing field for competition. Much of our work involves accessing capital for our business clients. The success of this effort follows closely their own investment of personal and sweat equity. Therefore, our clients understand that there is a great need for good regulation like Dodd-Frank that protects their investment of hard work and money from the risky behavior of the big banks that led to the Great Recession, which devastated small businesses around the country.

Our small business clients also know that the success of their businesses depends on the health of their communities. That is why regulations to protect our communities from chemical and environmental disasters, which disproportionately impact minority communities, is important to us. Environmental Protection Agency regulations are not stopping Black entrepreneurship. They protect our community so that our businesses can have a future. Regulations are needed to create the conditions under which society as a whole can prosper so their financial health and environmental protection can exist to support the growing economy.

That is why I and Emerging ChangeMakers is a part of the larger efforts of the American Sustainable Business Council and over 250,000 businesses that they represent to advance smart regulations that protect our communities and the environment, as we grow our businesses, create good jobs, and build a vibrant economy.

I am on the ground with Black entrepreneurs and small business owners every day. If you want to really help them, then provide more resources for professional business consultations to minority-owned businesses and provide more resources for compliance assistance and making sure that those small businesses providing services under Federal contracts get paid on time. Efforts to slow down regulation to deregulate are not being a friend to African-American small businesses. Thank you for the opportunity to be before you.

[The prepared statement of Mr. Scott appears as a submission for the record.]

Chairman CRUZ. Thank you, sir. Ms. Loving.

STATEMENT OF SABINA LOVING, PRESIDENT AND OWNER, LOVING TAX SERVICES, INC., CHICAGO, ILLINOIS

Ms. LOVING. I thank the Chairman and this Committee for the opportunity to testify today.

My name is Sabina Loving. I am the owner and president of Loving Tax Services, an independent tax preparation firm on Chicago's South Side. I am the "Loving" in the *Loving v. IRS* lawsuit that

successfully challenged an IRS power grab that would have posed national licensing on tax preparers.

I am a small businesswoman trying to stay afloat in the economy while helping people with their tax preparation and building up my community. I should have the right to earn an honest living doing what I love, and so should my employees. Equally important, my customers—not the IRS—should be the ones who decide who prepares their taxes.

You almost never hear the IRS or anyone else who advocates for tax preparer licensing talking about me or my co-plaintiffs when they talk about the *Loving* case. It is almost as though they forget that we are real people who were actually being harmed by the anticompetitive IRS licensing scheme. There are about 300,000 independent tax preparation entrepreneurs like me, many of whom would have been forced to close their businesses.

Today, I would like to share my story with you to help you understand how overregulation affects real entrepreneurs like me, why I sued the IRS, and why Congress should not give the IRS new power to license tax preparers.

I am a native of Chicago who is blessed to earn a living doing what I love: helping people with their taxes. In 2011, I opened my business, Loving Tax Services, on Chicago's South Side, where there are high unemployment and foreclosure rates. My business was the first to occupy its storefront in at least a dozen years. I have been fortunate enough to employ several people in my community and bring money back into our neighborhood.

Ever since I was young, I wanted be an accountant and work with numbers. I dreamed of one day being able to start my own business. I worked hard to make my dream a reality. I worked full-time as an accountant for major financial firms for nearly a decade. The economic downturn hit my industry so hard, so I decided to take this as an opportunity to realize my American dream. I put myself to work as an independent tax preparer while earning a master's degree. I formed Loving Tax Services in 2010, and I never looked back.

Tax preparation is a seasonal industry, and my business model depended on flexibility. Fortunately, I was able to find qualified people who could assist me seasonally. Just as my business was taking off, I learned that the IRS was going to force tax preparers to jump through a bunch of hoops in order to allow them to continue earning a living preparing taxes.

For the first time in 100 years, the IRS was imposing a license to prepare tax returns. We would have to pass an IRS-mandated exam and complete continuing education requirements each year. The license would give the IRS great control over tax preparers, making us dependent on the most powerful Federal agency for our livelihoods.

It also imposed additional costs and burdens on my business, which I would have to pass on to my customers in the form of higher prices. I pride myself on offering lower prices than the major tax firms. I did not want to raise my prices, but I could not afford to make any lower profits.

Higher prices meant fewer customers, but if my business shrank, I would not be able to hire people to help me during the tax season.

That would put me at a competitive disadvantage to the major tax firms which were likely to get my customers I was going to lose.

This licensing requirement did not apply to everyone. CPAs and attorneys were exempt, even if they had never taken a course in tax law or tax preparation. Even though I had a decade of experience in accounting, I was not a CPA, so I was not exempt. Powerful industry groups lobbied for another exemption. Anyone who was being supervised by an attorney or a CPS could also prepare returns without a license. I wanted the opportunity to hire more employees and supervise them as tax preparers so I could expand my business and serve more of my community. I did not write the rules, so I did not get a special exemption.

I knew that this new license would not do anything to protect consumers. There are already all sorts of laws on the books that do just that. Instead, it protects big tax preparation chains and CPAs from competition by smaller businesses like mine, many of whom would have been forced to close or shrink their businesses. The end result would be fewer options and higher prices for taxpayers. That is why I sued the IRS, and I was represented pro bono by lawyers at the Institute for Justice. Thankfully, we won.

The IRS and big tax preparation chains keep pushing for Congress to expand IRS power. After we won the case, several bills were introduced that would authorize tax preparer licensing. Just 2 weeks ago, the Senate Finance Committee announced one proposal. A national license for tax preparers was a bad policy then, and it is a bad policy now. It is anticompetitive, anticonsumer, and will hurt small businesses like mine. I urge the Senate not to give the IRS any more power and to vote against any bill that would authorize the IRS to license tax preparers. Thank you very much for this opportunity to testify.

[The prepared statement of Ms. Loving appears as a submission for the record.]

Chairman CRUZ. Thank you, Ms. Loving, for that powerful testimony. Mr. Mair.

STATEMENT OF AARON MAIR, PRESIDENT, SIERRA CLUB, WASHINGTON, DC

Mr. MAIR. Chairman Cruz and Ranking Member Coons, thank you for inviting me here today to testify about the importance of environmental protections and public health safeguards in ensuring the safety and well-being of all Americans, especially the communities of color who carry disproportionate risk of harm caused by pollution.

I speak today as the first elected African-American president in the 123-year history of the Sierra Club. The Sierra Club is the Nation's largest grassroots environmental organization with 2.4 million members and supporters. In addition to helping people from all backgrounds explore nature, the Sierra Club works to promote clean energy safeguard health in our community. It protects wildlife and it preserves our remaining wild spaces.

In addition, I have been an advocate for clean water, clean air, and environmental justice for over 31 years, including work as a resident in Arbor Hill, Albany, New York, against a waste incinerator that was causing respiratory illness in the community.

I am a father, a husband, and a public health analyst for the State of New York. Part of the reason I am here today is because some of the fossil fuel corporations are spending a lot of money to scare people of color and low-income families into believing that new clean air and clean water safeguards like the Clean Power Plan will hurt them. These corporations and their CEOs are terrified that holding dirty industries accountable would cut into their enormous profits. They want low-income and minority communities to think that these regulations will hurt us, but nothing could be further from the truth.

Recently, the National Black Chamber of Commerce, an organization represented here today and heavily funded by the fossil fuel industry, released a bogus report claiming that the Clean Power Plan would hurt African-American and Hispanic communities. This is just the latest example of polluters desperately trying to confuse leaders of color and trick them into sabotaging their best interests and the interests of our communities by opposing this essential plan.

Unfortunately, these dirty energy companies and those that amplify their information are jeopardizing the health of tens of thousands of kids across the country, and they should be ashamed. Fortunately, most of us are not buying what these companies are selling. Polls show that African Americans lead the country in support for tackling the climate crisis. A whopping 85 percent have said they want to see an international climate agreement. Similarly, the polls show that 90 percent of Latinos want to strengthen the Clean Air and Clean Water Act and 85 percent want to reduce smog and air pollution.

It is no surprise that the opponents of the Clean Air and Clean Water Act are fighting against us at every step of the way, just as they have done with virtually every safeguard ever proposed—acid rain protections, Clean Air Act. We have heard the same talking points from the same industry. They said the sky was falling, but the truth is the air just got cleaner.

What is shocking is the big way polluters are using smoke and mirrors to try and confuse communities of color. Big polluters desperately want Black and Hispanic voters to believe that the President's clean air protections will raise their electric bills and cost us jobs, when in reality the protections will save lives and actually lower these costs.

At the same time, all that is going on, thanks to people in movements like Black Lives Matter and Fight for 15, the call for racial and economic justice is getting louder and stronger. While we are out on the streets fighting for equality, our kids are being poisoned by the air they breathe. Environmental injustices are taking Black lives.

The overwhelming evidence shows that low-income areas and communities of color do not receive equal protection from environmental harm, despite suffering the greatest exposure to toxic pollutants. Lacking political power, these communities are frequently chosen as sites for polluting facilities or feel compelled to accept them as a source of jobs despite the health hazards they pose.

I know this firsthand by my experience in shutting down the incinerator in Albany. Industry and local government brushed us off

for 10 years, but through sheer persistence, we were able to prevail.

Because these communities often lack access to adequate health care, community residents face an increased risk of respiratory and cardiovascular illness, cancer, birth defects that can last long after these facilities have ceased to operate.

Despite the promise of jobs, such pollution actually causes economic harm, driving down property values and discouraging investment needed to keep communities healthy. Sadly, African Americans are more likely to live near environmental hazards like power plants and be exposed to hazardous air pollution, including higher levels of nitrogen oxide, ozone, particulate matter, and carbon dioxide while their white counterparts do not. The presence of these pollutants increase rates of asthma, respiratory illness, cardiovascular disease, and puts newborn babies at risk and causes missed days of work and school. We just cannot afford this.

African-American kids already have the highest rate of asthma in the Nation, and our infant mortality rate is nearly double that of the national rate. Conditions in which we are born, grow, work, and live are determined by the difference in our health outcomes, and it is essential to recognize that these circumstances are shaped by the inequalities in the powers and the resources at the local and national and global levels. Helping disadvantaged communities succeed in the forefront of strong and just and a clean green economy will benefit them and all Americans.

In closing, whether you are talking about new pollution protections against smog, carbon pollution, mercury, or other toxic metals that pollute our air and water, it is important to remember that nearly every major environmental public health safeguard, polluters have predicted dire economic outcomes that never actually will happen.

We are living in an alternate universe if we seriously took every instance that they said that these regulations will be the most expensive regulations in history. We have got to look at the facts and not look at self-serving polluter propaganda. Thank you.

[The prepared statement of Mr. Mair appears as a submission for the record.]

Chairman CRUZ. Thank you, sir. Mr. Alford.

STATEMENT OF HARRY C. ALFORD,
PRESIDENT AND CHIEF EXECUTIVE OFFICER,
NATIONAL BLACK CHAMBER OF COMMERCE,
WASHINGTON, DC

Mr. ALFORD. Good afternoon, Chairman Cruz, Ranking Member Coons, and distinguished Members of the Subcommittee. My name is Harry C. Alford, and I am the president and CEO of the National Black Chamber of Commerce. The NBCC represents 2.4 million Black-owned businesses within the United States, 140 chapters within the United States, and we have over 80 chapters offshore representing 4 different continents. We are the largest Black business organization in the world.

I am here to testify about the harmful and adverse effects of overregulation on minorities and their communities. As the hearing title suggests, the continuous stream of unreasonable and over-

reaching regulations that have come out of the Federal Government over the last few years has led to the denial of countless opportunities for minorities. Employment opportunities, income opportunities, and housing opportunities for minorities—all of these are being compromised by an ever growing number of Federal regulations.

At the onset, I think it is important to be clear about something: The National Black Chamber understands and appreciates the importance of regulations within our society. Regulations help keep our workers protected, our water and air cleaner, our food safer, and our consumer products reliable, to name a few. What we do not support are regulations that are based upon erroneous and opaque analysis and process. The rulemaking process—and the regulations that come out of it—should involve transparency, notice, sound science, quality data, and reliable cost-benefit analysis. Without a doubt, there are multiple new regulations that potentially will harm the economic opportunities of minorities; but for today's hearing, I am going to focus on two regulations from the Environmental Protection Agency to illustrate my point.

First, there is the EPA's new rule on regulating greenhouse gas emissions from existing power plants—often referred to as the "Clean Power Plan." While increased costs often come with increased regulation, the Clean Power Plan in particular seems poised to escalate energy costs for Blacks and Hispanics in the United States, including individuals, families, and minority-owned businesses.

In light of these concerns, the National Black Chamber of Commerce undertook an effort to examine the potential economic and employment impacts of the EPA's carbon regulations, including the Clean Power Plan, on minorities and low-income groups. On June 11, 2015, the National Black Chamber of Commerce released a study on the threat of the EPA carbon regulations to low-income groups and minorities. I note that since then, the EPA released the final Clean Power Plan rule, which has differences from the proposal. Nevertheless, we believe that the findings of our study are illustrative of the rule's potential economic impacts.

The National Black Chamber's study found that the proposed Clean Power Plan would impose severe and disproportionate economic burdens on poor families, especially minorities. In particular, the proposed rule would impose the most harm on residents of seven States with the highest concentrations of Blacks and Hispanics. These communities also suffer from higher unemployment and poverty rates compared to the rest of the country, yet the EPA's regressive energy tax threatens to push minorities and low-income Americans even further into poverty.

We have got statistics which you have written there. I am not going to go through those now. I want to move on to the National Ozone Air Quality Standard.

The second regulation that I want to address today is that ozone proposed rule. Just last week, the EPA finalized a new ozone standard—tightening it from 75 parts per billion to 70 parts per billion. While the agency adopted the higher end of the range under consideration, a 70 ppb ozone standard still will increase the number of areas in the country in "nonattainment." This nonattain-

ment classification will severely limit economic and employment opportunities in the affected areas. Unfortunately, this tightened ozone standard likely will hurt not only the Nation as a whole, but will disproportionately affect America's urban, low-income, and minority businesses.

If a community comes in below the 70 parts per billion, it will be deemed "in attainment," and the usual amounts of construction, infrastructure projects, development, and other elements of a healthy and growing economy can continue. These activities create jobs and generate revenue. On the flip side, the EPA wields a heavy stick for communities that are deemed in "nonattainment." It can step in and overrule State decisions to issue permits, stopping development and growth, with no consideration of the financial impact or loss of jobs. Air permits, in particular, can be difficult to obtain because companies building or expanding facilities will have to show ozone reductions from other sources. These offsets can be expensive and hard to obtain. For example, in the Houston area, offset prices are $175,000 per ton of nitrogen oxide and $275,000 per ton of volatile organic compounds.

In conclusion, the National Black Chamber of Commerce and its members value and support clean air, clean water, and environmental quality, and we recognize the importance of regulations protecting those things. We also value and support economic growth, job creation, and prosperity for our individual members and this country as a whole. These are not mutually exclusive goals, and one does not have to be sacrificed for the other.

We appreciate the Committee holding this hearing and highlighting these critical issues. Thank you for the opportunity to testify, and I look forward to answering any questions. The National Black Chamber of Commerce is going to roll on and make this a better and better Nation. Thank you.

[The prepared statement of Mr. Alford appears as a submission for the record.]

Chairman CRUZ. Thank you, Mr. Alford. I want to thank each of the witnesses for your very fine testimony. I think this hearing has powerfully illustrated that many of the people paying the biggest price for the economic stagnation we have seen for the last 6½ years are the most vulnerable among us; that overregulating is stifling opportunity for people who want to achieve the American dream.

Indeed, the numbers are sobering. If you compare overall median income in this country in 2009, it was just over $54,000. In 2013, it had dropped to $51,939. That is a decrease for the average family of $2,120, or 4 percent, median income has gone down. I would contrast that to what occurred during the 8 years of Ronald Reagan's administration when the Federal Government did not engage in overregulation, and, indeed, President Reagan pulled back the regulatory burden on small businesses. During those 8 years, median income for the average American family increased $5,555, or 12 percent. That is a real difference for an average family, whether your household income drops four percent or goes up 12 percent.

Indeed, the contrast is even starker when you look at minority households. Under President Obama, between 2009 and 2013, the median income for African-American households has dropped $789,

roughly 2.2 percent. In contrast, under President Reagan, between 1981 and 1989, the median income for African-American households rose $5,008. That is 18 percent.

It is worth thinking about for everyone here who is concerned about allowing those who are struggling to have an opportunity to achieve the American dream, the marked difference for Black families, your median income dropping 2.2 percent versus rising 18 percent under Reagan's economic policies.

Looking to the Hispanic community, under President Obama the median income for Hispanic families has dropped between 2009 and 2013 $349, roughly 0.8 percent. In contrast, under President Reagan, between 1981 and 1989, the median income for Hispanic families rose $2,160, roughly 5.7 percent. These policies make a real difference in the lives of millions of Americans who are struggling. An extra $5,000 a year for a family that is trying to make ends meet makes an enormous difference.

I would note in the Hispanic community there are roughly 2.3 million Hispanic small business owners, roughly 1 in 8 Hispanic households is a small business owner. This is something I know personally because my household was one of them. My father, who came as an immigrant from Cuba with nothing, with $100 in his underwear, who could not speak English, who washed dishes making 50 cents an hour, he and my mother, when I was a little boy, they started a small business together. The Hispanic community is a tremendously entrepreneurial community, and yet these barriers are making it harder and harder for Hispanics and African Americans and anyone who wants a better dream, a better opportunity for their family to start small businesses and to survive.

Mr. Barrera, as the former president of the U.S. Hispanic Chamber of Commerce, can you describe some of the challenges that your members faced in dealing with regulations, red tape, and Government bureaucracy?

Mr. BARRERA. Thank you, Senator, for the question. I believe a lot of them are facing what we are calling this "overregulation." I know I have heard people talk here today about regulation that everybody is against. I do not think that is what we are saying. What we are saying is overregulation is killing initiative. It is killing people to go and achieve much more.

What we have seen from the Hispanic community, a lot of them are being forced to open businesses because they do not have jobs. Many have become part-time workers, and they need to go into business in order to survive. Most of them want—most people, they want to comply with the rules and regulations. They do not want to cheat. They want to do the right thing. It is becoming so confusing nowadays that they do not know which way to turn. They want to be able to provide for their families and be a great business and be a great partner with their customers. They spend so much time, like some of the examples we heard today, trying to comply and not make any mistakes. They do not know which way to turn. One of the best examples I can say that they have problems with, "Do I need to get a lawyer? Do I need to get an accountant? Do I need to go to Washington, DC? I do not have money for any of that. I need to be able to do business."

That is probably the best way to respond to your question at this point.

Chairman CRUZ. You know, one of the things I have tried to do in my time in the Senate is host small business roundtables across the State of Texas, bring small business owners and listen to their concerns. Every one of these roundtables, I just open it up and say, "Share the biggest issues that are weighing on your heart, the biggest challenges you are facing." I have never held a small business roundtable in the State of Texas where at least half of the small business owners did not list Obamacare as the single biggest impediment to their small business surviving and creating jobs, the consistency with which small business owners say that over and over again. Of course, small businesses produce two-thirds of all new jobs, so if small businesses are being hammered, that in turn has a direct result on the jobs that are available to people.

One study by the American Action Forum finds that Obamacare is reducing small businesses between 20 and 99 employees pay, the salary you are taking home, by at least $22.6 billion annually, and that the laws, regulations, and increasing premiums have reduced employment by more than 350,000 jobs nationwide.

In Texas, for example, the study finds that workers and businesses with 50 to 99 workers are seeing upwards of $1,000 less in take-home pay and a nearly 20-percent increase in premiums because of Obamacare. Texas small businesses with 20 to 49 employees have shed nearly 30,000 jobs since Obamacare came into effect.

Mr. Barrera, can you talk about the impact of Obamacare on small businesses?

Mr. BARRERA. We have seen the same thing. In fact, there was a business in Texas, a restaurant owner. He actually forgo opening a second restaurant because of the expenses of Obamacare. It is not because they do not want the people insured, but the way it was written, it is so confusing for people, and nobody has been able to find this answer: Why did we drop the work week from 40 hours to 30 hours? Small businesses are not dumb. They are there to make a profit. When you start raising the cost of hiring people and imposing more costs like Obamacare on them, they are going to find another way to cut costs. As we all know, businesses, when they want to cut costs, they cut employees. Like it or not, that is what the first expense they are going to do.

I would like to know, and I think a lot of businesses I talk to, they would like to know why did we drop the hours from the 40-hour work week to the 30-hour work week? Because that is all it has done, is hurt more people and cause more part-time jobs. The scariest thing are the children and the teenagers, because now because we have got a lot of retirees and people who used to work full-time, they are now part-time, which has pushed out the youth. That has hurt a lot of people.

Chairman CRUZ. Ms. Loving, I want to thank you for your particularly powerful testimony. That is testimony I think every American should watch. The nightly news should put your testimony on television because it tells a uniquely American story of struggling to create a business and facing powerful interests coming against you.

I want to ask you, Ms. Loving, who gets hurt by overregulation and by occupational licensing laws putting barriers to forming a small business?

Ms. LOVING. Thank you, Senator Cruz. The consumers get hurt because it creates barrier to entry for small businesses. Bigger firms can absorb costs, where an extra $1,000 to my bottom line is significant because I am dealing with a limited number of resources. If there is not enough competition, then consumers are stuck with the big firms. They have fewer choices. There are fewer options, and it becomes a monopoly of sorts. They have no other options but to pay exorbitant fees for tax prep fees that really do not do anything special for them at all.

Chairman CRUZ. You mentioned also that these regulations benefited the rich and powerful, those with lobbying influence in Washington, those who had law degrees or accounting degrees. For someone that wanted to start a small business in the South Side of Chicago, you did not have the same lobbyists working on your behalf.

Ms. LOVING. I do not have the same resources, so, therefore, I do not have people coming to Congress and talking to the elected officials on my behalf. It's just me, and there are 300,000 other people just like me.

Chairman CRUZ. Thank you for telling your story, and thank you for standing up to the power of Government and the power of big money and lobbying trying to put barriers in the way to your starting your business, your creating jobs, and your helping your community.

Ms. LOVING. I appreciate being invited.

Chairman CRUZ. Mr. Alford, I want to ask a final question.

Mr. ALFORD. Yes, sir.

Chairman CRUZ. The National Black Chamber of Commerce, you described a study that you recently did on the EPA's climate change regulations, and, in particular one result of that study caught my attention, which is that the National Black Chamber of Commerce concluded that the EPA's new rules could cost as many as 125,000 African Americans in Texas their jobs and an even more astounding 325,000 Hispanics in Texas their jobs. Those are staggering numbers, and those are numbers in the minority community.

Mr. ALFORD. Yes, sir.

Chairman CRUZ. People that want to have a fair chance to achieve the American dream. Mr. Alford, what would you suggest that a politician who supports these rules say to the 125,000 African Americans in Texas who will lose their jobs under them, to the 325,000 Hispanics who will lose their jobs, how should a politician justify his or her support for rules costing them their likelihood?

Mr. ALFORD. Honestly, I want to be honest and looking at it as it is, for what it is, and smile or try to justify it. There are 10 million nationally, 10 million jobs nationally, and we have not rebounded from 2008. People who get billions of dollars from environmental organizations, and we have to scrub along and, you know, make $20,000 here, $20,000 there, but we carry the weight. One of the strangest thing that happened, sir, last week I was in Paris working on a plan with our Paris chapter to where we have got a

$80 billion commitment from some philanthropists in France that are going to fund electrical projects in Africa. We are going to do this with the African-American contractors, engineers, infrastructure, and take it over to Africa and start lighting up the villages and such.

The interesting thing is, though, the French are very strong on the Kyoto Treaty, very strong on environmentalism, but their approach is if it cannot be done, it cannot be done. We have to wait until the technology catches up. They do not put a gun to your head and say, "You have got to do this or go out of business." That is what I thought was very interesting, that they have a commonsense approach to it. We are going to put in a clean Africa electrical grid, and we are going to be friendly to the Earth. If we tried to do that here in this country under our rules, they would stop us dead in the tracks.

Chairman CRUZ. Thank you, sir. Senator Coons.

Senator COONS. Thank you, Chairman Cruz. I am going to defer my questioning to Senator Klobuchar given the press of her time and schedule, if I might.

Senator KLOBUCHAR. Thank you very much, Senator Coons, and thank you, Chairman Cruz, and thank you, Senator Hatch. As I look at Senator Coons and Senator Hatch, I think about the regulatory work we have done together since I have gotten here. I represented businesses for years in the private sector on regulatory issues, so I understand some of the issues you are talking about, Mr. Alford, and that is why Senator Coons and I teamed up on doing something on the Foreign Corrupt Practices Act, on immigration, and Senator Hatch and I have done a lot of work with medical devices and trying, not only on the tax side but also the regulatory side, to make it easier for our businesses.

At the same time, as a prosecutor and then as a mom, I have seen how you need some regulations in place to protect the safety and health of our citizens, to protect our clean air and water, whether it is working on lead in children's toys—which I know you are aware of, Mr. Mair, a bipartisan bill that we passed, the formaldehyde work I did with Senator Crapo—that there are times when you need regulations in place to protect the people that we are supposed to be representing.

Mr. Narang, I think I would start with you in terms of, if you want to talk just very briefly about an example of regulations that you think have helped people, that you think is important for the minority communities.

Mr. NARANG. Sure. Thank you, Senator. I want to refer to a current topic and a current issue of concern for minority communities, and that is predatory lending. We are seeing higher rates of predatory lending abuse of minorities than the general public, and that should be a concern. I know it is a concern for the minority community. I am glad—and Public Citizen supports strong measures from the Consumer Financial Protection Bureau that will address predatory lending schemes that are costing minorities sometimes their likelihoods. They are definitely resulting in significant costs to our economy.

Senator KLOBUCHAR. I guess that is a good segue to Mr. Scott, because as I was hearing Senator Cruz talk about some of those

economic numbers, I think we know that part of the difficulty was during a recession that minorities were inordinately hit with foreclosures and other things because of what was going on in the financial industry. Do you want to comment either on that or what you see as some rules that would be helpful to the minority community in terms of business as an entrepreneur yourself? I really want to ask what it was like working for Congresswoman Sewell, but I will leave that for later. Go ahead.

Mr. SCOTT. Sure. I think that there are regulations that help us, you know, that work along with business owners, that are not stifling or that are holding businesses back in any kind of way, but that help with clean food. Since I, a lot of times deal with farmers, and a lot of times we deal with putting seeds in the ground that have nourishment toward coming into our bodies, and having regulations in place that require—and having those nutrients in place, they help with our life as a whole, because if we do not have things in place, we will not actually be here today. I look at, too, within—looking in this room, we have wood that is in here, that this building, this table, and everything that is made out of wood. Without regulation, would we have clean wood in here or would it be contaminated? The carpet that we walk on, would the carpet be the quality that it is, or would it just tear up as soon as it is put down?

I think that those regulations, when working along with business owners, can be something that is beneficial to everybody.

Senator KLOBUCHAR. Thank you. Mr. Mair, I think we have seen the studies and the numbers and you brought them up about how minorities are inordinately hurt by environmental problems or toxic waste sites and things like that. Do you want to elaborate on that?

Mr. MAIR. Yes. Again, the question was: Who gets hurt? Who gets hurt happens to be the very communities that folks are here claiming that this so-called policy or proposal would benefit. It is a cruel irony. You know, 7 out of 10 African Americans live in areas that are unsafe and were three times more likely to be admitted to hospitals for asthma. More importantly, when we talk about what are the benefits of the Clean Power Plan, we are talking about a $54 billion estimated worth in public health benefits and climate benefits. We are talking about 3,600 fewer premature deaths. We are talking about 90,000 fewer asthma attacks in children, 1,700 heart attacks, 1,700 fewer hospital admissions. When we are talking about benefits, the benefits are real and tangible. The data, again, support this.

Senator KLOBUCHAR. Thank you so much. Just two last things I wanted to mention. One, I will not go into it. Maybe I will ask you about it later in writing. Senator Collins and I last year introduced something called the "SCORE Act"—she is a Republican Senator from Maine—to look back 5 years later at some of these rules and regulations to see how they have, you know, affected the economy and ways to look and see if we need to make changes, to look at things in a measured way. I would ask you to look at that.

I guess I just wanted to end with one set of rules that I think cries out for change, and that is, immigration reform. I know that the Hispanic Chamber, in which you are involved, has been a supporter, as well as the Chamber of Commerce in general, and we

worked really hard on the Senate bill. Particularly Senator Hatch and I worked on this issue of entrepreneurs and bringing in entrepreneurs. The fact that 90 of our Fortune 500 companies were formed by immigrants, 200 of them were formed by immigrants and kids of immigrants, 30 percent of our U.S. Nobel Laureates were born in other countries, yet we literally allow for unlimited visas for Wild hockey players. You may not cover our team, Mr. Barrera, or be a fan, but that is our professional hockey team. All the hockey players can come in from Canada, but the Mayo Clinic cannot bring in a doctor because their spouse cannot work for 7 years, or 3M cannot bring in an engineer. I just wondered if quickly you two on either end here could just comment on your views on getting immigration reform done from that entrepreneurial standpoint.

Mr. BARRERA. I think when it comes to workers, we have to improve our legal immigration system, and we need reform. I do not think anybody here would deny that. We need to work on legal immigration so we get the best workers. This is a country of immigrants, so we agree that we have to have some kind of immigration reform that takes into account getting the workers that the businesses need. Whether they be hockey players or people in the agriculture, we need to have immigration reform, and the LIBRE Institute stands ready to assist in any type of reform.

Senator KLOBUCHAR. Mr. Alford.

Mr. ALFORD. America is not—what we need is a program that is logical and people can follow and have some integrity about it. Eighty percent of the Black retail businesses in New York City are owned and operated by the Africans or Caribbeans. They come to work, they come with their skills, and we should welcome them with open arms.

Senator KLOBUCHAR. Okay. Thank you very much. I also would note it is one of Grover Norquist's top priorities because it brings the debt down so significantly if we pass comprehensive immigration reform. I will leave you with that note. Thank you for being here.

Chairman CRUZ. Thank you very much. Senator Hatch.

Senator HATCH. Thank you, Mr. Chairman. Mr. Barrera, I will direct this question at you, but I want to make a few comments before I actually form the question.

Federal regulations today impose by some estimates a burden of about $1.88 trillion on the economy. That is roughly $15,000 for every single household in this country. It is more than corporate and individual income taxes combined. Too much regulation, especially too much outdated regulation, means higher prices, smaller paychecks, and fewer jobs for hardworking Americans. We know that the communities that are struggling the most with the costly rules that I think this administration and Washington bureaucrats keep piling up are the ones that can least afford to do so.

Every President since Jimmy Carter has agreed on the need to review our regulatory burden to make sure that it is no more intrusive and burdensome. That is absolutely necessary. Nevertheless, regulations keep accumulating year after year. The Code of Federal Regulations is now more than 175,000 pages and contains more than 200 volumes. According to a study by the American Action

Forum, the Obama administration's efforts to review old rules actually added more than $23 billion in costs to the economy and nearly 9 million hours of paperwork.

To turn this long-standing bipartisan commitment to streamline our regulatory burden into a reality, we need to take the responsibility of clearing out all regulations away from the bureaucrats who keep failing at the job. That is why I have introduced the SCRUB Act, which uses the successful model of the independent BRAC Commission and applies it to get rid of a big chunk of regulatory overreach and burden.

I just wonder if you agree with me that, far from providing small businesses with relief from our crushing regulatory burden, the Obama administration's regulations have made the business environment much more challenging, especially for minority-owned businesses. Do you agree with me that simply relying on Washington bureaucrats to get rid of their own bad regulation is like asking the proverbial bunch of foxes to guard the chicken coop?

Mr. BARRERA. Thank you for your question, Senator. I think what most minority businesses and businesses in general—you know, we used to talk about—my dad used to like to talk about this. He goes, you know, "When you work with Government, I do not want your handout. I am not even concerned about your hand up. I do not even want your handshake when it comes to regulators. I just really want you to get out of my way because I want to have the freedom to do business the best way I can." Regulators, like we talked about, for every law passed, they pass 16 new regulations for every law passed. How can people do that? They keep piling on one and the other. I can almost guarantee you that any law that we have now, it is already there. We do not need to go do more and do not need any more new regulations, because I can guarantee you, it is already there.

I do agree that we need to go in and see what we have so we know what we have got to get rid of. I think one of the best quotes I ever heard is from Colorado. You know, it is all fine and great when we pass new laws, but come and tell me what you got rid of, because the more you get rid of, that gives me more freedom to do business.

I think everybody on this panel would agree we are not against regulation. We want clean air. We want safe food. Nobody is against that. It is the overregulation that is really depressing the freedom and spirit and ingenuity and hard work, attitudes of true Americans to prosper. We have talked about some of the other things going on here. A lot of the problems that we have here are due to poverty. Poverty occurs because there is no economic ability to get out of poverty. If you keep depressing businesses, particularly small businesses, to prosper, you are only going to hurt poverty, and we need to work on that.

Senator HATCH. Thank you. Mr. Sandefur, we have heard extensive testimony about the explosive growth of Federal regulations and their troubling effect on economic opportunity, especially in minority communities. Despite these harmful effects, regulations keep piling up, as both Mr. Barrera and I have been saying, making the situation worse and worse with each passing year.

This massive accumulation of regulations is due in large part to the fact that the current process by which agencies make regulations is utterly broken, from curtailing the opportunity for meaningful input by the public to flouting the legal requirements for transparency and accountability.

Given this mess, the courts are often the only practical means of holding this out-of-control bureaucracy accountable. Doesn't excessive deference by courts to agencies critically limit that opportunity to hold the agencies accountable? Instead, hasn't this deference allowed the agencies to expand the scope of their power dramatically, allowing them to pile up more and more damaging regulations?

Mr. SANDEFUR. Oh, yes, Senator, absolutely. The problem is that courts defer so excessively to the administrative agencies that agencies have become basically a fourth branch of Government, unelected, hired—many of these administrative agencies are staffed by members of Government unions so you cannot even fire them if you have to—who write regulations, investigate potential violations of those regulations, and then punish people for violating those regulations in violation of the constitutional principle of separation of powers. Courts not only defer to their decision-making in general, but they defer to their findings in ways that violate basic rules of due process.

For example, a lot of the time administrative agencies will hold informal hearings, and the evidence that they are allowed to receive—they are not bound by the Federal Rules of Evidence, and so they can receive evidence like hearsay, for instance, which would be barred from a courtroom. Then when you challenge, when you appeal from the administrative agency—and you are always going to lose in front of the administrative agency because the prosecutor is paying the judge, right? When you appeal to the court, a lot of the time—this is especially true of State courts—the courts are locked. They are not allowed to receive any more evidence than what the administrative agency already received. Evidence that would never have been admitted in a courtroom, like hearsay evidence, becomes the only evidence that the judge is later able to consider when he considers the appeal. That is in violation of basic principles of due process.

We need a judiciary that is more skeptical toward administrative agencies that are unelected agencies, that enjoy often extremely broad power to regulate in whatever they think is the public interest without any checks and balances. That is what the courts are supposed to provide, and, unfortunately, they have fallen short many times.

Senator HATCH. I have gone over my time, but let me just make one comment. You know, it is said by many people that the D.C. Federal District Court and the Circuit Court of Appeals are so pro-regulation—and they are the courts that hear these matters more than almost any other.

Mr. SANDEFUR. Right.

Senator HATCH. Frankly, almost always find on the side of the regulatory bodies. I think they have got to wake up and start realizing that they are part of the problem as well. I am very concerned about it because, you know, we see minorities—not just minorities but minorities in particular—who are just getting killed by this

overregulatory nature of our society. I am hoping we can get that SCRUB Act through. That would start to peel through all these overregulatory approaches and allow the good regulations to stay.

Mr. SANDEFUR. If I may agree with that, one of the big problems is that we do not know the costs of regulation, and we cannot assess those costs because the costs of regulation typically take the form of the businesses that are never started, the projects that are never begun, the people who look at how difficult it is and say, "Well, why should I even bother?"

When we hear statistics that say, well, existing businesses are fine with the regulatory burden, of course they are. They are already in business. They can afford to absorb those costs. Entrepreneurs, they cannot. Very often they give up, and then we never see the wealth that they could have created but which was stifled by the regulatory burdens.

Senator HATCH. Sometimes we justify this overregulatory approach because of the ills of our society, but we have got to have the guts to get involved and look at the stuff that we do not need and get rid of it and save the trillions of dollars that we are losing right now because of this overregulatory nature of our society. I think it is very important for the minority community throughout the country to take this on and start realizing that, you know, the Federal Government is not the last answer to everything. Frankly, in many ways it is the impediment in our society because we do not get rid of the bad stuff. Yet you still have to comply with a lot of bad things that really tear up especially minority businesses.

I want to thank you, Mr. Chairman, and also the distinguished Senator from Delaware, for allowing me to go over a little bit. Thank you. I want to thank all of you for being here today. It has been very helpful.

Chairman CRUZ. Thank you, Senator Hatch. Senator Coons.

Senator COONS. Thank you, Chairman Cruz. Mr. Narang, given what your research as well as the research by OMB and other independent organizations has found about some of the positive effects of regulation on our economy, and, in particular, protection and promotion of health and other concerns of the minority community, how do you explain or respond to testimony we have heard today from a number of witnesses that regulations are principally responsible for killing jobs?

Mr. NARANG. Thank you, Senator. I do want to make clear and I know my testimony makes clear that regulation obviously does provide benefits. I know a lot of the discussion so far has not centered on that. It is very true that there are opportunity costs, if you will, of not regulating. I think we saw that very clearly in the Wall Street crash. Deregulation led to many of the economic woes that we are currently experiencing now, and it is clear that numbers dating back from 2010 do track the severe damage that was caused to our economy.

Let me also just back up and say in terms of setting policy priorities, in terms of determining what are good regulations that are worthwhile, it is very important to keep regulatory benefits in mind and to make decisions based on regulatory benefits as well as costs. I think a simple analogy probably shows how intuitive this is.

When you go to a grocery store, you are not just looking at the cost of the food as the only determining factor as to whether you would buy food. Of course, in that instance you would not buy any food. It is a little bit difficult to determine sometimes, just as with the regulatory State, what the benefit of that food is, but clearly it is a critical benefit with respect to livelihood.

You know, if you look at the macro level, the same thing applies when making policy decisions on regulatory policy. The benefits have to be taken into consideration.

Senator COONS. Thank you, Mr. Narang. Mr. Mair, can you just elaborate on that point with respect to environmental regulations and how they affect minority communities and how we should do the cost-benefit analysis?

Mr. MAIR. Yes, Senator Coons. In our 40-year history of the Clean Air Act, public health safeguards in the economy have actually prospered with regards to cleaning up air and water. In fact, under Clean Air, we have actually seen these safeguards improve and actually grow new businesses. In fact, under the President's Clean Power Plan, it is projected that by 2020, under these low standards, modest standards, over 360,000 jobs will be created.

The real issue, I think, as has been pointed out on one level, because there is a little bit of a bait-and-switch here, is that while we are saying it is collapsing industry and, as my colleague to my left has mentioned, that his business has to go to Africa to implement a Clean Power Standard, the fact of the matter is that the big coal and big carbon, big oil industry is absolutely stifling that opportunity. We can actually have that job creation here in the United States right now. It was in the United States where we talk about the solar and wind industry was born, but yet through the big cartels, those opportunities have been pushed off.

We talk about real jobs lost and really repowering and retooling America and getting America back on a green, clean footing, while at the same time reducing ozone and greenhouse gases and, as I say, improving our climate. Again, you know, these are things that are under the control right now or heavy influence of the big carbon and big oil industry. Blocking the President's efforts under the Clean Power Plan I think actually really is the real test of, as I say, doing real economic harm to the average American community.

Senator COONS. Thank you. Mr. Narang, do you agree with the claims that were just being debated there? Mr. Alford earlier made claims that the Clean Power Plan will result in job loss and increased energy costs and rising poverty among Hispanic and African American communities?

Mr. NARANG. Public Citizen strongly supports the Clean Power Plan, and it is not just because it is a win for the environment. It is also a win for consumers. We are doing ground-breaking research right now looking State by State at the actual benefits to consumers in terms of lower electricity prices, partially including the energy efficiency measures in the Clean Power Plan, not just the carbon regulation measures. What you are seeing is that, across the board, consumers would see lower electricity prices, and they would see higher electricity prices, of course, in the absence of the Clean Power Plan.

Senator COONS. Thank you. I also—well, my time has expired. I will let you do another round, if you want. Are we going to do a second round?

Chairman CRUZ. Thank you, Senator Coons.

You know, it is rather striking. This is a hearing on overregulation, and yet as I review both the written testimony and the oral testimony of the three witnesses invited by the Democrats—Mr. Narang, Mr. Scott, and Mr. Mair—none of the three of you have identified even a single example of overregulation. I am curious if it is your collective view that every regulation is a good thing, that it never goes too far, that more and more Government power over our lives is always good. Is there not really one example of overregulation that any of the Democratic witnesses here can point to.

Mr. NARANG. Senator, I am sure there is. I would say that those who are pushing for less regulation, it is incumbent upon them to demonstrate those examples of overregulation. I will say that I have been quite surprised that we hear in the abstract instances of massive amounts of overregulation, but there are very few examples that are offered, very few detailed, technical regulations that folks are saying, you know, justify massive reforms to the regulatory process that would stop regulations——

Chairman CRUZ. I take it that that answer is a no, then, that you cannot identify a single example of overregulation.

Mr. NARANG. I believe I can. I would have to get back to you on that.

Chairman CRUZ. As you sit here today you cannot. In preparing your testimony, you did not. Is that correct?

Mr. NARANG. Again, I think it is incumbent on those who believe that overregulation is the current most pressing problem in our regulatory system to demonstrate those examples.

Chairman CRUZ. Thank you. That is a no.

You know, Mr. Mair, I found it very interesting, when you took over at Sierra Club, you were quoted in a High Country News interview as saying that it was your goal to change things and to be a change agent, to make sure that "when laws and regulations are fashioned, they are not advantaging one group over another," which was a very interesting statement. I am curious which regulations in particular you were referring to that were benefiting one group over another.

Mr. MAIR. Right now the most pressing regulations benefiting one group over another is the insistence by the carbon industry, as I say, to maintain the status quo at the expense of, say, opportunities with regard to the development and advancement of clean power. I think that, you know, we have a huge opportunity here, when we talk about regulation and our transition from dirty power to clean power, to advance new alternatives. We should not have to have African Americans going to Africa to green and put in their smart grid and green grid in Africa. We should be financing those incentives here in, say, Detroit or here in New York. The opportunity of where and how regulations are employed, you know, are very, very critical and clear.

From the point of justice, when we talk about justice, in other words, regulations or what we call "safeguards," it is about the equal protection and enforcement of the law. The question is—so

when we talk about regulations and regulatory reform, in this case safeguards that are protective of human health, we need to look at some of the communities that are being——

Chairman CRUZ. Mr. Mair, I want to keep the focus of the hearing on the topic of the hearing, which is, in particular, the burdens on the minority community of overregulation. You mentioned that your organization disagrees with the Black National Chamber of Commerce's conclusion about the impact of the Obama administration's climate change rules on jobs. In your view, how——

Mr. MAIR. No, I did not say that, sir.

Chairman CRUZ. You do not disagree with this study?

Mr. MAIR. I disagree with this study.

Chairman CRUZ. Right. That is what I just said.

Mr. MAIR. Yes, Okay.

Chairman CRUZ. You mentioned you disagree with that study.

Mr. MAIR. Yes, sir.

Chairman CRUZ. In your judgment, how many jobs will those new regulations cost?

Mr. MAIR. The answer is it will not cost. The opportunity—it will create jobs. I think that one of the things that we need to look at is the data that are supplied by an independent study that was done by the EPA using Department of Labor data, and, in fact, what it showed that by 2020, we will actually have a net increase of 360,000 jobs.

Chairman CRUZ. How much will it drive up the electricity bill of the average consumer to put these massive new regulations on the generation of electric power?

Mr. MAIR. Actually, sir, it will not drive up the cost of the average consumer. In fact, the Clean Power Plan would reduce cost.

Chairman CRUZ. I am curious. Is it your position that over the last 6½ years the average consumer's electric bill has gone up or down?

Mr. MAIR. Sir, the Clean Power Plan, the proposals and safeguards under it have just been promulgated.

Chairman CRUZ. You said a minute ago, when I asked is there any regulation that is bad, you could not point to a single regulation in 175,000 pages. My question is: The last 6½—we have had 6½ years of this administration putting oppressive environmental regulations in place, and you said, well, this new wave of regulations, it is not going to impact any jobs, it is not going to impact electricity bills. My question is simple: Have consumers' electric bills gone up or gone down in the last 6½ years?

Mr. MAIR. Sir, the test is in the pudding. When we see the Clean Power Plan fully implemented——

Chairman CRUZ. I am asking about the pudding today, though, not the future pudding, because I am willing to bet 6½ years ago you made the same predictions that the onerous regulations being put in place then were not going to cost any jobs, were not going to raise electric bills. Were you right?

Mr. MAIR. Senator, when we talk about existing status quo, right now, doing nothing is costing jobs. Doing nothing is poisoning our economy. Doing nothing is taking human health. When we talk about the Clean Power Plan and, as I say, the new policies that

are moving forward, shifting to this new clean, green economy will actually create jobs, not reduce them, sir.

Chairman CRUZ. I think the record will reflect and the facts will reflect that the average consumer's electric bills have gone up dramatically, despite promises that that would not happen.

Mr. MAIR. Under the existing old regime, sir.

Chairman CRUZ. You are right, under the existing Obama EPA——

Mr. MAIR. Old—no, not—sir, under the existing carbon regime, sir.

Chairman CRUZ. The existing Obama EPA has driven up electric bills dramatically and has cost already vast numbers of jobs.

A final question. Mr. Sandefur, you talked quite powerfully about occupational licensing in a host of areas. I want to ask you the same question I asked Ms. Loving. Who gets hurt by these laws? Who do they benefit? Why are they put in place?

Mr. SANDEFUR. Laws like these typically go in place because entrenched industry, which has influence with the regulatory agencies, is able to flex its muscle and excuse what it is doing as, oh, well, we are protecting the public. Force an interior decorator to get a 2-year college degree before they are allowed to decorate houses, and that is good for the public. I guess it would be a better thing if interior decorators had a college degree than if they did not. Those interior decorators who do have a college degree and so they get licenses, they will report, "Oh, we are perfectly fine with the regulations. We have no problem with the regulations." Then you will have witnesses up here saying, "Existing businesses have no problem with the regulations," right? It is the entrepreneurs who wanted to get jobs in that industry who are blocked from doing so, who have to go get a job somewhere else or get no job at all, those are the unseen costs of the regulation, and that factors into the increased costs to the consumer, which raises prices, as you mentioned. Of course, therefore, that is—and that is what Ms. Loving said. It harms consumers because they have less choice and they pay more.

I am much more focused on the rights of entrepreneurs, the wealth—the people who create the wealth that you people all redistribute, they are the people whose rights I am concerned with, and they are very often blocked from the opportunity that this country is supposed to promise by laws that require a third of them to get Government permission before they can do their job for things as simple as floristry. Louisiana has a law that says you have to have a license to be a florist. That is obviously absurd. It is so absurd, no other State has a law like that. It does not protect the consumer. It protects entrenched industries against legitimate competition from entrepreneurs.

Chairman CRUZ. Mr. Sandefur, are there successful American businesses that began with humble beginnings long ago that would be illegal today or impossible based on this current wall of regulations?

Mr. SANDEFUR. Oh, of course. A hundred years ago, an immigrant or a Black entrepreneur could paint the word "Taxi" on the side of his car, and there you go, right? As long as he is insured, as long as he does not run somebody over—and if he does, he is

going to get punished for that by the existing regulations, and those are safety regulations everybody on this panel would agree with. Under today's laws, in most States and metropolitan areas, they would have to get permission from their own competition before they can startup a taxi business. We have all read the headlines about Uber, but it is not just Uber that is an example of this. My client, Maurice Underwood, wants to start a moving business. How harmless can you get, a moving business? He should be allowed to paint the word "Mover" on the side of his truck and go into business. Instead, he has to get approved to—hire a lawyer, go to a hearing, and prove to Government bureaucrats that his business would "foster sound economic conditions," which nobody knows what that means.

These businesses stifle entrepreneurship, and to hear people—these witnesses say, "Oh, well, everything is fine. Industry is fine. We do not see any job loss," it reminds me of the story of the man who jumped off the 100-story building, and as he passes the 50th floor says, "Well, so far, so good." That is the problem that we have got when it comes to the economy in this country. We have a healthy economy that could recover if we would let it. Too many rules mean that we cannot let it. I could spend the entire day listing the bad regulations that these other witnesses have somehow been unable to identify, but we all have time to worry about.

Chairman CRUZ. Thank you very much, Mr. Sandefur. Senator Coons.

Senator COONS. Thank you, Chairman Cruz. If I might, Mr. Mair, Mr. Alford testified earlier that the new EPA ozone regulations will harm minority communities and that the Clean Power Plan will harm minority communities. Do you agree with that? What evidence do you point to? Frankly, Mr. Alford cited a study by the Black Chamber of Commerce, and I am wondering if the Sierra Club has any competing sources of information that they would like to point to?

Mr. MAIR. Yes. One of the things that we definitely rely upon is the EPA data, and according to our studies, actually, you know, the ozone studies are one of the critical pieces whereby, you know, our human health would be greatly impacted and affected, sir. Specifically—

[Pause.]

Senator COONS. Mr. Mair, if I might give you a minute to sort of work through any answer to that, I am going to move on to other witnesses, if I might.

Mr. MAIR. Please.

Senator COONS. Mr. Scott—let me just—Mr. Alford, you have said that on behalf of 2 million African-American owned businesses you oppose environmental regulations, the ACA, Dodd-Frank, a range of things—and I may be mischaracterizing your testimony, so feel free to correct me—because they have largely caused job loss at minority-owned businesses rather than creating opportunities.

Mr. ALFORD. I did not mention Dodd-Frank, but it certainly is an example. It dried up money on the street. The SBA will not even print their numbers of 7(a) loans to Black businesses because they are so ashamed. They have locked it up. The Export-Import Bank wanted our help because they were being de-authorized. I asked

them to give me one loan they have made to a Black business anywhere in this world. I have been waiting 6 months for that answer. They do not do it. We are on our own. We have no small business government, and we are finding other ways.

The San Francisco chapter has put in a $200 million development with Shanghai money through EB–5 visas. We had to get creative. Our own banks are not going to do it, so we will find a way.

In terms of asthma, there is no source to say how asthma is formed. There is no cure for asthma. Asthma has increased as the ozone has gone down. I grew up in Los Angeles. Let me tell you, we have improved the air a whole lot. When you are playing football on Saturday afternoon in L.A. in 90-degree weather, we have improved a whole lot. Asthma has gotten worse. There is no correlation between ozone and asthma.

Senator COONS. Thank you, Mr. Alford. Mr. Scott, as a minority business owner yourself and someone who works regularly with minority business entrepreneurs, do the positions Mr. Alford is taking and his characterization of the impact on regulation represent you fairly as a minority business owner?

Mr. SCOTT. I would say that it does not, and the reason I say that is that I think that one thing that we have been able to do through businesses that I have worked along with and also with Small Business Development Centers across this Nation that are available is to use more of a cooperative approach of businesses working together to find people maybe who have actually went through the system and may have became—followed regulations, became qualified, and bringing them in as an expert, and then sharing that knowledge to work as a team to make sure that we can help businesses that want to get certified or go through regulations of that nature. That was a way that I think that we was able to avoid some things maybe other people worked through, because we tried to communicate and work together. I think that when businesses work together as a team, just like the same rules of playing sports, when you work together as a team and we all have rules, you use those rules to your advantage toward making things work instead of fighting against the rules that are in place. Rules are not there.

Senator COONS. Thank you, Mr. Scott. If I might, Mr. Chairman, just noting the passage of time, I would just like to put into the record a letter from the U.S. Black Chambers, an African-American-led business organization with over 100 self-sustaining Black Chamber members around the country——

Mr. ALFORD. That is not true. That has been proven in a court of law. That is not true.

Senator COONS. Mr. Alford.

Mr. ALFORD. Yes, sir.

Senator COONS. I am speaking. Thank you very much.

Mr. ALFORD. Sorry.

Senator COONS. Forgive me. The letter that I am going to enter into the record from the president, Mr. Busby, says, among other things, that studies have shown African Americans are suffering an increase in asthma and respiratory issues in no small part because many Black families live near power plants and areas with unhealthy ozone levels. It goes on to support the Clean Power Plan

as the solution that will reduce health-related respiratory risks, and that strikes me as just a point in counterpoint that is worth raising.

[The information appears as a submission for the record.]

Senator COONS. If I might, Mr. Mair, did you want to make a closing point before I run out of time?

Mr. MAIR. Yes, I think that the blanket statement that there is no correlation between ozone and asthma, it just flies in the face of the studies by the American Lung Association, as well as our research, the CDC. These are some of the biggest triggers with regards to asthma, you know, with regards to air quality. I think that one of the big—as I say, the big dirty dozen, greenhouse gas, but also by the same token, it is one of those areas where, you know, if you look at the studies and the areas where populations have high asthma risk in ozone levels, the studies are there to support that.

Senator COONS. If I might, in closing, the Union of Concerned Scientists, which was not represented here today, has also raised some questions and concerns.

Mr. Chairman, if I might enter into the record a post from the Union of Concerned Scientists that raises issues based on the EPA's own cost-benefit analysis, studies from the NAACP about the racially disparate impact of pollution on minorities, cites a recent study by the University of Maryland, that all conclude that the Clean Power Plan may, in fact, have a net positive impact on minority communities and raises some serious questions about the Black Chamber of Commerce of study that was relied upon by Mr. Alford in his testimony.

[The information appears as a submission for the record.]

Senator COONS. I think this is a subject of active dispute. I do, in the interest of time, want to thank all the witnesses who testified here today, and I look forward to further hearings with the Chairman.

Chairman CRUZ. Thank you, Senator Coons, and I would like to go back briefly to Mr. Mair.

In your written testimony, you said that the science behind climate change and its effect on minority communities quote, "should not be up for debate." I am curious. Is the Sierra Club—is this a frequent practice to declare areas of science not up for debate, not up for consideration of what the evidence and data show?

Mr. MAIR. If you are relying on the evidence and data, you know, the science, the preponderance of the evidence are there.

Chairman CRUZ. That is a different thing than saying we should not debate a question, that the Sierra Club has declared this scientific issue resolved and there should be no debate?

Mr. MAIR. Based upon the preponderance of the evidence, the science is settled. The thing is that anything is up for debate, Senator. We can debate anything.

Chairman CRUZ. You know, I would note that even the phrase "preponderance of the evidence," having been a practicing lawyer for many years, means 51 percent. That means that 49—at least 51 percent is what the preponderance means. You know, I would ask, for example, if you want to end debate, you do not want to address the facts, how do you address the fact that in the last 18

years the satellite data show no demonstrable warming whatsoever?

Mr. MAIR. Sir, I would rely upon the Union of Concerned Scientists, and I would rely upon the evidence, again, from our own NOAA officials. The data are there.

Chairman CRUZ. Is it correct that the satellite data over the last 18 years demonstrate no significant warming?

Mr. MAIR. No.

Chairman CRUZ. How is it incorrect?

Mr. MAIR. Based upon our experts, it has been refuted long ago, and there is no long—it is not up for scientific debate.

Chairman CRUZ. I am curious. It is—I want to understand this. I do find it highly interesting that the president of the Sierra Club, when asked what the satellite data demonstrate about warming, apparently is relying on staff, so—the nice thing about the satellite data is these are objective numbers.

Mr. MAIR. Correct.

Chairman CRUZ. The numbers over the last 18 years-—are you familiar with the phrase "the pause"?

[Pause.]

Mr. MAIR. The answer is yes, and essentially we rest on our position.

Chairman CRUZ. To what you said, you are familiar with the pause, so to what does the phrase "the pause" refer? I am sorry. You said you were familiar with that term, so I asked to what does it refer.

Mr. MAIR. Essentially, it is the slowing of global warming during the 1940's, sir.

Chairman CRUZ. During the 1940's. Is it not the term that global warming alarmists have used to explain the inconvenient truth, to use a phrase popularized by former Vice President Al Gore, that the satellite data over the last 18 years demonstrate no significant warming whatsoever? Global warming alarmists call that "the pause" because the computer models say there should be dramatic warming, and yet the actual satellites taking the measurement do not show any significant warming.

Mr. MAIR. Senator, 97 percent of the scientists concur and agree that there is global warming, an anthropogenic impact with regard to——

Chairman CRUZ. The problem with that statistic that gets cited a lot is it is based on one bogus study—and, indeed, your response—I would point to your response—is quite striking. I asked about the science and the evidence, the actual data. We have satellites. They are measuring temperature. That should be relevant. Your answer was, "Pay no attention to your lying eyes and the numbers that the satellites show. Instead, listen to the scientists who are receiving massive grants who tell us do not debate the science."

Mr. MAIR. Sir, this is one of the national pastimes in America, and while we are debating what 97 percent of scientists have already settled, the 3 percent that we, as I say, have invested in with regards to the carbon industry, you know, our planet is cooking and heating up and warming. This is one of the reasons why with regards——

Chairman CRUZ. Hold on a second. It is the Sierra Club's position that right now the Earth is cooking up and heating and warming? Is that the Sierra Club's—I mean, I just want to quote you and understand your——

Mr. MAIR. I am saying I concur with 97 percent of our—as I say, of the world's scientists with regards to global warming and the anthropogenic effects of mankind with regards to climate.

Chairman CRUZ. Sir, would you answer the question? Is it the Sierra Club's position, as you just testified, that the Earth is cooking up and heating and warming right now? Is that the Sierra Club's position?

Mr. MAIR. Global temperatures are on the rise, sir.

Chairman CRUZ. I assume the Sierra Club would issue a public retraction if confronted with the facts that the data are precisely as I described, that over the last 18 years there has been no significant warming, and, indeed, that is why global warming alarmists invented the term "the pause" to explain what they call "the pause in global warming" because the data demonstrate what you just said, that the Earth is cooking and warming, is not back up by the data?

Mr. MAIR. We are concurring with 97 percent of the scientists that absolutely say the opposite, sir.

Chairman CRUZ. If the data are contrary to your testimony, would the Sierra Club issue a retraction?

Mr. MAIR. Sir, we concur with the 97 percent scientific consensus with regards to global warming.

Chairman CRUZ. I would like to——

Senator COONS. Mr. Chairman, if i——

Chairman CRUZ. Certainly in a moment, but I would like to repeat the question and get an answer. If the data are contrary to your testimony, would the Sierra Club issue a retraction?

Mr. MAIR. We concur with 97 percent of the scientists that believe that the anthropogenic impacts of mankind with regards to global warming are true.

Chairman CRUZ. Does that mean you are not willing to answer the question?

Mr. MAIR. We concur with the preponderance of the evidence and the science that 97 percent—you are asking me if we would take the three percent over the 97 percent——

Chairman CRUZ. No, I am actually not asking about a survey among scientists. I am asking about the objective data, the numbers.

Mr. MAIR. The scientists rely upon their objective data and their analysis, and 97 percent have concurred and conclude that global warming is indeed a fact.

Chairman CRUZ. You know, Mr. Mair, I find it striking that for a public policy organization that purports to focus exclusively on environmental issues that you are not willing to tell this Committee that you would issue a retraction if your testimony is objectively false under scientific data. That undermines the credibility of any organization if you will persist in a political position regardless of what the science shows, regardless of the facts, regardless of the evidence, and regardless of the data. That is not consistent, I would suggest, with sound public policy.

Mr. MAIR. Sir, you can pick whatever and cherrypick whatever data you wish, but I concur with the 97 percent of scientists who concur that global warming is a fact.

Chairman CRUZ. Senator Coons.

Senator COONS. Thank you, Mr. Chairman. I just simply wanted to observe that we have a broadly representative and qualified group of folks who were brought here to talk about overregulation and its impact on minority communities, and I do not speak for the Sierra Club, obviously, but it is my hope and expectation that if you want to pursue that line of inquiry with them further, they would be happy to. My assumption is that we will continue to focus on the subject of the hearing at hand.

Chairman CRUZ. I certainly concur with Senator Coons, and I would note that Mr. Mair's written testimony and oral testimony focused in significant part on the Obama administration's new global warming regulations that could cost up to 10 million jobs and impose massive costs on American consumers. He argued that the data support causing millions of Americans to lose their jobs, including millions of African Americans and Hispanics, and I was pressing on what the data was that he was testifying about. I would note that that is not only relevant to his testimony, it was almost the entire subject of his testimony. Yet apparently the testimony is not based on the data or the evidence, or he is not prepared to discuss the data or evidence beyond asserting that we should take the word—to take their word for it.

With that, I want to thank all the witnesses for being here. Thank you for joining us. We will be keeping the hearing record open for an additional 5 business days, which means the record will be closed at the end of the business day on Tuesday, October 13, 2015.

Thank you very much to each of the witnesses. The hearing is adjourned.

[Whereupon, at 4:25 p.m., the hearing was adjourned.]

[Additional material submitted for the record follows.]

A P P E N D I X

Miscellaneous submissons:

American Society of Interior Designers, letter 114
American Thoracic Society (ATS), letter 118
Benefits and Costs of the Clean Air Act from 1990 to 2020 197
CASAC Consensus Responses 130
Children's Health Protection Advisory Committee 195
National Medical Organizations, letter 435
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THE LIBRE INSTITUTE

FREEDOM DRIVES PROGRESS

Testimony of:

Michael Barrera

Economic Prosperity Manager of The LIBRE Institute

Before the:

United States Senate

Committee on the Judiciary

Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts

Hearing on "Opportunity Denied: How Overregulation Harms Minorities"

October 6, 2015

Mr. Chairman and members of the committee, my name is Michael Barrera, National Manager of Economic Prosperity for The LIBRE Institute, a non-partisan, non-profit organization that educates Hispanics on the importance of economic freedom. On behalf of the Institute, I welcome your invitation to testify regarding the impact of federal regulations on the minority community, small business, and in particular Hispanic-owned businesses.

Americans are suffering under the crushing burden of overregulation. According to the Competitive Enterprise Institute (CEI), economy-wide regulatory costs amount to an average of $14,976 per household – around 29% of an average family budget of $51,100. Although not paid directly by individuals, this "cost" of regulation exceeds the amount an average family spends on health care, food and transportation. Regulations also cost small businesses. Citing the Office of Information and Regulatory Affairs (OIRA) the National Federation of Independent Business (NFIB), notes there are 3,348 federal regulations in the pipeline, with nearly 1/3 impacting small business directly. Moreover, regulations are a growth business as the number of pages in the Federal Register for regulations grew from 22,877 pages in 1960 to almost 78,000 pages in 2015.

Businesses are being strangled by red tape and individuals face vast and growing limitations on personal freedom in nearly every aspect of their lives. Overregulation depresses economic growth, and it creates winners and losers, with some small businesses bearing the cost of regulations, while others either find a way around them or – in some cases – even manipulate the regulatory process to give them an edge over competitors. As rules are drafted, more efforts are put into lobbying Congress and regulatory agencies to tailor them to protect special interest groups, leaving many more with additional burdens or simply out of the market altogether. Unfortunately small and minority businesses don't have a bevy of lawyers and lobbyists advocating on their behalf. Even more frustrating, studies show many of these regulations are ineffective and fail to deliver the benefits they were implemented to produce. Policymakers should

examine both new and existing regulations to ensure that each is necessary, beneficial to the marketplace, cost-efficient and beneficial to people's lives and business success.

As federal regulation has grown, the business improvements that drive wage growth have plummeted. Today the U.S. productivity growth rate is nearly half of its historical rate, dropping from an annual average rate of 2.5% since 1948 to 1.1% since 2011. With so much ongoing debate about family incomes that are at or below historic levels, it behooves Congress to consider the impact of costly government regulation. According to a recent analysis of U.S. Census Bureau (Census) data published by the Wall Street Journal the annual rate of new business starts is about 28% lower today than it was in the 1980s. It's critical that we review government policies to ensure they are not crushing the economic engine that drives American greatness

The CEI estimates federal regulations cost nearly $2 trillion in 2014 through higher prices and lost productivity. The Small Business Administration's Office of Advocacy found small businesses, defined as firms employing fewer than 20 employees, bear the largest burden of federal regulations. As of 2008, small businesses face an annual regulatory cost of $10,585 per employee, which is 36% higher than the regulatory cost facing large firms (defined as firms with 500 or more employees). This number can be assumed to be considerably higher today as the Advocacy report above was done 7 years ago and did not include the rising cost of federal regulations and the cost of complying with the Affordable Care Act. Small business regulatory burdens have also been measured by the NFIB.

According to the NFIB Small Business Optimism Index, small business owners have cited regulations as a top impediment to conducting business for over 65 months in a row and 21% of small business owners cite regulations as their single most important problem. Citing information from the World Bank, NFIB reports the growth of regulations contributed to the U.S. falling out of the top ten ranks in the world in the ease of starting a business. In fact, the World Bank found that it's easier to start a new business in Portugal, Romania, Panama, Hungary and Belarus than in the U.S. Moreover, according to a Gallup

analysis of data from the Census, business failures began to outpace business startups in 2008 - and have been negative every year since. From 1977 through 2008, the number of new startups outpaced the number of failing businesses by about 100,000 annually. Since then however, the country has a deficit of about 70,000 firms. This weakening of the vibrancy and creativity of the U.S. economy has enormous ramifications for the nation. For decades, successful companies making the transition from startup to major player have been the driver of job growth in the U.S. With fewer startups and more business failures, today's younger workers face daunting times ahead. There will be less economic opportunity for young workers, less impetus for innovation, and ultimately less revenue for all levels of government to address important national priorities, including our national defense and education of our children.

It follows that the growth of federal regulations negatively impacts Hispanic owned businesses and the Hispanic community. The Unites States Hispanic Chamber of Commerce (USHCC) reports there are 4.07 million Hispanic owned businesses generating an estimated 661 billion dollars a year. The Census reports they are doubling the national rate of business growth and many of these businesses employ members of the community. However, Hispanic owned businesses tend to be small businesses and they are experiencing the same difficulty in complying with federal regulations as all small businesses.

Hispanic-owned businesses are not simple statistics and faceless numbers. These are real people, and many are family-owned businesses that are either run by or started on behalf of the family. In many cases a small business is the family's primary source of income for not only the immediate family but for the extended family. Nationally, family-owned businesses account for 50% of U.S. gross domestic product, generate 60% of the country's employment and 78% of all new job creation. In a report by Mass Mutual, 89% of Hispanic entrepreneurs report that they started their business to provide financially for their family and 70% of Hispanic business owners plan to pass their business on to family members vs. 54% of the general population. Additionally 31% of Hispanic entrepreneurs hire extended family vs 19% of the general population.

As such, the impact of federal regulations goes far beyond impacting the small business community alone. Regulations also impact American workers, their families as well as the growing Hispanic community. As federal regulations expand, the cost of doing business rises, thereby forcing small businesses and their families to make difficult choices. Do I spend my time and money complying with federal, state and city mandates or do I spend it managing and marketing my business? Do I have to hire a lawyer and accountants to ensure my business is in compliance? Should a Hispanic entrepreneur spend business resources satisfying the insatiable appetite of a bloated regulatory monster or should he or she spend the resources improving the business, hiring new people, and increasing wages for his or her employees and family? Unfortunately, many entrepreneurs are choosing to forgo their American dream and either not starting a business, expanding or closing up shop.

This is not a blanket rejection of all regulation. Far from it. Instead, we should weigh the costs and benefits of each proposed rule before proceeding. An overwhelming majority of Hispanics, like all Americans, want to comply with rules and regulations and uphold the rule of law. However, excessive regulation continues to diminish the spirit of their American Dream of business ownership. All too often, regulation is treated as innocent until proven guilty, rather than the other way around. The burden of proof is on the regulator to prove that a rule is necessary, not on small and minority business owners to prove that it is not.

Conclusion.

America's small businesses are always a popular subject when our leaders discuss their plans and aspirations to revive the American economy. This makes sense as small businesses employ close to 2/3 of American workers. Unfortunately, these plans are being hijacked by unelected officials who in theory claim to help, while in practice continue to hinder growth and prosperity. It is interesting to note that unelected agency officials pass 16 new regulations for every law passed by our elected officials.

Small businesses need to be more than a talking point. Most entrepreneurs will tell you government rules and regulations take a one size fits all approach and are confusing, complex, time consuming and expensive. Many small businesses are also hesitant to contest or complain - unable to defend or advocate for themselves due to the expense, the time and in some cases the intimidation - real or perceived - involved. In my career as an attorney, the former National Ombudsman for the SBA, President and CEO of the USHCC and with the LIBRE Institute I came into contact with numerous small business owners who told me about their difficulties working with government - but that they won't complain or fight it because they don't want to be on the government's "radar."

I believe most small businesses, including Hispanic owned business, would say that if our leaders are serious about achieving the American Dream, they must actually do something to eliminate the American nightmare of over-regulation and unnecessary enforcement. In the best American tradition of market competition, constitutionally-limited government means the market should primarily dictate the exchange of goods and services without the growing presence of cronyism and government overreach. Polls consistently show the economy and jobs are a top priority for Hispanics. Government's role is not to create wealth, but rather create an environment where ingenuity, hard work and risk are rewarded rather than punished. Economic freedom, the rule of law, the free market, and a constitutionally limited government - not cronyism and excessive regulation - are the road of freedom to prosper and the best way for each person to achieve their American Dream.

Written Testimony of

Amit Narang
Regulatory Policy Advocate, Public Citizen

before the

The Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts
U.S. Senate Judiciary Committee

on

"Opportunity Denied: How Overregulation Harms Minorities"

October 6, 2015

Mr. Chairman Cruz, Ranking Member Coons, and Members of the Subcommittee,

Thank you for the opportunity to testify today on the importance of regulations to all members of the public, including minorities. I am Amit Narang, Regulatory Policy Advocate at Public Citizen's Congress Watch. Public Citizen is a national public interest organization with more than 400,000 members and supporters. For more than 40 years, we have successfully advocated for stronger health, safety, consumer protection and other rules, as well as for a robust regulatory system that curtails corporate wrongdoing and advances the public interest.

Public Citizen co-chairs the Coalition for Sensible Safeguards (CSS). CSS is an alliance of more than 150 consumer, small business, labor, scientific, research, good government, faith, community, health and environmental organizations joined in the belief that our country's system of regulatory safeguards provides a stable framework that secures our quality of life and paves the way for a sound economy that benefits us all. Time constraints prevented the Coalition from reviewing my testimony in advance, and I write only on behalf of Public Citizen.

Over the last century, and through the Obama administration, regulations have made our food supply safer; saved hundreds of thousands of lives by reducing smoking rates; improved air quality, protected children's brain development by phasing out leaded gasoline; saved consumers billions by facilitating price-lowering generic competition for pharmaceuticals; reduced toxic emissions into the air and water; empowered disabled persons by giving them improved access to public facilities and workplace opportunities; guaranteed a minimum wage, ended child labor and established limits on the length of the work week; saved the lives of thousands of workers every year; protected the elderly and vulnerable consumers from a wide array of unfair and deceptive advertising techniques; ensured financial system stability (at least when appropriate rules were in place and enforced); made toys safer; saved tens of thousands of lives by making our cars safer; and much more.

Regulations have been also crucial to both protecting but also creating opportunities for minority populations by combating discrimination in employment and housing, ensuring basic voting rights, outlawing unfair and targeted lending practices by unscrupulous lenders, redressing inequities in exposure to environmental toxins, and much more.

To review the facts of how regulation has benefitted and strengthened our country, however, is not to suggest that all is well with the regulatory system. Indeed, our regulatory system is in need of reform, but not because there is too much regulation. Rather, under-regulation is the status quo and too little regulation is hurting the public, including minority populations.

The evidence of under-regulation includes both massive and dramatic disasters that catch the public's attention as well as daily tragedies that could have been easily prevented with regulatory standards in place. In both instances, the common link is a complete absence of any regulatory standards or ineffective and weak standards that do not protect the public. The costs of under-regulation are real and are borne by working families, consumers, taxpayers, and the public.

Regulations are Smart for our Economy

Regulation has led to some of the most important public health, safety, environmental and economic success stories in our country's history. Regulation has:

- Made our food safer.[1]
- Saved tens of thousands of lives by making our cars safer.[2]
- Made it safer to breathe, saving hundreds of thousands of lives annually.[3]
- Protected children's brain development by phasing out leaded gasoline and dramatically reducing average blood levels.[4]
- Empowered disabled persons by giving them improved access to public facilities and workplace opportunities, through implementation of the Americans with Disabilities Act.[5]
- Guaranteed a minimum wage, ended child labor and established limits on the length of the work week.[6]
- Saved the lives of thousands of workers every year.[7]

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[1] American Public Health Association. (2010, November 30). *APHA Commends Senate for Passing Strong Food Safety Legislation*. Retrieved 24 February, 2012, from http://www.makeourfoodsafe.org/tools/assets/files/APHA_Senate-Passage-Food-Act_FINAL2.pdf

[2] NHTSA's vehicle safety standards have reduced the traffic fatality rate from nearly 3.5 fatalities per 100 million vehicles traveled in 1980 to 1.41 fatalities per 100 million vehicles traveled in 2006. Steinzor, R., & Shapiro, S. (2010). *The People's Agents and the Battle to Protect the American Public: Special Interests, Government, and Threats to Health, Safety, and the Environment*: University of Chicago Press.

[3] Clean Air Act rules saved 164,300 adult lives in 2010. In February 2011, EPA estimated that by 2020 they will save 237,000 lives annually. EPA air pollution controls saved 13 million days of lost work and 3.2 million days of lost school in 2010, and EPA estimates that they will save 17 million work-loss days and 5.4 million school-loss days annually by 2020. *See* U.S. Environmental Protection Agency, Office of Air and Radiation. (2011, March). *The Benefits and Costs of the Clean Air and Radiation Act from 1990 to 2020*. Available from: <http://www.epa.gov/oar/sect812/feb11/fullreport.pdf>.

[4] EPA regulations phasing out lead in gasoline helped reduce the average blood lead level in U.S. children ages 1 to 5. During the years 1976 to 1980, 88 percent of all U.S. children had blood levels in excess of 10μg/dL; during the years 1991 to 1994, only 4.4 percent of all U.S. children had blood levels in excess of that dangerous amount. Office of Management and Budget, Office of Information and Regulatory Affairs. (2011). *2011 Report to Congress on the Benefits and Costs of Federal Regulations an Unfunded Mandates on State, Local, and Tribal Entities*. Available from: <http://www.whitehouse.gov/sites/default/files/omb/inforeg/2011_cb/2011_cba_report.pdf>.

[5] National Council on Disability. (2007). *The Impact of the Americans with Disabilities Act*. Available from: <http://www.ncd.gov/publications/2007/07262007>.

[6] There are important exceptions to the child labor prohibition; significant enforcement failures regarding the minimum wage, child labor and length of work week (before time and a half compensation is mandated). But the quality of improvement in American lives has nonetheless been dramatic. Lardner, J. (2011). *Good Rules: 10 Stories of Successful Regulation*. Demos. Available from: <http://www.demos.org/sites/default/files/publications/goodrules_1_11.pdf>.

[7] Deaths on the job have declined from more than 14,000 per year in 1970, when the Occupational Safety and Health Administration was created to under 4,500 at present. *See* AFL-CIO. (2015, April.) Death on the Job: The Toll of

- Saved consumers and taxpayers billions of dollars by facilitating generic competition for medicines.[8]

- Protected the elderly and vulnerable consumers from a wide array of unfair and deceptive advertising techniques.[9]

- For half a century in the mid-twentieth century, and until the onset of financial deregulation, provided financial stability and a right-sized financial sector, helping create the conditions for robust economic growth and shared prosperity.[10]

Regulation continues to improve the quality of life for every American, every day. Ongoing and emerging problems as well as a rapidly changing economy require the continual issuance of new rules to ensure that America is strong, safe, healthy and economically prosperous. Below is a selective and small sampling of rules recently issued, pending, or under consideration:

- **Fuel efficiency standards.** Pursuant to the Energy Policy and Conservation Act, the Energy Independence and Security Act and the Clean Air Act, the National Highway Safety and Transportation Agency and the Environmental Protection Agency have proposed new automobile and vehicular fuel efficiency standards. The new rules, on an average industry fleet-wide basis for cars and trucks combined, establish standards of 40.1 miles per gallon (mpg) in model year 2021, and 49.6 mpg in model year 2025. The agencies estimate that fuel savings will far outweigh higher vehicle costs, and that the net benefits to society from 2017-2025 will be in the range of $311 billion to $421 billion. The auto industry was integrally involved in the development of these proposed standards, and supports their promulgation.

- **Food safety rules.** In 2010, with support from both industry and consumer groups, and in response to a series of food contamination incidents that rocked the nation, Congress passed the Food Safety Modernization Act. The Act should improve the safety of eggs, dairy, seafood, fruits, vegetable and many processed and imported foods, but its effective implementation depends on rulemaking. Not so incidentally, food contamination

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Neglect. p. 1. Available from: <http://www.aflcio.org/content/download/154671/3868441/DOTJ2015Finalnobug.pdf>. Mining deaths fell by half shortly after creation of the Mine Safety and Health Administration. Weeks, J. L., & Fox, M. (1983). Fatality rates and regulatory policies in bituminous coal mining, United States, 1959-1981. *American journal of public health, 73*(11), 1278.

[8] Through regulations facilitating effective implementation of the Drug Price Competition and Patent Term Restoration Act of 1984 ("Hatch-Waxman"), including by limiting the ability of brand-name pharmaceutical companies to extend and maintain government-granted monopolies. Troy, D. E. (2003). *Drug Price Competition and Patent Term Restoration Act of 1984 (Hatch-Waxman Amendments)*. Statement before the Senate Committee on the Judiciary. Available from: <http://www.fda.gov/newsevents/testimony/ucm115033.htm>.

[9] See 16 CFR 410-460.

[10] See Stiglitz, J. E. (2010). *Freefall: America, free markets, and the sinking of the world economy*: WW Norton & Co Inc.; Kuttner, R. (2008). *The Squandering of America: how the failure of our politics undermines our prosperity*: Vintage.

incidents have major harmful economic impact on the agriculture and food industries and job creation and preservation in those industries.

- **Energy efficiency standards.** Pursuant to the Energy Security and Independence Act, the Department of Energy has proposed energy efficiency standards for a range of products, including Metal Halide Lamp Fixtures, Commercial Refrigeration Equipment, and Battery Chargers and External Power Supplies, Walk-In Coolers and Walk-In Freezers, Residential Clothes Washers.[11] The Department of Energy estimates the net savings from implementation of the Energy Security and Independence Act to be $48 billion - $105 billion (in 2007 dollars).[12]

- **Rules to avert workplace hazards.** By way of example, consider the case of beryllium, a toxic substance to which workers in the electronics, nuclear, and metalwork sector are exposed. The current OSHA beryllium standard, based on science from the 1950s, allows workers to be exposed at levels that are ten times higher than those allowed by Department of Energy for nuclear power plant workers. Public Citizen petitioned OSHA to update the standard in 2001. In response, the agency began a rulemaking in November 2002. It is a testament to major problems in the regulatory process that OSHA has still not issued appropriate rules. Issuance of a rule could avert thousands of cases of serious disease.[13]

- **Wall Street Accountability.** As discussed in more detail below, the 2008 financial crash was a direct result of regulatory failures. These failures including inadequate regulation of mortgages and other consumer financial products, on the one hand, and esoteric financial products and the markets on which they trade, on the other. Another critical failure was permitting the rise of too-big-to-fail financial institutions, traceable both to the failure to enforce existing rules and policies, and the repeal and nonissuance of important rules. While the Dodd-Frank Act is not perfect, it does include an array of very important reforms that will make our financial system fairer and more stable—if properly implemented through robust rulemaking.

  Among many other important provisions are crucial consumer protections. Dodd-Frank created the Consumer Financial Protection Bureau, charging the agency with the single mission of protecting consumers and empowering it to issue new consumer protection rules. Given the very considerable extent to which the financial industry has constructed a

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[11] List of Regulatory Actions Currently Under Review. Available from: <http://www.reginfo.gov/public/jsp/EO/eoDashboard.jsp>.

[12] U.S. Department of Energy. (2007). *Energy Independence and Security Act of 2007 Prescribed Standards.* Available from: <http://www1.eere.energy.gov/buildings/appliance_standards/m/eisa2007.html>.

[13] U.S. Occupational Safety and Health Administration. (2007). *Preliminary Initial Regulatory Flexibility Analysis of the Preliminary Draft Standard for Occupational Exposure to Beryllium.*

business model around deception and unjust fees, CFPB rulemaking can afford consumer dramatic benefits. Such rules concern matters including: requiring mortgage lenders to consider borrowers' ability to pay; prohibiting banks from charging excessive overdraft fees or tricking consumers into opting in to unreasonable overdraft fee harvesting schemes; eliminating forced arbitration provisions in consumer financial contracts; banning unfair practices in the payday loan industry; prohibiting kickbacks to auto dealers who steer buyers into overpriced loans; stopping student loan companies from tricking students into taking high-priced private loans before they exhaust cheaper federal loans.[14]

- **Generic competition for biotech medicines.** An overlooked component of the Affordable Care Act was the creation of a process for the Food and Drug Administration to grant regulatory approval for generic biologic pharmaceutical products—essentially generic versions of biotech medicines. Because the molecular composition of biologic drugs is more complicated than traditional medicines, FDA had adopted the position that, with some exceptions, it could not grant regulatory approval for biologics under its previously existing authority. In an important provision of the Affordable Care Act—supported by the biotech industry—FDA was explicitly granted such authority. The provision wrongly grants extended monopolies to brand-name biologic manufacturers, but belated generic competition is better than none. Implementation of the new regulatory pathway for biogenerics, however, depends on issuance of rules by the FDA. Biogeneric competition will save consumers and the government billions of dollars annually.

- **Crib safety.** Pursuant to the Consumer Product Safety Improvement Act of 2008, the Consumer Product Safety Commission (CPSC) finalized updated safety standards for cribs that halted the manufacture and sale of traditional drop-side cribs, required stronger mattress supports, more durable hardware and regular safety testing. These new crib safety standards mean "that parents, grandparents, and caregivers can now shop for cribs with more confidence—confidence that the rules put the safety of infants above all else."[15]

- **The Physician Payment Sunshine Act.** This component of the Affordable Care Act requires the disclosure of payments and gifts by pharmaceutical and medical device companies to physicians and hospitals. The mere fact of disclosure is expected to curtail

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[14] National Consumer Law Center. (2010). *An Agenda for the Consumer Financial Protection Bureau: Challenges for a New Era in Consumer Protection*. Retrieved 24 February, 2012, Available from:<http://www.nclc.org/images/pdf/regulatory_reform/pr-cfpb-agenda.pdf>

[15] Consumer Federation of America. (2011, June 28). *Senators, CPSC, Consumer Advocates Applaud Strong Crib Safety Standards to Prevent Infant Deaths and Injuries*. Available from: <http://www.consumerfed.org/pdfs/crib-standards-press-release-6-28-11.pdf>.

the improper influence of industry over research, education and clinical decision making. Putting the Act into place required implementing rules.[16]

- **Other examples.** The list of regulatory benefits is almost endless. Other recent examples from the wide spectrum include rules to address invasive species, require labeling of sourcing and origin in food, establishing standards for school lunch programs and specifying the migratory bird hunting season.

When viewed in the aggregate, regulations are overwhelmingly positive for the economy and reinforce the examples above. According to official government figures, the benefits that federal regulations provide to our country consistently dwarf the costs of those regulations. Every year, the Office of Management and Budget (OMB) analyzes the costs and benefits of rules with a major economic impact in a report to Congress. The most recent OMB report found that:

> The estimated annual benefits of major Federal regulations reviewed by OMB from October 1, 2003, to September 30, 2013, for which agencies estimated and monetized both benefits and costs, are in the aggregate between $217 billion and $863 billion, while the estimated annual costs are in the aggregate between $57 billion and $84 billion. These ranges are reported in 2001 dollars and reflect uncertainty in the benefits and costs of each rule at the time that it was evaluated.[17]

This means that even by the most conservative OMB estimates, the benefits of major federal regulations over the last decade have exceeded their costs by a factor of more than two-to-one, and benefits may have exceeded costs by a factor of up to fourteen. This makes regulation one of the best returns on investment and one that rivals some of the top performing businesses.

The Myth of Regulations Hurting our Economy

Sadly, false and misleading rhetoric propagates the myth that our country cannot have a strong economy without sacrificing bedrock public health, safety, environmental, and financial stability protections. There is simply no credible, independent, and peer-reviewed empirical evidence supporting the claim that there is a trade-off between economic growth and strong, effective regulatory standards. Experts from across the political spectrum have acknowledged that arguments linking regulations to job losses are nothing more than mere fiction. For example, Bruce Bartlett, a prominent conservative economist who worked in both the Reagan and George

[16] 42 CFR Parts 402 and 403. February 8, 2013.

[17] Office of Management and Budget, Office of Information and Regulatory Affairs. (2014). Draft 2014 Report to Congress on the Benefits and Costs of Federal Regulations an Unfunded Mandates on State, Local, and Tribal Entities. p.1. available at:

H.W. Bush administrations, referred to the argument that cutting regulations will lead to significant economic growth as "just nonsense" and "made up."[18]

Mr. Bartlett's claims are backed up by a recent book entitled "Does Regulation Kill Jobs?"[19], a comprehensive empirical study conducted by numerous distinguished regulatory experts and academics that closely scrutinized the claim that regulations are linked to job loss and concluded that "to date the empirical work suggests that regulation plays relatively little role in affecting the aggregate number of jobs in the United States."[20] The authors go on to definitively state that "the empirical evidence actually provides little reason to expect that U.S. economic woes can be solved by reforming the regulatory process."[21]

By contrast, the so-called "evidence" that regulations are killing jobs or ruining the economy comes from biased and partisan sources using methodology that is not peer-reviewed and doesn't pass muster under scrutiny. For example, the *Washington Post* recently vetted a report entitled "the Ten Thousand Commandments" from the Competitive Enterprise Institute claiming that the annual regulatory burden adds up to $15,000 for each household in America or 1.8 trillion for the whole country.[22] As the *Post* notes, the report foregoes any attempt at computing the benefits of the regulations it includes and the *Post* found that the report has "serious methodological problems" and deserved "two pinocchios" given that the report's authors themselves admit that the report is "not scientific" and "back of the envelope."[23] Reports using similar methodology and reporting similar trillion dollar cost figures have also been exposed as flawed and have been disavowed.[24]

These latest implausible and unfounded claims about regulations hurting the economy follow a long history of business complaining about the cost of regulations and predicting that the next regulation will impose unbearable burdens. Yet, in a 2013 report,[25] Public Citizen looked back at previous claims linking job losses to regulations, and found that none of them turned out to be even remotely accurate. Indeed, the disconnect between rhetoric and reality could not be more stark. In each case covered in the report, industry's claims look preposterous in retrospect. For instance, in the late-1970s, the petrochemical industry claimed that the phasing out of lead from

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[18] Charles Babington, Bruce Bartlett, Ex-Reagan Economist: Idea That Deregulation Leads to Jobs 'Just Made Up,' Huffington Post, October 30, 2011, http://www.huffingtonpost.com/2011/10/31/gop-candidates-plans-on-economy-housing_n_1066949.html?view=print&comm_ref=false.

[19] CARY COGLIANESE & ADAM M. FINKEL &CHRISTOPHER CARRIGAN, DOES REGULATION KILL JOBS (2013).

[20] *Id*. at 7

[21] *Id*. at 10

[22] Glenn Kessler, *The Claim That American Households Have a 15,000 Regulatory 'Burden'*, WASHINGTON POST (Jan 14, 2015) , http://www.washingtonpost.com/blogs/fact-checker/wp/2015/01/14/the-claim-that-american-households-have-a-15000-regulatory-burden/

[23] *Id*.

[24] Mark Drajem, *Rules Study Backed by Republicans 'Deeply Flawed,' Sunstein Says* (Bloomberg, June 3, 2011) *available at* http://www.bloomberg.com/news/2011-06-03/rules-study-backed-by-republicans-deeply-flawed-sunstein-says.html

[25] http://www.citizen.org/regulations-are-entirely-to-blame-report

gasoline would threaten an eye-popping 43 million jobs. Instead, the phase-out became an unmitigated public health and safety success story across the world. A 2011 study backed by the United Nations concluded that banning lead from gasoline had led to $2.4 trillion in annual benefits and 1.2 million fewer premature deaths, annually. The technological hurdles to find a suitable substitute for lead to stop engine "knock" barely rated a speed bump. Similar success stories regarding fuel efficiency measures, banning of carcinogenic vinyl chloride, Clean Air Act pollution standards, and unpaid family leave regulations proved that apocalyptic predictions from industry had no empirical basis whatsoever.

Lack of Strong and Effective Regulations Hurts Americans and Our Economy

Under-regulation is a form of regulatory failure that costs lives, results in preventable injuries, harms the environment often irreversibly, leaves consumers vulnerable to unsafe products and abusive practices, and leads to instability and recklessness in our financial system. Under-regulation touches virtually every regulatory sector and agency. Below is a sample of recent and current instances of under-regulation and the costs borne by the public and our economy:

- 2008 Wall Street Crash: The rampant deregulation that led to the crash cost our economy anywhere from 6 trillion to 14 trillion dollars or 50,000 to 120,000 for every US household. In addition, 8.7 million Americans lost their jobs during or immediately following the crisis.[26]
- Climate Change Inaction: Blocking or delaying new carbon emission rules from the EPA and other climate change measures will cost our country up to 150 billion dollars annually in economic damage in the future.[27]
- Preventable Workplace Deaths and Injuries: Every day, an average of 150 workers die from job injuries or occupational diseases. Every year, the lack of effective workplace safety protections costs our country 250 billion to 330 billion dollars in injuries and illnesses.[28]
- BP Oil Spill: This massive environmental disaster in the Gulf ended up costing more than 42 billion dollars. The oil spill harmed thousands of Gulf Coast residents and destroyed many local small businesses. BP has now been found "grossly negligent" in causing the disaster and faces up to 18 billion dollars in fines, some of which will go to Gulf Coast restoration projects.[29]

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[26] http://ourfinancialsecurity.org/blogs/wp-content/ourfinancialsecurity.org/uploads/2012/09/Costs-of-The-Financial-Crisis-September-20142.pdf

[27] http://fortune.com/2014/07/29/white-house-inaction-on-climate-costs-150-billion-a-year/

[28] AFL-CIO. (2015, April.) Death on the Job: The Toll of Neglect., http://www.aflcio.org/content/download/126621/3464561/DOTJ2014.pdf

[29] http://www.edf.org/blog/2014/09/05/bp-oil-spill-ruling-could-jumpstart-gulf-coast-restoration-work

- 2014 West Virginia Elk River Chemical Spill: those who were hurt by the damage caused by the spill are claiming 160 million in damages from the spill. These include small businesses in Charleston who were forced to shut down for days and the many thousands of residents who were forced to buy bottled water because of the severe water contamination.[30]
- Oil Freight Train Explosions: Trains carrying highly explosive crude oil are traveling through communities every day without most of those communities even aware of the threat. In 2013, a massive oil train derailment and explosion in Canada killed 47 people. The Department of Transportation expects an average of 10 oil train derailments each year over the next ten years totaling over 4.5 billion dollars in damages. [31]
- Lake Erie Algae Bloom: a half million Ohio residents were forced to buy bottled water because their water had become so badly contaminated from algae. In 2008, the government estimated algae blooms resulted in 82 million dollars annually in economic damages.[32] Algae Bloom damage to Lake Erie can be directly traced to successful attempts to roll back the Clean Water Act by special interests.[33]

Regulatory Paralysis Is One of the Main Causes of Under-Regulation

It is true that the regulatory system is broken, but not because there is too much regulation. Rather the system is broken because the current regulatory process is too slow, too calcified, and too inflexible to respond to public health and safety threats as they emerge. As Public Citizen's striking visual depiction of the regulatory process shows,[34] the current process is a model of inefficiency, with a dizzying array of duplicative and redundant requirements interspersed throughout a byzantine network that is a virtual maze for agencies to navigate. This is the result of an accumulation of analyses and procedures that Congress and the Executive have imposed on agencies over the years leaving agencies in a state of "paralysis by analysis." Far from the popular conception of "regulators run amok," the reality is that agency delays are rampant, congressional and judicial deadlines are routinely missed or pushed back, and ample evidence exists that the situation is getting worse. Below is a sampling of recent instances of regulatory delay that has hurt the public and our economy. As is apparent, delay permeates all aspects of the rulemaking process, touching virtually all agencies and regulatory sectors:

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[30] http://www.insurancejournal.com/news/southeast/2014/08/12/337282.htm
[31] http://www.sfgate.com/nation/article/Oil-trains-forecast-to-derail-at-10-per-year-in-6095446.php
[32] http://www.cop.noaa.gov/stressors/extremeevents/hab/current/econimpact_08.pdf the
[33] http://www.foodandwaterwatch.org/blogs/the-toledo-water-crisis-wont-be-the-last/
[34] Public Citizen, *The Federal Rulemaking Process*, http://www.citizen.org/documents/Regulations-Flowchart.pdf.

- Food Safety: Last month, the U.S. Food and Drug Administration (FDA) finally completed new food safety rules implementing the 2011 Food Safety Modernization Act. The regulations are intended to transform our food safety system into one that prevents tainted food outbreaks instead of just reacting to them. But the congressional deadline for finalizing these rules was in 2012. The cost of delay is steep: One in six Americans, or 48 million people, suffers from a foodborne illness each year, causing 128,000 hospitalizations and 3,000 deaths, according to the U.S. Centers for Disease Control and Prevention.[35]
- Workplace Safety: In a recent report, The Government Accountability Office (GAO) found that it takes the Occupational Safety and Health Administration (OSHA) an astonishing seven years on average to complete new rules to protect workers from known workplace safety hazards.[36] The GAO report points to OSHA's cumbersome rulemaking process as the culprit for delay. Many of the most important pending workplace safety rules have taken far longer than seven years to complete, including updates to decades-old standards on highly carcinogenic hazards such as beryllium and silica.
- Wall Street Reform: Significant delays have occurred at every stage of the implementation of the Dodd-Frank Act and continue to occur more than five years after passage of the Act. Almost a third of the rules required under Dodd-Frank have missed their statutory deadlines and dozens have yet to be proposed.[37] Overall, only sixty percent of Dodd-Frank rules have been finalized and roughly twenty percent of Dodd-Frank rules have yet to even be proposed.[38] The unfortunate reality is that five years after Dodd-Frank was passed, our country still doesn't have all the rules in place to prevent the next massive financial crisis.
- Oil Train Safety Standards: Earlier this year, The U.S. Department of Transportation (DOT) finalized new standards for trains transporting highly volatile oil, often through highly populated areas. This followed bi-partisan criticism that DOT had taken too long to put new rules in place while multiple oil train derailments and explosions occurred across the country. One of the regulators made clear why DOT was unable to move faster saying, "To be clear, I think we have to function in the regulatory process that exists. And it's not built for speed."[39]
- Passenger Rail Safety: The Rail Safety Improvement Act was passed in 2008 in response to multiple passenger rail accidents that claimed lives. One of the key elements of the law requires that railroad operators install positive train control systems (PTC), an automated train control technology that is designed to prevent train-to-train collisions. If PTC

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[35] http://www.cdc.gov/foodsafety/

[36] Workplace Safety and Health: Multiple Challenges Lengthen OSHA's Standard Setting, http://www.gao.gov/assets/590/589825.pdf

[37] http://www.davispolk.com/Dodd-Frank-Rulemaking-Progress-Report/

[38] *Id.*

[39] U.S. House Transportation and Infrastructure Comm., Oversight of the Ongoing Rail, Pipeline, and Hazmat Rulemakings, http://transportation.house.gov/calendar/eventsingle.aspx?EventID=398734

technology had been in place, it would have prevented the Amtrak crash outside of Philadelphia earlier this year that killed seven passengers and injured many others.[40] Instead, railroad operators have indicated that they will not be able to meet the deadline under the 2008 law to install PTC technology by December 31st of this year. This means further delays for a technology that is proven to save lives.

- Offshore Drilling Safety Measures: it has taken the U.S. Department of the Interior five years after the catastrophic British Petroleum (BP) oil spill in the Gulf of Mexico to propose new safety standards for blowout preventers on oil rigs. The failure of the blowout preventer on BP's Deepwater Horizon rig was a primary cause of this catastrophe, arguably the biggest ecological disaster of the past decade. The rule has yet to be finalized and implemented to prevent another offshore drilling disaster on the scale of BP.
- Truck Driver Training: In 1991, Congress passed a law requiring a rulemaking on training for entry-level commercial motor vehicle operators. More than 20 years, three lawsuits, and another statutory mandate later, DOT still has not enacted regulations requiring entry-level drivers to receive training in how to drive a commercial motor vehicle. It now says it plans to complete the rule in 2016.[41]
- Backover Rule: Each year, 292 people are killed, many of whom are children, due to backover collisions where drivers moving vehicles backward do not see people or objects behind the vehicle. Congress passed a law in 2008 requiring the DOT to update safety standards by requiring automakers to install technology to allow drivers to see behind their vehicles when moving backwards. DOT finally issued the standard in 2014, 3 years after the statutory deadline to issue the standard and after Public Citizen engaged in protracted litigation to force the finalization of the rule. The delay led to hundreds of pointless deaths.
- Cranes and Derricks: After a dozen years of delay, OSHA finally issued a rule demanded by both industry and workers alike to prevent accidents involving cranes and derricks toppling over at construction sites and injuring both workers and onlookers who were passing by the construction site. As a Public Citizen report explains in detail, OSHA held at least 18 meetings about the rule, published at least 40 notices in the federal register, and was required to repeatedly prove that the rule was needed, that no alternative could work, and that it had minimized effects on small businesses, even though many small businesses were requesting that the rule be implemented swiftly.[42]

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[40] http://www.cbsnews.com/videos/ntsb-investigator-positive-train-control-would-have-prevented-amtrak-crash/

[41] A full account of this history is included in In Re Advocates for Highway and Auto Safety: Petition for Writ of Mandamus, September 18, 2014. Available from: <http://www.citizen.org/documents/in-re-advocates-for-highway-and-auto-safety-petition-for-writ-of-mandamus.pdf>.

[42] Lincoln, T. and Mouzoon, N. (2011, April.) Cranes & Derricks: The Prolonged Creation of a Key Public Safety Rule. Public Citizen. p. 4. Available from: <http://www.citizen.org/documents/CranesAndDerricks.pdf>.

These numerous examples are anything but isolated incidents and are the rule with respect to the paralysis in our regulatory system, not the exception. Studies from organizations and think tanks across the political spectrum have conclusively demonstrated that regulatory delay is the current norm. For example, the R Street Institute, a conservative libertarian think tank, released a study[43] this summer that looked at all of the regulations that Congress had required over the last twenty years and where Congress had mandated that agencies meet rulemaking deadlines. The results of the study are astounding and should be deeply troubling for members of Congress. According to the study, federal agencies have only been able to meet *half* of the rulemaking deadlines that Congress has set out over the last twenty years. In other words, agencies have been unable to comply with congressional deadlines, in other words the law, an astonishing fifty percent of the time.

With respect to important public health and safety standards, environmental and consumer protections, and financial security measures, the situation may be even worse. In 2012, Public Citizen analyzed a list of rulemakings with statutory deadlines in the areas of food safety, Wall Street Reform, and auto safety among others. Our analysis showed that most rules are issued long after their deadlines have passed, needlessly putting American lives at risk. Of the 159 rules analyzed, seventy-eight percent missed their deadline. Federal agencies miss these deadlines for a variety of reasons, including having to conduct onerous analyses, dealing with politically motivated delays, inadequate resources or agency commitment, and fear of judicial review.[44]

Regulations Have Created Important Opportunities for Minorities

Regulations implementing laws passed by Congress to address racial discrimination, environmental injustice, and market practices in certain sectors which unfairly target minority populations have been among the most important and groundbreaking developments in the fight to level the playing field for minorities. Without these crucial regulations, numerous opportunities would have been denied to minority populations and would have reinforced the historical discrimination and unfair treatment that these populations have faced. These regulations range from prohibitions on employment and housing discrimination, to prohibitions on predatory lending practices that disproportionately impact minorities, to workplace safety protections that provide safe workplaces in industries dominated by Hispanic and immigrant workers, to establishment of voting rights for historically disenfranchised minority populations, to prioritizing lending to minority-owned small businesses and much, much more. While much has ben accomplished in the past, much more regulation is necessary to fulfill the promise of equal and fair treatment under the law. Below is a sample of recent or pending regulations that will create opportunities for minorities:

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[43] Atherley, S. (2015, August) Federal Agency Compliance with Regulatory Deadlines, R Street Policy Study No. 39, http://www.rstreet.org/wp-content/uploads/2015/07/RSTREET39.pdf

[44] Mouzoon, N. (2012). *Public Safeguards Past Due: Missed Deadlines Leave Public Unprotected.* Public Citizen. Available from: <http://www.citizen.org/documents/public-safeguards-past-due-report.pdf>.

- Environmental Justice: In 1994, President Clinton promulgated Executive Order 12898 which directed federal agencies to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high adverse human health or environmental effects of its activities on minority and low-income populations. This was an explicit recognition that minority populations, and particularly African Americans, are disproportionately harmed by air pollution from dirty energy sources including fossil fuel. Indeed, there are volumes of empirical evidence demonstrating that African Americans live in communities that violate air quality standards at a higher rate than whites, that African Americans are significantly more likely to live near a coal-fired power plant, that African Americans suffer from asthma at a far greater rate than whites, including a death rate from asthma that is twice that of whites.[45] Last week, the Environmental Protection Agency tightened the ozone or smog standard after many delays. While the standard will help increase air quality standards and reduce smog, the rule likely did not go far enough.
- Predatory Lending Practices that Target Minorities: while predatory lending affects many consumers, entrapping borrowers in a cycle of debt from which they cannot escape and funneling fees and charges to unscrupulous and abusive lenders, studies show that minorities are more vulnerable to predatory lenders than the general public. For example, African-American and Latino borrowers with credit scores above 660 were more than three times as likely as white borrowers with the same credit profile to receive a high-cost mortgage loan.[46] Across multiple loan categories, studies show that minorities receive predatory loans at higher rates than white borrowers. For example, African Americans are more than twice as likely to receive a payday loan as white borrowers. According to an analysis of automobile loans by the Consumer Financial Protection Bureau (CFPB), African Americans and Hispanic paid significantly higher interest rates compared to whites. Specifically, African Americans paid an additional twenty nine basis points and Hispanics paid an additional twenty basis points on auto loans relative to whites.
- Housing Discrimination: in 1968, Congress passed the Fair Housing Act (FHA) to address discrimination in the housing market that had led to geographic segregation. Many courts, including most recently the Supreme Court,[47] have acknowledged that addressing disparate treatment in the housing market would not fully achieve the FHA's goal of eradicating housing discrimination. Instead, disparate impacts on minority populations in the housing market would also demonstrate unlawful discrimination irrespective of discriminatory intent. The Department of Housing and Urban Development's forthcoming disparate impact rule under its Affirmatively Furthering Fair

[45] Air of Injustice, African Americans & Power Plant Pollution (October 2002).
[46] Wolff, S. State of Lending in American & Its Impact on U.S. Households, Center for Responsible Lending (June 2015), http://www.responsiblelending.org/state-of-lending/reports/13-Cumulative-Impact.pdf
[47] *Texas Department of Housing and Community Affairs v. The Inclusive Communities Project, Inc.*(June, 2015) opinion available at http://www.supremecourt.gov/opinions/14pdf/13-1371_m64o.pdf

Housing program will be a landmark step in ensuring that minorities are not subject to unfair discrimination in the housing market.

- Workplace Safety: Hazards at worksites disproportionately impact minorities, particularly Hispanics. According to the AFL-CIO, The fatality rate among Latino workers increased in 2013 to 3.9 per 100,000 workers, up from a rate of 3.7 per 100,000 in 2012. At the same time, the number and rate of fatalities for all other races declined or stayed the same. There were 817 Latino workers killed on the job in 2013 up from 748 deaths in 2012.[48]

Conclusion: Strengthening the System of Regulatory Protections to Strengthen America

There is much to celebrate in our nation's system of regulatory protections. It has tamed marketplace abuses and advanced the values we hold most dear: freedom, safety, security, justice, equality, competition and sustainability. We should celebrate the achievements of regulatory protections.

But in its current form, the regulatory system is failing to meet its promise. Rather than looking at how to scale back or hinder the regulatory system, Congress should look to reforms to strengthen the rulemaking process and regulatory enforcement which would address under-regulation that costs lives and our economy and would lead to new opportunities for minority populations.

[48] AFL-CIO. (2015, April.) Death on the Job: The Toll of Neglect, <http://www.aflcio.org/content/download/154671/3868441/DOTJ2015Finalnobug.pdf>.

"Testimony to the U.S. Senate Judiciary Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts: Opportunity Denied: How Overregulation Harms Minorities"

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The Most Precious Liberty That Man Possesses

The right to earn a living is, as Justice William O. Douglas said, "the most precious liberty that man possesses."[1] The right to get a job, or to start a business of one's own, in order to earn an honest living for oneself and one's family, is a fundamental human right.[2] The founding fathers called it "the right to pursue happiness." It is commonly considered a keystone of "the American Dream," and one of the major reasons why the "tired, the poor, the huddled masses yearning to breathe free" have sought American shores: the chance at economic independence is central to what it means to be free.

Sadly, that right is often stifled by laws that forbid people to practice certain trades unless they get government permission first. Occupational licensing laws of various sorts often impose such expensive and heavy burdens on people who want to start a business as to make those jobs virtually unreachable for those who cannot afford to undergo years of training and education and pass an expensive licensing exam. Occupational licensing is supposed to protect the public against dangerous, incompetent, or dishonest practitioners, but as Justice John Paul Stevens warned, "private parties have used licensing to advance their own interests in restraining competition at the expense of the public interest."[3] Licensing laws are already pervasive and is becoming more so. Today, a third of all workers need some form of government permission to do their jobs.[4] And the more burdensome licensing requirements become, the more difficult it becomes for members of minority groups, who have fewer resources to get licenses, to obtain the permission necessary to practice their trade.

The fact that government restrictions on business have a disproportionately negative impact on members of racial minorities is no surprise. For decades, economists of the "public choice" school have explained that when government has the power to impose burdens on some people and grant benefits to others, that power itself becomes a valuable commodity. Groups within society will therefore invest time and money in obtaining the use of that power, in hopes of profit. Economists call this "rent seeking," ordinary people call it "lobbying." Those with less political influence will typically fail to obtain that power. Therefore any government program to redistribute wealth or opportunity will typically fall into the hands of the most politically influential—and the burdens of that program will typically fall on those who lack the political wherewithal to defend themselves in the democratic process. Usually this means the poor or members of minority groups.

Consider just one example: Florida requires people to have a college degree and pass a government exam before they can practice the business of "interior design."[5] In other words, a person must spend thousands of dollars, and study for two years, and then pass a difficult test, before that person can advise me on what color drapes to hang in my living room. This requirement has a racially disproportionate impact, and it is no surprise: black and Hispanic interior designers are about 30 percent less likely to have a college degree than are whites.[6] And because it costs $1,200 just to take the exam,[7] many poor people doubtless find it prohibitively expensive to get a license.

Similar patterns exist in most industries, and the effects are more severe toward the entry-level side of the spectrum. Thus one recent study showed that increasing the number of hours required to obtain a manicurist license by 100 hours reduced the number of Vietnamese

manicurists by 18 percent.[8] Other studies have shown that members of minority groups are significantly more likely to fail the written portion of a licensing exam than the practical portion—which indicates that failure is less attributable to an applicants' actual inability than to other factors, such as reading skills, which are skewed by the racial disproportion in overall educational attainment that is already well-documented nationwide.[9] In many cases, minority members are forced to respond to licensing requirements not by shutting down their businesses, but by simply operating illegally, and hoping not to get caught. One Maryland survey in 1953 found only two licensed black plumbers in the entire state—and 96 unlicensed ones.[10] Of course, people operating without licenses are vulnerable to abuse by organized crime or by corrupt government officials. In 2010, Florida police officers used licensing laws as a handy excuse to conduct armed raids of black- and Hispanic-owned barbershops, where they suspected drug deals were going down. (Apparently they found nothing, but arrested 37 suspects for unlicensed barbering.)[11]

The racially disproportionate impact of licensing laws is nothing new. In the 19th century, my home state of California sought to exclude Chinese immigrants from competing against whites for jobs. One common way of doing this was to use licensing to block the Chinese from engaging in their trade.[12] At the state's Constitutional Convention of 1879, some delegates were quite explicit about this. "I am willing to go as far as any gentleman on this floor," said one, "by way of police, sanitary, criminal, or vagrant regulations, or refusing to license this class of aliens to carry on any trade or business whatever, if we can in any way, by statute or otherwise, prevent the same. And I would go further and continue to hamper them in every way that human ingenuity could invent, so that the 'heathen Chinee' himself would see that it was getting too hot for him to attempt to try to make a living here, and would consequently leave for his own or some other more genial climate."[13]

In 1883, the Supreme Court struck down a San Francisco law that imposed a licensing requirement on laundry businesses in the city, because it was common knowledge that the law was used to exclude the Chinese from running laundry businesses. The Court declared that "the very idea that one man may be compelled to hold his…means of living…at the mere will of another" was "intolerable in any country where freedom prevails." Indeed, it was "the essence of slavery itself."[14] Nevertheless, states regularly used licensing laws to forbid economic competition from disfavored racial groups,[15] or immigrants,[16] or political undesirables.[17] In the South, of course, states regularly used licensing laws to restrict economic competition from former slaves and their descendants.[18] Licensing of barbers and cosmetologists, for example, was often used in the early 20th century for the express purpose of blocking minority entrepreneurs from competing for jobs.[19]

These disfavored minorities, unable to defend themselves at the ballot box, necessarily turned to the courts—and particularly federal courts—for protection, and they often received it, at first. During the period between about 1880 and 1940, federal courts were often attentive to protecting the right to earn a living, including the right of disfavored groups to pursue and occupation. Perhaps the best example is 1923's *Adkins v. Children's Hospital*,[20] in which the Supreme Court struck down a Washington, D.C., law that imposed a minimum wage for women. Such a law, which requires employers to pay women more than men, obviously encourages employers to replace their female employees with cheaper male labor. That is why

male-dominated trade unions supported these laws, as a way of barring their female competitors from the labor market.[21] The Court had, about 20 years previously, upheld an Oregon law that prohibited women from working overtime, on the theory that women were too shy and weak to decide for themselves what hours they were willing to work for.[22] But in *Adkins*, the Progressive feminist Justice George Sutherland overruled that prior case, declaring that women had every bit as much right as men to decide for themselves what wages and hours they were willing to work for, and did not need the government to "protect" them from themselves.[23]

Rational Basis Scrutiny: Judicial Abdication

Alas, federal courts today have today largely abandoned precedents like *Adkins*, as a consequence of the Supreme Court's invention of so-called "rational basis scrutiny." This is the legal test judges use when deciding whether a law unconstitutionally restricts a person's right to pursue an occupation.[24] The "rational basis" test holds that when a law is "rationally related to a legitimate government interest," it will be upheld, and any restriction on economic liberty is presumed to be constitutional unless the plaintiff can prove that no legislator could ever have believed it was a good idea. This is a truly extreme proposition. One judge has explained that the test requires judges "to cup [their] hands over [their]eyes and then imagine if there could be anything right with the statute."[25] The rational basis test requires plaintiffs to prove a negative: to prove that there cannot be any conceivable state of facts that would justify the law.[26] Justice John Paul Stevens rejected this idea, holding that it would be "tantamount to no [judicial] review at all," because "it is difficult to imagine a legislative classification that could not be supported by a 'reasonably conceivable state of facts.'"[27] And the Court has indeed backed away slightly from the most extreme form of the rational basis test,[28] but these steps have been uncertain, and its progress is much too slow. Today, thanks to the rational basis test, restrictions on economic liberty are upheld in all but the most extreme instances.

That test represents the judiciary's abdication of its constitutional obligation to fully and fairly guarantee economic liberty—a right "deeply rooted in this nation's history and tradition"[29]—against unjustifiable interference by the government.[30]

Such abdication has particularly harsh consequences for members of minority groups, because courts are typically where they look for protection against the tyranny of the majority—or against legislatures that arbitrarily deprive them of life, liberty, or property. As Justice Robert Jackson said, the "very purpose" of the Constitution is "to withdraw certain subjects from the vicissitudes of political controversy, to place [our rights] beyond the reach of majorities and officials."[31] But thanks to the rational basis test, federal courts have almost entirely forsaken the right to economic freedom. Thus Americans have virtually no meaningful protection against exploitation by legislatures or appointed government officials when it comes to this right.

Consider the Florida interior design law. If it were not already obvious that there is no justification for forcing people to get a government license before allowing them to advise consumers on interior decoration, there are plenty of comprehensive surveys that show no significant danger to the public from unlicensed interior designers.[32] Interior designer licensing

is a monopolistic privilege created by the American Society of Interior Designers, a nationwide lobbying group that has devoted millions of dollars to getting laws passed that make it illegal for people to practice the trade of interior design without government permission—not to protect the public, but to protect themselves against potential competitors.[33]

But when a would-be designer challenged the constitutionality of Florida's licensing law, the Eleventh Circuit refused to consider the evidence in the case, and applied the rubber-stamp rational basis test. It held that the state had "no obligation to produce evidence" showing that licensing interior designers was necessary,[34] and that the state could forbid people from practicing this business based purely on legislative "speculation unsupported by evidence or empirical data."[35] The court would uphold this prohibition on a person's ability to earn a living "even [though] it seems…illogical."[36]

Imagine if this were the way criminal law cases were decided: a person accused of a crime shows at trial that there is no evidence to prove his guilt—but the judge deprives him of liberty anyway, because, after all, he did not "disprove" the state's "speculation"! This Committee would be outraged by such a rule, and it would be outraged by a rule allowing states to deprive people of freedom of speech, or freedom of religion, or freedom of travel, on such a flimsy and biased pretext. But when it comes to economic freedom—even something as harmless as the right to run a business that recommends what color I should paint my kitchen—courts regularly allow states to arbitrarily deprive people of their liberty without any evidence that such deprivations are justified by the facts. Courts simply refuse to discharge their duty to consider the evidence. Instead, they "cup [their] hands over [their] eyes"[37] and allow federal and state legislatures or administrative agencies virtually unlimited power to deprive people of a central aspect of freedom.

D.C. Circuit Judges Brown and Sentelle have explained the point well. "The practical effect of rational basis review," they write, "is the absence of any check on the group interests that all too often control the democratic process. It allows the legislature free rein to subjugate the common good and individual liberty to the electoral calculus of politicians, the whim of majorities, or the self-interest of factions. The hope of correction at the ballot box is purely illusory…. Rational basis review means property is at the mercy of the pillagers. The constitutional guarantee of liberty deserves more respect—a lot more."[38]

Competitor's Veto Laws

There is one particularly insidious kind of occupational licensing law that deserves special notice: Competitor's Veto laws, also known as "Certificate of Public Convenience and Necessity" or "Certificate of Need" laws. Unlike ordinary occupational licensing, which requires people to satisfy certain education and training requirements, Competitor's Veto laws have no connection whatever to whether a person is honest or qualified. Instead, these laws forbid anyone, no matter how qualified, from practicing a trade unless that person first *gets permission from all of the businesses already operating*. Bizarre as that may seem, such laws are on the books in most states, regulating a wide variety of industries—everything from taxi and limousine businesses to moving companies, liquor stores, car dealerships, and even hospitals.

In all these industries, it is illegal to operate unless a person first gets permission from his own competitors.[39]

These laws were first invented to regulate public utilities such as railroads. But they remain on the books regulating even perfectly ordinary competitive industries such as moving companies. As I have shown in two recent articles, these laws are frequently used for the exclusive purpose of restricting competition against incumbent businesses.[40]

These laws are simply unconstitutional.[41] However lax the Supreme Court has been in protecting economic liberty, at least it has always held that licensing laws must relate in some way to a person's "fitness or capacity to practice" the business in question.[42] Competitor's Veto laws do not even pretend to relate to a person's fitness or capacity. Instead, they provide that even fully qualified applicants may be denied a license to operate simply because government officials believe that there are already "enough" businesses already pursuing that line of work. That is why the Supreme Court has struck down every Competitor's Veto law that it has ever reviewed.[43]

Competitor's Veto laws are routinely couched in extraordinarily broad and vague terms, which have the sole purpose of protecting established insiders against legitimate competition from newcomers. Consider, for example, the cases of my clients, Maurice Underwood, Steve Saxon, and Danelle Perlman. Maurice lives in Reno, where he wants to start a moving business.[44] Danelle lives in the Lake Tahoe area, where she runs a limousine business. Steve lives in Sacramento, California, where he runs a moving business that he'd like to expand into Nevada.[45]

Unfortunately, Nevada has a Competitor's Veto law on the books, which is the nation's most explicitly anti-competitive licensing law. Before Maurice or Steve can run their moving companies, and before Danelle can add a new limousine to her fleet, they must get permission from the Nevada Transportation Authority. To get permission is not easy. First they have to attend a hearing, which requires them to obtain legal representation—often a very costly proposition for a small business. At that hearing, existing businesses are allowed to object and testify that they don't want any more competition. Maurice, Danelle and Steve must then prove to the government that, among other things,

- "The granting of the certificate or modification will not unreasonably and adversely affect other carriers operating in the territory…"

- The granting of a new license will "foster sound economic conditions,"

- "The proposed operation . . . will benefit and protect . . . the motor carrier business in this State"

- "The market identified by the applicant as the market which the applicant intends to serve will support the proposed operation or proposed modification";

- "the potential creation of competition in a territory which may be caused by the granting of the certificate or modification, by itself, will [not] unreasonably and adversely affect other carriers operating in the territory"; and

- "The proposed operation or the proposed modification will be consistent with the legislative policies set forth in NRS § 706.151"—which itself says that one of these legislative policies is to "discourage any practices which would tend to increase or create competition."[46]

These criteria have nothing to do with whether Maurice Underwood is fit and qualified to operate a moving business, or whether Danelle Perlman is qualified to add another limousine to her fleet. Moreover, the Ninth Circuit Court of Appeals—which of course governs Nevada—has held that it is unconstitutional for the government to use licensing laws simply to protect some people against competition from others.[47] Yet the state continues to enforce these laws without regard to the constitutional right of all Nevadans to earn a living without unreasonable government interference. Note also how vague these standards are: even the head of the Nevada Transportation Authority testified at a state Senate hearing that he could not define what "sound economic conditions" means. "You know it when you see it," he said.[48]

Faced with restrictions like these, it's no wonder that most entrepreneurs simply abandon their efforts to get a license when they learn of these laws. When I litigated challenges to similar laws in Missouri and Kentucky, we found that applicants typically did not bother to go through the expensive, time-consuming hearing and licensing process, because they knew they were almost certain to be denied a license.[49] And, again, because Competitor's Veto laws privilege insiders against outsiders and impose expensive and time-consuming burdens on entrepreneurs in entry-level businesses, they also typically have a racially disproportionate effect. In 2009, Kentucky officials settled a lawsuit against them that alleged that the state's Competitor's Veto law had a racially disproportionate impact—by allowing the plaintiff to start a moving company.[50]

Competitor's Veto laws are unconstitutional, at least in ordinary competitive industries like moving companies or limousines, and should be entirely and immediately abolished.

What Can Congress Do?

Because most restrictions on economic liberty are imposed by state laws, I am often asked if there is anything that the federal government can do to protect this essential freedom. The answer is yes. Because this is a constitutional right of all Americans, the Fourteenth Amendment gives Congress a powerful tool to protect this right against federal interference. I have three initial recommendations for how Congress could act today to protect the right to earn a living.[51]

1. *Civil rights legislation to protect economic liberty.* Congress should use its Fourteenth Amendment powers to protect this long-neglected civil right against abridgment by states. Although today's civil rights laws would do this job if they were properly

enforced, courts have failed in that duty, in part because they believe Congress has acquiesced in the judiciary's neglect of this right. Further legislation is therefore essential to emphasize the importance of the right to earn a living, and ensure meaningful protection in the courts. I suggest language along the following lines: "All adult persons, except as a punishment for crime whereof the party shall have been duly convicted, shall be free, in every state and territory in the United States, to make and enforce contracts; to earn, purchase, sell, hold, and convey real and personal property; and to pursue lawful occupations, subject only to such restrictions as substantially protect the public health and safety…."

2. *Spending clause legislation that conditions federal grants to jobs and education programs on states abolishing unjustifiable restrictions on economic liberty*. Such legislation could be framed along the lines of the Religious Freedom Restoration Act or the Religious Land Use and Institutionalized Persons Act. It makes eminent sense that if Congress is going to give states money to spend on job-training, states should reduce their barriers to economic liberty in exchange for those grants. I recommend language such as: "No government shall impose or implement a licensing requirement on a trade or occupation in a manner that imposes a substantial burden on the economic liberty of a person, unless the government demonstrates that imposition of the requirement on that person (a) furthers the protection of public health or safety; and (b) is the least restrictive means of furthering that protection…."

3. *Reducing or eliminating antitrust immunities for government regulatory agencies*.[52] In its recent decision in *North Carolina Board of Dental Examiners v. FTC*,[53] the Supreme Court made clear that states cannot exempt private parties from antitrust laws simply by deputizing them as government regulators. As the Court declared, "prohibitions against anticompetitive self-regulation by active market participants are an axiom of federal antitrust policy."[54] If, in fact, antitrust law exists to protect competition, and not competitors, then state governments—the entities best situated to create and maintain monopolies that harm consumers and block competitors from earning a living—should not only be liable to antitrust prosecution, but should probably be the prosecutors' first target. Under today's *Parker* immunity doctrine, unfortunately, they are usually immune from those laws. *Parker* immunity should be sharply limited to cases where it is actually necessary for states to restrict competition to protect the public safety. Congress could amend the antitrust laws to require as a condition for *Parker* immunity: (1) that the restrictions on competition at issue in a case be actually commanded by state law, (2) that the state actors at issue be actively supervised by individuals directly answerable to voters, and (3) that the state prove that its restriction on competition substantially advances an important government interest.

These are only initial suggestions. There is also much need to rein in the extreme discretion of administrative agencies at the state and federal levels;[55] for a coherent legal doctrine of free speech for business owners;[56] for protections against states banning convicted

felons from ever obtaining licenses;[57] and for an Office of Economic Liberty in the Civil Rights Division of the Justice Department. There should be at least some central clearinghouse to collect data and monitor the violations of this long-neglected civil right.[58]

If America is to be Land of Opportunity; if she is to be the refuge for the unfree people of the world, as she has been for generations of immigrants who found here the possibility of independence and success; if she is to be a place where the American Dream can become a reality, and the poor man or woman can rise prosperity and comfort through hard work instead of political favoritism; if she is to make good on her promise of life, liberty, and the pursuit of happiness—then her judicial system must give force to her constitutional guarantees. But while this nation's courts refuse to protect the right to earn a living, we all suffer—entrepreneurs and consumers alike. And those who need economic liberty the most—the poor and members of minority groups—also suffer the most.

Notes

[1] *Barsky v. Bd. of Regents*, 347 U.S. 442, 472 (1954) (Douglas, J., dissenting).
[2] *See generally* Timothy Sandefur, *The Right to Earn a Living* (2010).
[3] *Hoover v. Ronwin*, 466 U.S. 558, 584 (1984) (Stevens, J., dissenting).
[4] Dept. of Treasury Offc. of Econ. Pol'y, et al., *Occupational Licensing: A Framework for Policymakers* 3 (July 2015), https://www.whitehouse.gov/sites/default/files/docs/licensing_report_final_nonembargo.pdf.
[5] Fla. Stat. §§ 481.207, 481.209.
[6] David E. Harrington & Jaret Treber, *Designed to Exclude: How Interior Designers Use Government Power to Exclude Minorities & Burden Consumers* 1 (Institute for Justice, Feb. 2009), https://www.ij.org/images/pdf_folder/economic_liberty/designed-to-exclude.pdf.
[7] Exam Fee Schedule, http://www.ncidqexam.org/exam/fees/.
[8] Kathy K. Krynski & David E. Harrington, *The Impact of State Licensing Regulations on Low-Skilled Immigrants: The Case of Vietnamese Manicurists*, 96 Am. Econ. Rev. 237-31 (2006), http://digital.kenyon.edu/cgi/viewcontent.cgi?article=1018&context=economics_publications
[9] Walter Williams, *Race and Economics: How Much Can Be Blamed on Discrimination?* 76-77 (Stanford: Hoover Institution, 2011).
[10] Daniel Klein, *et al., Was Occupational Licensing Good for Minorities? A Critique of Marc Law and Mindy Marks*, 9 Econ. J. Watch 210, 214 (2012), http://econjwatch.org/articles/was-occupational-licensing-good-for-minorities-a-critique-of-marc-law-and-mindy-marks.
[11] Jeff Weiner, *Criminal Barbering? Raids at Orange County Shops Lead to Arrests, Raise Questions*, Orlando Sentinel, Nov. 7, 2010, http://articles.orlandosentinel.com/2010-11-07/health/os-illegal-barbering-arrests-20101107_1_criminal-barbering-licensing-inspections-dave-ogden.
[12] *See* David E. Bernstein, *Lochner, Parity, and the Chinese Laundry Cases*, 41 Wm. & Mary L. Rev. 211 (1999).
[13] E.B. Willis & P.K. Stockton, *Debates And Proceedings of The Constitutional Convention of the State of California* 727 (1878) (Remarks of Mr. Thompson).
[14] *Yick Wo v. Hopkins*, 118 U.S. 356, 370 (1886).
[15] *See, e.g, Takahashi v. Fish & Game Comm'n*, 334 U.S. 410 (1948).
[16] *See, e.g., Truax v. Raich*, 239 U.S. 33 (1915).
[17] *Schware v. Board of Examiners*, 353 U.S. 232 (1957).
[18] *See generally* David E. Bernstein, *Only One Place of Redress* (2001).
[19] David E. Bernstein, *Licensing Laws: A Historical Example of the Use of Government Regulatory Power Against African-Americans*, 31 San Diego L. Rev. 89, 99-103 (1994); Benjamin Shimberg, et al., *Occupational Licensing: Practices and Policies* 160-64 (1973); Even Marc T. Law & Mindy S. Marks, *Effects of Occupational Licensing Laws on Minorities: Evidence from The Progressive Era* (Oct. 19 2006) http://economics.ucr.edu/papers/papers06/06-05.pdf, which otherwise rejects the thesis that occupational licensing had deleterious effects on black entrepreneurs, acknowledges that such effects did occur in the barbering trade. Their study has been subject to some severe critiques. Daniel Klein, *et al., supra* note 10.
[20] 261 U.S. 525 (1923).
[21] *See* Michael McGerr, *A Fierce Discontent: The Rise and Fall of the Progressive Movement in America* 136-38 (2003).
[22] *Muller v. Oregon*, 208 U.S. 412, 421-23 (1908) ("woman's physical structure and the performance of maternal functions place her at a disadvantage in the struggle for subsistence.... [W]oman has always been dependent upon man.... [S]he has been looked upon in the courts as needing especial care.... Though limitations upon personal and contractual rights may be removed by legislation, there is that in her disposition and habits of life which will operate against a full assertion of those rights.").
[23] *See* Hadley Arkes, *The Return of George Sutherland* ch. 3 (1994).

[24] Modern rational basis scrutiny essentially began with *Nebbia v. New York*, 291 U.S. 502 (1934), but it was not until several years afterward that the Court embraced the extreme form of deference today known by that name. *See generally* Timothy Sandefur, *Rational Basis and the 12(b)(6) Motion: An Unnecessary "Perplexity,"* 25 Geo. Mason U. Civ. Rts. L.J. 43, 59 (2014).

[25] *Arceneaux v. Treen*, 671 F.2d 128, 136 n.3 (5th Cir. 1982) (Goldberg, J., concurring). Even more telling is the exchange between the Ninth Circuit and a Justice Department attorney recounted in Gideon Kanner, *"(Un)equal Justice Under Law": The Invidiously Disparate Treatment of American Property Owners in Taking Cases*, 40 Loy. L.A. L. Rev. 1065, 1080 n.68 (2007).

[26] *F.C.C. v. Beach Commc'ns, Inc.*, 508 U.S. 307, 313 (1993).

[27] *Id.* at 323 (Stevens, J., dissenting).

[28] *See* Sandefur, *Rational Basis and the 12(b)(6) Motion, supra* note 24 at 59-60.

[29] This phrase, from *Washington v. Glucksberg*, 521 U.S. 702, 721 (1997) (quoting *Moore v. City of E. Cleveland*, 431 U.S. 494, 503 (1977)), purports to identify those rights considered "fundamental" under our Constitution. There can be no dispute that the right to economic liberty falls within this definition. *See* Sandefur, *Right to Earn A Living, supra* note 2 at 1-25; Steven G. Calabresi & Larissa C. Leibowitz, *Monopolies and the Constitution: A History of Crony Capitalism*, 36 Harv. J.L. & Pub. Pol'y 983, 984 (2013). Yet it has been almost entirely ignored by modern courts, which have relegated it by fiat to "non-fundamental" status.

[30] See further Timothy Sandefur, *Disputing the Dogma of Deference*, 18 Tex. Rev. L. & Pol. 121, 122 (2013).

[31] *W. Virginia State Bd. of Educ. v. Barnette*, 319 U.S. 624, 638 (1943).

[32] One of the most comprehensive was Colorado's 2000 "Sunrise Report" that found no need to establish a licensing requirement for interior designers in that state. *See* Interior Designers 2000 Sunrise Review, http://tinyurl.com/nfjamjt. *See also* Jared Meyer, *Interior Design Doesn't Kill, but Regulating It Does*, Manhattan Institute, Aug. 6, 2015, http://www.economics21.org/commentary/interior-design-occupational-licensing-Institute-Justice-08-06-15.

[33] David E. Harrington & Jaret Treber, *Designed to Exclude: How Interior Designers Use Government Power to Exclude Minorities & Burden Consumers* 1 (Institute for Justice, Feb. 2009), https://www.ij.org/images/pdf_folder/economic_liberty/designed-to-exclude.pdf.

[34] *Locke v. Shore*, 634 F.3d 1185, 1196 (11th Cir. 2011).

[35] *Id.* at 1196.

[36] *Id.* at 1196-97.

[37] *Arceneaux*, 671 F.2d at 136 n.3.

[38] *Hettinga v. United States*, 677 F.3d 471, 482-83 (D.C. Cir. 2012) (Brown and Sentelle, JJ., concurring), cert. denied, 133 S.Ct. 860 (2013). Although he chose not to join their opinion, Judge Griffith expressed sympathy with his colleagues' views. *See id.* at 483 (Griffith, J., concurring).

[39] *See generally* Timothy Sandefur, *CON Job*, Regulation (Summer 2011), http://object.cato.org/sites/cato.org/files/serials/files/regulation/2011/8/regv34n2-1.pdf.

[40] Timothy Sandefur, *State "Competitor's Veto" Laws and the Right to Earn A Living: Some Paths to Federal Reform*, 38 Harv. J.L. & Pub. Pol'y 1009 (2015); Timothy Sandefur, *A Public Convenience and Necessity and Other Conspiracies Against Trade: A Case Study from the Missouri Moving Industry*, 24 Geo. Mason U. Civ. Rts. L.J. 159 (2014).

[41] *See Bruner v. Zawacki*, 997 F. Supp. 2d 691 (E.D. Ky. 2014).

[42] *Schware*, 353 U.S. at 239.

[43] *See New State Ice Co. v. Liebmann*, 285 U.S. 262 (1932); *Buck v. Kuykendall*, 267 U.S. 307 (1925); *Frost v. Railroad Commission of California*, 271 U.S. 583 (1926). *See also Schaffer Transp. Co. v. United States*, 355 U.S. 83, 90-91 (1957) ("To reject a motor carrier's application on the bare conclusion that existing rail service

can move the available traffic, without regard to the inherent advantages of the proposed service, would give one mode of transportation unwarranted protection from competition from others.").

[44] Pacific Legal Foundation, *Moving Roadblocks to Competition And Free Enterprise in Nevada*, http://www.pacificlegal.org/cases/Moving-roadblocks-to-competition-and-free-enterprise-in-Nevada

[45] Pacific Legal Foundation, *Nevada is Sued for Stifling Competition in Transportation Industry*, http://www.pacificlegal.org/releases/release-2-19-15-wilson-perlman-15-307

[46] Nev. Rev. Stat. §§ 706.391, 706.151.

[47] *Merrifield v. Lockyer*, 547 F.3d 978, 991 n.5 (9th Cir. 2008).

[48] Timothy Sandefur, *PLF Urges Court to Protect Maurice Underwood's Right to Earn A Living*, PLF Liberty Blog, June 3, 2013, http://blog.pacificlegal.org/plf-urges-court-to-protect-maurice-underwoods-right-to-earn-a-living/.

[49] *See* Sandefur, *State "Competitor's Veto" Laws, supra* note 40 at 1036-37; Sandefur, *A Public Convenience and Necessity*, supra note 40 at 181.

[50] Sandefur, *State "Competitor's Veto" Laws, supra* note 40 at 1040-41.

[51] I explain in greater detail in *id.* at 1057-66.

[52] I explain this proposal in greater detail in Timothy Sandefur, *Freedom of Competition and the Rhetoric of Federalism: North Carolina Board of Dental Examiners v. FTC*, Cato Sup. Ct. Rev., 2014-2015, at 195.

[53] 135 S. Ct. 1101 (2015).

[54] *Id.* at 1111.

[55] For one thing, administrative agencies should be restricted to enforcing existing rules instead of making new ones. Arizona has taken a step in this direction by enacting A.R.S. § 41-1038, which limits the ability of agencies to impose new rules that burden the right to earn a living. Agencies should also be required to comply with ordinary legal rules of evidence in all enforcement proceedings. At present, many states allow agencies to use, for example, hearsay evidence in enforcement proceedings. This is a plain violation of due process of law, particularly where—as in California—any subsequent judicial review of the agency proceeding is subject to rules of deference that forbid the litigants from introducing any new evidence or contradicting the "evidence" that was admitted at the administrative agency level.

[56] Particularly troubling is the legal doctrine of "professional speech"—a term the Supreme Court has never used, since it has never pronounced on the subject at all. This doctrine holds that First Amendment protections do not apply to speech by licensed professionals or persons acting within their profession. Thus medical doctors and others may have their speech rights overridden by legislative fiat. Given the absence of controlling Supreme Court precedent on this question, however, there is much confusion among the courts as to what sort of constitutional protections apply to this sort of speech. *See* Brief Amicus Curiae Pacific Legal Foundation in Support of Petition for Certiorari, *Hines v. Alldredge*, No. 14-1543, http://blog.pacificlegal.org/wp/wp-content/uploads/2015/07/HinesACCert.pdf.

[57] Such blanket prohibitions are unconstitutional, *Barletta v. Rilling*, 973 F. Supp. 2d 132, 137 (D. Conn. 2013), and have a racially disproportionate impact. *See* Leroy D. Clark, *A Civil Rights Task: Removing Barriers to Employment of Ex-Convicts*, 38 U.S.F. L. Rev. 193, 201-05 (2004)

[58] To take one example of the neglect of this fundamental right: in February, 2013, I joined several other witnesses in testifying before the United States Commission on Civil Rights regarding the disproportionate burden that economic regulations have on racial minorities. In November, 2013, the Commission quashed the report that resulted from that hearing, because it considered the results "too one-sided."

Impact of Regulations on Minority businesses

Testimony of

Mr. William C Scott
Senior Consultant, Emerging ChangeMakers
and CEO Tristatz, LLC
Mosses, Alabama

October 6, 2015

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Good afternoon, my name is William Scott and for almost 11 years, I have focused my career on providing economic development and resources to small businesses education institutions, and nonprofits. My motto is "A Quitter Never Wins and A Winner Never Quits". I am the CEO of Tristatz, LLC, a successful community & economic development consulting company in Selma, AL. I am the host of a top rated Small Business Radio Show "The Business Doctor" that broadcasts live and streams through the internet to an audience of over 150,000. I have worked in various business cultures and professional environments. I won first place in the 2013 Tuskegee University Booker T. Washington Business Pitch Contest for a presentation of the impact of a Private Owned Business Resource Center in Rural America. I am the former Mayor and council member of the Town of Mosses that is located in Lowndes County, Alabama.

Over the years, I have worked for the United States Department of Commerce as a Partnership Specialist and as the Black Belt Outreach Coordinator for The Honorable Congresswoman Terri A. Sewell of the 7th Congressional District.

I have completed 12 years of dedicated service with the United States Army, earned an Iraq War Honorable Service Award, was selected as the Battalion Solider of the year and received the Army Achievement Medal. I am active member of The Delta Leadership Network, The Black Belt Commission Executive Board, The Black Belt Infrastructure Committee, and The State Bicentennial Committee. I have served as a member of numerous organizations such as The Delta Regional Authority, The League of Municipalities, The Children's Policy Council, Community Action Agency, 21st Century Leadership and other civic organizations.

I am the youngest of 14 siblings, a faithful member of the St. Francis Apostle Church of God, Board Trustee.

“Helping people and providing quality service is my primary goal in life”.

All this is to say that I come today as someone deeply committed to helping my community and this country. As you can hear from my some of my background, my diverse experiences allow me to understand issues from multiple perspectives.

I represent small business businesses in economically distressed communities with majority black populations. What I find in these communities is a high level of innovative and creative minds. I speak for these entrepreneurs who provide vital resources and services and products that keep their local economy operating daily.

But it’s not just the black small businesses in Alabama that I represent. Nationwide there has been a dramatic increase in black entrepreneurship. In fact, according to Fortune, “the number of businesses owned by African American women grew 322% since 1997, making black females the fastest growing group of entrepreneurs in the U.S.”

So while many say that federal regulations are stifling small business growth, the statistics and I are here to tell you that is not the case certainly in the African-American community.

I understand first hand the needs of so many black entrepreneurs in our communities. And I can tell you that regulations play an important role in my work and success, in meeting the needs of our businesses and in protecting our community.

In addition to being the CEO of Tristatz, I am also the senior consultant with Emerging ChangeMakers Network in Alabama. This Network brings innovative idea and inspiring leaders together to address issues of economic inequality. Emerging Changemakers functions at the intersection of cultural change by community leadership and social entrepreneur building; brokering and building multiple forms of community sourced and social investment capital and supporting policy strategies that increase ownership and income among historically marginalized communities. This means that we work closely with our business leaders to maximize the opportunities that good regulations provide as a pathway to good business.

Our experience is with community sourced economic development - a model that harvests ideas and ventures based on local assets, and then connects entrepreneurs, investors, philanthropists and other stakeholders in order to build the flow of capital to local businesses. We focus on triple-bottom- line lending that economically contributes to the community, that offers livable wages to

employees or ownership opportunities to the borrower, and are environmentally responsible.

We believe that you do not have to choose between growing business and social and environmental protections. In fact our businesses here in Alabama understand that we do better because of these protections as they create a level playing field for competition.

Blu Design Company, a Printing and Design Company, is one of the companies that has benefited from our Soul'utions Accelerator Business Development Counseling at our Business Center located in Selma, AL. Mr. Michael Williams had a home-based business that was under paid for services. Our program was able to offer a virtual office location, so he could develop a business structure, receive marketing services and utilize our client network. We were able to assist Mr. Williams to obtain a business license, understand local/state/federal regulations and access the SBDC (Small Business Development Center) resources. Blu Design Company's pay rate for services increased by 500% within one year and its client base grew dramatically.

Our experience shows that good regulations tend to stimulate innovation and entrepreneurship in addition to limiting or preventing destructive forms of economic activity.

We are engaged in brokering opportunities between businesses and investors, providing limited micro-loan, conducting business accelerator for investment readiness; investor network for private capital, database of investment ready projects, research and economic Studies, community asset mapping and facilitation. We understand that there is a great need for good regulations when so much money is flowing back and forth. Business owners understand that with investments in their business come responsibilities, contracts and regulations to ensure protections.

Therefore our clients understand that there is a great need for good regulations like Dodd-Frank that protects their investment of hard work and money from the risky behavior of the big banks that led to the Great Recession, which devastated small businesses around the country.

The bottom line is that regulations are essential tools for ensuring that markets meet the needs of all stakeholders. Regulations are needed to create the conditions under which society as a whole can prosper, so that financial, health, and environmental protections can exist to support a growing economy.

Given the increasing severe weather and the impact on businesses, The American Sustainable Business Council commissioned scientific polling of random small business owners and found that Eighty-seven percent (87%) of

business owners named one or more consequences of climate change as potentially harmful to their businesses.

Businesses understand that regulations like the clean power plan that reduce our carbon outputs and climate risks – will work to protect businesses in our coastal regions including Alabama. Small business sees climate change as a threat and supports EPA taking action as proposed in this rule. Sixty-four percent (64%) of business owners believe government regulation is needed to reduce carbon emissions from power plants. Let's remember that business under water can serve no one.

Well-designed regulations not only level the playing field for small businesses competing with big businesses, they also lay the groundwork for entrepreneurship. And statistics show that blacks are the fastest growing demographic for entrepreneurship. I'm not just speaking for black business owners in Alabama but for black entrepreneurs and small business owners across the country who are benefiting from good regulations.

Federal regulations affect the Automobile industry in Alabama by requiring vehicles to be built to certain standard of quality. This gives a consumer an opportunity to purchase a safe, efficient and comfortable vehicle that has passed federal regulation standards. Don't we all want those assurances that the vehicles that we use in our businesses or personally are safe?

The Alabama Department of Transportation is controlled by federal regulations that ensure the roads are uniform in construction. As a traveler drives along the Interstates and Highways there is a consistent road guideline that makes the traveler more comfortable. People are more willing to travel when they know that regulations are in place, which benefit towns/cities with tourism dollars (millions per year). Again regulations are not the villain as they create common understandings and guidelines for business and society.

Because of the lack of good chemical regulations in West Virginia, the Elk River spill wreaked havoc on the state economy where at least $61 million dollars in economic damage was calculated. There was impact for most business but this had a particularly bad impact on minority and small businesses in the region. Add to that impact on the community without access to clean water and even greater economic impact can be calculated from lack of spending when consumers are facing catastrophic damage, as well as the added health costs associated with exposure to toxic chemicals

Ben Green in South Carolina is an independent insurance broker whose business has increased because of the regulatory implementation of the Affordable Care Act.

Nikhil Arora, CEO, of Back to the Roots believes that "Regulation is not the enemy of business - especially not small businesses. Smart and sensible regulations help level the playing field for businesses owners - from all backgrounds. Accounting regulations, product safety regulations, ingredient labeling, etc. - these rules actually help businesses compete - on their own merit & on the weight of their product and services quality- NOT on lobbying money, massive marketing budgets, or access to influencers. In food, the lack of regulation around labeling and what true "whole wheat" actually means makes it far tougher for us, as a small business investing in high quality grains, to compete with larger companies who can spend their way out of misleading product labels because of a lack of regulations holding companies accountable to their actions and marketing messages."

e-Management is a woman-owned, minority-owned, small business that provides award-winning cybersecurity and professional Information Technology (IT) services to U.S. government agencies and private companies. Established in 1999, the company has achieved significant growth and recognition for its IT subject matter expertise and results driven culture. e-Management is the 2015 IT Company of the Year for Montgomery County, Maryland. A CMMI® Maturity Level 3 rated company, e-Management has successfully launched two commercial software innovations over the past decade, including CyberRx for improving cybersecurity readiness and eGov Risk Portfolio Manager for enterprise risk management. e-Management has benefited from smart government programs such as the SBA 8(a) program in which it participated for nine years. The program created opportunities for small innovative businesses like e-Management to learn how to market their products and services directly to government clients and to develop capabilities to successfully compete with similarly sized companies. e-Management's future looks promising with the introduction of another new smart government regulation, the recently enacted Woman Owned Small Business (WOSB) program, which levels the playing field for women-owned small businesses across the federal contracting marketplace, particularly in industries such as IT in which WOSBs are substantially underrepresented.

Salman Ravala, an International Business Lawyer in New York, sees regulations as a mechanism to provide not only clear instructions but also a mechanism of transparency and accountability. His clients, minority owned businesses, understand "knowing clearly what is required and having all parties involved follow the rules rather than responding to costly unknowns and avoiding pitfalls that slow down the growth of their business.

At the same time regulations can drive business innovation. Renewable energy and energy efficiency provides much better opportunity for durable competitive advantage, creates more jobs, pays higher salaries, and generates more capital investment than a megawatt of electricity generated from coal. This strengthens the consumer economy and the opportunity for minority owned businesses.

The Internet offers another example of how regulation stimulates economic growth. The free and open internet has generated far more innovation, jobs, and investment returns than when telecommunications giants could restrict information flowing through their wires and ban third-party applications from their cellular phones. Good regulations do not stifle opportunity; they open up markets to new breakthroughs.

A national poll conducted for the American Sustainable Business Council found that “lack of demand” – and not regulation – is the biggest problem that small businesses face. Small-business owners see regulations as a necessary part of a modern economy (86%) and believe they can live with regulations if they’re fair and reasonable (93%). Enforcing regulations on the books is important to small-business owners (76%) and they view regulations as protection from unfair competition from big business (78%). And it’s not just regulations in general that small-business owners perceive to have value. Specific regulations to hold down health insurance premiums (78%), ensure food safety (84%), promote clean air and water (79%), and move the country towards energy efficiency and clean energy (61%) were also recognized as helpful by small-business owners.

Every sport has rules and every sport has great players that excel with the parameters of those rules. Those great players are our champions and national heroes. Good regulations helps set the guidelines that offers businesses the opportunity to innovate and create the new champions of business.

The Selma Business Center in Alabama was developed to help entrepreneurs and veterans in economically distressed communities. This center promotes information, counseling, resources, regulations, financing, networking and training classes to over 150,000 residents weekly. We know that small businesses are often at a disadvantage with large corporations. However through education and updates from the SBA, SBDC, Department of Labor and American Sustainable Business Council, the center is able to learn and share information about regulations that affect businesses. A partnership network has been established with the chamber of commerce, local businesses and regional organizations that support entrepreneurship. We and many other organizations across the country can work with government to provide that extra support for new entrepreneurs and small businesses owners when needed.

Again regulations is not the problem but a commitment to make them work for all is our opportunity and this is more easily achieved when you recognize the partnership opportunities between business and government.

We do not need to choose between growing our businesses and our economy and ensuring that there is a level playing field, fair systems and key protections.

I am on the ground with black entrepreneurs and small business owners every day. If you want to really help them, then provide more resources for professional business consultation to minority-owned businesses. As for regulations, what would be helpful are more resources for compliance assistance and making sure those small businesses providing services under federal contacts get paid on time. Efforts to slow down regulations or to de-regulate are not being a friend to the African-American small business community.

That is why Emerging ChangeMakers is a part of the larger efforts of the American Sustainable Business Council and the over 250,000 businesses that they represent to advance smart regulations that protect our communities and the environment, as we grow our businesses, create good jobs and build a vibrant economy.

Testimony of Sabina Loving
President and Owner, Loving Tax Services, Inc.

Before the United States Senate Judiciary Committee,
Subcommittee on Oversight, Agency Action, Federal Rights and Courts

Hearing on "Opportunity Denied: How Overregulation Harms Minorities"

October 6, 2015

I thank the Chairman and the members of the Committee for the opportunity to testify about how overregulation harms minorities.

My name is Sabina Loving, and I am the owner and President of Loving Tax Services, a small, independent tax preparation firm in West Woodlawn on the South Side of Chicago. I am the "Loving" in the *Loving v. IRS* lawsuit that successfully challenged the IRS's attempt to license all tax-return preparers through regulatory overreach.

I'm simply a small businesswoman, trying to stay afloat in this economy while helping people with their tax preparation and building up my community. I should have the right to earn an honest living doing what I love, and so should my employees. Equally important, my customers—not the IRS—should be the ones who decide who prepares their taxes.

Oddly enough, you almost never hear the IRS or anyone else who advocates for tax-preparer licensing talk about me or my two co-plaintiffs when they talk about the *Loving* case. It's as though they forget that we're real people who were actually being harmed by the IRS licensing scheme. In fact, there are about 300,000 independent tax preparation entrepreneurs like us, many of whom would have been forced to close their business by this IRS power grab.

So today, I'd like to share my story with you, to help you understand how overregulation affects real entrepreneurs like me, why I sued the IRS over its anti-competitive licensing scheme, and why Congress should not pass legislation granting the IRS statutory authority to license tax preparers.

I am a lifelong Chicagoan who is blessed to earn a living doing what I love: helping people with their taxes. In 2011, I opened my business, Loving Tax Services, in West Woodlawn, where there are high unemployment and foreclosure rates. My business was the first to occupy its storefront in at least a dozen years, and I've been fortunate enough to employ several people in my community and bring money back into our neighborhood.

Ever since I was a little girl, I wanted be an accountant and work with numbers. I dreamed of one day starting my own business. I worked hard to make that dream a reality. I worked full-time as an accountant for major Future Commission Merchants

from 1994-2006 while simultaneously earning my undergraduate degree in Business Administration. In 2006, after my company was acquired, I decided that I wanted to pursue a career as a mortgage broker, so I resigned my position. The economic downturn hit my industry hard, so I went back to work for a precious metals brokerage firm until I was laid off in 2009. I decided to use that as an opportunity to realize my American Dream and put myself to work as an independent tax preparer, while earning a Master's degree from Roosevelt University. I incorporated Loving Tax Services in 2010 and never looked back.

Everything I've done for my business has been right out of my pocket. But I worked hard and was able to attract customers who appreciated that I met with them in person and provided personalized service. After my business grew a bit, I hired a few employees to assist me. But tax preparation is a seasonal industry, and my business model depended on flexibility—I needed to be able to expand seasonally to accommodate demand, while not paying fixed costs for salaries all year long. Fortunately, I was able to find qualified people who could assist me seasonally, and my business began to grow.

But just as my business was really taking off, I learned that the IRS was going to force tax preparers to jump through a bunch of hoops in order to be allowed to continue earning a living preparing taxes. The IRS called it the registered tax return preparer (RTRP) program, but it was not a mere registration requirement.

For the first time in 100 years, the IRS was imposing a license to prepare tax returns, something that anyone had always been able to do for themselves. We would have to pass an IRS-mandated exam and complete continuing education requirements each year. This RTRP license would give the IRS great control over tax preparers, making us dependent on the most powerful federal agency for our livelihoods.

I knew it would also impose additional costs and burdens on my business, hundreds or thousands of dollars per employee, which I would have to pass on to my customers in the form of higher prices. I pride myself on offering more affordable tax preparation services than major tax preparation firms. I didn't want to raise my prices, but I couldn't afford to have my fledgling business make any lower profits.

Higher prices also mean fewer customers, and I knew that if my business shrank, I wouldn't be able to hire as many people during tax season to assist me. That would put me at a competitive disadvantage to the major tax preparation chains, because they benefit from economies of scale and can more easily absorb these new costs. They were likely to get the customers I was going to lose.

But this licensing requirement didn't apply to everyone. CPAs and attorneys were exempt, even if they had never taken a course in tax law or tax preparation. Most attorneys have no experience or special knowledge about preparing tax returns. And many CPAs aren't tax experts either; a large number focus on corporate audits, not tax preparation. But if they wanted to prepare taxes on the side, they wouldn't need a

license. The IRS had absolutely no data to support this exemption; nothing indicated attorneys or CPAs made fewer errors on tax returns than anyone else.

Meanwhile, I had spent over a decade working as an accountant for major financial firms and was a member of the American Institute of Professional Bookkeepers. But I was not a CPA. So I wasn't exempt.

Not only was that unfair, but powerful industry groups lobbied for another exemption: anyone who was being *supervised* by an attorney or CPA could also prepare tax returns without a license. But I wanted to hire more employees and supervise them as tax preparers so that I could expand my business and serve more of my community. But I didn't have powerful lobbyists working for me, and I didn't help write the rules, so I didn't get a special exemption. Because I'm not a CPA or an attorney, even if I got the RTRP license, anybody I employed as a tax preparer would also have to go through this costly and time-consuming process of becoming an RTRP.

And I also knew that this new license would not do anything to protect consumers—there are already all sorts of laws on the books that do that. Instead, it protects big tax preparation chains and special interest groups from competition by smaller businesses like mine, many of which would be forced to close or shrink their business. The end result would be fewer options and higher prices for taxpayers.

So that's why I and two other independent preparers sued the IRS. We were represented *pro bono* by lawyers at the Institute for Justice. Thankfully, we won in district court, and then we won again on appeal in the D.C. Circuit. The IRS power grab was stuck down, and the license never fully went into effect.

But the IRS and big tax preparation chains keep pushing for Congress to expand IRS power and authorize it to license tax preparers. After we won our case, several bills were introduced that would do just that. Just two weeks ago, the Senate Finance Committee announced one such proposal. But a national license for tax preparers was a bad policy then, and it is bad policy now. It is anti-competitive, anti-consumer, and will hurt small businesses. I urge the Senate not to give the IRS any more power and to vote against any bill that would authorize the IRS to license tax preparers.

Thank you very much for the opportunity to testify before this Committee.

Statement of Aaron Mair
President, Sierra Club

Senate Judiciary Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts
October 7, 2015

Good morning, Chairman Cruz, Ranking Member Coons, and Members of the Committee. I am proud to be here today as President of the Sierra Club, our country's largest and most influential grassroots environmental organization. Our 2.4 million members and supporters are spread across all fifty states, Puerto Rico and the District of Columbia and it is an honor to be here today on their behalf.

Sierra Club works to promote a transition to clean, renewable energy sources, strong public health protections to safeguard our families and communities from toxic pollution, and the preservation of our public lands and remaining wild places for future generations. We are particularly concerned about the disproportionate effects of air and water pollution on low-income families, communities of color and other historically marginalized and oppressed populations. Sierra Club works to discuss and explore the linkages between environmental quality and social justice, the resulting environmental injustices, and to promote dialogue, increased understanding and appropriate action. Environmental protection and the pursuit of environmental justice are civil rights and social justice issues.[1]

ENVIRONMENTAL JUSTICE COMMUNITIES NEED STRONG ENVIRONMENTAL LAWS

Although the Environmental Protection Agency (EPA) and the federal government have taken great steps to bring environmental justice issues to the forefront of our public discourse and consciousness, minority and low income communities continue to face great environmental and socio-economic burdens.[2] Of particular concern, minority and low-income communities bear a disproportionate risk from climate change. The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report concludes that climate disruption will hit low-income neighborhoods and people of color the hardest. According to the IPCC, "[m]any key risks constitute particular challenges for the least developed countries and vulnerable communities, given their limited ability to cope."[3] These risks are both health-related and socio-economic. In the United States, minority and low income communities often live near dirty power plants and other industrial facilities. For example, 60 percent of African Americans and Latinos nationwide

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[1] Civil rights are just one part of human rights. Every individual has a human right to be treated fairly and equally by state and private actors, to enjoy their rights to health, food, equal pay, and decent working conditions, among others. Environmental justice should contribute to further these rights. *See, e.g.*, Harden, M., Advocates for Environmental Human Rights, *The Need for Human Rights Advocacy to Overcome Injustice: Lessons from the Environmental Justice and Climate Justice Movement*, U.S. Human Rights Network (Dec. 5, 2013), *available at* http://www.ushrnetwork.org/sites/ushrnetwork.org/files/environment_justice_framing_paper_-_ushrn.pdf.

[2] *See, e.g.*, Bullard et al., Barbara Jordan-Mickey Leland School of Public Affairs, Texas Southern University, *Environmental Justice: Milestones and Accomplishments: 1964-2014* (Feb. 2014), *available at* http://www3.law.harvard.edu/orgs/els/files/2014/02/Environmental-Justice-Milestones.pdf.

[3] IPCC, *Climate Change 2014: Impacts, Adaptation, and Vulnerability: Summary for Policymakers* (2014), at 13.

reside in communities with toxic waste sites. These communities are also more likely to live near busy highways, all of which leads to higher risk of air pollution-based illnesses.[4] Researchers have found that African-Americans and Latinos are also more likely to reside in areas vulnerable to climate change impacts such as sea-level rise, flood risk, and wildfire risk, and that median household incomes are inversely related to these vulnerability risks.[5] As climate change worsens, minority and low income communities will also bear the burden of spending higher proportions of their income as a result of rising food prices or increased water scarcity.[6]

That people of color and low-income communities are disproportionately impacted by pollution and climate disruption should not be up for debate any more so than the science behind climate change itself. To do so ignores the facts and the history of institutionalized racism in this country. Rather than intentional efforts to muddy the waters of political discourse, confuse voters and distract from the issues at hand, we need Congress to come together and work to make sure all communities receive equal and just protection under the law.

CONGRESS MUST PROTECT AND ENFORCE OUR BEDROCK ENVIRONMENTAL LAWS

Strong enforcement of our existing public health and environmental laws is critically important for the well-being and safety of all Americans, but especially for environmental justice communities. Laws like the Clean Air Act, Clean Water Act, the Resource Conservation and Recovery Act can work to clean up our communities but Congressional support for commonsense implementation and enforcement is needed. Sierra Club strongly urges bipartisan cooperation to protect and enforce these and other lifesaving statutes. We are alarmed by the efforts of some in Congress to block enforcement of these laws or, even more radically, seek to gut or do away with them all together.

Historically, environmental conservation was an area of consensus for Republicans and Democrats. The Environmental Protection Agency was created under President Nixon and the Clean Water Act and Clean Air Act both received strong bipartisan Congressional support. We urge a return to this tradition of working together for mutual environmental and public health benefits.

A CLEAN ENERGY FUTURE CAN AND MUST INCLUDE COMMUNITIES OF COLOR

There are some who assert that measures to cut air and water pollution somehow harm minority and low-income communities, and that strong rules and regulations to protect all of our families are unnecessary and particularly burdensome to these groups. These specious claims ignore the epidemiological science, the history of institutionalized racism in our country, and also the historical record that clearly demonstrates enforcement of environmental laws in our country has

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[4] Truong, V., *Addressing Poverty and Pollution: California's SB 535 Greenhouse Gas Reduction Fund*, 49 Harvard Civil Rights-Civil Liberties L. Rev. 493, 498 (2014).

[5] English et al., *Racial and Income Disparities in Relation to a Proposed Climate Change Vulnerability Screening Method for California*, The International Journal of Climate Change: Impacts and Responses, Volume 4, Issue 2, at 1-18.

[6] Truong, V., *Addressing Poverty and Pollution: California's SB 535 Greenhouse Gas Reduction Fund*, *supra* n.

gone hand in hand with economic growth and improvements in our collective public health. The Clean Air Act, for example, has a more than 40 year history of reducing air pollution and growing the economy that has contributed to an improved quality of life for all Americans. This law has been one of the most successful pieces of legislation ever passed by Congress, saving hundreds of thousands of lives, preventing millions of asthma attacks and providing an estimated $2 trillion in benefits to taxpayers. [7]

We should be working to continue this tradition of guarding public health and growing our economy by protecting our laws on the books and enforcing them in a way that creates jobs and opportunity for environmental justice communities. We have a chance to drive clean energy investments and jobs towards the communities that are hit the hardest. Already more than 3.4 million Americans work in the green sector[8] and, dollar for dollar, clean energy investments create three times as many jobs as fossil fuel investments.[9] Polls consistently show that Black and Latino voters overwhelming support action on climate and strong air and water pollution protections. This is because minorities and low income families are on the front lines of dealing with pollution and see first-hand the need for strong federal action. They want and need laws that move us forward and closer to an inclusive and just 21st century green energy economy. They want and need Congressional support for bold action and commonsense application of existing statutes.

SIERRA CLUB STRONGLY SUPPORTS EFFORTS TO PROTECT COMMUNITIES FROM AIR AND WATER POLLUTION

Sierra Club strongly supports efforts to protect all communities from air and water pollution and encourages Congress to work with the Administration in a bipartisan fashion to implement important and long-overdue measures like the Clean Power Plan, Steam Electric Effluent Limitation Guidelines, the Clean Water Rule and stringent enforcement of the National Ambient Air Quality Standards (NAAQS) for criteria pollutants such as ground-level ozone, particulate matter, and sulfur and nitrogen oxides. These are just a few of the standards that, if allowed to work, can help better protect all families but specifically safeguard some of our most vulnerable and marginalized fellow Americans.

To those expressing concern about the health and well-being of low income families and communities of color, we invite you to join Sierra Club in supporting not just robust enforcement of our country's air and water protection laws, but other initiatives and measures that would lift up and protect people of color and the working class. We would welcome your public support for racial justice and equality and would urge you to join us in expressing support for the Black Lives Matter movement, restoration and strengthening of the Voting Rights Act, and a pathway

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[7] EPA, 2011, *The Benefits and Costs of the Clean Air Act from 1990 to 2020 Final Report – Rev. A U.S. Environmental Protection Agency Office of Air and Radiation, The Benefits and Costs of the Clean Air Act from 1990 to 2020 Final Report,* http://www2.epa.gov/clean-air-act-overview/benefits-and-costs-clean-air-act-1990-2020-second-prospective-study

[8] U.S. Bureau of Labor Statistics 2013, *Green Goods and Services (GGS) Survey* http://www.bls.gov/opub/mlr/2013/article/green-goods-and-services-survey-results-and-collection.htm

[9] Robert Pollin, James Heintz, and Heidi Garrett-Peltier 2009, Department of Economics and Political Economy Research Institute (PERI) University of Massachusetts, Amherst http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF

to citizenship for undocumented immigrants. We extend an open hand and invitation to partner with us and our allies on the Fight for 15 to help ensure hard-working men and women earn a living wage and are able to provide for themselves and their families. As gun violence continues to rip apart families across our country, and as Black and Latino families suffer a disproportionate loss of loved ones, we would welcome your support in joining us in the call for common-sense gun controls like the assault weapon ban.

If this Committee, Members of Congress and business interest groups are serious about protecting minorities and low-income families, there is no shortage of opportunities to work together across the aisle on legislative fixes to some of our most pressing economic and public health challenges. But to attack our federal rulemaking system and block enforcement of air and water protections would be steps in the wrong direction that would take us backward and put families at further risk. Blocking all regulations and safeguards, as some in Congress have sought to do, would mean no restrictions on how much pollution power plants and industrial facilities can spew into our air and water, no oversight or worker protections for risky offshore oil drilling or coal mining operations, and no fuel and vehicle efficiency standards that save Americans money at the pump and clean up our air.

Under the guise of protecting environmental justice communities, there are those in Congress that would seek to dismantle the very laws that protect them. These are not efforts to protect or reform. These are efforts to put polluter profits ahead of public health by giving a free pass to corporate bad actors that disdain accountability and want no limitations on their actions. In years past, such extreme tactics would have likely prohibited government's work to mandate seat belts, remove lead from our gasoline and paint, abolish child labor and establish a minimum wage. Most Americans would join me in appreciating a rulemaking system that has worked so effectively to protect our communities and strengthen our society.

Thank you for the opportunity to speak today on behalf of our millions of members and supporters. Sierra Club looks forward to working with Congress to protect and enforce this country's bedrock environmental laws so that every American has the opportunity to live out our mission – to explore, enjoy and protect the planet.

October 1, 2015

Testimony
Harry C. Alford (National Black Chamber of Commerce)
Senate Judiciary Subcommittee Hearing – Tuesday, October 6, 2015 (2:15 p.m.)
Location: 226 Dirksen Senate Office Building

"Opportunity Denied: How Overregulation Harms Minorities"

Introduction

Good morning, Chairman Cruz, Ranking Member Coons, and distinguished Members of the Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts of the Committee on Judiciary. My name is Harry C, Alford and I am the President/CEO of the National Black Chamber of Commerce. The National Black Chamber of Commerce represents 2.4 million Black-owned businesses within the United States.

I am here today to testify about the harmful and adverse effects of overregulation on minorities and their communities. As the hearing title suggests, the continuous stream of unreasonable and overreaching regulations that have come out of the federal government over the last few years has led to the denial of countless opportunities for minorities. Employment opportunities, income opportunities, and housing opportunities for minorities – all of these are being compromised by an ever-growing number of federal regulations.

At the onset, I think it is important to be clear about something – the National Black Chamber understands and appreciates the importance of regulations within our society. Regulations help keep our workers protected, our water and air cleaner, our food safer, and our consumer products reliable, to name a few. What we do not support are regulations that are based upon

erroneous and opaque analysis and process. The rulemaking process – and the regulations that come out of it – should involve transparency, notice, sound science, quality data, and reliable cost-benefit analysis. Without a doubt, there are multiple new regulations that potentially will harm the economic opportunities of minorities; but for today's hearing, I'm going to focus on two regulations from the Environmental Protection Agency to illustrate my point.

Clean Power Plan

First, there is the EPA's new rule on regulating greenhouse gas emissions from existing power plants – often referred to as the Clean Power Plan. While increased costs often come with increased regulation, the Clean Power Plan in particular seems poised to escalate energy costs for Blacks and Hispanics in the United States, including individuals, families and minority-owned businesses.

In light of these concerns, the National Black Chamber undertook an effort to examine the potential economic and employment impacts of the EPA's carbon regulations, including the proposed Clean Power Plan, on minorities and low-income groups. On June 11, 2015, the National Black Chamber of Commerce released a study on the threat of the EPA carbon regulations to low-income groups and minorities.[1] I note that since then, the EPA released the final Clean Power Plan rule, which has differences from the proposal. Nevertheless, we believe that the findings of our study are illustrative of the rule's potential economic impacts.

[1] Available at http://nbccnow.org/wp-content/uploads/2015/06/Minority-Impacts-Report-June-2015-Final.pdf. A copy of the study is also attached to this testimony.

The National Black Chamber's study found that the proposed Clean Power Plan would impose severe and disproportionate economic burdens on poor families, especially minorities. In particular, the proposed rule would impose the most harm on residents of seven states with the highest concentrations of Blacks and Hispanics. These communities already suffer from higher unemployment and poverty rates compared to the rest of the country, yet the EPA's regressive energy tax threatens to push minorities and low-income Americans even further into poverty.

I want to highlight some of the key findings from the study:

- EPA's rule increases Black poverty by 23% and Hispanic poverty by 26%.
- In 2035, job losses total 7 million for Blacks and nearly 12 million for Hispanics.
- In 2035, Black and Hispanic median household income will be $455 and $515 less, respectively.
- Implementing the EPA carbon regulations would in 2025, increase the energy burden of Blacks by 16% and Hispanics by 19%.
- Compared to Whites, Blacks spend 20% more of their income on food, 10% more on housing, 40% more on clothing, and 50% more on utilities.
- Compared to Whites, Hispanics spend 90% more of their income on food, 5% more on housing, 40% more on clothing, and 10% more on utilities.

- The rule will especially harm residents of seven states with the highest concentrations of Blacks and Hispanics: Arizona, California, Florida, Georgia, Illinois, New York, and Texas.

The study demonstrates that the EPA's proposed Clean Power Plan would harm minorities' health by forcing tradeoffs between housing, food, and energy. The inability to pay energy bills is second only to the inability to pay rent as the leading cause of homelessness. The bottom line is that we should pursue policies that expand opportunity for the less fortunate, not ones that further disadvantage them.

National Ozone Air Quality Standard

The second regulation that I want to address today is the EPA's national air quality standard for ozone. Just last week, the EPA finalized a new ozone standard – tightening it from 75 parts per billion to 70 parts per billion (ppb). While the agency adopted the higher end of the range under consideration, a 70 ppb ozone standard still will increase the number of areas in the country in "nonattainment." This nonattainment classification will severely limit economic and employment opportunities in the affected areas. Unfortunately, this tightened ozone standard likely will hurt not only the nation as a whole, but will disproportionately affect America's urban, low-income and minority families.

If a community comes in below the 70 ppb standard, it will be deemed "in attainment" and the usual amounts of construction, infrastructure improvement, development and other elements of a healthy and growing economy can continue. These activities create jobs and generate revenue. On the flip side, the

EPA wields a heavy stick for communities that are deemed in "nonattainment." It can step in and overrule state decisions to issue permits, stopping development and growth, with no consideration of the financial impact or loss of jobs. Air permits, in particular, can be difficult to obtain because companies building or expanding facilities will have to show ozone reductions from other sources. These "offsets" can be expensive and hard to obtain. For example, in the Houston area, offset prices are nearly $175,000 per ton of NOx and $275,000 per ton of VOCs.

And here is why last week's tightening of the ozone standard almost certainly will disproportionately affect those who can least afford it: Urban areas — where many low-income and minority families live — find it more difficult to cut ozone levels due to traffic congestion and density of industry and manufacturing. Under a 70 ppb ozone standard, more urban areas will be in nonattainment, which means further penalties for places that already face slower than average economic growth. This new ozone standard also could raise energy costs, and families on fixed incomes have little room to absorb them. Most importantly, the loss of development and economic expansion would affect many of the blue-collar jobs that power our low-income and minority communities.

Local Forums

This summer, the National Black Chamber undertook an educational and listening tour to certain key urban areas, such as Chicago, Columbus and Pittsburgh. The goal was to provide forums for minority leaders, officials and business representatives to discuss the ozone proposal and its potential employment impacts in those communities. A reoccurring theme that we heard from the forum participants from Illinois to Ohio to Pennsylvania was that they

want a balance when it comes to environmental regulations like the ozone standard. They want regulations that protect the environment and public health, but that also refrain from damaging employment and economic opportunities for minorities and their communities.

Conclusion

In conclusion, the National Black Chamber of Commerce and its members value and support clean air, clean water, and environmental quality, and we recognize the importance of regulations protecting those things. We also value and support economic growth, job creation, and prosperity for our individual members and this country as a whole. These are not mutually exclusive goals, and one does not have to be sacrificed for the other.

We appreciate the Committee holding this hearing and highlighting these critical issues. Thank you for the opportunity to testify and I look forward to answering any questions you may have.

Statement Of Senator Patrick Leahy (D-Vt.),
Ranking Member, Senate Judiciary Committee,
Hearing of the Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts on "Opportunity Denied: How Overregulation Harms Minorities"
October 6, 2015

We are a nation of laws, and regulations issued as a result of the statutes Congress passes are a fundamental part of our legal system. Regulations protect the quality of the air we breathe, the water we drink, the cars we drive, and the toys we give our children. They help ensure that consumers are protected, our financial markets are stable, our workplaces are safe and our environment is preserved. While we must always ensure that regulations are fair and tailored to achieve their goals, regulatory safeguards provide a vital tool for protecting American workers and consumers.

Today's hearing focuses on the impact of regulation on minority populations, with the title concluding—before receiving a word of testimony—that "overregulation" is harming minorities. Several witnesses who are testifying before the Committee today disagree with that sweeping conclusion. So do I. Regulations have played a critical role in combating employment discrimination; deterring unfair lending practices; and promoting workplace safety. They are essential to protect minority and low-income communities that are disproportionately threatened by air pollution and the effects of climate change. There are many issues this Committee should focus on that are harming minority populations: the gutting of the Voting Rights Act; the loss of trust between law enforcement and the communities they police; unprecedented levels of incarceration that disproportionately impact minority youths. I reject blanket indictments of a policy tool that, in many instances, is being used to help level the playing field for minority communities.

This is an important time to consider the role that federal regulations play in protecting and promoting the public interest. For too long, this Committee has heard concerns about delays in the agency rulemaking process that are preventing agencies from fulfilling their statutory mandates. A recent study by the R Street Institute revealed that over the past 20 years, federal agencies have met less than half the rulemaking completion deadlines set by Congress; a problem caused in large part by the complex labyrinth of requirements that rulemaking entails. Such delays create uncertainty for businesses and defer important protections for consumers, workers, seniors and the environment. Yet instead of confronting this obvious problem, the Senate majority has chosen to focus its efforts on further hamstringing agencies' ability to adopt these types of rules.

This week, legislation is being reviewed in another Committee of the Senate that would add more bureaucratic hurdles to agency rulemaking and impose new criteria by which industry stakeholders could challenge agency rules. As I wrote in a letter to the Chair and Ranking Member of that Committee last week, the Judiciary Committee has a strong interest in ensuring that rulemaking functions effectively, and that corporate stakeholders cannot unfairly use their resources to hold up important consumer protections in our federal courts.

We all have a responsibility to ensure that agencies are carrying out their mandates fairly and effectively. I hope that today's hearing will focus not just on anecdotes of regulations that some Senators may disagree with, but instead is an opportunity for thoughtful discussion about what we can do to promote the goal of effective laws that protect minority communities and all Americans.

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Senator Cruz Questions for the Record for
Harry Alford, President and CEO of National Black Chamber of Commerce
Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts
Opportunity Denied: How Overregulation Harms Minorities
Tuesday, October 6, 2015

Questions

1. **The black unemployment rate is still twice that of the white unemployment rate. And while small gains have been made recently in that area, those gains come largely from people completely giving up on finding work. How do excessive regulations contribute to this dire unemployment situation? And what has the present Administration done to combat the problem? Is it concerned?**

ANSWER: The recent EPA rules are a great example to this. The Ozone Rule which requires levels that cannot be met by most municipalities will cause many areas to be declared "out of attainment". Being out of attainment means no new construction or expansion of existing businesses. The denial of such business growth will reduce the potential of new jobs and the preservation of current jobs will total into the millions nationally. The Administration is the very source of this disaster. There appears to be absolutely no concern from the Administration.

2. **As the President of the National Black Chamber of Commerce, can you describe some specific challenges particular NBCC members have faced when dealing with regulations, red, tape, and government bureaucracy?**

ANSWER: The debate on Project Labor Agreements (union only construction projects) came up during the construction of the Wilson Bridge (DC area). Maryland wanted a PLA while Virginia insisted on Right to Work rules. The NBCC commissioned a study which showed that the two states had almost identical demographics. Yet, Virginia utilized three times more Black workers than Maryland. President George W. Bush's response was to ban PLA's from all federally funded construction projects. The first Executive Order issued by President Obama was to lift the ban and declare PLA's be implemented on all federal projects valued at a million dollars or more. As 98% of Black construction workers are non-union, this order has had a devastating impact on Black employment.
Also, before the Dodd-Frank Amendment the SBA was processing loans to Black owned businesses at a rate of 8.0%. Today, that rate is at 1.8%. This is clearly devastating.

3. **In your opinion, is the Affordable Care Act (a/k/a "Obamacare") good for black-owned businesses? If not, why not?**

ANSWER: No. The Act with its 20,000 pages is starting to have a very expensive impact on small businesses. Personally, I have a 90 day prescription which used to cost me $134. The new price is now $440. This is challenging for business owners with limited funds. We have two staffers whose policies have been abruptly cancelled. This is bewildering.

4. **Can you name some of the most problematic federal schemes that have produced**

excessive regulations?

ANSWER: Affordable Care Act, Dodd – Frank Amendment

5. At the hearing, we discussed various aspects of the problem of overregulation, but did not address in much detail how to best remedy the problem. Do you have any specific proposals for stemming the tide of overregulation? And what is your opinion about the following possibilities?

ANSWER: Yes, see below

a. Under the Congressional Review Act of 1996 (CRA), Congress can overturn bureaucratic regulations by enacting a joint resolution of disapproval. According to a July 2015 report from the Congressional Research Service, however, this option has only been utilized *once* in nearly twenty years. Should we strengthen the CRA to give this avenue some teeth? If so, how?

ANSWER: A quadrennial review should be performed with actions.

ANSWER: Independent surveys by business owners could be made every four years. Conclusions can be reviewed and acted upon.

b. Would you support automatic "sunsets" for all regulations—that is, would you support the idea that every regulation will automatically expire at a future date (*e.g.* three years) unless Congress specifically reinforces the regulation?

ANSWER: Absolutely

c. Are you familiar with the Davis-Bacon Act? If so, do you view it as an example of federal government overregulation that harms minorities? Would you support amending or repealing it?

ANSWER: Yes, the Davis-Bacon Act has a racial pedigree. Black construction workers in the South had a legacy of fine craftsmanship (they built the South during slavery). They started migrating North and competing on contracts and would demand reduced costs for labor. Their success led to adverse regulation blocking their competitiveness. Thus, was born the Davis-Bacon Act. It should be repealed immediately

6. Are there any other points or issues that were not explored (or adequately explored) during the hearing that you would like to bring to our attention?

ANSWER: The Office of Federal Contract Compliance Program-OFCCP (Department of Labor) is not performing its function. Many construction unions are not hiring in a non-discriminatory manner. With the national average for minority hiring being approximately 14%. Most construction unions, by trade, hire minorities in single digit percentages. No union which practices discrimination should be certified by the Department of

Labor. This is a big driver of high unemployment among Blacks.

Senator Cruz Questions for the Record for
Michael Barrera, National Economic Prosperity Manager at The LIBRE Institute, Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts Opportunity Denied: How Overregulation Harms Minorities
October 6, 2015

Questions

1. **In your oral testimony, you detailed how the Affordable Care Act (a/k/a "Obamacare") and its regulatory scheme have hurt many small businesses in the Hispanic community. What other federal schemes, in your opinion, have most damaged Hispanic small businesses through excessive regulation?**

Hispanic small businesses – like all small businesses – bear both the direct and indirect cost of federal regulations. In our experience, Hispanic small businesses are likely to cite regulatory schemes such as Obamacare, environmental regulation, and occupational regulations as among the costliest and most burdensome. Additionally, the increasing amount of paper work associated with the growing regulatory environment only enhances the frustration for businesses.

While the costs of direct regulations are easier to quantify, the indirect cost of regulation should not be ignored. This can take the form of higher financial costs (for policies such as EPA rules on carbon emissions, which raise electric rates for small businesses) or the opportunity costs that come when policymakers adopt "solutions" that do not truly solve the problem they are intended to address.

The Dodd-Frank Wall Street Reform and Consumer Protection Act for example, was touted as an important measure to help ensure small businesses have access to capital at competitive rates. Instead, it is widely agreed that the law has at best proved ineffective – or may even have worsened the problem. In the wake of the financial crisis and the Great Recession, many Hispanic small businesses eagerly awaited changes that would have provided an incentive for financial institutions to increase lending. After months of debate and years of regulatory implementation, the problem of poor access to credit remains. It is impossible to quantify the damage done to Hispanic businesses by the failure to diagnose and correct the problem. However, the lack of capital affects both startups and those that want to expand their businesses.

2. **At the hearing, we discussed various aspects of the problem of overregulation, but did not address in a significant amount of detail how to best remedy the problem. In your written testimony, you indicated the burden of proof should be placed on the regulators to prove that each regulation is necessary, beneficial, and cost-efficient. Do you have any other thoughts on how to stem the tide of overregulation? And what is your opinion on the following proposals?**

    a. **Under the Congressional Review Act of 1996 (CRA), Congress can overturn bureaucratic regulations by enacting a joint resolution of disapproval. According to a July 2015 report from the Congressional Research Service, however, this option has only been utilized *once* in nearly twenty years. How could we best strengthen the CRA to give this avenue some teeth?**

b. **Would you support automatic "sunsets" for all regulations—that is, would you support the idea that every regulation will automatically expire at a future date (*e.g.* three years) unless Congress specifically reinforces the regulation?**
c. **Are you familiar with the Davis-Bacon Act? If so, do you view it as an example of federal government overregulation that harms minorities?**

The LIBRE Institute does not endorse or oppose specific pieces of legislation. However, the experience of the small business operators with whom we work is that existing measures intended to curb regulation have proved ineffective to this point.

As noted however, the Congressional Review Act (CRA) has rarely been used to block the implementation of new and costly regulations. In practice, the CRA may have had the effect of permitting the Executive Branch to promulgate broad and costly regulations without Congress being accountable – unless Members of Congress choose to make themselves accountable through the CRA. If policymakers intend the CRA to limit regulation, it is worth considering whether this approach is fundamentally flawed - so long as Congress is able to choose when to go on record on specific regulations, and when not to. One possible alternate approach would be to require regulations to be approved by Congress before they could take effect. Alternately, broader measures such as regulatory sunsets and temporary moratoria on the issuing of new regulations may also merit consideration.

Additionally, other laws were enacted to reduce the federal regulatory burden on small entities such as small businesses, non-profits and small government jurisdictions. For example, the Regulatory Flexibility Act (FRA) requires regulatory agencies to determine how much their regulations or rules will cost small entities and consider alternatives rather than take a one size fits all approach. Adherence to the RFA by federal agencies is detailed in a yearly report by the Office of Advocacy and should be used as a process to grade agencies on their support of small businesses. The report appears to be only type of enforcement mechanism in the law as it leaves it to Congress to ultimately follow up with the agencies on their actions.

The Paperwork Reduction Act (PRA) requires that federal agencies submit all information collection requests to the Office of Information and Regulatory Affairs (OIRA) before collecting information from the public. One of the primary purposes of the PRA is to minimize the paperwork burden on individuals and small entities. OIRA is only permitted to approve reporting and recordkeeping requirements if they will be useful to the agency or are required by law. Again the intent is admirable, however, change should be considered to strengthen protections against unnecessary and duplicative reporting and recordkeeping requirements. Moreover, despite the "protections" in the CRA, RFA and PRA regulations continue to grow.

In regards to the Davis-Bacon Act, we understand this legislation was enacted in the 1930s ostensibly to ensure federal contactors pay "prevailing wages". However, many small business would argue the law only serves to keep them out of the federal contracting marketplace and that the law has morphed into an Act that protects union wages and benefits without regard to experience, labor needs, or free market principles. Moreover, the law's paper requirements is a large burden on many small businesses that want to compete in the federal marketplace. This further complicates the growth of numerous minority owned businesses who employ many people from their communities.

3. **Are there any other points or issues that were not adequately explored during the hearing that you would like to bring to our attention?**

Congressional oversight on regulators will be needed as well as more accountability. There are several laws already on the books which can be enhanced to offer more protection for small businesses. While The LIBRE Institute doesn't advocate for more government with increased legislation, we believe enforcing what is already on the books (if it is working) and deleting out of date legislation are good first steps in helping small businesses prosper, increase profits and hire more Americans.

Answers to Senator Cruz's Questions for the Record by
Sabina Loving, Owner and Operator of Loving Tax Services, Inc.
Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts
Opportunity Denied: How Overregulation Harms Minorities
Tuesday, October 6, 2015

Questions

1. **Bureaucrats often justify new regulations by painting the pre-existing situation as completely unregulated. Was that true for tax preparers, before the IRS issued the new regulations that you successfully challenged? Were you operating in a vacuum without any oversight or regulation whatsoever?**

The idea that tax preparers are currently "unregulated" is a common misunderstanding actively promoted by those who want tax preparers to be licensed. Tax preparers are already regulated by a number of criminal and civil laws and regulations at the federal, state, and local levels.

Today, tax preparers are directly regulated by the IRS under a number of federal statutes and regulations. First, all tax preparers must register with the IRS by applying for a Preparer Tax Identification Number (PTIN) and paying the $63 PTIN fee.[1] (We did not challenge this registration requirement in our lawsuit.) That application process includes completing Form W-12, which includes questions about whether you have a felony record and your federal tax compliance. Tax preparers must include their unique PTIN (as well as their signature) on every tax return they prepare.[2]

In addition, as the district court explained in its opinion in *Loving v. IRS*: "Congress has already enacted a relatively rigid penalty scheme to punish misdeeds by tax-return preparers. Title 26, in fact, has at least ten penalties specific to tax-return preparers, each of which targets particular conduct related to preparing and filing tax returns, and each of which comes with a specific fine."[3] The IRS also has the authority to seek injunctions against tax preparers who fail to comply with legal requirements.[4] And those are just the statutes specific to tax-return preparers; many other federal statutes regulate the conduct of anyone involved in preparing or filing a tax return, including tax preparers.[5]

Tax preparers are also subject to state and local laws related to consumer protection, fraud prevention, and the like. Like any business, tax preparers can also be sued by their customers in civil court and found liable for any harm they cause their customers.

But business reputation is even more important than civil liability. At the end of the day, I answer to my customers. If I do anything to expose my customers to an audit or other troubles with the IRS, they won't come back next year, and I'll lose business to my competitors. That's why it is vitally important that the tax-return preparation market remain competitive. Taxpayers should have ample alternatives if they aren't satisfied with their current tax preparer.

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[1] *See* 26 U.S.C. § 6109(a)(4); 26 C.F.R. § 1.6109-2.
[2] *See* 26 U.S.C. § 6695(b)–(c).
[3] *Loving v. IRS*, 917 F. Supp. 2d 67, 76 (D.D.C. 2013). These penalties can be found in 26 U.S.C. §§ 6694, 6695, 6713, 7216.
[4] *See* 26 U.S.C. § 7407.
[5] *See, e.g.*, 26 U.S.C. §§ 6700, 6701, 6702, 6707A, 6713, 7201, 7206, 7207, 7213.

2. Are there any other points or issues that were not explored (or adequately explored) during the hearing that you would like to bring to our attention?

Yes. The IRS should be looking for ways to partner with independent tax preparers instead of alienating and demonizing us. After all, we are much more in touch with the taxpayer community at large. The real threats to consumers are more likely to be undocumented tax preparers, a.k.a. "ghost preparers," who do not register for a PTIN but who illegally prepare hundreds of thousand returns each year as if they were self-prepared.

The IRS's arbitrary and capricious enforcement of the EITC due-diligence requirement

One policy that has a particularly disparate impact on tax preparers (and their taxpayer clients) in low-income and minority areas is the arbitrary and capricious way the IRS enforces the Earned Income Tax Credit (EITC) due-diligence requirements, which impose a $500-per-return penalty on tax preparers.[6] In some low-income areas, tax preparers with numerous EITC-eligible clients are getting hit with tens of thousands of dollars in fines, even if the returns they prepare pass IRS review, because the IRS decides the preparer has not fully satisfied some aspect of the byzantine EITC due-diligence requirements, often the vague and arbitrary "Knowledge" requirement.

Tax preparers are not only required to complete the 27-question IRS Form 8867 (some questions need to be answered multiple times for each child) and ask for copies of documents substantiating the client's claims about their EITC eligibility, but they have to keep copies of all records, including: (1) a record of when and how (including from whom) the preparer got the information used to prepare the return; and (2) a record of any additional questions the preparer asked and the customer's answers.[7]

In addition, tax preparers are held responsible under a vague and subjective "Knowledge" requirement that the IRS can always determine is not satisfied. Tax preparers must "[n]ot know, or have reason to know, that any information used to determine if the taxpayer is eligible or to compute the amount of the credit is not correct, not consistent or not complete."[8] Under this standard, tax preparers "must ask [their] client additional questions if a reasonable and well-informed tax return preparer, knowledgeable in the law, would conclude the information furnished seems incorrect, inconsistent or incomplete."[9] If tax preparers think that the information provided by a client is incorrect, inconsistent, or incomplete, they "must document in [their] files the questions [they] asked and [their] client's answers."[10]

This presents a number of problems. First, this effectively deputizes preparers as front-line investigators for the IRS and puts preparers in an adversarial position with their clients. That can undermine the relationship that preparers have with their clients, and can actually lead to clients

[6] *See* 26 U.S.C. § 6695(g) (which fails to set any standards for these due diligence requirements); 26 C.F.R. § 1.6695-2.
[7] *See* IRS Publication 4687 (Rev. 7-2015), *The Due Diligence Must Do's*, https://www.irs.gov/pub/irs-pdf/p4687.pdf.
[8] *See id.*
[9] *See id.*
[10] *See id.*

not fully or honestly disclosing certain relevant facts to their preparer. Second, this puts the burden on tax preparers to anticipate what the IRS will determine that "a reasonable and well-informed tax return preparer, knowledgeable in the law, would conclude" in a wide variety of contexts involving different customers, some of whom the preparer may know much better than the IRS investigator who reviews the file. Third, this is an arbitrary standard that is impossible to satisfy; no matter how many additional questions a tax preparer asks (beyond the 27 questions on Form 8867), the IRS can always identify one or more additional questions that the preparer supposedly should have asked.

At the same time, those taxpayers who wish to falsify their EITC eligibility can simply self-prepare their tax return using tax software or go to a "ghost preparer" without a PTIN who will mark their return as self-prepared. Both of these options bypass all of the EITC due diligence requirements, which only apply to paid preparers (and which are only enforceable against preparers who put their name and PTIN number on the tax returns they prepare).

Thank you for this opportunity to supplement my answers at the hearing.

Questions for the Record
"Opportunity Denied: How Overregulation Harms Minorities" Tuesday, October 6, 2015
Senator Sheldon

Whitehouse

Mr. Aaron Mair:

(1) Your testimony asserts that the science behind climate change is clear and there is overwhelming consensus about its human causes. Does recent satellite data invalidate the consensus views of climate change, its human causes, or future risks?

No, satellite data on temperature definitely does not invalidate the consensus views about climate science, including global warming and its primary cause by human-caused greenhouse gas emissions. The hiatus does not render global models invalid for predicting future risks due to long-term average climate change and sea level rise.

Available satellite measurements of temperatures of the upper atmosphere, such as data from the microwave sounding instruments, have limitations and uncertainties, such as varying methods for correcting errors in instrument calibration and satellite orbits and piecing together short-term records from many different satellites to identify long-term trends. They are not necessarily fully representative of warming of the atmosphere as a whole, especially during short-term variations of climate. The 2013 IPCC report stated that:

"New advances since AR4 have highlighted the substantial degree of uncertainty in both satellite and balloon-borne radiosonde records and led to some revisions and improvements in existing products and the creation of a number of new data products."(p. 194), and "These various data sets and analyses have served to highlight the degree of uncertainty in the data and derived products. " (p. 195)[1]

However, satellite and other data of tropospheric temperatures generally have shown an overall warming trend over the past 35 years, qualitatively similar to surface data, but varying substantially in the trend rate among different data reduction methods of the raw satellite measurements. Satellite and other measurements of stratospheric temperatures show a marked cooling of that layer, which tends to confirm the expected (from basic physics) effect of increased greenhouse gases as a major cause of warming of the lower atmosphere (and of the whole climate system) rather than other proposed causes.

The major causes of the recent so-called *pause* or *hiatus* in the rate of increase of atmospheric temperatures after 1998 until about 2013 also are now understood in terms of short-term effects. Essentially, the pause was mainly due to a shift of heat from the atmosphere to the oceans associated with the Pacific Decadal Oscillation, plus smaller

effects due to decadal variability in the Atlantic ocean, to an increase in aerosols from volcanic eruptions, and to slightly weaker solar radiation.[2] Irrespective of any issues about differences among data sets on atmospheric temperature, ocean temperatures and the overall climate system continued to warm, even during the hiatus. The latest IPCC report captures two of the relevant consensus scientific positions:

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased", and the further statement that:
"Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*). It is *virtually certain* that the upper ocean (0−700 m) warmed from 1971 to 2010 (see Figure SPM.3), and it *likely* warmed between the 1870s and 1971."[3]

Other recent data on ocean temperature increases at depths down to 2000 meters add even stronger evidence of ocean warming.[4] Most current global models are not yet designed to predict all the shorter-term internal oscillations of the climate system, and of course they cannot predict unpredictable natural events; however, they are reasonably good at predicting the longer-term average changes in climate due to major persistent factors such as greenhouse gas emissions and thus can be used to predict future average climate change with some degree of confidence. The IPCC 2013 report concluded, in part that: "There continues to be *very high confidence* that models reproduce observed large-scale mean surface temperature patterns ..." [5]

Global atmospheric surface temperature already began increasing more rapidly again in 2014, and 2015 is on track to become the hottest year in historical records by far. As expected, El Nino conditions are resuming and the hiatus appears to have been a short-term fluctuation from the general upward trend in atmospheric warming.

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[1] Hartmann, D.L., et al, 2013: Observations: Atmosphere and Surface. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[2] Trenberth, K., "Has there been a hiatus?: Internal climate variability masks climate-warming trends", Science, 349, 691-692, 14 August 2015.
[3] IPCC, 2013: Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*
[4] Levitus et al., "World ocean heat content and thermosteric sea level change (0-2000 m), 1955-2010", GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L10603, doi:10.1029/2012GL051106, 2012.
[5] Flato, G., J. *et al.*, 2013: Evaluation of Climate Models. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

(2) Your testimony claims that minority and low-income populations bear disproportionate risks from the effects of climate change. What evidence supports this claim?

We know climate change will put vulnerable populations at greater risk – including the elderly, communities of color, children, and people already suffering from burdensome allergies, asthma, and other illnesses. Pre-existing health conditions make older adults susceptible to the cardiac and respiratory impacts of air pollution. Higher rates of diabetes, obesity, or asthma in some communities place them at greater risk of climate-related health impacts. Children, who breathe more air relative to their size than adults, are also at higher risk of worsened asthma and respiratory symptoms from air pollution. More than 8 percent of Americans are living with asthma, including more than 9 percent of children. In fact, asthma is the third leading cause of hospitalizations for children. African American children are twice as likely to be hospitalized for asthma as whites, and are more likely to die from asthma. Latino children are 40 percent more likely to die from asthma than white children. Asthma is not just making people sick, it is costing taxpayers.

According to the Centers for Disease Control, the U.S. is spending billions of dollars in Medicaid expenses related to asthma each year. Ozone pollution is directly linked to temperature, thus climate change could likely lead to increased ozone levels. Our analysis found that, within the next ten years, climate change-induced ozone increases in the United States could result in 2.8 million additional respiratory illnesses, 5,100 more infants and seniors hospitalized with serious breathing problems, and 944,000 extra missed school days (Perera, Sanford 2011). All told, these and other health-related impacts could cost approximately $5.4 billion in 2020 alone. And if global warming pollution continues unabated, the impacts and costs could rise significantly higher.

In addition, climate change also increases the number and severity of heat waves. Older individuals who have a higher risk of dying during extreme heat events will bear a disproportionate share of the impacts. Heat waves and other extreme weather events can also disproportionately affect low-income communities and some communities of color, raising environmental justice concerns. We would like to submit the following reports for the record that detail these impacts to minority and low-income populations:

1. Union of Concerned Scientist Climate Change and Your Health Report Series:
    a. Perera, Sanford, White-Newsome, Heat in the Heartland: 60 Years of Warming in the Midwest http://www.ucsusa.org/global_warming/science_and_impacts/impacts/global-warming-and-heat-waves.html#.VjJ7MLerTIU
    b. Perera, White-Newsome,Sanford, Rising Temperatures, Worsening Ozone Pollution (2011)http://www.ucsusa.org/global_warming/science_and_impacts/impacts/climate-change-and-ozone-pollution.html#.VjJ7_berTIU

c. Perera, White-Newsome, Sanford, After the Storm:The Hidden Health Risks of Flooding in a Warming World, http://www.ucsusa.org/global_warming/science_and_impacts/impacts/global-warming-and-flooding.html#.VjJ8PberTIU

2. EPA'S CLEAN POWER PLAN RESOURCES FOR COMMUNITIES http://www3.epa.gov/airquality/cppcommunity/fs-cpp-resources-communities.pdf
3. Social Vulnerability and Climate Change: Synthesis of Literature, Kathy Lynn, Katharine MacKendrick, and Ellen M. Donoghue, 2011 **http://www.fs.fed.us/pnw/pubs/pnw_gtr838.pdf**
4. Environment and health risks: a review of the influence and effects of social inequalities, World Health Organization, 2010 **http://www.euro.who.int/__data/assets/pdf_file/0003/78069/E93670.pdf**
5. The Health Impacts of Climate Change on Americans, The Whitehouse, 2014, https://www.whitehouse.gov/sites/default/files/docs/the_health_impacts_of_climate_change_on_americans_final.pdf
6. ASSESSING THE VULNERABILITY OF COASTAL COMMUNITIES TO EXTREME STORMS: THE CASE OF REVERE, MA., USA http://foehn.colorado.edu/nome/HARC/Readings/Clark.pdf
7. Masozera, Distribution of impacts of natural disasters across income groups: A case study of New Orleans, 2007 http://www.d.umn.edu/~pfarrell/Natural%20Hazards/Readings/Katrina%20article.pdf
8. Harlan, Sharon L. Neighborhood microclimates and vulnerability to heat stress, 2006 http://www.climateknowledge.org/heat_waves/Doc4002_Harlan_Microclimates_Vulnerabilty_Heat_SocSciMed_2006.pdf

(3) Are people with preexisting respiratory diseases, such as Asthma, at increased risk of worse symptoms, acute attacks, or need for medication as a result of ozone pollution?

The science is clear that exposure to ozone pollution can be dangerous for even healthy adults, but sensitive populations – including children, the elderly, people with pre-existing respiratory and cardiovascular diseases, low-income families, outdoor workers, and communities of color – are at particular risk. EPA's updated ozone standard took into account thousands of peer-reviewed studies documenting harm to public health. Beyond the well-documented and more obvious relationship between exposure and decreased respiratory function and disease, studies also indicate broader epidemiological harm, including threats to cardiovascular health, reproductive and developmental harm, central nervous system effects, and even premature mortality.

Informing our advocacy for the strongest possible protections from ozone pollution are the recommendations and guidance of this country's top medical experts. Attached is a letter from 13 leading health organizations – including the American Lung Association, the American Medical Association, the American Academy of Pediatrics, and the Asthma and Allergy Foundation of America – to EPA Administrator Gina McCarthy supporting a standard of 60ppb that specifically cites respiratory health effects, and in particular harm to vulnerable populations, as justification for a much stronger standard.

We would also point to the American Thoracic Society's letter to Administrator McCarthy from September of 2015, the Children's Health Protection Advisory Committee letter to the Chair of the Clean Air Scientific Advisory Committee from May of 2014, and the Clean Air Scientific Advisory Committee's letter to Administrator McCarthy from June of 2014 – all attached – that clearly demonstrate scientific consensus that ozone pollution is harmful to public health, particularly to people with preexisting respiratory diseases like asthma.

(4) Can you provide an example of how well clean air regulations, like the Clean Air Act, have protected peoples' health?

The Clean Air Act has been one of the most successful pieces of legislation ever enacted by Congress. It has saved hundreds of thousands of lives and prevented millions of asthma attacks, all while growing our economy by driving innovation, creating good American jobs, and saving taxpayers billions in healthcare costs. We submit for the record EPA's 2011 report entitled "The Benefits and Costs of the Clean Air Act from 1990 to 2020" that clearly demonstrates how well the Clean Air Act has worked to protect public health.

Questions for the Record from Senator Chris Coons

Mr. Narang: Senator Cruz asked you to name an example of overregulation. Are there examples of overregulation that you would like to highlight for the Subcommittee?

At the outset, I would like to make clear, as I did in both my written testimony and my oral remarks, that the current status quo with respect to federal regulations is not overregulation but under-regulation and such under-regulation results in lost lives, preventable injuries, damage to the environment, and instability in our financial system. Thus, the premise that overregulation is harming our country is flawed in that any potential overregulation is dwarfed by systemic under-regulation.

That said, there is a particular instance of regulation that has disproportionately hurt minority populations. I am referring to laws and implementing regulations requiring voters to produce identification as a precondition to exercising their right to vote. These voter ID laws are premised on the false belief that voter fraud is widespread which is in direct contradiction to the clear majority of empirical work showing that voter fraud claims are drastically overstated. Nonetheless, empirical work also convincingly demonstrates that such voter ID laws have led to large numbers of disenfranchised voters among whom the overwhelming majority is comprised of minority voters. Voter ID laws and implementing regulations are one of the rare if compelling examples of regulation hurting minority populations.

Mr. Narang: During live testimony, another witness cited the Competitive Enterprise Institute for the proposition that federal regulations cost the economy $2 trillion and the Small Business Administration for the proposition that small businesses bear a regulatory cost of $10,585 per employee. What is your response to these claims?

Let me begin by addressing the generic claim that regulations hurt the economy, often used to justify assertions of overregulation. This rhetoric is simply not supported by reality. All studies that have attempted to demonstrate this falsehood have been completely discredited by credible, independent, and in certain cases, non-partisan observers such as the Congressional Research Service. None of these studies have been subjected to peer-review and none would pass scrutiny under peer-review.

This is certainly the case with respect to these two reports in particular, one by the Competitive Enterprise Institute (CEI) and one by the Small Business Administration Office of Advocacy (SBA Advocacy), both of which assert that regulation costs our economy roughly 1.8 trillion annually which breaks down to about 15,000 dollars per household. Both are readily cited by lawmakers and by a fellow witness at the hearing. And yet, when the Washington Post looked at the CEI report, it thoroughly discredited the study, finding it "misleading" and worthy of two pinocchios.[1] The CEI report's authors themselves claim it is "not scientific" and rather "back of the envelope." Likewise, the SBA Advocacy report has been heavily criticized by all independent observers and has even been disavowed by the SBA Advocacy itself who now warns readers that "findings of the study have been taken out of context and certain theoretical estimates of costs have been presented publicly as verifiable facts."[2] It is long past time for the SBA to take the report off its website and publicly apologize for the inappropriate use of taxpayer funds. These reports, and others relying on similar discredited methodology, cannot and should not inform critical policy debates, and certainly should not be the primary justification for claims of overregulation.

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[1] https://www.washingtonpost.com/news/fact-checker/wp/2015/01/14/the-claim-that-american-households-have-a-15000-regulatory-burden/

[2] https://www.sba.gov/advocacy/impact-regulatory-costs-small-firms

Mr. Narang: The issue of occupational licensing was raised as an area of overregulation of concern to minorities. Do federal health and safety regulation reform proposals affect occupation licensing requirements, which are usually implemented at the state and local level?

None of the regulatory reform proposals currently pending in Congress would impact or affect occupational licensing requirements that apply at the state and local level. Indeed, lawmakers should be very careful not to conflate purported problems with state level occupational licensing regimes with calls for significant reforms to the federal rulemaking process. Stipulating that Congress should adopt regulatory reform measures, which as I explain in my written testimony would significantly undermine the government's ability to protect the public's health, safety, the environment, and the stability of our financial system, on the basis of concerns with occupational licensing makes little sense and would result in misleading the public.

AMERICAN SOCIETY OF INTERIOR DESIGNERS

October 5, 2015

US Senator Ted Cruz
Chair
US Senate Judiciary Subcommittee on Oversight,
Agency Action, Federal Rights and Federal Courts
224 Dirksen Senate Office Building
Washington, D.C. 20510-6050

US Senator Chris Coons
Ranking Member
US Senate Judiciary Subcommittee on Oversight,
Agency Action, Federal Rights and Federal Courts
224 Dirksen Senate Office Building
Washington, D.C. 20510-6050

Chairman Cruz and Ranking Member Coons,

I hope this correspondence finds you well. It has come to our attention that the interior design profession, and more specifically the licensure of interior designers, will be addressed in written testimony submitted by Timothy Sandefur in front of the US Senate Judiciary Subcommittee on Oversight, Agency Action, Federal Rights and Federal Courts hearing entitled *Opportunity Denied: How Overregulation Harms Minorities* on October 6. In summary, Mr. Sandefur's written testimony is inaccurate and results in gross and false accusations about licensure of interior designers and the American Society of Interior Designers (ASID). Therefore, this correspondence is intended to provide access to the truth for the members of the subcommittee and public at large.

First and foremost, note that the Mr. Sandefur confuses and interchangeably uses the terms "interior ***designer***" and "interior ***decorator***." The committee is thereby misled when trying to understand the role of an interior designer in constructing and/or renovating the built environment and therefore the necessity for licensure.

Licensure of built environment professionals such as architects, engineers, and interior designers is based entirely on government adopted building codes. As you are no doubt aware, building codes focus on upholding public safety through standards for the design and construction of structures. In their role to safeguard the public, every level of government across the entire country has adopted codes for both public and private building projects. Consequently, the professionals working in the built environment must be qualified to comprehend, implement, and comply with the codes as they carry-out their own scope of work on a project. For the architects and engineers, their "code focus" is on structural integrity and other systems in the building. Interior designers focus on planning a structure's interior spaces otherwise known as the physical layout / features of a building. These laws and codes influence every decision an interior designer makes when they personally plan *and* monitor the construction of a building's interior elements. For hallways, walkways, doors and stairwells, they ensure compliance with fire codes for proper egress and exiting. Their work also includes designing and placing the lighting systems to comply with emergency lighting requirements, location of exit signs, and even fire extinguishers. For Americans With Disabilities Act (ADA) compliance, interior designers guarantee accessibility by designing a "barrier free" environment specifically for the disabled that also has benefits to all building occupants.

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Interior designers also must ensure fire code is followed when they specify building materials, interior finishes, and commercial furniture. To summarize, licensure of interior designers is highly important and necessary based on the direct role our profession has to protect public safety through building code compliance – a fact that was recognized with the passage of the first U.S. interior design licensure law over 40 years ago.

Regarding the aesthetics of a building; they are just one consideration for interior designers. However, they will always take a back seat to an interior designer's responsibility and vital role on a project to guarantee the public's safety. For interior decorators, **not** designers, aesthetics are well over a majority of their consideration and job. Decorating is a matter of personal taste and style that does not necessarily require formal education / training. However, interior design does. Unqualified individuals attempting to practice interior design without proper training are a risk to upholding public safety. They must have formal education/training and experience. It is absolutely the key to protecting public and consumer safety after a project's completion. Licensure is the confirmation that said education and experience have been satisfied in order for an interior designer to work in "code impacted" spaces. It is the recognition overall that built environment professionals, such as interior designers, are qualified and capable to protect the public throughout their careers.

The licensure process for interior designers is based on experience, education, and examination. This is much like the model for other profession's licensing both inside and out of the built environment such as architects or attorneys respectively. Like them, interior designers attend school for numerous years in order to obtain a degree in interior design. There are approximately 400 interior design programs offered by colleges and universities that issue certificate, associate, bachelor and grad degrees. Aspiring licensed interior designers also must have "on the job" experience. This is not unlike attorneys. During their education years interior design students also work for a firm in order to apply the skills they obtain in the classroom. The combination of education and work experience prepares them to pass the industry exam known as the National Council for Interior Design Qualification or NCIDQ. A parallel example would be the bar exam for attorneys. The NCIDQ is a comprehensive examination that incorporates each individual's classroom and work experience, including a specific focus on building codes. Therefore, it is no surprise that all governments in the US offering licensure to practice interior design require an individual to pass NCIDQ – just like states' requiring aspiring attorneys to pass "the bar" in order to practice law.

Despite the previously stated facts about interior designers, Mr. Sandefur characterizes and accuses our association and the licensure of interior designers in general as a conspiracy to prevent minority populations from becoming interior designers. He creates a false narrative based on incorrect or at best half-truths that fail to support any of his argument.

Up front, he fails to recognize that 89 percent of interior designers are women and 11 percent male. We are almost an entire profession of minorities.

Regardless, he targets the licensure process' requirement to obtain a college degree as a barrier to minority populations to practice interior design in general. He begins with the following;

"*Florida requires people to have a college degree and pass a government exam before they can practice the business of 'interior design.'*"

This is very inaccurate. Anyone can practice interior design without a college degree in the state of Florida and in any of the other states offering interior design licensure. The exception is if one wants to practice in a

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commercial space. As previously stated, this is due to the necessity for an individual to be properly trained with the knowledge and compliance measures associated with building codes in these spaces.

Only 4 states, 1 territory and the District of Columbia require interior designers to be licensed. They are Louisiana, Alabama, Nevada, Florida, District of Columbia, and Puerto Rico. None of them require all interior designers to be licensed, only those working in commercial spaces – i.e. buildings that are heavily impacted by the building codes due to the large number of occupants. In other words, all interior design licensure laws and regulations only apply to individuals practicing in commercial buildings. Also, it is important to note in this context that no local, state, or federal entity regulates the practice of interior *decoration* in any type of structure and/or interior *design* in residential structures. Anyone, anywhere can practice interior decorating and/or interior design in a residential structure without licensure. Therefore, it is inaccurate for Mr. Sandefur to imply that without a college degree, an individual is prohibited from practicing the business of interior design.

Regardless, Mr. Sandefur proposes that the college degree "*requirement has a racially disproportionate impact"* on entry into the profession. Again, no individual needs a college degree to practice in the residential space anywhere in America. If an individual does need a degree because they want to practice in the *commercial* space, there are more than 400 interior design programs in the country that offer certificate, associate, bachelor, and graduate degrees. This provides a vast amount of opportunity for any individual to chart their own course through an education program that is appropriate for them, their financial situation, and overall goal of becoming an interior designer. The profession and every single type of degree granting educational institution are clearly not closing any doors or opportunities to be an interior designer.

Mr. Sandefur specifically addresses that there are a disproportionate number of Black and Hispanic interior designers. He is not wrong and we agree, this is unfortunate. However, licensure is not the cause of their underrepresentation.

Race	US Population*	Interior Designers**
White	77%	89%
Hispanic/Latino	17%	5%
Asian	5%	5%
Black	13%	1%
Native American	1%	>1%

*US Census Bureau. http://quickfacts.census.gov/qfd/states/00000.html
** US Census Bureau, 2007 US Economic Census.

Blacks and Hispanics are underrepresented both in states that do and do not require licenses. This suggests licensure is not a significant barrier to entry for these groups. Only 4 states out of 50 and the District of Columbia as well as Puerto Rico offer a license to practice interior design. Let's suppose for a moment that licensure is an important barrier to practice interior design for Blacks and Hispanics. If that were the case, then it's fair to say this barrier does not exist for 46 out of 52 states/territories (88%). Yet Blacks and Hispanics are still underrepresented without the "barrier" of licensure in place. In other words, if licensure were a meaningful barrier to entry for Blacks and Hispanics, we would see much more representative numbers of those groups in the total population of interior designers.

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Mr. Sandefur's accusations can also be refuted by the growth of the interior design profession. According to the US Bureau of Labor Statistics, the number of interior designers has increased by 10,000 in just the last three years. Also, the number of interior design firms is up 7.5 percent to 13,257. We see this growth even though licensure laws for interior design have existed for more than 40 years. Clearly, they have no negative effect on entry into the profession.

Finally, Mr. Sandefur posits that "*[i]nterior designer licensing is a monopolistic privilege created by the American Society of Interior Designers"*. First, note that no law or regulation requires membership in our association nor do we require anyone to be licensed to be a member. The fact is we are opposed to monopolies in the built environment among design professionals. It is for that reason that we exercise our First Amendment rights to advocate on behalf of all interior designers for licensure, not just ASID members. Without these laws, interior designers are legally subservient to other members of the design team, such as architects and engineers. Both of these built environment professions are woefully low in female and ethnic diversity. Therefore, Mr. Sandefur is, by advocating for removal of interior design licensure, not only jeopardizing public safety, but also advocating for two professions that are overly dominated by white males. Such conditions do not represent a truly diverse and free market, but it is the unfortunate reality that tens of thousands in our profession live every day – in states that don't offer licensure for interior designers.

It is unfortunate Mr. Sandefur was not aware of the true facts regarding the profession when preparing his statement.

Thank you on behalf of the 26,000 members of the American Society of Interior Designers (ASID) for the opportunity to correct the record. Please feel free to contact Jim Brewer, our Vice President of Government and Public Affairs, if you or members of the committee have further questions regarding interior design.

Sincerely,

Randy Fiser
Chief Executive Officer
American Society of Interior Designers

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September 23, 2015

Honorable Gina McCarthy
Administrator
Environmental Protection Agency
1200 Pennsylvania Ave Washington, D.C. 20460

Administrator McCarthy:

On behalf of the 15,000 members of the American Thoracic Society and the patients we serve, we strongly urge you to adopt a final 8-hour average daily ozone (O_3) National Ambient Air Quality Standard of 60 ppb. The lives of thousands of Americans are at stake.

The American Thoracic Society, in partnership with the Marron Institute of Urban Management at NYU, will soon release a report that documents the potential lives saved and serious morbidity avoided by setting a more protective ozone standard. The information in this report makes a compelling case for why EPA must adopt a more protective standard of 60 ppb:

- A standard of 60 ppb will prevent 6,408 premature deaths annually, as compared to current exposure levels.

- A less protective standard of 70 ppb would result in 3,752 more premature deaths annually, as compared to 60 ppb.

The lives of 3,700 Americans are too important for EPA to ignore.

Attached to this letter, we have provided summary information about the report's methods and its findings. While the report provides important city-by-city information, it merely confirms the existing scientific record available to EPA demonstrating the need for a more protective standard. We hope this additional information will be useful as you move forward with a final standard for ozone

Administrator McCarthy, the fate of thousands of lives annually rests on your decision. We urge you to use EPA's authority to protect the lives and health of these Americans by adopting a protective standard of 60 ppb.

Sincerely,

George Thurston, Sc.D.
Chair, ATS Environmental Health Policy Committee

Mary B. Rice, M.D.
Vice Chair, ATS Environmental Health Policy Committee

Kevin Cromar Ph.D.
Lead Report Author, ATS Air Quality Report
Director, Air Quality Initiative, Marron Institute of Urban Management at NYU

Background
Ozone air pollution, much of it a result of emissions from power plants and motor vehicles, represents a particularly widespread threat to American families. Ozone is especially dangerous for sensitive populations, including children, the elderly, those with preexisting respiratory and cardiovascular disease, outdoor workers, low-income families, and communities of color. The Clean Air Act is clear in requiring EPA to set its clean air standards to protect vulnerable populations, without consideration of cost.

Methods
To assess the health benefits of attaining the ATS-recommended National Ambient Air Quality Standard (NAAQS) for ozone standard of 60 ppb, the ATS Environmental Health Policy Committee and the Marron Institute of Urban Management at New York University have partnered to develop a web-based annual report outlining the health benefits of achieving the ATS recommended standards for particle pollution and ozone in cities across the United States. The first of these reports is expected to be released in the *Annals of the American Thoracic Society* shortly. This letter contains study results pertinent to the revision of the NAAQS for ozone.

This report is unique from EPA's estimated benefits of reduced ozone, in that the ATS report does not attempt to account for the reductions of ozone driven by other EPA policies.

Due to the demonstrated health impacts of ambient ozone across the entire age spectrum as reported in the published literature, ATS has consistently advocated for a revised ozone standard of 60 ppb.[1] Since 2007, when this recommendation was first made by ATS, the scientific evidence has significantly strengthened, especially in regards to mortality risk and reduced lung function.[2] In our joint report, we quantify health benefits of meeting our recommended revised standard of 60 ppb, and also higher standards that are being considered by the EPA administrator.

Health benefit estimates for meeting the current (75 ppb) and prospective ozone standards (70, 65 and 60 ppb) were made for counties with at least one monitor with a valid design value for years 2011-2013 (downloaded from http://www.epa.gov/airtrends/values.html). Health benefit estimates for these counties were then made based on hourly 2013 monitoring data (downloaded from EPA AirData).

Using concentration-response functions, health incidence data, and population statistics as contained in BenMAP CE 1.1 (open-source software provided by the EPA to estimate health impacts due to changes in air quality), health estimates were made for mortality risk, hospital admissions, emergency department visits, restricted activity days, and lost school days.[3-12] Health studies using 24-hour mean, 8-hour maximum, and 1-hour maximum metrics were all investigated. In instances where more than one study was available for a particular health endpoint, uniform averages of central estimates were determined.

Results
Looking at mortality benefits of other prospective standards indicates that meeting a revised standard of 70 ppb would result in 2,656 total avoided deaths and another similar incremental

mortality benefit (1,212 deaths) from going further from 75 to 70 ppb vs. meeting the current standard (1,444 deaths). Incremental mortality benefits further increase in moving from 70 to 65 ppb (1,740 additional deaths avoided), and from 65 to 60 ppb (2,013 additional deaths avoided), because of larger proportion of the U.S. population that would benefit from the cleaner air these lower standards would provide.

Table 2 shows a list of the top 30 metropolitan districts and metropolitan statistical areas with the highest number of estimated mortality benefits. The estimated 3,659 avoided deaths in these 30 metropolitan areas constitutes 57% of the total mortality benefits estimated for the United States in meeting the ATS recommendation of 60 ppb.

Table 1. Estimated Mortality Benefits from Full Attainment of Current and Prospective Ozone Standards

Ozone Standard	Concentration	Total Avoided Mortality*	Additional Avoided Mortality**
Current EPA Standard	75 ppb	1,444	1,444
Prospective Standard	70 ppb	2,656	1,212
Prospective Standard	65 ppb	4,395	1,739
ATS Recommendation	60 ppb	6,408	2,013

*Total mortality benefits compared to current ozone levels.
**Additional benefits compared the next highest standard.

Table 2. Top 30 Metropolitan District and Metropolitan Statistical Areas for Estimated Mortality Benefits for Full Attainment of ATS Recommended Standard (60 ppb)

Rank	Location (Metropolitan District or Statistical Area)	Total Avoided Mortality
1	Los Angeles-Long Beach-Glendale, CA	619
2	Riverside-San Bernardino-Ontario, CA	361
3	New York-Jersey City-White Plains, NY-NJ	280
4	Phoenix-Mesa-Scottsdale, AZ	199
5	Dallas-Plano-Irving, TX	142
6	San Diego-Carlsbad, CA	132
7	Sacramento--Roseville--Arden-Arcade, CA	128
8	Houston-The Woodlands-Sugar Land, TX	122
9	St. Louis, MO-IL	117
10	Baltimore-Columbia-Towson, MD	103
11	Chicago-Naperville-Arlington Heights, IL	91
12	Pittsburgh, PA	88
13	Fort Worth-Arlington, TX	87
14	Atlanta-Sandy Springs-Roswell, GA	86
15	Philadelphia, PA	84
16	Las Vegas-Henderson-Paradise, NV	82
17	Cleveland-Elyria, OH	81
18	Warren-Troy-Farmington Hills, MI	79
19	Nassau County-Suffolk County, NY	78

20	Cincinnati, OH-KY-IN	77
21	Montgomery County-Bucks County-Chester County, PA	72
22	Denver-Aurora-Lakewood, CO	71
23	Washington-Arlington-Alexandria, DC-VA-MD-WV	67
24	Anaheim-Santa Ana-Irvine, CA	64
25	Detroit-Dearborn-Livonia, MI	64
26	Columbus, OH	63
27	Fresno, CA	60
28	New Haven-Milford, CT	55
29	Indianapolis-Carmel-Anderson, IN	53
30	San Antonio-New Braunfels, TX	52
		Total= 3,659*

*57% of total mortality benefits in the United States.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

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June 26, 2014

EPA-CASAC-14-004

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: CASAC Review of the EPA's *Second Draft Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards*

Dear Administrator McCarthy:

The Clean Air Scientific Advisory Committee (CASAC) Ozone Review Panel met on March 25 - 27, 2014, to review the EPA's *Second Draft Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards*, hereafter referred to as the Second Draft PA. This letter highlights the chartered CASAC's consensus advice, followed by consensus responses to the charge questions from the Agency. Individual review comments from the CASAC Ozone Review Panel are also attached.

Overall, the Second Draft PA is an excellent summary of information needed to judge the adequacy of the current National Ambient Air Quality Standards (NAAQS) for ozone and to consider alternative standards. The information on emissions, atmospheric chemistry and common patterns of ozone concentration is presented clearly and is appropriately characterized. "Background" ozone (i.e., ozone that originates from precursors from natural sources or anthropogenic international emissions) is extensively and appropriately characterized, although in our consensus responses to charge questions, we have some technical comments that should be addressed to improve the coverage of this issue. The Second Draft PA is not clear as to how background estimates might impact the primary and secondary standards and whether these impacts may differ regionally. The Second Draft PA cites a 2002 court decision (*American Trucking Associations, Inc. v. EPA, 283 F.3d at 379*) that allows the EPA to consider relative proximity to peak background levels when evaluating alternative standards but it also cites a case where the court said "attainability and technological feasibility are not relevant considerations in the promulgation of the NAAQS" (*American Petroleum Institute v. Costle*, 665 F. 2d at 1185). The Second Draft PA was silent as to how the EPA intends to navigate between these two legal guidelines when considering background ozone in a policy and standard-setting context. This question became an important issue in the CASAC deliberations as we listened to public comments regarding

high background levels in the intermountain Western United States.

In addressing the adequacy of the primary standard, the Second Draft PA presents scientifically sound information on the health effects evidence for each major effect category: lung function decrements, pulmonary inflammation, respiratory symptoms, respiratory morbidity and respiratory mortality. The CASAC finds scientific justification that current evidence and the results of the exposure and risk assessment call into question the adequacy of the current standard. Furthermore, there is clear scientific support for the need to revise the standard. The CASAC supports the scientific rationale presented in the Second Draft PA on these points.

The CASAC concurs with the staff's justifications in the Second Draft PA for retaining the current indicator (ozone), averaging time (maximum daily 8-hour average) and form (annual 4th highest maximum daily 8-hour average, averaged over three years) for the primary standard. The indicator of ozone is appropriate based on its causal or likely causal associations with multiple adverse health outcomes and its representation of a class of pollutants known as photochemical oxidants. The current 8-hour averaging time is justified by the combined evidence from epidemiologic and clinical studies referenced in Chapter 4. The CASAC concurs that the ozone standard should be based on the fourth highest, daily maximum 8-hour average value (averaged over three years). This averaging time provides programmatic stability by allowing for atypical meteorological conditions that can lead to abnormally high ambient ozone concentrations while providing health protection.

The CASAC further concludes that there is adequate scientific evidence to recommend a range of levels for a revised primary ozone standard from 70 ppb to 60 ppb. The CASAC reached this conclusion based on the scientific evidence from clinical studies, epidemiologic studies, and animal toxicology studies, as summarized in the Integrated Science Assessment (ISA), the findings from the exposure and risk assessments as summarized in the HREA, and the interpretation of the implications of these sources of information as given in the Second Draft PA. However, as noted below, we believe there is an important distinction in our finding and advice regarding the upper bound level of 70 ppb as compared to that of EPA staff as given in the Second Draft PA.

In reaching its scientific judgment regarding a recommended range of levels for a revised ozone primary standard, the CASAC focused on the scientific evidence that identifies the type and extent of adverse effects on public health. The CASAC acknowledges that the choice of a level within the range recommended based on scientific evidence is a policy judgment under the statutory mandate of the Clean Air Act. The CASAC advises that, based on the scientific evidence, a level of 70 ppb provides little margin of safety for the protection of public health, particularly for sensitive subpopulations. In this regard, our advice differs from that offered by EPA staff in the Second Draft PA. At 70 ppb, there is substantial scientific evidence of adverse effects as detailed in the charge question responses, including decrease in lung function, increase in respiratory symptoms, and increase in airway inflammation. Although a level of 70 ppb is more protective of public health than the current standard, it may not meet the statutory requirement to protect public health with an adequate margin of safety. In this regard, the CASAC deliberated at length regarding advice on other levels that might be considered to be protective of public health with an adequate margin of safety. For example, the recommended lower bound of 60 ppb would certainly offer more public health protection than levels of 70 ppb or 65 ppb and would provide an adequate margin of safety. Thus, our policy advice is to set the level of the standard lower than 70 ppb within a range down to 60 ppb, taking into account your

judgment regarding the desired margin of safety to protect public health, and taking into account that lower levels will provide incrementally greater margins of safety.

With respect to the secondary standard, the CASAC concurs with EPA's identification of adverse welfare effects related to ecosystem services, food and fiber products from crops, and damage to resource use from foliar injury. The CASAC concurs that tree species relative biomass loss, foliar injury, and crop yield loss are appropriate surrogates of adverse welfare effects. The CASAC further supports the causality determinations of the ISA between exposure to ozone and adverse welfare effects. The CASAC supports the scientific conclusion in the Second Draft PA that the current secondary standard is not adequate to protect against current and anticipated welfare effects of ozone on vegetation. We recommend retaining the current indicator (ozone) but establishing a revised form of the secondary standard to be the biologically-relevant W126 index accumulated over a 12-hour period (8 a.m. – 8 p.m.) over the 3-month summation period of a single year resulting in the maximum value of W126 (henceforth W126). The CASAC recommends that the level associated with this form be within the range of 7 ppm-hrs to 15 ppm-hrs to protect against current and anticipated welfare effects of ozone. The CASAC does not support a level higher than 15 ppm-hrs. For example, at 17 ppm-hrs, the median tree species has 6% relative biomass loss, and the median crop species has over 5% yield loss. These levels are unacceptably high. These combinations of indicator, form, averaging time, and level are scientifically justifiable given evidence of current and anticipated welfare effects as captured in the Second Draft PA, and supported by the ISA and the second draft of the WREA.

In reaching its scientific judgment regarding the indicator, form, summation time, and range of levels for a revised secondary standard, the CASAC has focused on the scientific evidence for the identification of the kind and extent of adverse effects on public welfare. The CASAC acknowledges that the choice of a level within the range recommended based on scientific evidence is a policy judgment under the statutory mandate of the Clean Air Act. Specifically, the Clean Air Act grants discretion to the Administrator to specify a standard that is "requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of [the] pollutant in the ambient air" (Section 302(h), 42 U.S.C., §7602(h)). As a policy recommendation, separate from its advice above regarding scientific findings, the CASAC advises that a level of 15 ppm-hrs for the highest 3-month sum in a single year is requisite to protect crop yield loss, but that lower levels provide additional protection against crop yield loss. Furthermore, there are specific economically significant crops, such as soybeans, that may not be protected at 15 ppm-hrs but would be protected at lower levels. A level below 10 ppm-hrs is required to reduce foliar injury. A level of 7 ppm-hrs is protective of relative biomass loss for trees and offers additional protection against crop yield loss and foliar injury. Therefore, 7 ppm-hrs is protective of ecosystem services. Thus, lower levels within the recommended range offer a greater degree of protection of more endpoints than do higher levels within the range.

The CASAC does not recommend the use of a three-year averaging period for the secondary standard. We favor a single-year period for determining the highest three-month summation which will provide more protection for annual crops and for the anticipated cumulative effects on perennial species. The scientific analyses considered in this review, and the evidence upon which they are based, are from single-year results. If, as a policy matter, the Administrator prefers to base the secondary standard on a three-year averaging period for the purpose of program stability, then the level of the standard should be revised downward such that the level for the highest three-month summation in any given year of the three-year period would not exceed the scientifically recommended range of 7 ppm-hrs to 15 ppm-

hrs. For example, if in a three-year period the highest three-month summation during a one year period is 15 ppm-hrs, and the corresponding lowest value associated with a three-year average of the highest three-month summations in each year is 13 ppm-hrs, then the appropriate level for the three-year average would be 13 ppm-hrs to protect against a peak one year level of 15 ppm-hrs. The final Policy Assessment should quantify the ratio of the three-year average of the highest three-month summations in each year to the highest three-month summation in the highest year. This ratio should be used to determine what downward adjustment from the three-month summation in one year recommended here is needed if a three-year form is selected.

The CASAC recommends that EPA facilitate research needed for the next review of the ozone NAAQS. For the health-based standard, we note that the Second Draft PA outlines key uncertainties and research that needs to be addressed for future reviews of the health-based standards. Specifically, we underscore the need for research to address the characterization of the exposure-response function; the identification of population thresholds; the role of co-pollutants and temperature in modifying or contributing to ozone effects; alternative modeling specifications; population-based information on human exposure for at-risk populations; time-activity data to improve population-based exposure and risk assessment; and the characterization of background levels.

For the secondary standard, the Second Draft PA also identifies uncertainties and needed research to develop data and better methods for extrapolating results to plant species for which exposure-response functions have not been developed; assessing the effects of ozone on climate (and the effects of climate on ozone); characterizing the effects of ozone on whole ecosystem structure and function; and evaluating how the public judges the adversity of various kinds of ecological effects including foliar injury and estimated reduced tree biomass growth. This policy-relevant research could be conducted in collaboration with other federal and non-governmental organizations to improve our understanding of ozone effects in support of the next review of the ozone NAAQS.

While these scientific research priorities will enhance future scientific reviews of the ozone primary and secondary standards, we also make clear that there is sufficient scientific evidence, and sufficient confidence in the available research results, to support the advice we have given above for this review cycle of the primary and secondary standards.

Although CASAC was not asked to comment about international transport of ozone, we would like to call your attention to this issue as a matter separate from our advice regarding the standard. North American background ozone is defined by the EPA as the ozone that would be present in U.S. surface air in the absence of North American anthropogenic emissions. North American background ozone can be estimated using global models by conducting simulations with North American anthropogenic emissions set to zero. Results indicate that background is only partly natural (lightning, biosphere, fires, stratospheric influence) and is enhanced by anthropogenic sources outside North America. Estimates of this external anthropogenic enhancement are fairly consistent across models [Fiore et al., 2009]. Zhang et al. [2011] estimated that during spring-summer 2006-2008 the mean enhancement from intercontinental pollution and anthropogenic methane is 9 ppb at low-altitude sites and 13 ppb at high-altitude sites (>1,500 m elevation), both roughly one third of the North American background ozone in the respective areas. The authors also indicated that the background ozone is higher than average when ozone concentrations exceed 60 ppb, particularly in the intermountain West. There is currently no international legal agreement on ozone or its precursors that would effectively deal with long-range transport, despite the recommendations by the National Academy of Sciences (2009) and the Task Force

on Hemispheric Transport of Air Pollution (2010) that such an agreement be sought. Given the significant portion of ozone coming from anthropogenic sources outside North America, the CASAC recommends that EPA seek opportunities for international cooperation to reduce long-range transport of ozone.

During the course of the review of the Second Draft PA, the CASAC received public comments focused on costs and implementation issues associated with a possible revised ozone standard, mainly focused on the primary standard. *Whitman vs. American Trucking Associations, Inc.* (2001) decreed that the EPA cannot consider implementation costs in setting the NAAQS. Furthermore, "[a]ttainability and technological feasibility are not relevant considerations in the promulgation of national ambient air quality standards" (*American Petroleum Institute vs. Costle*, 665 F. 2d at 1185) and EPA need not tailor the NAAQS to fit each region or locale. Thus, cost and implementation issues are not relevant or allowable considerations in setting or revising a NAAQS. Therefore, CASAC did not consider such issues in its scientific review of the current standards or in developing its advice regarding revising the standards. However, the CASAC acknowledges that the Clean Air Act, section 109(d), states that the CASAC shall "advise the Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such national ambient air quality standards." Separate from the standard-setting process, the CASAC would be receptive to a request from EPA to review EPA analyses of "adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such national ambient air quality standards" (42 U.S. Code § 7409). It should be noted, however, that not all of these effects will be "adverse" and any comprehensive assessment would include both adverse and beneficial effects. For example, positive economic effects accrue from implementation of national ambient air quality standards, such as the economic benefit of avoided morbidity and mortality. In response to such a request, the SAB Staff Office would form an *ad hoc* CASAC panel to obtain the full expertise necessary to conduct such a review.

The current approach to review and revision of the primary NAAQS is based on a one-pollutant-at-a-time approach. As the state of science regarding the joint effects of human exposure to multiple pollutants improves, the EPA should consider how review and revision of the NAAQS can be done synergistically for logical, scientifically relevant groupings of criteria pollutants. For example, O_3 and NO_2 are both criteria pollutants that are inter-related via atmospheric chemistry, and human exposure to these pollutants is often in the form of a mixture that includes both, and other pollutants such as particulate matter. The National Research Council and the North American Research Strategy for Tropospheric Ozone have both made detailed recommendations for multipollutant approaches to air quality management, and EPA has been exploring a multipollutant approach for the secondary standards for SO_X and NO_X. CASAC encourages EPA to explore multipollutant approaches for review of the primary standards, and would be receptive to a request by EPA to review planning or methods documents for such approaches.

Overall, we find the Second Draft PA to be adequate for its intended purpose of providing a strong scientific basis for findings regarding the inadequacy of current primary and secondary ozone air quality standards; for scientifically justifiable indicators, averaging times, and forms for alternative revised primary and secondary standards; and for our advice regarding scientifically justifiable ranges of levels for each of the primary and secondary standards. The CASAC appreciates the opportunity to provide advice on the Second Draft PA and looks forward to receiving the agency's response.

Sincerely,

/signed/

Dr. H. Christopher Frey, Chair
Clean Air Scientific Advisory Committee

Enclosures

NOTICE

This report has been written as part of the activities of the EPA's Clean Air Scientific Advisory Committee (CASAC), a federal advisory committee independently chartered to provide extramural scientific information and advice to the Administrator and other officials of the EPA. The CASAC provides balanced, expert assessment of scientific matters related to issues and problems facing the agency. This report has not been reviewed for approval by the agency and, hence, the contents of this report do not necessarily represent the views and policies of the EPA, nor of other agencies within the Executive Branch of the federal government. In addition, any mention of trade names or commercial products does not constitute a recommendation for use. The CASAC reports are posted on the EPA website at: http://www.epa.gov/casac.

CASAC Consensus Responses
to Charge Questions
On the Second Draft Policy Assessment
for the Review of the National Ambient Air Quality Standards for Ozone

Introduction (Chapter 1)

1. *Does the Panel find the introductory and background material (sections 1.1 and 1.2) to be appropriately characterized and clearly communicated?*

This chapter is an excellent introduction to the legislative requirements of the Clean Air Act as they apply to ozone. It also provides an excellent history of the standard-setting process; Table 1-1 does a good job summarizing the different NAAQS that have been set historically. The historical review of legal challenges to previous decisions and their eventual outcomes is well done. The chapter clearly delineates the scope and approach for the Second Draft PA. This review is especially informative about the ruling by the U.S. Court of Appeals for the District of Columbia concerning the failure of the CASAC to be clear in its recommendations on "whether it was providing scientific or policy recommendations...." which led to retention of the 75 ppb standard instead of a standard between 60 and 70 ppb.

2. *In section 1.3, we describe the general approach for the review. This includes the key aspects of the approach employed in the last review in judging the adequacy of the then-existing standards and in selecting revised standards. Does the Panel find this description of the approach in the previous review adequate and clear? Does the summary of the approach in the current review appropriately describe important considerations in this review?*

Sections 1.3.1 through 1.3.1.2 clearly delineate the Administrator's stated rationale for lowering the NAAQS in 2008 based on the weight of the evidence at that time. The process by which this decision was made is explained in a clear and lucid manner. Figure 1-1 is an excellent flow diagram that establishes the basis for the Second Draft PA on the primary standard. The description of the five-point hierarchical weight of evidence classifications and how they are used in the Second Draft PA (e.g., greatest weight placed on those effects deemed to be caused, or likely to be caused, by ozone) is clearly explained. The fact that the Second Draft PA focuses on at-risk populations for which the evidence is "adequate" is also made clear (see page 1-21). Stressed throughout is the EPA's concern about the uncertainty and likelihood of ozone effects at lower exposures, which is important for setting a lower end to the recommended range for the NAAQS. How the EPA deals with this type of uncertainty is very well explained throughout this chapter and the rest of the Second Draft PA.

How the EPA deals with controlled human exposure studies and epidemiologic studies is well delineated. There is considerable discussion about the possible existence of threshold effects, with the EPA concluding that there is no evidence for a sharp break point between exposures of 80 and 60 ppb.

There is an extensive discussion of how the welfare risks were evaluated in previous reviews (section 1.3.2.1) and why in the last review the secondary standard was set equal to the primary standard, even though the CASAC had recommended a different form and level from the primary standard (i.e., a cumulative exposure index, the W126; pg 1-30). The discussion of the weight of the evidence and how it was considered in the Second Draft PA is quite understandable and well written.

In several places (e.g., page 1-27, lines 7-10; page 1-36, lines 24-27) the document states that at low W126 exposures, the "magnitude of the response becomes increasingly uncertain." This statement is misleading; the exposure-response functions for seedlings of some tree species definitely show growth losses (decrements) at chronically low exposure levels, whereas other species show decrements only at higher exposures. Crop species show a similar range of responses. For both crop and tree species, there is strong evidence of adverse effects on common, ecologically and economically important species at exposure levels at and below 7 ppm-hrs (W126).

Overall, this is a well written introduction which sets the stage for the rest of the Second Draft PA.

Ozone Monitoring and Air Quality (Chapter 2)

1. *To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of O_3 concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?*

Chapter 2 is concise and well written. In sections 2.1 to 2.3, the discussions of monitoring, atmospheric chemistry and ozone patterns are well done. The chapter focuses primarily on the issues involving background ozone, which is an appropriate discussion, but it should further discuss the response of lower level ozone to controls (e.g., as an extension of the section on atmospheric chemistry or as a stand-alone section). As shown in the Second Draft HREA, this is a very important consideration. The Second Draft PA should be clear that controls designed to reduce the peak levels of ozone (e.g., the 4th highest annual MDA8) may not be effective at reducing lower levels of ozone on more typical days and may actually increase ozone levels on days where ozone concentrations are low. The EPA should consider showing the meteorologically adjusted ozone levels in the figures.

2. *With regard to information on estimating O_3 concentrations associated with non-anthropogenic sources or "background O_3" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?*

The discussion of background ozone is extensive and generally clear though some pieces are missing. First, the method by which the various backgrounds are calculated or taken into account (e.g., models used) should be further described, and the uncertainties discussed. This section should discuss how the background might impact various standards (both health and welfare-based) and how that might differ regionally. The discussion of the source apportionment model estimates is too minimal to really understand what is being done and its importance is not evident; consequently, it should be moved to the appendix. The issues of using monitoring to estimate background should be discussed.

There appears to be confusion in the proper use of the zero-out approach. On p. 2-12, lines 23-26, and again on p. 2A-7, lines 231-241, the Second Draft PA indicates that removing NO_x emissions completely and unrealistically could lead to inflated estimates of background ozone in urban areas where NO_x titration of ozone is significant. The authors consider this a paradoxical result of the zero-out approach. It is not apparent what is meant by paradoxical in this case as the behavior is well known, and is part of the non-linearity in ozone chemistry (see above suggesting a further discussion of the increase in lower ozone levels from controls). Furthermore, the authors ran separate Community Multi-scale Air Quality (CMAQ) model runs for base case (designated as total), natural background (NB), North American Background (NAB) and United States Background (USB), and then took the ratios of one of the

background runs to the base case runs as the percent contribution of the background to the base case. This is inappropriate because it assumes ozone additivity; however, ozone chemistry is nonlinear. The zero-out approach is not intended for use in assigning relative contributions, and relative contribution is not a meaningful concept unless the perturbation due to some source emissions is small enough that linearity can be approximated. Based on the above discussion, in the case of the zero-out approach, it is best to change the text in the chapter from "percent contribution" (like in Fig. 2-11 on p. 2-18) to "ratio" when the background ozone is compared to the base case ozone.

Adequacy of the Primary Standard (Chapter 3)

1. *To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?*

Section 3.1 captures the important studies discussed in the ISA and integrates them into a logical narrative to summarize the important findings in each of the major effect categories: lung function decrements, pulmonary inflammation, respiratory symptoms, respiratory morbidity, and respiratory mortality. The adversity of the effects and their implications for public health are discussed in a straightforward and clear manner that leads the reader through the body of data.

The CASAC notes that Figure 3.1, which is intended to illustrate mode-of-action, does not present a logical sequence of steps leading to specific endpoints. The discussion of mode-of-action could be more clearly communicated as it has been in the Appendix. Various specific technical comments are included in individual panel member comments. In some cases, individual panelists suggest changes in the wording or thrust of some of the sentences and paragraphs. One such example is the discrepancy between epidemiological studies supporting anti-oxidants being partially protective of ozone-induced lung function decrements and controlled human studies showing no such protection.

The CASAC concurs with the findings of the Integrated Science Assessment, as summarized in the Second Draft PA, pertaining to the scientific evidence of the kinds of identifiable effects on public health that are expected from the presence of ozone in the ambient air.

For public health, these effects are health outcomes from short-term exposure to ozone that include respiratory effects, cardiovascular effects, central nervous system effects, and total mortality. Of these, the scientific weight of evidence of a causal relationship between short-term exposure and adverse effect is "causal" for respiratory effects, "likely to be causal" for cardiovascular effects and total mortality, and "suggestive of a causal relationship" for central nervous system effects. Given the stronger weight of evidence for several of these endpoints, EPA has appropriately focused its assessments of short-term exposure levels of concern to those most related to respiratory and cardiovascular effects, and its assessments of risk based on epidemiologic studies to mortality from short-term exposures. In the context of exposure and risk assessment, the CASAC concurs that estimation of FEV_1 decrements of $\geq$15% is appropriate as a scientifically relevant surrogate for adverse health outcomes in active healthy adults, whereas an FEV_1 decrement of $\geq$10% is a scientifically relevant surrogate for adverse health outcomes for people with asthma and lung disease.

For long-term exposures, the CASAC concurs with the findings of the ISA that the scientific weight of evidence for long-term exposure to ozone and adverse health effects is "likely to be causal" for respiratory effects and "suggestive of a causal relationship" for cardiovascular effects, reproductive and developmental effects, central nervous system effects, and total mortality. In terms of quantitative risk assessment, the most relevant scientific evidence available is with respect to epidemiologic estimates of the relationship between ambient concentration and mortality. Thus, EPA's risk assessment appropriately focuses on this particular heath end point for long-term exposure.

Furthermore, with regard to the exposure assessments, the CASAC concurs that children are an important at-risk group. In particular, school-age children spend an increased amount of time outdoors in relatively high levels of activity, which increases air intake, and include asthmatic children. Outdoor workers and other adults who engage in moderate exertion for prolonged periods or heavy exertion for shorter periods during the day also comprise at-risk groups. Therefore, the focus on estimation of FEV_1 decrements for asthmatic school age children and adult populations is appropriate. Asthmatic subjects appear to be at least as sensitive, if not more sensitive, than non-asthmatic subjects in manifesting ozone-induced pulmonary function decrements.

At the level of the current standard, 11% to 22% of school age children are predicted to experience at least one day with an FEV_1 decrement $\geq$10%, which is not protective of public health. The range of values represents variability among the analyzed cities. The proportion of school age children predicted to experience at least one day with an FEV_1 decrement $\geq$10% is 8% to 20% at a level of 70 ppb; 2% to 18% at a level of 65 ppb; and 4% to 13% at a level of 60 ppb. Concurrently, the proportion of school age children experiencing $\geq$ 6 days with FEV_1 decrements $\geq$10% decreases with level, at 1% to 6% for a level of 75 ppb; 1% to 5% at a level of 70 ppb; 0% to 4% at a level of 65 ppb; and 0% to 3% at a level of 60 ppb.

2. *With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?*

The major exposure and risk information requisite to assess the adequacy of the current standard is well presented for the adjusted air quality data, exposure-based considerations, and risk-based considerations. Overall, the salient points are clearly presented with enough detail to allow the reader to make judgments on how much weight to assign to any limitations or uncertainties. Individual panelist comments are provided that, if addressed, will strengthen these points. Major points are supported by reference to studies or data presented either earlier in the Second Draft PA or in the Second Draft ISA or Second Draft HREA, which leads to the conclusion that the points have been appropriately interpreted.

3. *In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection?*

Section 3.4 clearly articulates the findings and points that underpin the EPA staff's preliminary conclusion to call into question the adequacy of the current standard and the appropriateness of revising

it. The CASAC finds scientific justification that current evidence and exposure/risk information call into question the adequacy of the current standard. Furthermore, there is scientific support for the need to revise the standard to achieve additional public health protection.

The CASAC finds that the current NAAQS for ozone is not protective of human health. The HREA emphasizes the conclusion reached in the ISA that there is a causal relationship between short-term ozone exposure and a range of respiratory effects, including lung function decrements, respiratory symptoms, and inflammation—all of which are observed below the level of the current ozone NAAQS. As summarized in our advice on the HREA, the HREA presents ample scientific evidence from human controlled exposure and epidemiology studies that adverse health effects in young healthy adults occur with exposures to 72 ppb of ozone for 6.6 hours. For example, the combination of decrements in FEV_1 together with the statistically significant alterations in symptoms in human subjects exposed to 72 ppb ozone meets the American Thoracic Society's definition of an adverse health effect (American Thoracic Society, 2000). It is the judgment of CASAC that if subjects had been exposed to ozone using the 8-hour averaging period used in the standard, adverse effects could have occurred at lower concentration. Further, in our judgment, the level at which adverse effects might be observed would likely be lower for more sensitive subgroups, such as those with asthma.

While the scientific evidence supporting the finding that the current standard is inadequate to protect public health is strongest based on the controlled human exposure studies of respiratory effects, the CASAC also finds sufficient scientific evidence based on epidemiologic studies for mortality and morbidity associated with short-term exposure to ozone at the level of the current standard. Recent animal toxicological studies support identification of modes of action and, therefore, the biological plausibility associated with the epidemiological findings. The scientific evidence from multiple approaches including toxicology, clinical studies, and epidemiologic studies support an overall finding that the current standard is not adequate to protect public health. The Second Draft PA provides more detailed discussion on these and related points in the section on pages 3-118 to 3-123 in supporting the staff conclusion, which the CASAC supports, that the current standard is not adequate to protect public health. In particular, the scientific evidence provides strong support for the occurrence of a range of adverse respiratory effects and mortality under air quality conditions that would meet the current standard. Therefore, the CASAC unanimously recommends that the Administrator revise the current primary ozone standard to protect public health.

Consideration of Potential Alternative Primary Standards (Chapter 4)

1. *In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering potential alternative standards?*

This chapter provides a comprehensive, clear, and carefully documented assessment of potential alternative primary standards for ozone. As discussed in some individual comments, it could be improved to minimize repetition within the chapter and with earlier chapters. The discussion could be more focused on the salient points such as in the discussion of studies conducted in locations that meet possible alternative standards (p. 4-12 to 4-13) and the cut-point analysis (p. 4-14 to 4-15). Figures 4.1 – 4.8 could use some cosmetic improvements.

2. *In the Panel's view, does the discussion in section 4.6 provide an appropriate and sufficient rationale, supported by the discussions in sections 4.1 through 4.4, to support staff's preliminary*

conclusions regarding alternative primary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?

Section 4.6 is well written with a clear rationale presented for each of the possible alternative standards. Scientific justification for retaining the current indicator (ozone), averaging time (maximum daily 8-hour average), and form (annual 4th highest maximum daily 8-hour average, averaged over three years) is provided, as well as the scientific basis for consideration of alternative levels.

The CASAC concurs with staff conclusions in the Second Draft PA that the current indicator, averaging time, and form be retained. The indicator of ozone is appropriate based on its causal or likely causal associations with multiple adverse health outcomes and its representation of a class of pollutants known as photochemical oxidants.

The current 8-hour averaging time is justified by the combined evidence from epidemiologic and clinical studies referenced in Chapter 4. Results from clinical studies, for example, show a wide range of respiratory effects in healthy adults following 6.6 hours of exposure to ozone, including pulmonary function decrements, increases in respiratory symptoms, lung inflammation, lung permeability, decreased lung host defense, and airway hyperresponsiveness. These findings are supported by evidence from epidemiological studies that show causal associations between short-term exposures of 1, 8 and 24-hours and respiratory effects and "likely to be causal" associations for cardiovascular effects and premature mortality. The 8-hour averaging window also provides protection against the adverse impacts of long-term ozone exposures, which were found to be "likely causal" for respiratory effects and premature mortality.

Regarding the form of the standard, the CASAC concurs that the ozone standard should be based on the fourth highest, daily maximum 8-hour average value (averaged over three years). This provides health protection while allowing for atypical meteorological conditions that can lead to abnormally high ambient ozone concentrations which, in turn, provides programmatic stability.

In considering the upper and lower bound of the range of levels that CASAC recommends for consideration by the Administrator, CASAC took into account the scientific knowledge of the kind and extent of identifiable effects on public health from exposure to ambient ozone, including scientific information on the nature and severity of the health effects, size of the sensitive populations at risk, and the kind and degree of uncertainties. While uncertainty is inherent in assessments of this type, the CASAC finds that there is sufficient weight of evidence and degree of confidence to reach the following scientific conclusions.

CASAC concurs with the summary of the public health significance of exposure benchmarks levels of concern as described in the Second Draft PA on Page 5-18, lines 15-21. The 80 ppb-8hr benchmark level represents an exposure level for which there is substantial clinical evidence demonstrating a range of ozone-related effects including lung inflammation and airway responsiveness in healthy individuals. The 70 ppb-8hr benchmark level reflects the fact that in healthy subjects, decreases in lung function and respiratory symptoms occur at concentrations as low as 72 ppb and that these effects almost certainly occur in some people, including asthmatics and others with low lung function who are less tolerant of such effects, at levels of 70 ppb and below. The 60 ppb-8hr benchmark level represents the lowest exposure level at which ozone-related effects have been observed in clinical studies of healthy individuals. Based on its scientific judgment, the CASAC finds that the 60 ppb-8hr exposure benchmark is relevant for consideration with respect to adverse effects on asthmatics.

The CASAC concurs with EPA staff regarding the finding based on scientific evidence that a level of 60 ppb corresponds to the lowest exposure concentration demonstrated to result in lung function decrements large enough to be judged an abnormal response by ATS and that could be adverse in individuals with lung disease. The CASAC further finds, as does EPA staff, that a level of 60 ppb also corresponds to the lowest exposure concentration at which pulmonary inflammation has been reported. Based on the exposure assessments conducted by EPA, a standard with a level of 60 ppb would reduce children exposures of concern of 60 ppb or higher over 8-hours by 96% and would allow virtually no children to experience two or more exposures in a year at this exposure of concern. Such a standard would allow 2% or fewer of children to have lung function FEV_1 decrements $\geq$15% one or more times per year, although it would allow 5 to 11% of children, including asthmatic children, to have ozone-induced lung function decrements $\geq$10%. A standard with a level of 60 ppb would be expected to reduce epidemiology-based mortality and morbidity risk for short-term exposures to ozone.

The Second Draft PA concludes that the scientific evidence and available information support consideration of a new primary ozone standard within the 60 ppb to 70 ppb range based on ozone as the indicator, an 8-hour averaging time, and annual 4th highest daily form of the standard (averaged over three years). The CASAC concurs that 60 ppb is an appropriate and justifiable scientifically based lower bound for a revised primary standard. This is based upon findings of adverse effects, including clinically significant lung function decrements and airway inflammation, after exposures to 60 ppb ozone in healthy adults with moderate exertion (Adams 2006; Schelegle et al., 2009; Brown et al. 2008; Kim et al., 2011), with limited evidence of adverse effects below 60 ppb. The CASAC further notes that clinical studies do not address sensitive subgroups, such as children with asthma, and that there is a scientific basis to anticipate that the adverse effects for such subgroups are likely to be more significant at 60 ppb than for healthy adults.

At a level of 70 ppb for the averaging time and form of the current standard, clinical and epidemiological studies show adverse effects to human health. As discussed in the Second Draft HREA and the Second Draft PA, approximately 1% of children are estimated to experience exposures of 70 ppb or more (daily maximum 8-hour exposures) in an ozone season, with 3% to 10% of children (depending on urban area) estimated to experience one or more exposures of concern at or above 60 ppb. Up to 5% of children are expected to experience ozone-induced lung function decrements greater than or equal to 15% in a "worst case" year with respect to meteorological conditions. Exposures of these magnitudes have been shown to result in significant adverse effects. For example, controlled human exposure studies show respiratory symptoms combined with clinically significant lung function decrements following ozone exposures to 60 ppb to 70 ppb in healthy individuals. On average over the years 2006 to 2010, a standard set at 70 ppb is estimated to allow about 11 to 17% of children to experience one or more moderate O_3-induced lung function decrements (i.e., $\geq$ 10%), which could be adverse for people with lung disease. This reflects an average reduction of about 15%, compared to current standard. A standard with a level of 70 ppb is also estimated to allow about 6 to 11% of children to experience two or more such decrements (17% reduction, compared to current standard). With regard to epidemiologic studies the CASAC concurs with the EPA staff finding in the Second Draft PA that, compared to the current standard, a revised standard with a level of 70 ppb would be more effective in maintaining short-term ambient O_3 concentrations below those present in locations that provided the basis for positive and statistically significant health effect associations. However, a level of 70 ppb offers only modest incremental reductions in short-term mortality risk compared to the current standard. Taken as a whole, these findings indicate that ozone exposures of 70 ppb pose reduced risk compared to the current standard but, nonetheless, are of significant concern, especially for children, asthmatics, the elderly and other at risk populations.

We also considered the adverse health implications of a level of 65 ppb. An alternative standard level of 65 ppb would reduce the frequency of occurrence of lung function decrements of 15% or higher, as compared to a level of 70 ppb, but does not eliminate such occurrences. Further, an alternative standard level of 65 ppb would lead to lower frequency of short-term premature mortality than the current standard or a level of 70 ppb. The frequency of lung function decrements and premature mortality from short-term exposure to ozone decreases even further when the alternative standard is lowered to 60 ppb. As noted earlier, based on results for clinical studies of healthy adults, and scientific considerations of differences in responsiveness of asthmatic children compared to healthy adults, there is scientific support that 60 ppb is an appropriate exposure of concern for asthmatic children.

In summary, based on the scientific evidence from clinical studies, epidemiologic studies, animal toxicology studies, as summarized in the ISA, the findings from the exposure and risk assessments as summarized in the HREA, and the interpretation of the implications of all of these sources of information as given in the Second Draft PA, the CASAC concludes that there is adequate scientific evidence to recommend a range of levels for a revised primary ozone standard from 70 ppb to 60 ppb. However, as noted below, we believe that there is an important distinction in our finding regarding the level of 70 ppb in contrast to that of EPA staff as given in the Second Draft PA.

In reaching its scientific judgment regarding a recommended range of levels for a revised ozone primary standard, the CASAC has focused on the scientific evidence for the identification of the kind and extent of adverse effects on public health. The CASAC acknowledges that the choice of a level within the range recommended based on scientific evidence is a policy judgment under the statutory mandate of the Clean Air Act. The CASAC advises that, based on the scientific evidence, at a level of 70 ppb, there is little margin of safety for the protection of public health, particularly for sensitive subpopulations. In this regard, our advice differs from that offered by EPA staff in the Second Draft PA. At 70 ppb, there is substantial scientific certainty of a variety of adverse effects, including decrease in lung function, increase in respiratory symptoms, and increase in airway inflammation. Although a level of 70 ppb is more protective of public health than the current standard, it may not meet the statutory requirement to protect public health with an adequate margin of safety. In this regard, the CASAC deliberated at length regarding advice on other levels that might be considered to be protective of public health with an adequate margin of safety. For example, the recommended lower bound of 60 ppb would certainly offer more public health protection than levels of 70 ppb or 65 ppb and would provide an adequate margin of safety. Thus, our policy advice is to set the level of the standard lower than 70 ppb within a range down to 60 ppb, taking into account your judgment regarding the desired margin of safety to protect public health.

Other suggestions for improving the section were relatively minor, including better labeling, annotation, and discussion of tables and figures, such as Figure 4-13, and adding sub-headings for the consideration of 70, 65, and 60 ppb standard levels.

3. *Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?*

The chapter provides a cogent presentation of the rationale behind the Second Draft PA's conclusions and the key uncertainties and areas for future research (Section 4.7). The CASAC recommends future research to address key uncertainties related to ozone health effects. This research, which could be

conducted in collaboration with other federal and non-governmental organizations, will help to improve our understanding of ozone health effects in support of the next review of the ozone NAAQS.

The current approach to review and revision of the primary National Ambient Air Quality Standards (NAAQS) is based on a one-pollutant-at-a-time approach. As the state of science regarding the joint effects of human exposure to multiple pollutants improves, the EPA should consider how review and revision of the NAAQS can be done synergistically for logical, scientifically relevant groupings of criteria pollutants. For example, O_3 and NO_2 are both criteria pollutants that are inter-related via atmospheric chemistry, and human exposure to these pollutants is often in the form of a mixture that includes both, and other pollutants such as particulate matter. The National Research Council (NRC, 2004) and the North American Research Strategy for Tropospheric Ozone (Hidy et al., 2011) have both made detailed recommendations for multipollutant approaches to air quality management, and EPA has been exploring a multipollutant approach for the secondary standards for SO_X and NO_X. CASAC encourages EPA to explore multipollutant approaches for review of the primary standards, and would be receptive to a request by EPA to review planning or methods documents for such approaches.

Adequacy of the Secondary Standard (Chapter 5)

1. *To what extent does the information in sections 5.1 through 5.5 capture and appropriately characterize the key aspects of the evidence for ozone welfare effects assessed and integrated in the ISA? To what extent does the information in section 5.1 (Nature of Effects and Biologically Relevant Exposure Metric) appropriately summarize the nature of ozone welfare effects and to what extent does it appropriately characterize the evidence with regard to biologically relevant exposures?*

This chapter does a nice job summarizing evidence for welfare effects of ozone exposure and for linking ecological effects to welfare effects. We support EPA's continued emphasis on Class I and other protected areas. The discussion of flux-based metrics is useful and appropriate, concluding that potential benefit may eventually derive from such metrics but that excessive uncertainty remains at this time. We note that when discussing the W126 metric, the phrase "Exposure-Response" (E-R) should be used in place of "Concentration-Response". The discussion regarding the reduction of uncertainty associated with Open Top Chamber (OTC) derived E-R relationships since the last review (page 5-10; page 5-31) is appropriate and clearly presented. It should be further emphasized in the revised chapter that the National Crop Loss Assessment Network (NCLAN) studies covered multiple locations in the U.S. and multiple crops, along with multiple ozone exposure levels, using consistent methods. All of these factors are important because they enhance the reliability of the results.

The secondary standard should be protective against known or anticipated ozone effects that are adverse to the public welfare. The CASAC concurs with EPA staff that adverse effects of interest are characterized as "damage," which are injury effects that reach sufficient magnitude as to reduce or impair the intended use or value of the plant to the public, and thus are adverse to public welfare.

The CASAC supports the concept of ecosystem services, which are the benefits that individuals and organizations obtain from ecosystems, as part of the scope of characterizing damage that is adverse to public welfare. For example, CASAC concurs that trees are important from a public welfare perspective because they provide valued services to humans, including aesthetic value, food, fiber, timber, other forest products, habitat, recreational opportunities, climate regulation, erosion control, air pollution removal, and hydrologic and fire regime stabilization. Damage effects to trees that are

adverse to public welfare occur in such locations as national parks, national refuges, and other protected areas, as well as to timber for commercial use. The CASAC concurs that biomass loss in trees is a relevant surrogate for damage to tree growth that affects ecosystem services such as habitat provision for wildlife, carbon storage, provision of food and fiber, and pollution removal. Biomass loss may also have indirect process-related effects such as on nutrient and hydrologic cycles. Therefore, biomass loss is a scientifically valid surrogate of a variety of adverse effects to public welfare.

The CASAC concurs that another important surrogate for damage that is adverse to public welfare is crop loss. Crops provide food and fiber services to humans. Evaluation of market-based welfare effects of ozone exposure in forestry and agricultural sectors is an appropriate approach to take into account damage that is adverse to public welfare.

The CASAC concurs that visible foliar injury can impact public welfare by damaging or impairing the intended use or service of a resource. Visible foliar injury that is adverse to public welfare can include: visible damage to ornamental or leafy crops that affects their economic value, yield, or usability; visible damage to plants with special cultural significance; and visible damage to species occurring in natural settings valued for scenic beauty or recreational appeal.

In summary, CASAC concurs that relative biomass loss for tree species, crop yield loss, and visible foliar injury are appropriate surrogates of a wide range of damage that is adverse to public welfare.

2. *To what extent is staff's consideration of the welfare effects evidence, including the implications of reported vegetation effects with regard to adversity to public welfare technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?*

The linkage of ecological effects of ozone to welfare effects is effective in this draft. The effort to monetize welfare impacts and benefits is appropriate although techniques for this monetization are not yet fully developed. Specifically, calculation of consumer and producer surpluses is a useful contribution to quantification of welfare effects. However, this national-level approach does not adequately account for negative effects on individual farmers and forest owners in high-ozone areas. Tabulating and discussing the number of counties in which yield loss is predicted to exceed a threshold of 5% for individual sensitive crops for alternative candidate standards should be added to Table 6-4 to help address this issue.

The interaction of agriculture and forestry as modeled by the Forest and Agricultural Sector Optimization Model with Greenhouse Gases (FASOM-GHG) is mentioned in both the Second Draft WREA and the Second Draft PA but not adequately explained.

The cottonwood data (Figures 5-1 and 5-3) receive too much emphasis. These results are from a gradient study that did not control for ozone and climatic conditions and show extreme sensitivity to ozone compared to other studies, as already noted in the text (page 5-14, line 5). Although they are important results, they are not as strong as those from other experiments that developed E-R functions based on controlled ozone exposure.

E-R functions for individual tree seedling species, supported by results from other methods such as

Free Air Carbon Dioxide/Ozone Enrichment (FACE) and naturally occurring gradients, demonstrate that some species are very sensitive to ozone and show decreased growth at very low chronic exposure levels, while other species show little response even at much higher levels. A similar result is found for crop species. Thus there is strong evidence of decreased growth and yield of sensitive tree and crop species at very low ozone levels.

The method used with FASOM for forest growth is based on individual species' E-R functions, but this is strictly accurate only for forest stands comprised of single species. For mixed-species forest stands, competition among species with different sensitivity will reduce overall stand growth losses, but also exacerbate effects on sensitive species. Some panel members were concerned about the difficulty of interpreting "median" response for both ozone-sensitive and relatively insensitive species. It should not be assumed that species of unknown sensitivity are tolerant to ozone. It is more appropriate to assume that the sensitivity of species without E-R functions might be similar to the range of sensitivity for those species with E-R functions.

The spatial extent and degree of impact on sensitive species expected at current ozone exposures, the current standard, and at alternate standards should be better quantified for different regions of the country. A county-level analysis will provide insights regarding the spatial extent and degree of impact. For example, rather than focusing solely on the median relative biomass loss (RBL), the number of counties containing sensitive tree species that are expected to have growth loss of greater than 2% should be quantified.

In addition, the Second Draft PA should clarify whether the denominator basal area in the calculation includes only the 12 species with available E-R functions, or rather includes all species. If it is all species, then there is a bias introduced by implicitly assuming that species without E-R functions are insensitive to ozone. If it only includes the species with E-R functions, then the interpretation will vary depending on what fraction of the basal area is represented by species without known E-R functions. In either case this requires explicit consideration.

3. *With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?*

This chapter makes a strong case that the current secondary standard fails to protect vegetation and ecosystem services from adverse effects. The form of the current standard is inadequate to provide such protection. From correlation analysis based on the Higher Order Direct Decoupled Method (HDDM), the EPA suggests that a W126 level of 15 ppm-hrs may in many cases be similar to the current standard. However, as noted in the CASAC's review of the Second Draft WREA (EPA-CASAC-14-003), the CASAC finds that a W126 level of 15 ppm-hrs may not be similar to the current standard, since the actual approaches that would be used to achieve such a level are likely to be different than those assumed in the HREA air quality scenarios for just meeting the current standard. Specifically, and quoting from our review of the Second Draft WREA:

> "The currently reported finding of only small differences in risk between just meeting the current standard and a W126-based level of 15 ppm-hrs must not be interpreted to mean that just meeting the current standard will be as protective as meeting a W126-based standard at 15 ppm-hrs. There are two key factors that must be considered when

> making this comparison. First, air quality was simulated in the Second Draft WREA based on the magnitude of across-the-board reductions in NOx emissions required to bring the highest monitor down to the target level. Meeting a target level at the highest monitor requires substantial reductions below the targeted level through the rest of the region. This artificial simulation does not represent an actual control strategy and may conflate differences in control strategies required to meet different standards and different targets. As a result, there may be a number of monitors that meet the current standard but would not meet an alternative W126 standard. Second, and equally important, the current form of the standard is much less biologically relevant for protecting vegetation than is a seasonal, peak weighted index such as the W126, which was designed to measure the cumulative effects of ozone exposure"

Because injury is clearly observed at and below 15 ppm-hrs, the chapter demonstrates that the current standard is inadequate to protect against welfare effects due to ozone. Despite the paucity of data in certain areas, the Second Draft PA makes appropriate statements about causality and risk with which to evaluate the adequacy of the current welfare standard.

The uncertainties are well described and appropriately interpreted. As mentioned previously, there is some confusion that should be clarified regarding increasing uncertainty of responses at lower ozone levels versus smaller magnitudes of response. There is adequate evidence for effects in sensitive species at levels of W126 well below 15 ppm-hrs. In Figure 5-5 some information is needed about the referenced sites. Uncertainties do not weaken the case for a more stringent standard. The paucity of data on ozone sensitivity of most U.S. plant species should not prevent the Second Draft PA from discussing "anticipated" effects on a number of unidentified sensitive species. As in the Second Draft WREA, the consideration of uncertainty is repetitive to the point of detracting from the considerable strength of the analyses and the evidence on which they are based.

The discussion of economic losses due to bark beetles and fire perpetuates the confounding of spatial association with causation in the Second Draft PA. As stated, this does not contribute much to the assessment of risk nor evaluation of the adequacy of the current or alternative standards.

4. *In the Panel's view, does the discussion in section 5.7 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public welfare protection?*

The CASAC concurs with the justification in this section that the form of the standard should be changed from the current 8-hr form to the cumulative W126 index and finds that the discussion provides an appropriate and sufficient rationale.

This section clearly demonstrates that ozone-induced injury may occur in areas that meet the current standard. As noted above, the correlative similarity between the current standard and a level of the W126 index of 15 ppm-hrs must not be interpreted to mean that just meeting the current standard is equivalent to just meeting a W126 level of 15 ppm-hrs. Most of the analyses found effects below 15 ppm-hrs (many at 10 or even 7 ppm-hrs). Based on review of relevant science, the CASAC concludes that the upper bound of the range that should be considered for the W126 standard should not exceed 15 ppm-hrs. The CASAC does not support a level higher than 15 ppm-hrs. Levels above 15 ppm-hrs should not be included in the revised PA as options for an alternate secondary standard. For example, at

17 ppm-hrs, the median tree species has 6% relative biomass loss, and the median crop species has over 5% loss. These levels are unacceptably high.

The CASAC does not recommend the use of a three-year averaging period. We favor a single-year averaging period, which will provide more protection for annual crops and for the anticipated cumulative effects on perennial species. The scientific analyses considered in this review, and the evidence upon which they are based, are from single-year results. If a 3-year averaging period is established, then the upper limit will need to be reduced to protect against one-year ozone peaks. We consider this further in the response to charge questions for Chapter 6.

In summary, the CASAC concurs with the Second Draft PA that the current secondary standard is inadequate with respect to form, level and averaging time. Only the current indicator (ozone) should be retained. The potential revised standard is considered further in the response to the charge questions for Chapter 6 below.

Consideration of Potential Alternative Secondary Standards (Chapter 6)

1. *In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering levels of protection and potential alternative standards?*

2. *In the Panel's view, does the discussion in section 6.5 provide an appropriate and sufficient rationale, supported by the discussions in sections 6.1 through 6.4, to support staff's preliminary conclusions regarding alternative secondary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?*

3. *Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?*

Charge Questions 1, 2, and 3 are all closely related and are being addressed together in this summary response.

The Second Draft PA makes a very strong case, consistent with previous CASAC judgment, for changing the secondary metric to the W126 averaged over the highest three-month interval. Accumulation over the 08:00 a.m. – 08:00 p. m. daytime 12-hour period is a scientifically acceptable and recommended means of generalizing across latitudes and seasons.

The suggestion in Section 6.2 to use a 3-year averaging period is not supported by the available data. We have not supported it in the past nor do we support it here. The primary justification for a 3-year averaging period is to improve the program stability of the classification of regions as being in or out of compliance. The proposed form includes a 3-month period, so it is not nearly as sensitive to extreme events as an hourly or 8-hour averaging period. The case has not been made that welfare benefits from the stability of a 3-year average are greater than those from using the biologically relevant 1-year value. If a 3-year averaging period is implemented, it should be at a lower level than a single-year standard to protect against single unusually damaging years that will be obscured in the average.

The key issue in the Second Draft PA with respect to welfare effects is the level of the standard. If protection of the most sensitive members of the community is extended to components of ecosystems that impact public welfare, then several potential levels of the standard should be considered. A 2% biomass loss is an appropriate scientifically based value to consider as a benchmark of adverse impact for long-lived perennial species such as trees, because effects are cumulative over multiple years. For example, a 2% annual RBL fully explains the observed the biomass loss of 21% over 7 years in the study of pure stands of aspen at the Rhinelander, WI FACE site (Wittig et al. 2009). The CASAC considers it significant that a similar value of 1% to 2% for tree seedling biomass loss was recommended previously by a consensus meeting of experts on ecological effects of ozone (Heck and Cowling 1997). In our scientific judgment, it is appropriate to identify a range of levels of alternative W126-based standards that includes levels that aim for not greater than 2% RBL for the median tree species.

The CASAC considered carefully the data presented in Figure 5-2 and Table 6-1 of the Second Draft PA. The Monte Carlo analysis (red dots, Fig. 5-2) should not be used in evaluating the effect of ozone on RBL of tree seedlings. This analysis overemphasizes the species for which relatively few E-R functions are available, is biased toward the few less sensitive response functions available for some individual species, makes unsupported assumptions regarding the representativeness of available response functions, and confounds intra- and inter-species variability in unquantifiable ways. We favor using a measure of central tendency of the data, specifically the median across species (the green line in Fig. 5-2). This analysis provides the median of best available estimates within each species, and the median across species with all species treated equally. Table 6-1 presents the RBL results for individual species for different levels of W126. This table demonstrates that a range of 7 ppm-hrs to 15 ppm-hrs will protect against RBL of 2% for at least 5 of the 12 species. We do not consider a value of 17 ppm-hrs from Table 6-1 because even though only 5 of 12 tree species are estimated to have relative biomass loss of 2 percent or less at this level, the median species has relative biomass loss of 6.0 percent, which is unacceptably high. With compounding over the harvest cycle or life span of these species, this will result in considerably greater cumulative RBL as discussed above. For the more sensitive tree seedlings, a value closer to the lower end of the range (7 ppm-hrs) would be more appropriate. The level of 7 ppm-hrs is the only level analyzed for which the relative biomass loss for the median tree species is less than or equal to 2 percent. At 7 ppm-hrs, 7 of the 12 analyzed species have relative biomass loss of less than 2%.

Visible foliar injury is even more sensitive than RBL of 2%, with W126 values below 10 ppm-hr required to reduce the number of sites showing visible foliar symptoms.

The range of 7 ppm-hrs to 15 ppm-hrs is protective of median crop loss of 5% or less, with lower values within the range offering more protection than higher values. Crop loss appears to be less sensitive than these other indicators, largely because of the CASAC judgment that a 5% yield loss represents an adverse impact, and in part due to more opportunities to alter management of annual crops. At a W126 level of 15 ppm-hrs, the median species crop yield loss is less than 5%, with 6 of the 10 analyzed species having crop yield loss less than 5%. At a level of 7 ppm-hrs, all analyzed crop species are estimated to have crop yield losses less than 5%.

This discussion, like that in the Second Draft WREA and Second Draft PA, focuses on annual values for W126, and lower values should be considered for a multi-year average.

The spatial region for which a standard is intended to be protective should be specified. Some analyses are done for large regions of the country, some for counties, etc. A county scale is appropriate for assessing crop yield loss. Calculating producer and consumer surpluses at national or large region scales does not

provide adequate protection. Farmers growing sensitive crops in high ozone locations can be considered a "sensitive population" for welfare impacts, and crop yields under these conditions should be protected.

Care should be taken not to overstate uncertainties. For example, there is quite a lot of certainty in estimates of biomass loss for forest tree seedling species and crop species for which E-R functions have been developed. Because several dominant crop species have E-R functions, there is a quite a lot of certainty about impacts of ozone on crop yield across most annual cropland in the U.S..

There is considerable uncertainty in extrapolating from the 12 forest tree species to all forest tree species in the U.S. It should be anticipated that there are species of vegetation that are highly sensitive to ozone that do not have E-R functions, and others that are insensitive. It is scientifically justifiable to extrapolate from the known E-R curves, assuming that they are representative of the un-sampled population.

Thus, based on identification of known or anticipated ozone effects that are adverse to public welfare, taking into account the weight of evidence for causality of exposure to ozone and adverse welfare effects as given in Table 2-4 of the *Integrated Science Assessment*; results of the Second Draft WREA with regard to assessment of relative biomass loss for tree species, foliar injury, and crop yield loss; and the breadth of adverse welfare effects for ecosystem services, foliar injury, and crop loss, the CASAC recommends that the secondary standard for ozone be revised as follows: (1) ozone should be the indicator; (2) the form and summation time of the standard should be the W126 index summed over the highest three-month interval during a year, based on accumulation over the 08:00 a.m. – 08:00 p.m. daytime 12-hour period; and (3) the level of the standard should be between 7 ppm-hrs and 15 ppm-hrs. These recommendations are based on scientific evidence of adverse effect associated with the presence of ozone in ambient air. Note that these levels are based on an annual form of the standard.

In reaching its scientific judgment regarding the indicator, form, averaging time, and range of levels for a revised secondary standard, the CASAC has focused on the scientific evidence for the identification of the kind and extent of adverse effects on public welfare. The CASAC acknowledges that the choice of a level within the range recommended based on scientific evidence is a policy judgment under the statutory mandate of the Clean Air Act. Specifically, the Clean Air Act grants discretion to the Administrator to specify a standard that is "requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of [the] pollutant in the ambient air" (Section 302(h), 42 U.S.C., §7602(h)). As a policy recommendation, separate from its advice above regarding scientific findings, the CASAC advises that a level of 15 ppm-hrs is requisite to protect crop yield loss, but that lower levels provide additional protection of crop yield loss. Furthermore, there are specific economically significant crops that may not be protected at 15 ppm-hrs but that would be protected at lower levels. Based on scientific judgment of CASAC, a level of 10 ppm-hrs is required to reduce foliar injury. A level of 7 ppm-hours is protective of relative biomass loss for trees. Furthermore, 7 ppm-hours offers additional protection against crop yield loss and foliar injury. Therefore, 7 ppm hours is protective of ecosystem services. Thus, lower levels from the recommended range offer a greater degree of protection of more endpoints than do higher levels from the range.

If, as a policy matter, the Administrator prefers to base the secondary standard on a three year averaging period for the purpose of program stability, then the level of the standard should be revised downward such that the annual level in any given year of the three year period would not exceed the scientifically recommended range of annual levels of 7 ppm-hrs to 15 ppm-hrs. For example, if in a three year period the highest annual W126 value is 15 ppm-hrs, and the lowest W126 value associated with a three year average is 13 ppm-hrs, then the appropriate level for the three year average would be 13 ppm-hrs to

protect against a peak annual level of 15 ppm-hrs. The final Policy Assessment should quantify the ratio of the annual to three year average W126 values to determine what downward adjustment from the annual levels recommended here is needed if a three year form is selected.

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Appendix A

Individual Comments on the Policy Assessment
For the Review of the Ozone NAAQS (Second Draft)
CASAC Ozone Review Panel

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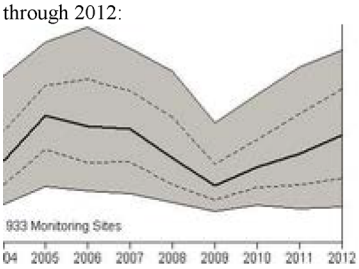
Charge Questions on O3 Monitoring and Air Quality (Chapter 2).

Ch. 2, Q #1. To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of O3 concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?

Section 2.1, Monitoring. National trends of annual 4th highest max 8-hour values are plotted in Figure 2-2, page 2-4. Section 2.1 appropriately notes the distinct drop between 2002 and 2004, consistent with the drop in summer NOx emissions due to the "NOx SIP call", and notes the decreasing trend between 2000 and 2009. While that time period does appear to have a distinct downward trend, it is also informative to look at this same plot constrained to the period from 2004 through 2012:



This 9-year time period starting after the NOx SIP call drop in O3 shows no indication of a trend, and leads to a very different conclusion. While both this time window and EPA's interpretation of O3 trends over 2000 through 2009 are valid, the latter is totally driven by a one-time intervention; since then there does not appear to be any progress in reducing O3 concentrations. Year to year variations in summer meteorological conditions can play a large role in "raw" trends of less than 15 to 20 years duration. In the past EPA has presented trend estimates that include adjustments for meteorology; see: http://www.epa.gov/airtrends/weather.html and references therein. It may be helpful to present such "adjusted trend" data to better assess progress since the NOx SIP call; these adjustments tend to pull "high" years down and "low" years up in concentration. 2013 O3-season data is now in AQS; even though those data will not be "certified" for another 3 months, it would be informative to add that data for 2013 to this trend plot.

Section 2.2, Emissions and Atmospheric Chemistry. This section is a clearly written and concise summary of this topic. It makes the interesting point regarding the co-benefit from NOx emission reductions for O3, NO2, and PM2.5.

Section 2.3, Air Quality Concentrations. This section is a clearly written and concise summary of this topic. Footnote 7, page 2-10, makes the sometimes overlooked point that since O3 is measured seasonally in most areas, the 4th highest day's value is similar to the 98th percentile annual metric form used for some other criteria pollutants.

Section 2.4, Background O3.

Ch. 2, Q #2. With regard to information on estimating O3 concentrations associated with nonanthropogenic sources or "background O3" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?

This section is the core of this chapter. Estimates of background O3 now play a minimal role in the REA document given the new approach to estimating risk under various emission reduction scenarios using the HDDM rollback method and total O3 concentrations.

Background O3 is still a factor in the Policy Assessment however, since a 2002 court decision allows EPA to consider background levels when evaluating risk for alternative (lower) standards (section 1.3.1, page 1-26, lines 17-19). But case law also states that "that attainability and technical feasibility are not relevant considerations in the setting of a NAAQS" (section 1.2.1, page 1-4 lines 19-21, API v. Costle, 1981). It is unclear how EPA might navigate between these two legal guidelines in terms of how background O3 would be used in a policy and standard-setting context.

EPA performed new 2007 base "year" (7-months) zero-out and CAMx source apportionment modeling that is presented in this section. Section 2.4.2 (page 2-16, lines 6-14) introduces the concept of "apportionment-based US background" O3 (AB-USB?) as the most relevant metric for estimation of a "fractional background" metric. Overall this chapter is difficult to follow. It seems the new modeling's utility is to confirm earlier outcomes using these improved modeling approaches. It would be helpful if the chapter could better focus on these specific issues.

Section 2.4.3: The discussion on page 2-17, lines 1-12, is helpful in understanding the fractional contribution of background O3 on days with elevated O3.

Figures 2-13 and 2-14 on page 2-19 could benefit from the addition of "N" (# of site-days) to each bin. Figure 2-13 is difficult to interpret without this information.

Section 2.4.4 presents background O3 in the context of the 12 urban case study areas. Table 2-2 (page 2-21) seems to be the most relevant presentation, but is only for site-days > 60 ppb; it would be helpful to also include this information for site-days >65 and > 70.

Section 2.4.5 presents background O3 in the context of a W126 secondary standard form for four locations (2 are large urban areas). Page 2-22 lines 10-12 refer to figure 2-7 (page 2-7) as showing high observed 2010-2012 W126 values for these four sites. These sites can not readily be identified on this map, so these values also need to be provided in a text form.

Other Comments.

Chapter 1, Section 1.2.2. (History of O3 NAAQS reviews)

This section is a useful summary of recent actions and court rulings regarding the O3 NAAQS review process. There are two topics regarding the 2008 NAAQS revision and subsequent reconsideration process that I would like to expand on that may be relevant to the current review.

First is the "Reconsideration" of the 2008 O3 primary NAAQS, discussed on page 1-9. It is not widely known that in the summer of 2011, EPA sent a final rule to OMB/ORIA with 65 ppb as the standard. This and the role that ORIA played in the process was detailed in a New York Times

article on Nov. 17, 2011:

www.nytimes.com/2011/11/17/science/earth/policy-and-politics-collide-as-obama-enters-campaign-mode.html

It is worth noting that EPA proposed this standard (in the middle of the CASAC range of 60 to 70 ppb) based on the scientific literature used for the 2008 rule – e.g., new studies since 2006 could not be considered in this reconsidered rulemaking. EPA subsequently posted the full preamble of what was to be the final Summer 2011 rule, as well as the draft impact analysis at:http://www.epa.gov/glo/actions.html

While this background material is not directly relevant to the current review process, it provides some useful context for the decisions the agency made in 2011 during the reconsideration process, and may be of interest to the current O3 panel.

Second, this section is a useful summary of the court's 7/23/2013 decision (reissued 12/11/13) regarding the 2008 O3 NAAQS rule. While this ruling upheld the 2008 primary NAAQS of 75 ppb, it did so based on an unusual interpretation of CASAC's intent in saying a range of 60 to 70 ppb was appropriate to consider. This may have implications on how future CASAC advisory reviews are written. Although this issue is not part of the PA review, it would be helpful if EPA staff could provide some guidance to CASAC on how to avoid future perceived ambiguity in its recommendations.

On page 1-10 lines 10-14, the court's rationale for the 0.075 ppm not being inconsistent with CASAC advice is correctly explained. However it is informative to look more closely at the detailed wording of this argument, especially since it may require the CASAC to be more explicit in future letters regarding this issue.

The court decision is summarized at:

http://www.lawandenvironment.com/2013/07/mississippi-v-epa-support-of-the-clean-air-science-advisory-committee-is-not-necessary-to-affirm-epas-naaqs/

The decision itself:

http://www.lawandenvironment.com/wp-content/uploads/2013/07/08-1200-1447980.pdf

The essence of the decision, on page 41:

"...in order for EPA to explain adequately its reasons for disagreeing with CASAC, CASAC itself must be precise about the basis for its recommendations. Because in this case CASAC failed to specify whether the 0.070 ppm level it recommended as a maximum rested on a scientific conclusion about the existence of adverse health effects at that level, EPA's invocation of scientific uncertainty and more general public health policy considerations satisfies its obligations under the statute."

Additional excerpts from the decision relevant to CASAC follow.

Pages 38-39:

EPA did not make such a specific scientific determination about the 0.070 ppm level that served as

the ceiling of CASAC's recommendation; instead, EPA referred generally to declining certainty below 0.075 ppm. Had CASAC reached a scientific conclusion that adverse health effects were likely to occur at the 0.070 ppm level, EPA's failure to justify its uncertainty regarding the existence of adverse health effects at this level would be unacceptable. Indeed, it is a familiar principle that agencies may not "merely recite the terms 'substantial uncertainty' as a justification for [their] actions"; instead, they "must explain the evidence which is available, and must offer a rational connection between the facts found and the choice made." State Farm, 463 U.S. at 52 (internal quotation marks omitted). In other words, EPA must explain why the evidence on which CASAC relied cannot support the degree of confidence CASAC placed in it. This is especially true given the added layer of stringency imposed by EPA's obligations under section 307(d)(6).

But we are unable to determine whether CASAC reached any such scientific conclusion. Although CASAC stated that "overwhelming scientific evidence" supported its recommendation that the standard be set no higher than 0.070 ppm, Mar. 2007 CASAC Letter, at 2, it never explained whether this proposal was based on its scientific judgment that adverse health effects would occur at that level or instead based on its more qualitative judgment that the range it proposed would be appropriately protective of human health with an adequate margin of safety. Indeed, although CASAC concluded that "there is no longer significant scientific uncertainty regarding [its] conclusion that the current 8-hr primary NAAQS must be lowered," given the "large body of data clearly demonstrat[ing] adverse human health effects at the current level," CASAC recognized that "[s]cientific uncertainty does exist with regard to the lower level of ozone exposure that would be fully-protective of human health." Oct. 2006 CASAC Letter, at 5.

To be sure, EPA's statutory obligation to respond to CASAC does not evaporate whenever CASAC exercises judgment amidst scientific uncertainty. Quite to the contrary, had CASAC acknowledged uncertainty in the scientific evidence but explained that, based on its expert scientific judgment, it nonetheless believed adverse health effects were likely to occur at the 0.070 ppm level, then section 307(d)(6) would have required EPA to explain why it disagreed with this scientific conclusion. Put differently, to the extent that CASAC has exercised scientific judgment, EPA must respond in kind. But because CASAC never made clear the precise basis for its recommendation, all we know for certain is this: both CASAC and EPA believed the existence of adverse health effects to be certain at the 0.08 ppm level and reached differing conclusions about what level below 0.08 ppm was requisite to protect the public health with an adequate margin of safety. [end quote]

Page 41:
Absent a definitive scientific conclusion from CASAC that adverse health effects would occur at the 0.070 ppm level, we must assume that it too took these same considerations into account and simply exercised its judgment to recommend a standard set at a lower level. Although both CASAC and EPA must exercise public health policy judgment when confronted with scientific evidence that does not direct it to a specific outcome, it is to EPA's judgment that we must defer. And (as noted earlier):

But in order for EPA to explain adequately its reasons for disagreeing with CASAC, CASAC itself must be precise about the basis for its recommendations. Because in this case CASAC failed to specify whether the 0.070 ppm level it recommended as a maximum rested on a scientific conclusion about the existence of adverse health effects at that level, EPA's invocation of scientific uncertainty and more general public health policy considerations satisfies its obligations under the statute.

Consideration of Potential Alternative Primary Standards (Chapter 4). These are general comments regarding this chapter.

Section 4 of the draft Policy Assessment is a concise summary of the science presented in the ISA and the health REA with regard to evaluating the health impacts of the current and alternative ozone NAAQS. I agree that all aspects of the form of the current ozone NAAQS are appropriate to retain. It is worth noting that in much of the country, ozone is monitored for 6 or 7 months of the year; this makes the 4th-highest 8-h daily mean form similar to the 98th percentile form used in other NAAQS with a daily form.

When choosing ozone concentrations to consider for alternative (lower) values of a standard, there is a continuum of decreased risk along with increased uncertainty of the quantitative assessment of that risk as ozone exposures decrease. Thus there are no "bright risk lines" at any one ozone concentration when considering values for a revised standard. However, the risk and exposure assessment process creates bright lines at intervals of 5 ppb, ranging from 80 to 60 ppb, focusing on health risks at standards of 70, 65, and 60 ppb in this review. This approach is appropriate since there is no meaningful value in attempting to characterize differences in risk between standards of 70 and 69 ppb for example; the supporting science simply isn't that precise, and we are working from a starting point of 75 ppb (the current ozone NAAQS).

Section 4.6 of the draft Policy Assessment summarizes the reduction in risk for various health endpoints associated with alternative standards of 70, 65, and 60 ppb. 70 ppb is the upper end of the range recommended in this assessment. I agree with the many panel members who expressed concern during the March 27, 2014 CASAC meeting that 70 ppb was not sufficiently protective of vulnerable populations. In that context, EPA's discussion of risks and the science supporting those risks for 65 ppb (starting on page 4-52) is informative to this process. Lines 3-13 on that page provide a framework for this value, noting 65 ppb is "somewhat below" the 70 ppb level where health effects "judged adverse" by the ATS were reported, and higher than the level where lung function decrements "that could be adverse in individuals with lung disease." 65 ppb is also above the 60 ppb level where "pulmonary inflammation has been reported."

Risk is not eliminated at 65 ppb, but this is a concentration where the science behind the reported health effects of concern can be considered to be sufficiently robust for the NAAQS process. Thus I recommend that EPA consider setting a revised ozone standard that is no higher than 65 ppb. This is consistent with the CASAC letter of March 30, 2011 regarding the ozone "reconsideration" review process, which says that 70 ppb "would provide little margin of safety". This review was based on the science available to the panel in the 2008 NAAQS revision, and thus does not reflect new research since 2006. It is also consistent with the "first version" of EPA's final rule for the reconsideration process, which went to OMB in 2011 with a standard of 65 ppb (see my comments on Chapter 1 of this document).

Finally, although not directly relevant to this process, it is worth noting that a new Canadian Ambient Air Quality Standard (CAAQS) for ozone was approved in 2012; this replaces the existing Canada Wide Standard of 65 ppb. The ozone CAAQS of 63 ppb (same form as the current ozone NAAQS) goes into effect in 2015, followed by a standard of 62 ppb in 2020. More information on the ozone CAAQS can be found at:

http://gazette.gc.ca/rp-pr/p1/2013/2013-05-25/html/notice-avis-eng.html#d106

Ed Avol

CHAPTER 1 INTRODUCTION

1. P1-2, line 16 and Footnote 5: not clear that this footnote or caveat are needed; there could be other reasons, including substantive technical as well as basic grammatical or textual, reasons that might lead to a request for a 2nd draft document.
2. P1-14, line 4: With all due respect, there was considerable controversy over the Administrator's recommendation of a 0.075 ppm ozone standard. One cannot "know" what the Administrator "relied" on to make his determination. It would be more appropriate (and accurate) to say that "...the Administrator *was provided* the available scientific evidence...*He subsequently* revised the level of the 8-hour primary O3 standard..."
3. P1-14, line 21: We cannot know what "The Administrator *believed*..." This should be changed to something like "In the opinion of the Administrator..."
4. P1-19, Figure 1-1: A more accurate presentation of the review of the primary standard would suggest that the **Averaging Time** box in the figure be re-worded to allow for the possibility of either a longer *or shorter* -term averaging time.
5. P1-21, lines 8-12: This is a pretty convoluted and wordy sentence, almost obscuring the message. The point here is that based on available research, there is no evidence of a biological threshold for ozone health effects (...and that's a lot shorter and more understandable sentence!).
6. P1-27, lines 21 forward: Why is so much time and effort spent in this document discussing what a former Administrator did or did not do with regard to the last review? While it's appropriate to refer to this, it seems like there is an inordinate amount of text devoted to revisiting (or arguably, attempting to re-formulate) the historical record with regard to what a former Administrator did or did not rely on to make his prior determination. The issue before the current CASAC is NOT what the prior review did or did not decide; the issue before the current CASAC is the strength of the cumulative current evidence regarding ozone exposure and protection of the public's health, and the clarity and appropriateness of proposed staff recommendations to the current Administrator.
7. P1-27, line29: We do not and cannot know to what extent the Administrator *carefully considered the public comments*...or to what *degree he further recognized that several additional lines of evidence had progressed sufficiently since the 1997 review to provide a more complete and coherent picture*... (p1-28, lines 1-3); this phrasing should be removed. The comments and information were provided, the Administrator had access to them, and he made a determination. (This PA is not the place to justify or re-interpret previous Administrator's actions, but rather to present current data and judgments).
8. (typographical error; p1-35, line 35, "evidence")
9. P1-40, lines 25 to 34: this is a useful paragraph describing the organization of the overall document, but it is completely out of place at the end of Chapter 1. This should be moved to the first few pages of Chapter 1, prior to the Background section, and an overview sentence could be added describing the presentation in Chapter 1.

CHAPTER 2 OZONE MONITORING AND AIR QUALITY

10. P2-8, line 13: This is an important point but is awkwardly phrased. Recommend re-wording to say, "…contributes to subsequent O_3 formation further downwind."
11. P2-9, line 7: replace "high" with "elevated", so that sentence reads "…result in a higher frequency and duration of days with elevated O_3 conditions."
12. P2-9, line16: replace "high" with "higher" and "low" with "lower"
13. P2-10, lines 26 to 27: The lower rates of chemical scavenging in downwind rural areas can often result in characteristically broader, more gradual hourly ambient O_3 concentrations, rather than the more"peaky" O_3 spikes often seen in urban areas with substantive rush-hour-type combustion NO contributions. This observation helps to clarify why locations such as Lake Arrowhead downwind of Los Angeles can exhibit elevated eight-hour levels compared to surrounding reporting locations.
14. P2-11 forward, Section 2.4Background O_3: Although I appreciate the figures, depth, and discussion regarding background ozone levels, this presentation seems to conflict with the prior determination that background levels are less important, since total ozone concentrations are being used in the current document to assess risk. This section might be valuable as a supplement or Appendix, but if total ozone is the perspective and approach being used, this whole section seems overly detailed, out of scope, and a diversion from keeping the presentation focused and crisp. If staff were to consider every possible question that might be asked of them and seek to develop and provide as complete an answer to every other possible question, the resulting document would be several times larger than it already is and considerably less accessible to the Reader. In my opinion, this document should focus on the approach, implications, and process put into place by the related ISA and HREA, and not delve off into addressing every possible corollary or potential derivative consideration.

CHAPTER 4 CONSIDERATION OF ALTERNATIVE PRIMARY STANDARDS

(No specific comments on specific sections)

This chapter provides a useful and carefully documented assessment of alternative primary standards for ozone. Although I personally found it wordy and a bit indirect, it does provide a comprehensive evaluation of the anticipated health implications of alternative ozone standards in the 60 to 70ppb range. The figures and tabular summaries regarding assorted health indices should be of particular utility to the Administrator in her assessment.

Joe Brain

O3 Monitoring and Air Quality (Chapter 2): This chapter provides a description of the current O3 monitoring network and recent concentrations, information on emissions and atmospheric chemistry, common patterns and variability in O3 concentrations, as well as, discussion of current information on estimating O3 concentrations associated with non-anthropogenic sources.

1. To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of O3 concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?

I believe that to a great extent, the most relevant information on monitoring, emissions, atmospheric chemistry, and resulting patterns of ozone concentration are presented in Chapter 2. A great deal of information is presented concisely. Especially the figures are helpful in understanding the geographic distribution of the network and the ozone concentrations that have been measured.

A key question is not answered. How does the information collected – the geographic distribution of monitoring stations – correlate with the distribution of humans throughout the United States. It's clear that information is more densely collected in the northeast and in coastal California. We know that that makes sense. But overall, if one simply designed a system of monitoring sites that was solely based on accurately measuring exposure of as many inhabitants as possible, would it be the same or would it be different?

For example, one can imagine that the monitoring sites were selected decades ago. To what extent does the current network operating today represent recent changes in population, such as dramatic declines in Detroit and growth in Las Vegas. There should be a paragraph or so defending the network or at least explaining the extent to which it resembles an ideal, unbiased network. This same discussion should be made not only in relation to all people, but in relation to more responsive populations. What's the distribution of children? What's the distribution of people with preexisting disease and/or the elderly? To what extent do these distributions resemble the current ozone monitoring network?

Ozone, as we all know, is not a primary emission from cars, trucks, factories, or other anthropogenic sources. As we know, ozone comes from two primary precursors, oxides of nitrogen and volatile organic compounds. When they combine in the presence of sunlight, ozone is produced. Carbon monoxide and methane may modulate these chemical reactions.

Shouldn't we also have a map showing the distribution of sites that monitor these precursors or perhaps a map showing the relative quantitative importance of these precursor emissions? Should we then comment on the extent to which ozone creation is produced from local sources to ones that contribute because of long distance transport mechanisms? Of course, these issues are perhaps more related to control strategies than to the focused mandate of this report.

2. With regard to information on estimating O3 concentrations associated with nonanthropogenic sources or "background O3" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?

I am delighted at the well-developed Section 2.4, which deals with background levels of ozone and their contributions from natural sources, as well as from anthropogenic emissions outside our borders. The PRB or the NAB (North American background) is important. (There is also the USB, US background.) The text and the figures are extremely useful, and clearly demonstrate that these background levels are appreciable.

Figures 2-8 through 2-10 include the phrase "zero-out modeling." The text, especially 2-12, has a thorough discussion of the limitations of this strategy. But what approaches to dealing with this background are rational and how have they been incorporated into this document? This clearly affects the magnitude of attributable outcomes to ozone and to the nature of the dose-response curves at low and realistic levels. It also calls into question pivotal clinical studies. For example, when examining the responses of exercising human chamber subjects to 60, 70, 80, or 100 ppb ozone, should their measurements be compared to 0 ppb or is it more relevant and appropriate to compare that to background ozone levels? That has rarely been done, but would clearly diminish the magnitude of the changes reported. Again, I would be interested in variability in ozone levels in these geographic areas. The hypothesis that greater variability is associated with heightened responses, even if the average values are the same, is a hypothesis worth exploring. I also think there should be more discussion of co-exposures such as ozone and PM or ozone and heat stress.

David Chock

CHAPTER 2: OZONE MONITORING AND AIR QUALITY

Charge questions:
1. To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of ozone concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?

2. With regard to information on estimating ozone concentrations associated with non-anthropogenic sources or "background ozone" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?

This Chapter provides a very clear and concise picture of the monitoring network, the recent observed ozone concentration trends, both spatially and temporally, and a very brief but relevant and credible description of the emissions and atmospheric chemistry. It also provides a clear description of the different definitions of background ozone concentrations.

There appears to be a confusion in the proper use of the zero-out approach. On p. 2-12, lines 23-24, and again on p. 2A-7, lines 231-241, the authors indicate that removing NOx emissions completely and unrealistically could lead to inflated estimates of background ozone in urban areas where NOx titration of ozone is significant. The authors consider this result as a paradoxical result of the zero-out approach. The implication is that background ozone should not be higher than when anthropogenic precursor emissions are involved. This is erroneous, and in fact contradictory to the acknowledged notion that ozone chemistry is nonlinear. Furthermore, the authors ran separate CMAQ runs for base case (designated as total), NB, NAB and USB, and then took the ratios of one of the background runs to the base case runs as the percent contribution of the background to the base case. This is again erroneous, because it assumes ozone additivity, which violates chemistry's nonlinearity. The zero out approach is not intended for use to assign relative contributions, and relative contribution is not a meaningful concept unless the perturbation due to some source emissions is so small that linearity can be approximated. The source-apportionment method can be used to assign relative background contributions when base case (total) emissions are run, but the resulting relative background contributions are valid only for these particular base case conditions, and the contributions cannot be converted to absolute concentrations to represent background ozone for other emission scenarios including the background emissions alone. Note also that the source apportionment methodology used in CAMx is an approximate tool taking some ozone nonlinearity (local identifications of NOx-limited and VOC-limited environments) into consideration. Its general applicability to a wide range of conditions remains to be established.

Based on the above discussion, in the case of the zero out approach, it is best to change the text in the Chapter from "percent contribution" (like in Fig. 2-11 on p. 2-18) to "ratio" when the background ozone is compared to the base case ozone. Here two model results are compared, and the ratios need not be less than 100%. In the case of source apportionment, "percent contribution" can be used, but is applicable only to the base case run. A separate model run still has to be made to determine the background-only ozone concentrations. So if the authors are willing to replace

"percent contribution" by "ratio", the zero-out approach is actually more straightforward and does not involve the additional assumptions in the source-apportionment methodology.

In the case of W126, the EPA uses a counterfactual assumption by determining the ozone concentrations by separately zeroing out different background emissions based on the definitions of NB, NAB and USB. The procedures are more complicated but are presented in the Appendix. The resulting estimates of background fractions for different definitions of background are generally consistent with but slightly lower than those for the MDA8. This is partly due to the definition of W126 which has a higher weighting for higher ozone concentrations.

One very minor comment: Since seasonal means have been used quite extensively, it is better to incorporate the definition of season in the text rather than leaving it in the footnote (footnote 8 on p. 2-13).

Overall, other than the misstatements about the zero out approach and the erroneous implications that background ozone cannot become greater than when anthropogenic emissions are involved, this is an outstanding chapter in terms of clarity, conciseness, and scientific credibility. The authors should be congratulated for a job well done.

Ana Diez Roux

Chapter 3. Adequacy of the Primary Standard

1. To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?

Overall section 3.1 appropriately describes key aspects of the evidence. I found the consideration if the evidence to be technically sound, and the information appropriately interpreted for the purpose of assessing the adequacy of the current standard. My main comment is that the section would benefit from synthesis and emphasis of the most important facts relevant to assessing the adequacy of the current standard. There is also some repetition within sections (for example the section on at risks populations repeats the key message several times).

2. With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?

Section 3.2 also contains abundant repetitions from the REA and could be synthesized.

The section refers to two important issues in estimating the health impact of alternative standards:

1. It is noted that the simulations used to estimate Ozone levels under alternative standards result in spatial patterns different than those observed in the epidemiologic studies on which the health effects measures are based. This would result in different health impacts than those predicted from the epidemiologic studies if one or both of the following conditions are met (a) factors associated with space modify the effects of ozone on heath or (b) spatial mobility of persons within the area is a key driver of individual-level exposures. If we are confident that the impact of these two conditions is absent or negligible then we can be confident in the expected health benefits as predicted despite the change in the spatial pattern.

2. It is noted that based on the approach used to model ozone reductions under alternative standards, ozone levels may actually rise in some areas when meeting lower overall standards. This is because of the dynamics used to model ozone reductions. It should be noted that as a consequence the estimates of the health effects are not precisely the health impacts of reducing ozone to a certain level, but rather the health impact of meeting an alternative standard *through a postulated set of changes to precursors* (some of which results in reductions and some of which result in increases in ozone). This is a subtle but important difference I think. It may be useful to at least note this. Also, is the approach used to model meeting alternative standards (which results in increases in some locations but decreases in others) realistic?

Pg 3-106 lines 23-28 suggest that since approximately 30-60% of the average daytime O3 is attributable to US anthropogenic sources, then 30-60% of total 03- associated health risks in the urban case studies is attributable to US anthropogenic sources. I don't think this statement is accurate: if the reductions in ozone exposure necessary to eliminate or sharply reduce ozone associated health effects can be achieved through redctions in US anthropogenic sources alone, then much more than 30-60% in health effects can be attributed to anthropogenic sources.

3. In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection?

Overall I though this section was adequate but could benefit from synthesis and emphasis.

Chapter 4. Consideration of Potential Alternative Primary Standards

1. *In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering potential alternative standards?*

   Overall I found the chapter to be very well written and to the point. The point regarding ozone serving as an indicator for a standard meant to provide protection against photochemical oxidants is well taken. The discussion regarding averaging times is focused and supported by appropriate evidence. The discussion regarding the form was also very well written. The points supporting he use of an nth highest daily maximum (as opposed to an expected excedance or percentile-based form) were well stated, however I found the justification of the 4th highest daily max (as opposed to the nth highest) incomplete.

   The section on controlled human exposures studies is an excellent summary although it loses focus in the latter part (pg 4-10 line 19 through pg 4-11 line 6). For example it is not clear why panel studies are discussed here as they are not controlled human exposures studies. The section on page 4-11 lines 6-20 should be consistent with and avid repetitions with pg 4-10 lines 1-18.

   The approach of summarizing associations in cities meeting various alternative standards may be informative but the point of this analysis is not stated clearly and the overall conclusion is not well stated (pg 4-13). What can we conclude then from table 4-1? If studies conducted in areas that have met lower standards do not show an effect do we conclude then that the standard produces appropriate health protection? But if they do does this suggest that an even lower standard is necessary? The logic of this analysis needs to be clarified.

   The subsequent section (on associations below various cutpoints) is clearer but the conclusion could also be summarized more clearly. Is the key point that a standard of 60 ppb is protective whereas a standard of 65 or 70 is not because studies for which all exposures were below 65-70 still reported associations whereas those at levels below 60 did not? I also found Table 4-2 confusing. The main point needs to be summarized. The

reference to the table in the text was confusing.

The section on protection from long term exposures is well done and convincing.

Section 4.4.2.1 would benefit from a final statement of the key conclusions derived from figure 4-1 to 4-4. The same applies to section 4.4.2.2. the bullets are useful but an overall summary statement of what we can conclude from these bullets taken together would be very helpful.

Section 4.4.2.3. The reason for the large difference in the % reduction in mortality associated with meeting a standard of 70 ppb for areas with area wide concentrations > 40ppb and >60ppb is not clear (the footnote does not help clarify). This also applies to other health outcomes. Also the rationale for reporting these two particular estimates is not presented. These types of estimates are repeated later in the chapter so their meaning needs to be clarified.

I'm not sure I would characterize a 9% reduction in ozone associated mortality as a "small " change (pg 4-41 , top of page). In any case it is larger than the effect observed with a standard f 70 ppb so it is not clear why it is considered small.

The chapter also does a reasonable job of grappling and acknowledging the complex issue of uncertainties.

Minor comment: avid using the word mortality (a rate) when you mean total number of deaths (as in Figure 4-10).

2. *In the Panel's view, does the discussion in section 4.6 provide an appropriate and sufficient rationale, supported by the discussions in sections 4.1 through 4.4, to support staff's preliminary conclusions regarding alternative primary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?*

The section provides an appropriate and sufficient rationale. Overall he section is very well organized and the arguments are laid out n a clear and compelling way. A few clarifications, particularly of the data presented, would make this an outstanding chapter.

Tables 4-4 and 4-5 are clear but I found figure 4-13 cryptic. It is not clear exactly what is shown on the Y axis. Is it the ratio of deaths attributable to ozone for alternative standards compared to the 75 ppb standard ? Maybe label the x axis : total ozone attributable deaths, ozone attributable deaths at ozone levels > 20, >40 and >60.

It is difficult to follow the calculations reported on page 4-51 lines 14-21. "For days with area wide concentrations at or above 20ppb a standard with a level of 70….". Is this derived from figure 4-13? But if so isn't this the reduction in deaths attributable to ozone above 20ppb (**not** on days with area wide concentrations at or above 20 ppb??)

3. *Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?*

   No additional recommendations. Overall this is an excellent chapter. The final section in particular is very well done.

David Grantz

Chapter 5. Adequacy of the Secondary Standard.
1. To what extent does the information in sections 5.1 through 5.5 capture and appropriately characterize the key aspects of the evidence for ozone welfare effects assessed and integrated in the ISA? To what extent does the information in section 5.1 (Nature of Effects and Biologically Relevant Exposure Metric) appropriately summarize the nature of ozone welfare effects and to what extent does it appropriately characterize the evidence with regard to biologically relevant exposures?

This chapter does a nice job off summarizing evidence for welfare effects of ozone exposure. The paragraph (page 1-37, lines 4-14) provides an excellent rationale for considering the range of available studies, and how they might be assessed. Similarly, lines 30-36 on page 1-37 provide an excellent rationale for emphasis on Class I and other protected areas.
The discussion of flux based metrics is useful and appropriate, concluding that potential benefit may eventually derive from such metrics but that excessive uncertainty remains at this time. The discussion regarding reduced uncertainty associated with OTC derived C-R relationships (page 5-10; page 5-31) is appropriate and clearly presented.
The reference to EPA 2013 (page 5-13, line 5) is curious. Meta-analysis has demonstrated that reduced carbon transport to roots is a generally observed phenomenon, though exceptions exist. This sentence needs to be reviewed, for accuracy and for syntax.

2. To what extent is staff's consideration of the welfare effects evidence, including the implications of reported vegetation effects with regard to adversity to public welfare technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?

The linkage of ecological effects to welfare effects is clearly and appropriately explained, and in sufficient detail.
The cottonwood data (Figures 5-1 and 5-3) receive too much emphasis. These data are clearly outliers, as already noted in the text (page 5-14, line 5) and require further confirmation.
The effort to monetize welfare impacts and benefits is appropriate, though techniques for this are not yet fully developed. Specifically, calculation of consumer and producer surplus data is a useful contribution to quantification of welfare effects. The interaction of agriculture and forestry as modeled by the Forestry and Agricultural Sector Optimization Model with Greenhouse Gases (FASOM-GHG) is mentioned in both the WREA and the PA but not adequately explained.

3. With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?

Given that a W126 of 15 ppm hr is in many cases approximately equivalent to the current standard, and that injury is clearly observed below 15 ppm hr, the chapter demonstrates that the current standard is inadequate to protect against welfare effects due to ozone. The consideration of uncertainty (page 5-22, line 23 on) represents an appropriate level of concern and level of

interpretation. A similar tone should be adopted in the WREA. However, as in the WREA, the periodic consideration of uncertainty is again accumulated and repeated later (e.g. Page 5-27). Consolidation near the end of the chapter would enhance the impact of the evidence, reduce redundancy, and substantially shorten the document.
It is unclear why the information on foliar injury in four National Wildlife Refuges (Table 5-6) did not appear in the Risk Assessment.
The discussion at the top of page 5-55, related to economic losses due to bark beetles and to fire, perpetuates the questionable discussion in the WREA, confounding association with any evidence of causation. As stated these effects do not contribute much to the assessment of risk due to ozone nor to the adequacy of the current or alternative standards.
In Table 5-8 the ranges for Normal and Dry Palmer Z indices overlap. Is this intentional?

4. In the Panel's view, does the discussion in section 5.7 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public welfare protection?

This section can be made more concise and impactful. It clearly demonstrates that ozone induced injury may occur in areas that meet the current standard. It systematically justifies the conclusion that the form of the standard should be reconsidered, and begins to build the case for levels that should be considered.
There is a wrong word/typographical error at page 5-62, line 2, which alters the meaning.

Chapter 6. Consideration of Potential Alternative Secondary Standards.

1. In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering levels of protection and potential alternative standards?

It is well justified and consistent with previous CASAC judgment, that a cumulative, non-threshold metric, such as W126 is an appropriate form for the standard. Accumulation over the 08:00 – 20:00 daytime 12 hour period is an acceptable means of generalizing across latitudes and seasons. The compromises involved in this selection are clearly explained.
It is not convincing to argue that a multi-year averaging period is superior to a single year standard. Many cultivated and un-managed species are annuals, or cultivated as annuals. Perennials including trees may compound annual effects, but the effects are inherently single year impacts. Potential differences in soil moisture do not really bear on this question, as there are many factors that vary between years. The only significant reason provided in the chapter to consider a three year average is for increased statistical stability (page 6-11, lines 14-27). This may be sufficient reason, but this should be clearly stated. If a three year averaging period is implemented, it should be at a lower level than a single year standard to protect against single unusually damaging years that will be obscured in the average.
The key issue in the PA with respect to Welfare Effects is the level of the standard. It is surprising to find the statement at page 2-20, line 17-18, that "we are not able to identify a range of appropriate W126 index values". If protection of the most sensitive members of the community is extended to components of ecosystems that impact public welfare, then several potential levels of the standard suggest themselves. Both visibility and seedling biomass exhibit identifiable

thresholds at around 10 ppm hr (though visibility is more of a slope change than a decline to low injury level) and for relative biomass loss it is closer to 7 ppm hr. Crop loss appears to be less sensitive than these other indicators from the current analysis.

There is substantial redundancy in this chapter that could be consolidated for clarity and brevity.

2. In the Panel's view, does the discussion in section 6.5 provide an appropriate and sufficient rationale, supported by the discussions in sections 6.1 through 6.4, to support staff's preliminary conclusions regarding alternative secondary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?

Given the apparent break points around 7-10 ppm hr for various endpoints, it is difficult to understand how staff comes to suggest a standard as high as 17 ppm hr. In many cases, 15 ppm hr is nearly equivalent to the current standard, which is considered here to be inadequate to protect against ozone induced welfare effects. If uncertainty is invoked to prevent over-protection, then 15 ppm hr is the highest justifiable level for the revised standard based on the internal logic of the WREA and PA. If, as seems more likely given patchy species and spatial data coverage, the uncertainty results in potential underestimation of risk, then a lower level should be considered.

3. Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?

None.

Daniel J. Jacob

***Introduction (Chapter 1)*:**
1. Does the Panel find the introductory and background material (sections 1.1 and 1.2) to be appropriately characterized and clearly communicated?

Yes. My only confusion is in the use of "We" at various points in the text. It isn't clear to me who "We" refers to.

On page 1-9 lines 3-4, "a causal relationship between O3 and 8-hour exposures" doesn't seem to make sense. Probably a typo.

2. In section 1.3, we describe the general approach for the review. This includes the key aspects of the approach employed in the last review in judging the adequacy of the then-existing standards and in selecting revised standards. Does the Panel find this description of the approach in the previous review adequate and clear? Does the summary of the approach in the current review appropriately describe important considerations in this review?

It is generally fine. I only have a few concerns:

1. Page 1-38: The choice of the W126 index as metric for the secondary standard is not revisited as part of the current review. Why is it not?
2. Page 1-40: It's not clear if the analysis of the background contribution to ozone is to have solely a scientific purpose or also a policy purpose.
3. Page 1-40, lines 22-24: the notion that background ozone does not significantly impact the W126 index has been challenged by recent work, particularly for the Intermountain West where the background is high.

Steven Kleeberger

Chapter 4: Consideration of Potential Alternative Primary Standards

1. In Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering potential alternative standards?

I believe the information has been appropriated characterized and interpreted.

2. In the Panel's view, does the discussion in section 4.6 provide an appropriate and sufficient rationale, supported by the discussions in sections 4.1 through 4.4, to support staff's preliminary conclusions regarding alternative primary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?

In my opinion, the rationale and discussion that lead to preliminary conclusions are appropriate. For more clear presentation, staff may wish to consider sub-headings for the consideration of 70, 65, and 60 ppb standard levels. Conclusions (p 4-57) are clearly stated, and the rationale for not considering levels below 60 ppb is appropriate. However, in general, the table and figure legends should provide more detail to enable the reader to understand better what is presented. Specifically, legends for Figures 4.1 – 4.4 and 4.5 – 4.8 are good examples where more detail in the figure legends would help the reader understand all of the included information.

3. Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?

I do not have additional interpretations or conclusions to add to the chapter. However, I would like to commend the staff for including the key uncertainties and areas for future research (4.7). This is very helpful for the reader to understand that the 'ozone field' still requires much additional effort/studies to fully understand all of the consequences of exposure to this pollutant.

Fred Miller

Introduction (Chapter 1):

1. Does the Panel find the introductory and background material (sections 1.1 and 1.2) to be appropriately characterized and clearly communicated?
2. In section 1.3, we describe the general approach for the review. This includes the key aspects of the approach employed in the last review in judging the adequacy of the then-existing standards and in selecting revised standards. Does the Panel find this description of the approach in the previous review adequate and clear? Does the summary of the approach in the current review appropriately describe important considerations in this review?

Response: The introductory and background material provides the reader with a synopsis of the evolution of the NAAQS review process for photochemical oxidants together with insights into major litigation actions that have occurred over the last 30 years. The description of the approach in the previous review is clearly presented, and the summary of the current review approach captures the salient features of the review process.

O3 Monitoring and Air Quality (Chapter 2):

1. To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of O3 concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?
2. With regard to information on estimating O3 concentrations associated with nonanthropogenic sources or "background O3" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?

Response: My comments address the layout of the figures and tables in this chapter and do not address the charge questions. The authors should consider a different color scheme for some of the figures -- it is hard for the reader to sometimes discern differences (e. g., Figure 2-1). Since figures and tables should stand alone, the legends sometimes need to be expanded so the reader does not have to refer to the text to interpret the table or figure (e. g., Figure 2-2).

Adequacy of the Primary Standard (Chapter 3):

1. To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?

Response: This section captures the important studies discussed in the ISA and integrates them into a logical narrative of what the important findings were in each category of effect such as lung function decrements, pulmonary inflammation, respiratory symptoms, and respiratory mortality.

The adversity of the effects and their implications for public health is discussed in a straightforward and clear manner that leads the reader through the body of data that has been amassed for this ubiquitous pollutant. The level of detail used is appropriate for the task at hand. Most importantly, the studies have been appropriately interpreted and discussed in Section 3.1.3 in the context of assessing the adequacy of the current standard. Section 3.1.3 presents the discussion of adversity in a manner that one might find in a legal briefing document, which speaks to the clarity of the points raised and supported by facts brought forward from the ISA and the HREA.

On page 3-15, the statement is made that the group mean decrements in various controlled human exposure studies at 60 ppb O_3 are not consistently statistically significant. While a correct statement, the authors should add that this is due to a lack of consistency in statistical power among the studies reflecting an inadequate number of subjects in some of the studies. There are places where paragraphs are duplicated almost verbatim on the same page, such as on page 72 for the first 2 paragraphs. On page 3-81, there is a reference to Table 3-12 but no such table appears in the chapter.

2. With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?

Response: The exposure and risk information pertinent to assessing the adequacy of the current standard is presented for 3 main categories: the adjusted air quality data, exposure-based considerations, and risk-based considerations. The salient points are clearly presented, and enough detail is provided so the reader can ascertain how much weight to assign to any limitations or uncertainties. Major points being made are always supported by reference to studies or data presented either earlier in this draft of the PA or in the ISA or HREA, which leads one to conclude that the points have been appropriately interpreted.

Consideration might be given to having the Y-axis on each of Figures 3-7 to 3-10 all be from 0 to 30 percent. This would allow the reader to better understand the importance of the different points that are being made in this body of figures.

3. In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection?

Response: Absolutely! – Section 3.4 is a "slam dunk". This section, which is just slightly over 5 pages in length, clearly articulates the findings and points that underpin Staff's preliminary conclusion to call into question the adequacy of the current standard and the appropriateness of revising it.

Consideration of Potential Alternative Primary Standards (Chapter 4):

1. In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of

considering potential alternative standards?
2. In the Panel's view, does the discussion in section 4.6 provide an appropriate and sufficient rationale, supported by the discussions in sections 4.1 through 4.4, to support staff's preliminary conclusions regarding alternative primary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?
3. Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?

Response: The evidence and exposure/risk information together with an acknowledgement of the inherent limitations and uncertainties is presented in a logical manner and the data have been appropriately interpreted. The discussion in section 4.6 is well constructed and the case for considering alternative standards is articulated clearly. However, the CASAC O_3 Panel should discussion meeting the summary paragraphs for the 3 alternative levels considered by staff as the arguments/discussions presented in the PA have this reviewer inclined to want to revisit the upper level of 70 ppb based upon scientific body of evidence considerations and not on any policy recommendations.

Howard S. Neufeld

Chapter 1: Introduction

1. This chapter is an excellent introduction to the history of the standard setting process and the legal challenges to previous decisions and their outcomes. It also clearly outlines the goals of the PA. This was a well-written and well organized chapter.

2. Yes and yes. I have no other substantive comments.

Chapter 2: Monitoring and Air Quality

*First item here deleted as it was incorrect – the 8 hr standard should be expressed in units of concentration. I had previously confused it with an exposure index that has hours of ppb*hrs.*

1. The discussion on background ozone is satisfactory and clearly explains how staff is dealing with this concept.

Chapter 3: Adequacy of the Primary Standard

1. The analysis of the ISA conclusions is well done. The particular emphasis placed on studies on the low end of ozone concentrations is commendable. Staff has done a careful and thorough analysis of respiratory effects purportedly caused by ozone. The writing is clear and understandable to the general public.

2. I thought staff did an excellent job of translating the ISA and Risk Assessment results into a statement of adequacy with regards to the current standard. Their analysis of the uncertainty and variability is both thorough and complete and serves to strengthen their conclusions reached about the adequacy of the current standard.

3. As noted above, staff has properly interpreted the new scientific studies and reached a logical conclusion that the current standard is not adequately protecting human health. This chapter was one of the strongest of all in the document: well synthesized, well justified, and with appropriate conclusions drawn from the analyses. I feel, therefore, that they are justified in proposing that the current standard should be revised.

Chapter 4: Consideration of Potential Alternative Primary Standards

1. The analyses of the various standard attributes (indicator, averaging time, form, and level) are well done. The conclusions that follow are appropriately stated and thoroughly justified.

2. I agree in all respects with the conclusions in section 4.6. I think the analyses preceding this section clearly justify the proposals in this section. I found nothing with which to disagree. In particular, staff's analysis of the difficulties in setting the standard too low are much appreciated and their detailed consideration of alternative metrics are to be commended. They clearly justify why the current indicator, averaging time and form of the standard should be retained, but that the level should be lowered.

3. I have no additional recommendations here.

Chapter 5: Adequacy of the Secondary Standard

1. Staff make a strong case (perhaps stronger than in any previous reviews) both that the current secondary standard fails to protect vegetation and ecosystem services from adverse effects, and that the form of the standard is inadequate to provide such protection. Sections 5.1 through 5.5 clearly lay out the argument for the impacts of ozone on ecological processes and ecosystem services. Their descriptions and analyses of the uncertainties are refreshingly clear and unbiased. Despite the paucity of data in certain areas, staff is still able to make statements of causality and risk with which to evaluate the adequacy of the current welfare standard.

2. Staff did an excellent job regarding technical soundness and providing clarity to the public. I might note that during the risk analysis, and also here, staff compares changes in seedling growth under ozone exposure to adult tree changes in circumference, expressed as percent losses. However, circumference as a surrogate for growth is somewhat questionable since growth in diameter would imply an increase in area, which is related to changes in circumference by the square (and total growth, i.e. volume, would increase by the cube). A 10% reduction in circumference would translate into a 19% reduction in trunk area. How this might affect the conclusions drawn I don't know, but it suggests that using circumference underestimates the effects.

   With regard to adequately interpreting the data for the purpose of assessing the adequacy of the current standard, I am satisfied with the analyses presented and agree with staff's interpretations.

3. The uncertainties are well laid out and explained and place the interpretations into proper perspective. It appears both in this section, and in the previous chapter, that staff has gone to great lengths to justify the conclusions reached from their analyses of the ISA and REA documents as well as making sure to follow the requirements of the Clean Air Act. I was very impressed with this aspect of the current PA.

4. I agree with most of the conclusions in section 5.7. I support moving from the 8-hr standard form to the cumulative W126 index, and I agree with using the maximum 3 month interval. I think a strong case can still be made that the timing should be for an individual year, rather than averaged over three years. I am concerned about the level and at what upper limit it should be set. Most of the analyses seemed to find effects below 15 ppm*hrs (many at 10 or even 7), so it would seem reasonable to set it lower than 15 ppm*hrs, and not as high as 17 ppm*hrs. Also, in many cases 15 ppm*hrs is approximately equivalent to the current standard, so keeping it that high would engender little benefit.

Chapter 6: Consideration of Alternative Secondary Standards

1. Staff make a very strong case for switching the secondary form to the W126 and for averaging it over three months and using the highest three month interval as the metric that is evaluated. The lack of an arbitrary threshold and the higher weightings for higher ozone concentrations are the appealing aspects of this ozone metric. I also support the use of daylight hours for this metric, from 8 am to 8 pm. There could be some quibbling about whether this time interval is shifted too late in the day, and misses some uptake early in the morning, but as staff notes, ozone at low elevations rarely rises to high values before 8 am.

However, in mountain regions, ozone is high over a 24 hour period, and as such, starting the metric at 8 am instead of 7 am or even 6 am, may miss some aspects of the exposure impacts. However, given that only one time interval can be selected, and that most areas across the country are not at high elevations, I can support using the 8 am to 8 pm interval.

2. I am less convinced that the three year average form is better than a single year form. I fully understand staff's arguments about stability but remain to be convinced that this would provide superior protection (requisite protection) given the comments from CASAC on this topic from earlier reviews. And if the increased statistical stability is that important, then the level should be reduced in order to protect the most sensitive vegetation.

   There seems little justification for allowing the increased flexibility of setting the level of the W126 above 15 ppm*hrs. See comments above in the Chapter 5 section. Most of the tree data show 2% annual growth losses at up to 14 ppm*hrs. It would seem prudent to take out the statement that the Administrator could consider exposure values above 15 ppm*hrs.

3. I have no further recommendations except one: the PA document contains many redundancies, which take away from its ability to clearly transmit its message to the public. This is especially so for Chapters 5 and 6. If there is any prudent way to shorten these chapters some, I think that would improve this document.

In conclusion, I would like to commend EPA Staff for their due diligence and hard work in putting these documents together. I was much impressed by the analyses and conclusions. They represent a real step forward from the first drafts.

Armistead (Ted) Russell

Overall, I found the PA informative and providing much of the information needed to inform the Administrator in regards to potentially modifying the ozone NAAQS. It generally has a good discussion on the adequacy of the current health and welfare standards, and potential revisions. Further, the preliminary revisions are in line with the evidence provided in the ISA and the analyses in the two REAs. The current presentation, for the most part, picks a reasonable balance between the desire to make the PA readable, concise and to the point, and providing sufficient information. The greatest need has to deal with issues involving the increases in lower levels of ozone in response to controls designed to reduce higher ozone levels. This issue impacts the risk and exposure assessments and the form of the standard.

Chapter 2: O3 Monitoring and Air Quality

1. To what extent is the most relevant information on monitoring, emissions and chemistry, and common patters of ozone concentrations is presented, etc.:

The current Chapter 2 is very streamlined; too much so. At present, it focuses primarily on the issues involving background ozone, which is an appropriate discussion, but there is at least one larger issue that needs to be addressed here in some detail, that being the response of lower level ozone levels to controls. As shown in the Health REA this is a very important consideration, and should be discussed in more detail in Chapter 2 as it is an important consideration in the potential form of a standard, and the possible limitations of the current form. As such, the PA should provide a discussion of how the observed ozone levels at various percentiles have been found to be evolving, e.g., the decreases in higher levels and increases in lower levels. This should be augmented with results from the modeling. The PA should provide the Administrator with a firm understanding that controls oriented at reducing the peak levels of ozone (e.g., the 4^{th} highest annual MDA8) may not be that effective at reducing more typical levels and may actually increase ozone levels on lower ozone levels and also increase 24 hour levels on a broader range of days. Chapter 2 needs an overall summary. What are the major take-home points for the Administrator (and others) from Chapter 2?

2. Is the discussion of Background Ozone appropriately characterized and adequately communicated?

The discussion of background ozone is much more extensive than any other part of the air quality characterization. None-the-less, there are some missing pieces. First, the method by which the NB is calculated (e.g., models used) should be further described. The discussion of the source apportionment model estimates is much too minimal to really understand what is being done. Provide an extra sentence or two. The sentences beginning on 2-16, line 9 going to line 14 are not clear. The potential use of monitoring to estimate background should be discussed. I would also include a bit more on the range of controversy surrounding this issue. This should be recapped later on as well. In general, however, the discussion does provide a good and reasonably thorough assessment of the "background ozone" issue on setting a standard.
In the PA, I would also bring forward more of the results on the levels of controls needed to just meet various levels of the standards being assessed, both for the health and welfare standards. One

could use the two tables from the Appendices for the H-REA (Table 2 of Appendix 4) and the W-REA (Table 4A-2). This could be part of a synthesis as well.
Page 2-16, line 16: It is not apparent that the difference between 66 and 59 is due to the definitional approach versus the difference in model .
2-17, l21-23: What exactly does this mean? In particular, does "but for" mean if background sources were not present, there would not be an exceedance, or does it mean, if only background sources were present, there would be an exceedance?
2-9, l34: When discussing specific metrics, be very careful as to what is being said as to not be ambiguous.
2-9 l 14. I think you mean "intrusions" not "inversions"

Chapter 4: Form of the health based standard. Given the potential for controls to increase lower levels of ozone, one might consider a different form of the standard that would be protective at lowering high levels of ozone and also decreasing mid and lower levels. This should at least be discussed at a level that could lead the Administrator/reader to confidently say that the current form is appropriate. Indeed, one might come to the conclusion that another form would be better.

Chapter 6. One of the conclusions of the W-REA was that just meeting the current standard (75 ppb) leads to very similar ozone levels as a W126 of 15. This should be brought out more. Indeed, I am not sure that the difference is beyond the uncertainties in the approaches used. Given that a W126 of 15 roughly corresponds to a 75 ppb standard, the rationale for considering a W126 of 17 should be further discussed.

The PA could use a synthesis as well. The Synthesis should include how the health and welfare standards might work together. Further, it could identify the critical findings that would likely drive the decision to keep or revise the standards, including the characterization of the likely benefits of various choices of the standards and the uncertainties that are key. Maybe this will be included as part of the Executive Summary in the next draft. At present, the Executive Summary is a bit too short and weak. For example, it currently uses the phrase "call in to question", which might be stated as finds that the current standard is inadequate to protect health, and provide the specific evidence to suggest so. One thing that the synthesis could provide is the similarities in ozone fields at different levels of the health and welfare standards under consideration. It could also include tables showing the levels of control to meet those levels.

Executive Summary:
As noted above, the ES is rather short, and appears to be a work in progress. Compared to the ES's for the two REAs, this one does not stand up. It really does not do the PA justice. An important point from the W-REA should be made here, that being that a W126 of 15 ppm-hrs is very similar to just meeting the current standard. The ES could also use a synthesis.

Helen Suh

Adequacy of the Primary Standard (Chapter 3)

1. *To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?*

The section is comprehensive. While this comprehensive summary is accurate and clear, it does appear in other documents. Further, its volume is overwhelming. As a result, the Chapter is somewhat unfocused, and evidence supporting its conclusions regarding the adequacy of the primary standard are not sufficiently targeted. As one suggestion to increase the clarity of the Chapter, Section 3.4 could be moved to the beginning of the Chapter, with the summaries of findings and other sections used to support the conclusions of Section 3.4. Other comments and suggestions are discussed briefly below:

- Figures need additional annotation, better titles and a better color scheme (for example Figures 3-7 to 3-10).
- The discussion of the policy-relevant background risks should be removed or moved to the discussion of the history.
- Subsection 3.1.2
  - The subsection 3.1.2, which addresses the nature and strength of conclusions, could be more targeted, focused less on a summary of all findings but instead on findings contributing to the adequacy determination. In this way, it can provide an introduction to the topics discussed in later subsections, including adversity of effects and concentrations associated with observed impacts, with these later subsections being at the heart of Section 3.1.
  - While causal determinations were stated at relevant places in the text, it would be helpful to include at the beginning of Section 3.1.2 a table that lists the causal determinations made in the 2006 and current ISA. This table should be accompanied by a brief discussion that explains how health outcomes were selected for further discussion in Section 3.1.2.
  - Summary figures and/or tables should be added to Subsection 3.1.2 in place of text for the major outcomes. While summary figures of epidemiological studies were included (such as Figure 3-2), a preferable model for summarizing findings may be to include tables, such as Tables 4-23 and 5-19 from the NOx ISA, which summarize information succinctly across evidence and study types to support causality determinations. It may also be helpful to note in these summary figures and tables studies or findings that show ozone impacts at standard-relevant ozone levels.
  - The summary of ozone-attributed health outcomes in epidemiological studies should include a brief discussion of the potential for confounding of the observed effects, since is it is relevant to causal determinations.
  - Page 3-53, line 29-33 The statement beginning "Generally, the epidemiologic studies used nearest air monitors to assess ozone concentrations…explained by the different exposure assignment methods used…" relates not only to this subsection but also to previous

subsections. It should be mentioned in earlier subsections, if only to say that significant associations were found despite the presence of exposure error resulting from the use of ambient ozone concentrations to assess exposures.

- Section 3.1.3: It seems that much of this section is a repeat of earlier discussions, although with a different focus. To reduce repetition, it may make sense for this discussion to be incorporated into section 3.1.2, possibly using the following outline
    - Health outcome 1
        - Summary of findings (including causality determination and whether it has changed)
        - Adversity of impacts
        - Ozone concentrations associated with health effects
    - Health outcome 2 (etc.)

- Section 3.1.4: Important discussion that summarizes information across health effects. The summary tables 3-1 and 3-2 were very helpful. This subsection would be improved with further organization and integration of the findings across health effects, as this would help to demonstrate coherence with regard to the lowest ozone concentration at which key health impacts have been observed. The discussion of coherence doesn't begin for many pages (page 3-71) and is consequently buried. It would be better to summarize the earlier discussion more concisely to highlight the key points of the section.

2. *With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?*

Again, this section is comprehensive and accurate. The discussion on page 3-94 was clear, to the point, and clearly related to standard-setting considerations. Similarly, the discussion of uncertainties was well written and concise. However, in other areas, the section was overly repetitive and should be summarized more concisely to highlight discussions that focus more specifically on standard-relevant issues.

3. In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection.

Section 3.4 was a terrific synthesis of the current health and exposure/risk information. In some ways, the chapter should lead with this section, as it captures the key points, summarizes the evidence clearly and concisely in a manner that keeps the focus on standard-setting considerations.

Consideration of Potential Alternative Primary Standards (Chapter 4)

1. In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering potential alternative standards?

This Chapter was well written, comprehensive, clear, and focused. It was a pleasure to read. Suggestions to improve the chapter are rather minor. They include:

- In general, the figures and tables need further descriptions, better titles and better annotation. For example, several figures, such as Figures 4-1 and 4-2 and Figures 4-3 and 4-4, seem extremely similar (with the same title) and it is not clear what the graphs are depicting.
- The question on page 4-8 (and following text) should be reworded to focus on lung function decrements and airway hyperresponsiveness rather than controlled human studies given the inclusion of panel study results in this section. Correspondingly, the title of the subsection "epidemiological evidence" to hospital admissions and mortality should be reworded to focus on health outcomes rather than study type.
- The discussion on page 4-14 of the cut-point analysis is a repeat of that in Chapter 3. Rather than repeat the discussion, instead reference it and draw conclusions relative to the level of the standard.
- The interpretation of Figure 4-10 is unclear from the text and the figure.
- Figure 4-9 (and other figures), the y axis should be labeled as "deaths" and not "mortality". In the text, it may be helpful to explain reasons for the observed between-city variability in figures such as Figure 4-9. Is this between-city variability important?

2. *In the Panel's view, does the discussion in section 4.6 provide an appropriate and sufficient rationale, supported by the discussions in sections 4.1 through 4.4, to support staff's preliminary conclusions regarding alternative primary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?*

Yes. The section was clear, well-written, and effective.

3. *Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter*?

The chapter was a cogent presentation of the rationale behind the report's conclusions.

James Ultman

> *To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?*

The chapter does an excellent job of summarizing the current evidence-based considerations of short-term and long-term O_3 health effects and placing them in the contexts of adversity to the individual as well as public health implications.

Section 3.1.1

I believe that appendix 3A describes specific modes of action much better than current text in section 3.1.3. I would go so far as to replace the latter by the former.

Regarding figure 3-1 (copied from figure 5-8 in the ISA), the mode-of-action pathways for specific adverse effects do not necessarily follow from the hierarchy in the figure. For example, inflammation and cell remodeling are both placed on the second level while epithelial metaplasia appears on the third level. I would argue that a more accurate sequence for the metaplastic changes that have been observed in toxicological studies might be: inflammation (second level)→cell repair and remodeling (third level)→ metaplasia (fourth level not currently on figure).

The mode-of-action discussion implies that secondary oxidation products rather than ozone itself drive the respiratory responses. This point of view is based on well-accepted dosimetry analyses indicating that ozone is almost completely reacted during its transit through the mucous layer in conducting airways. However, these analyses are not directly supported by experimental observations. Furthermore, it is still quite possible that ozone quantitatively penetrates the thin surfactant layer in alveoli distal to the conducting airways.

The first step in the respiratory response is described as oxidant stress, but this catch-all term does not tell the whole story. While ozone and some of its reaction products are oxidants that can be detoxified by endogenous antioxidants, other reaction products (e.g., aldehydes) cause cell damage by non-oxidative processes.

> Page 3-13 (line 6) gives a literal interpretation of the McDonnell and the Schelegle models in terms of a specific mechanism (i.e., oxidant stress). Although this is a reasonable hypothesis, one should recognize that both models are simply two-stage mathematical constructs that include a build-up of inhaled *ozone* dose by continuous inhalation in competition of a reduction in biologically-effective dose by some clearance or metabolic process. It is also possible that such a reduction is the result of absorption of ozone in airways regions (such as the nose and mouth) that are proximal to the airway sites where dysfunction actually occurs.

Section 3.1.2.2

Entry is missing from the table of contents.

> *With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?*

I think that the document is quite effective in presenting risk reduction information between recent conditions and just meeting the current standard.

> *In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection?*

This section provides a sufficient rationale for staff's conclusion the current standard does not provide adequate health protection.

Sverre Vedal

Ch. 3. Adequacy of the current standard

Adequacy of the Primary Standard (Chapter 3)
1. To what extent does section 3.1 (Evidence-based Considerations) capture and appropriately characterize the key aspects of the evidence assessed and integrated in the ISA? To what extent is staff's consideration of the health effects evidence, including the adversity of reported respiratory effects and public health implications technically sound and clearly communicated at an appropriate level of detail? In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?

- Although there is some evidence from epi studies that anti-oxidants partially protect from lung function declines due to ozone exposure (3-15), the more direct evidence from human clinical studies does not support this.
- Toxicologic morphologic changes do not provide evidence of bronchial hyperresponsiveness – these changes occur at the level of the respiratory bronchiole and alveoli, which probably does not influence larger airways effects such as those in asthma. Perhaps there is some problem with the wording or intent here (3-40, lines 28-32).
- Observations on three endpoints (and conclusions on 3-119):
  - Long-term exposure effects on lung-function: valiant attempts are made to provide evidence for this using relatively weaker studies, whereas the best study (CHS) showed no effects.
  - Short-term exposure effects on symptoms in asthmatic children: arguments to justify not considering the two multi-city (multi-site, actually) studies that find no evidence of associations. I wonder if this same effort would have been made if these were the only two studies in which evidence for associations was found?
  - New onset asthma: argument is presented as to why the lack of a confirming main effect of long-term ozone exposure in the CHS is ok in light of the interesting gene polymorphism interaction analysis.
- In "Pulmonary Structure and Function" (3-44) there is no mention of the CHS study that provides the strongest evidence against long-term exposure effects of ozone on lung function.
- Does Section 3.1.3, Adversity of Effects, really require so much exposition? It's very repetitious of earlier material.
- Is compression of the ozone distribution due to model-based air quality adjustments realistic, i.e., decreases in high ozone concentrations and increases in low concentrations? (3-86)
- It is difficult to accept, if I'm understanding this correctly, that the percentage of children experiencing lung function declines is approximately the same as the percentage of children exposed (Figures 3-7 through 3-14). For example, in Atlanta, 14% of children are estimated to experience at least one exposure of concern at or above 60 ppb (Fig. 3-7) and 17% of children are estimated to experience at least one day of >10% decline in FEV_1 (Fig. 3-11).
- In addition to the sensitivity of epidemiologic-based risk on C-R functions due to choice of study region, e.g., large vs. small (3-114), there was also seeming substantial sensitivity to choice of regional vs. national C-R functions.
- Missing references detected: Rojas-Martinez 2007 (3-44, line 11), Joad 2006 (3-45, line 16), NRC 2008 (3-85), US EPA 2007 (3-98).

- [Refs to check: Kim 2011 AJRCCM re: inflamm at 60 ppb, Lin EHP 2008 on first asthma admission; Fanucchi 2006 infant rhesus]

2. With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?

I found this section to be among the best sections of Chapter 3.

3. In the Panel's view, does the discussion in section 3.4 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public health protection?

Most definitely. It's well done.

Peter Woodbury

Executive Summary

Page ES-2, line 26. I don't think suggesting that values "somewhat above" 15 ppm-hrs is appropriate. If the EPA staff judge that a value above 15 ppm-hrs for W126 should be considered, then the analysis throughout the WREA and the PA should include a specific value above 15 ppm-hrs so that this suggestion can be reviewed by CASAC and others.

***Introduction (Chapter 1)*:** This chapter provides context for the review, including the background of past reviews, as well as the scope and approach for the current review. This includes discussion of the basis for the current standard.

1. Does the Panel find the introductory and background material (sections 1.1 and 1.2) to be appropriately characterized and clearly communicated?

Yes, this material is important and the coverage is appropriate.

2. In section 1.3, we describe the general approach for the review. This includes the key aspects of the approach employed in the last review in judging the adequacy of the then-existing standards and in selecting revised standards.

Does the Panel find this description of the approach in the previous review adequate and clear?

Yes, this material is important and the coverage is appropriate.

Does the summary of the approach in the current review appropriately describe important considerations in this review?

Overall, this summary is cogent and useful. However, regarding the secondary standard, certain important conclusions are misleading and require revision. For example, on page 1-27, lines 7-10 states that the "magnitude of the response becomes increasingly uncertain". A similar statement is made on page 1-36, lines 24-27. This is somewhat misleading. Data such as the concentration-response functions for individual tree seedling species, supported by results from other methods such as FACE and naturally occurring gradients demonstrate that some species are very sensitive to ozone and show decreased growth at very low chronic exposure levels, while other species show little response to much higher levels. A similar result is found for crop species. Thus there is strong evidence of decreased growth and yield of some common tree and crop species at very low ozone levels. The more important source of uncertainty at these low levels is determining what degree of growth decrement should be considered unacceptable to protect public welfare. This issue extends throughout the PA, and the PA could be strengthened by more specifically quantifying the spatial extent and degree of impact expected at current ozone exposures, the current standard, and at the alternate standards. For example, rather than focusing on the "median RBL", quantify the number of counties containing sensitive tree species that are expected to have growth loss of greater than 1%, 2%, etc.

***O3 Monitoring and Air Quality (Chapter 2)*:** This chapter provides a description of the current O3 monitoring network and recent concentrations, information on emissions and atmospheric chemistry, common patterns and variability in O3 concentrations, as well as, discussion of current information on estimating O3 concentrations associated with non-anthropogenic sources.

1. To what extent does the Panel agree that the most relevant information on monitoring (section 2.1), emissions and atmospheric chemistry (section 2.2), and common patterns of O3 concentrations (section 2.3) is presented, and to what extent is the information presented appropriately characterized and clearly communicated?

2. With regard to information on estimating O3 concentrations associated with non-anthropogenic sources or "background O3" (section 2.4), to what extent is this information appropriately characterized and clearly communicated?

The large difference in "counterfactual" vs "source apportionment" methods for estimating backgrounds, is important for W126 (p. 2-23 and elsewhere). This issue is challenging to describe, but is done reasonably well. In particular, the summary on Page 2-26 and 2-27 is helpful..

"Anthropogenic" emissions of VOCs are distinguished from "natural" sources. However, as mentioned on Page 2-7 (lines 19-20) and 2-8 (lines 1-4), "natural" emissions can include human-influenced emissions from fire, agriculture, forestry, and other land management practices. This issue of definitions should be further clarified (see my further comment below). Even more importantly, the extent to which such human-influenced emissions are included in "natural background" or other "background" ozone scenarios, should be clarified, and preferably quantified since it could affect interpretation of what portion of ozone is potentially controllable.

On a more minor but related point, the terms "anthropogenic", "man-made" and "manmade" all seem to be used to mean the same thing, with "anthropogenic" being the most commonly used term. Perhaps the term "man-made" should be used throughout for emissions directly from human activity, with the term "anthropogenic" used more broadly to include indirect human-influenced emissions such as from agriculture, forestry, and other land management practices. Or if the term "anthropogenic" is used throughout then, make it clear that this narrower and I believe non-standard definition is being used.

Adequacy of the Secondary Standard (Chapter 5): This chapter discusses key aspects of the welfare effects evidence and exposure/risk information, particularly relevant to consideration of adequacy of the current secondary standard and specifically describes staff's consideration of this information in reaching preliminary conclusions about the adequacy of the current standard.

1. To what extent does the information in sections 5.1 through 5.5 capture and appropriately characterize the key aspects of the evidence for ozone welfare effects assessed and integrated in the ISA?

In general, the information from the ISI is presented appropriately. The brief quotes are particularly helpful, as are the references to specific portions of the ISI.

To what extent does the information in section 5.1 (Nature of Effects and Biologically Relevant Exposure Metric) appropriately summarize the nature of ozone welfare effects and to what extent does it appropriately characterize the evidence with regard to biologically relevant exposures?

In general, Section 5.1 is useful and appropriate, and the use of questions and answers is a good format. However, I suggest rearranging the order of material within each subsection such that the question is answered at the end of the section discussing each question. For example, the current section on page 5-1, lines 21-33 should be placed just before Page 5-3, line 9. Furthermore, each question should be clearly answered. For example, Page 5-7, before Line 1, there should be a short paragraph that directly answers the question about appropriate paradigm posed on Page 5-5, lines 29-30.

Page 5-2, line 25. Replace "vegetative species" with "many species of vegetation".

Page 5-13, line 5. Delete "although"

2. To what extent is staff's consideration of the welfare effects evidence, including the implications of reported vegetation effects with regard to adversity to public welfare technically sound and clearly communicated at an appropriate level of detail?

In general, the draft is appropriate and substantially improved from the previous draft, with some caveats. First, it is important to appropriately address the fact that the sensitivity of most tree species and many crop species has not been quantified in terms of a C-R function. It should not be assumed that species of unknown sensitivity are not sensitive to ozone. For example, on page 5-18, lines 28-29, discusses "if present in these specially protected areas", referring to 7 of the 12 tree species for which C-R functions are available. More appropriately, it should state that "if ozone-sensitive species are present". This may sound like a minor point about language, but I believe it is actually an important point about how to apply the available scientific data to ecosystems, and it has large implications. For example, stating that "Half (6/12) of species with known C-R functions would have growth decreases greater than 5%, and of these species are representative of responses of unmeasured species, this degree of impact would occur in [state percentage of studied locations with this level of response]. In brief, it is important not to assume that unmeasured species are not sensitive to ozone, it is much more appropriate to assume that the sensitivity of species without C-R functions might be similar to the range of sensitivity for those species with C-R functions.

In the Panel's view has the information been appropriately interpreted for the purpose of assessing the adequacy of the current standard?

Please see comments above.

3. With regard to the presentation of the exposure and risk information for the purpose of assessing the adequacy of the current standard, to what extent is the information, including associated limitations and uncertainties, sufficiently characterized, appropriately interpreted and clearly communicated?

The choice of the word "paradigm" seems odd in question on p. 5-5, but I don't have a suggestion of a better term.

Make sure not to define "adverse" effects too narrowly (p. 5-6), loss of biomass growth could be important even if the species is not harvested for timber or fiber. This topic is mentioned elsewhere, and on Page 5-12 this issue is appropriately broadened, but perhaps on p. 5-6 some mention of other effects could be made, or a reference to other locations that address these broader impacts.

p. 5-13, line 5 delete "although"

Figure 5-1 should be improved by moving the legend to the right of the main figure panel and arranging the legend species in the same order (top to bottom) as in the main figure panel.

p. 5-14, line 16 and elsewhere. As I mentioned in comments on the previous drafts, it is difficult to interpret a "median" response for both ozone-sensitive and relatively insensitive species. Instead, it makes sense to characterize the expected impacts on the sensitive species, and quantify the spatial extent and effect on biomass growth for (1) known sensitive species (i.e., those that are shown be particularly sensitive with their C-R functions, and (2) the same result assuming that the 12 species with known C-R functions represent all tree species. A more complex scheme could be developed to try to extrapolate known species to unknown species based on physiological characteristics, as was done for crops in the FASOM analysis, but there would be substantial uncertainty in such extrapolation.

p. 5-21. I think that the "modeling regions" in Table 5-4, are the 9 large US climate regions shown in Fig. 4-6, but this should be made explicit (the term "modeling region" doesn't seem to be defined in the text currently).

p. 5-24. As in my comments on the first draft WREA and PA, and second draft WREA (Section 6.8) I still have a question about the RBL values weighted by basal area. Does the denominator basal area in the calculation include only the 12 species with C-R functions or does it include all species? If the latter, it is biased. If the former, the interpretation will vary depending on what fraction of the basal area is for species without C-R functions. Furthermore, if the goal is to assess ozone effects on total biomass growth of a mixed-species forest, then this value is not very informative because it will overestimate impacts in mixed species forests because of not including competition between sensitive and insensitive species (see previous comments on competition). If the purpose is to assess ozone impacts on sensitive species, this value is also not informative because it underestimates impacts on sensitive species for the same reason. A comparatively small growth decline in a sensitive species (e.g. 2%) based on a seedling study may translate into a larger effect at the stand scale.

Page 5-25. The method used with FASOM for forest growth is based on individual species C-R functions, but that is only appropriate for mono-specific stands. For mixed-species stands, overall forest growth will not be affected as much as would be implied by a weighted average of the growth rates (or yield losses) from individual C-R functions. This is because of competition among species with different sensitivity to ozone. This is a serious limitation in the approach for mixed-species forests that are common in many parts of the USA.

I still don't agree about ignoring impacts on farmers and forest owners in high ozone areas just because national assessments include winners and losers. An example of such a calculation is presented on page 5-32, line 9-12 for soybean for 2 counties in Kansas. The number of counties in which yield loss is predicted to exceed 1, 2% or 5% could be tabulated for alternative standards. See comment for Chapter 6 of the WREA related to this topic. Summaries of county-scale information could be added to Table 6-4.

p. 5-30 line 31 etc. Clarify that NCLAN covered multiple locations in the USA and multiple crops, with multiple O3 exposure levels using consistent methods – all of these factors are very important because they mean that the results are highly valuable for national risk assessments.

Check for occurrences of "PSDI", should be "PDSI" throughout.

p. 5-41, line 6. Change "by of" to "by".

Figure 5-5 (page 5-48). In figure legend, provide some information about the sites.

EPA should assure that uncertainties are not suggested or implied to always weaken the case for a more stringent standard. For example, the paucity of data on ozone sensitivity of most US plant species should be considered as "anticipated" that there are a large number of unidentified sensitive species, as well as of course many less sensitive species.

Page 5-62, replace "commiserate" with "commensurate".

Page 5-63, beginning line 31. Rephrase the sentence on line 31 to be more definite (replace "might be" with "are").

Page 5-65, lines 20-23. Replace "likelihood and magnitude of a response become increasingly uncertain" with "magnitude of effects become smaller". As discussed above, the evidence is very strong for tree biomass loss and crop yield loss for sensitive species at W126 values of 5-10. It is the magnitude of the effect that is smaller. And for less sensitive species, there will be little or no biomass loss at low ozone exposure values. Again the important uncertainty is determining what magnitude of an effect is important for welfare, not whether there are any effects at lower ozone exposure levels. This is an important distinction.

4. In the Panel's view, does the discussion in section 5.7 provide an appropriate and sufficient rationale to support staff's preliminary conclusion that the current evidence and exposure/risk information call into question the adequacy of the current standard and that it is appropriate to consider revising the standard to achieve additional public welfare protection?

In general, this section is appropriate. However, because it is a summary section, many comments on other sections of this chapter should also be applied to this section. Also, note my specific comments above for this section (i.e. Pages 5-59 through 5-65).

Consideration of Potential Alternative Secondary Standards (Chapter 6): This chapter discusses key aspects of the welfare effects evidence and exposure/risk information particularly relevant to consideration of potential alternative secondary standards and specifically describes staff's

consideration of this information in reaching preliminary conclusions on alternative standards appropriate to consider.

1. In the Panel's view, has the evidence and exposure/risk information, including associated limitations and uncertainties, been appropriately characterized and interpreted for the purpose of considering levels of protection and potential alternative standards?

In general, yes, except for a few points. First, I don't understand the suggestion of values "somewhat above" 15 ppm-hrs. If the EPA staff judge that a value above 15 ppm-hrs for W126 should be considered, then the analysis throughout the WREA and the PA should include a specific value above 15 ppm-hrs so that this suggestion can be reviewed by CASAC and others. Second, there needs to be greater attention paid to sensitive species. While there is analysis of both sensitive crop and tree species, much of the focus is on a median response, for example for tree species. And even when sensitive species are discussed, it is with statements such as 7 of 12 species had a relative yield loss of X below an ozone exposure value of y. However, with trees, the two most sensitive species had a substantial yield loss well below this value. Thus more attention should be paid to including information about commonly occurring sensitive species. Third, more attention should be paid to crop yield loss and tree biomass growth losses at smaller spatial scales such as counties. If yield of a sensitive crop such as soybean is greater than 5% in a county, it affects the farmers in that county, even if at larger regional or national scales there are smaller impacts on yield or on producer surpluses. Fourth, the suggestion to use a 3 year averaging period is not supported by the available data, nor has it been supported by CASAC. The only justification for a 3-year averaging period is to improve the stability of the classification of regions as being in or out of compliance. Greater attention should be paid to accounting for cumulative impacts of a 1% or 2% loss in growth of tree species and other impacts if a 3-year averaging period is to be used. Specifically, a lower value of the standard would be appropriate for a longer averaging period than 1 year. See also detailed comments below.

Additionally it seems to me that there is likely to be a strong bias effect of using across-the-board NOx reductions (see comments for Chapter 4 of WREA). For the large climate regions used, there is a wide variation in ozone exposure values throughout the region. If "across-the-board" cuts are used to reduce ozone exposure in the highest locations, then ozone exposure in locations where it is lower to start with will tend to become very low. But an actual targeted control strategy would likely only reduce NOx in the locations necessary to bring the high ozone-exposure locations into compliance, thus having much less effect on other locations than would across-the-board cuts. If this bias is large, then it strongly affects all of the risk analyses based on the alternate standards, because impacts of ozone under the alternate standards would be underestimated because ozone exposure values are underestimated for much of each region. If this bias is substantial it could mean that the ozone exposure is underestimated and thus the benefit of the alternate standards might all be underestimated. This could mean that the benefits of any of the alternate standards compared to "just meeting" the current standard and are underestimated as well.

Page 6-8, line 4-5. Change to "extremely highly correlated metrics, with Pearson correlation coefficients of 0.99".

Page 6-9, line 16-17. I don't find that this conclusion is warranted – the data support an annual time frame. There should be some compelling reason to use a multi-year time frame. Note

that the proposed form already includes a 3-month period, so it is not as sensitive as an hourly or 8-hour period to extreme events.

Page 6-9, lines 18-36. As in my comments in the previous 1st draft PA, it is not appropriate to assume that the only welfare effect of crop yield loss is total producer and consumer surpluses. I think that a goal of avoiding yield losses of sensitive crops of 5% or greater for each county would be appropriate to protect welfare. Farmers growing sensitive crops in high ozone locations can be considered a "sensitive population" for welfare impacts, and their crop yields should be protected. Furthermore, I do not find any support herein for the idea that the data do not support an annual time period for yield losses in annual crops.

Page 6-12. The argument that stability of compliance is of value is stated on this page. I agree with the previous CASAC statement (lines 26-29) that if a multi-year period is chosen for stability purposes, the level of the standard should be lowered to prevent exceedences of a threshold of impact. This is a very important point as it affects the choice of a level depending on the averaging time (1 versus 3 years).

Page 6-17 and 6-18. This discussion of individual species responses to different W126 levels is very helpful and informative, as is Table 6-1. However, I think Table 6-1 could be reformatted to make it easier to read by moving much of the text into column headings, and increasing the number of columns. For example "ppm-hrs" should appear at the top of the first column, under the column heading rather than be repeated on every row. And "median species" could be a column heading for both tree seedlings and crops, as could "loss". These changes would make it easier to see the actual values in the table. Also, it is not clear to me what "varying lower" means in the table.

Page 6-24, lines 10-24. See previous comments herein and for the first draft PA regarding a question with the weighted RBL scheme.

Page 6-25, line 14. Change "great" to "greater".

Page 6-30, lines 14-18. It would be helpful to include here and elsewhere the fraction of US forests represented by the species with C-R functions (probably using basal area) as well as the fraction of US crop area covered by the crop species with C-R functions. This helps quantify the uncertainty, which is quite different for crops and forest tree species. This information is available in the REA and could be summarized here as well.

Beginning page 6-30 line 6 and onward. While it is useful to list the various uncertainties, it would be more helpful to give some idea of how the uncertainty might affect the interpretation. I realize that this is challenging, but my concern that it is important to communicate what is known with reasonable certainty versus what is really unknown. I commend the staff for accomplishing this challenging task well in the REA in Table 7-23. There is quite a lot of certainty in estimates of biomass loss for forest tree seedling species and crop species for which C-R functions have been developed. Because several dominant crop species have C-R functions, there is a quite a lot of certainty about impacts of ozone on crop yield across most annual cropland in the USA. But it is much more uncertain to extrapolate from the 12 forest tree species to all forest tree species in the US. For uncertainty in ozone exposure, while it is true that the sparseness of rural monitors means

that in many regions there is uncertainty, there are large portions of the US where monitors are dense enough, and where there are not large mountains or other features that make interpolation more difficult, such that regional estimates of ozone exposure are pretty certain, even if there are somewhat larger uncertainties for individual locations.

Page 6-39, lines 29-31. This is a non-sequitur. The difficulty in determining the degree of impact that is important for welfare is not related to the question of averaging the standard across 1 or 3 years. Also, as quoted in the PA (page 6-36, line 19), the CASAC said "averaging across years in not recommended".

Page 6-43, line 13-14. As for the tree species, crop results should focus on both a group (such as median) response and also individual species response. This is important because sensitive species such as soybean are very widespread and important crops. Also, there is little attention given in the PA and WREA to non-crop annual species. The results for annual crops can be considered as also surrogates for a very large number of annual non-crop species that may have many welfare values. While I appreciate the much greater attention to effects on crop yield in this second draft compared to the first draft, I still think a bit more attention to crops is warranted given the strength of the database on crop yield response to ozone.

Page 6-43, line 35 and elsewhere. While the EPA chose to focus on 2% biomass loss for forest species, greater acknowledgement should be made that CASAC recommended 1 to 2%. This is particularly important in conjunction with the decision by EPA to focus on a 3-year rather than annual averaging time as recommended by CASAC.

Page 6-44, line 21. I think it is worth discussing the implications of focusing on sensitive tree species in addition to the existing focus on median and majority species. I think it is misleading for example on line 14-15 to say "less than 9 or 10" without including that the 2 remaining species have much higher predicted biomass losses. I am not suggesting that these sensitive species should be the primary focus, but rather including them for consideration rather than not including them, as happens with the current emphasis. As for sensitive crop species, these sensitive tree species are ecologically important and widespread. Furthermore, they may also serve as surrogates for the high likelihood that there are other sensitive tree species for which C-R functions have not been developed. As an example of how information on sensitive species might be included, the human health section of this PA includes estimates of the number of not just all children, but also asthmatics for example in Table 4-45, to better represent sensitive populations.

Page 6-45, lines 21-23. I don't understand why these lines are here. The EPA has selected a range of appropriate alternate values for the standard, and it is in accord with many previous CASAC recommendations. But this sentence says that the Administrator can reasonably choose a value beyond this range. This is a very open ended statement, and I don't understand what it is based on. If the EPA staff judge that a value above 15 ppm-hrs for W126 should be considered, then the analysis throughout the WREA and the PA should include a specific value above 15 ppm-hrs so that this suggestion can be reviewed by CASAC and others.

Page 6-45 lines 24-35. This is very helpful, pointing out the implications of choosing different values for the standard among the values put forward by EPA and by CASAC.

Page 6-46, lines 3-5 and 13-14. As mentioned above for the previous page, I don't understand the suggestion of values "somewhat above". If the EPA staff judge that a value above 15 ppm-hrs for W126 should be considered, then the analysis throughout the WREA and the PA should include a specific value above 15 ppm-hrs so that this suggestion can be reviewed by CASAC and others.

Page 6-48, lines 12-13. The only support that I find in the PA for a 3-consecutive-year time frame is stability of compliance among years. As discussed in the PA and in my prior comments, CASAC specifically recommends NOT averaging across years, so I think this recommendation should be reconsidered or at least further qualified.

Page 6-48, line 18, Again I find the usage of "somewhat above" to be vague and misleading and impossible to evaluate, see comments above.

2. In the Panel's view, does the discussion in section 6.5 provide an appropriate and sufficient rationale, supported by the discussions in sections 6.1 through 6.4, to support staff's preliminary conclusions regarding alternative secondary standards (including the indicator, level, averaging time and form) that it is appropriate to consider?

For the most part yes, except for the issue of mentioning values "somewhat above 15 ppm-hrs (see comments above). Also, I think more attention needs to be paid to suggesting a lower value for the standard if using a 3-year rather than a 1-year averaging time.

3. Does the Panel have any recommendations regarding additional interpretations and conclusions based on the available information that would be appropriate for consideration beyond those discussed in this chapter?

Please see comments above.

Ronald E. Wyzga

Introduction (Chapter 1):
Charge questions:

1. Does the Panel find the introductory and background material (sections 1.1 and 1.2) to be appropriately characterized and clearly communicated?

I believe that these sections are extremely well-written. I especially commend the Agency's intent to provide a document "written to be understandable to a broad audience". With respect to the latter, there are a few places where jargon and/or technical terms have crept in that could be clarified for a more naïve audience. For example, p. 1-7, l. 19: "certoriori", p. 1-21: "Controlled Human Exposure Studies"; p. 1-36: "OTC", which I believe refers to open-topped chambers.
In other places legal references could be placed in a footnote as they are distracting from the text; e..g, p. 1-3, ll. 24-28.

2. In section 1.3, we describe the general approach for the review. This includes the key aspects of the approach employed in the last review in judging the adequacy of the then-existing standards and in selecting revised standards. Does the Panel find this description of the approach in the previous review adequate and clear? Does the summary of the approach in the current review appropriately describe important considerations in this review?

This is well-written and provides an important introduction.
A minor comment is that some of the material in section 1.3.1.2.3 is repetitious of material in section 1.2.2.

Some comments on Chapters 3 and 4:

Does the currently available scientific evidence and exposure/risk information …support or call into question the adequacy of the current O_3 primary standard?

The studies of Schelegle et al. (2009) clearly demonstrate that there are adverse health effects among a subpopulation of healthy young subjects after a 6.6 hour expsoure of 72ppb, a level below the current standard; hence there is clear scientific evidence that exposures at the current standard could lead to adverse effects and alternative standards are appropriate for consideration. It should be noted that lung function results from clinical studies at exposure levels at or below 72ppb also demonstrate a clear response. Whether these are "adverse" depends upon the definition of "adverse"; the Schelegle et al study clearly statisfies the definition of "adverse" as defined by the American Thoracic Society, which defines adversity as a combination of lung functions changes accompanied by symptoms. If an alternative definition of "adverse" is used, it should be clearly defined. There is also epidemiological support that finds adverse health responses at contemporary ozone levels in the US.

What is the range of potential alternative standards that are supported by the currently available scientific evidence….?

Clearly, from the above, the upper end must be at or below 72ppb. The Schelegle et al. (2009) study was conducted using healthy volunteers 18-25 years of age for an exposure of 6.6 hours. At issue is how to compensate for the shorter exposure time and the possible impacts among a more sensitive or less healthy population. Figure 2 from the Schelegle et al. (2009) study shows that at higher exposure levels lung function and symptom scores tend to increase with longer exposures. This increase is less apparent for the 70 and 80 ppb protocol exposures; nevertheless prudence suggests that some compensation could be made to adjust for the 6.6 hour exposure period. Panel studies also suggest that more sensitive individuals can respond to levels at or below 70ppb. There is no easy way to extrapolate from exposure levels at which healthy adults respond to comparable levels among sensitive populations, such as asthmatics and children; hence there is uncertainty associated with the lower end of the proposed range.

Children's Health Protection Advisory Committee

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May 19, 2014

H. Christopher Frey PhD
Chair
US EPA Clean Air Scientific Advisory Committee

RE: CASAC Review of the Health Risk and Exposure Assessment for Ozone and Policy Assessment for the Review of the Ozone NAAQS: Second External Review Drafts

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Dear Dr. Frey:

I appreciate the opportunity to comment on the review of US EPA's second drafts: Health Risk and Exposure Assessment and Policy Assessment for the Review of the National Ambient Air Quality Standard (NAAQS) for 8 hour exposure to ozone. In 2007, the US EPA Children's Health Protection Advisory Committee (CHPAC) submitted two letters to Administrator Johnson that highlighted scientific findings regarding ozone-related children's health effects and urged him to support an ozone standard of 60ppb in order to adequately protect children's health with a sufficient margin of safety. I am writing now to strongly re-affirm the recommendation of 60ppb based on the expanding scientific evidence base documenting adverse childhood health impacts in relation to ambient ozone exposure. The higher end of the range, 60ppb – 70ppb, put forth by the Clean Air Scientific Advisory Committee (CASAC) in 2007 will not be sufficient to protect children's health.

Children suffer a disproportionate burden of ozone-related health impacts due to critical developmental periods of lung growth in childhood and adolescence that can result in permanent disability. In addition, children have increased susceptibility due to increased ventilatory rates and increased outdoor physical activity compared with adults. The 6.8 million children suffering from asthma in the US are some of the most vulnerable to ozone-related respiratory impacts (CDC, 2014). The US EPA 2013 Ozone Integrated Science Assessment summarized numerous recent epidemiologic studies that cite relationships between ambient ozone exposure concentrations within and even below the CASAC previously proposed range, 60-70 ppb, and adverse childhood health impacts including: increased asthma exacerbations, impaired lung development, changes in birth outcomes, and increased upper respiratory illness (US EPA, 2013). Therefore, the current scientific evidence base documenting ozone-related childhood health impacts is now expanded and stronger compared to the last review and warrants a lower recommended range of standards to adequately protect children's health and well-being.

One concrete example of how children's health will be positively impacted by a lower standard is outlined in the 2014 EPA Second Draft Policy Assessment for the Review of Ozone NAAQS (US EPA, 2014). It estimates that 14-19% of children (approximately 952,000 – 1,292,000 asthmatic children based on CDC statistics) living in urban centers will have a greater than 10% decrement in lung function based on a standard of 75ppb, and this percentage decreases to 5-11% (approximately 340,000 – 748,000 asthmatic children based on CDC statistics) with a 60ppb standard. The reduction from 75ppb to 60ppb would translate to approximately 500,000 fewer children affected by ozone exposure. Therefore, the reduced standard would result in significant quantifiable children's health protections, and this is only one example of the numerous childhood health protections afforded.

Based on the strengthened scientific evidence reporting adverse childhood-related health impacts at concentrations above 60ppb, I strongly re-affirm the original 2007 CHPAC recommendations to set the NAAQS ozone standard for 8 hour exposure to 60ppb in order to adequately protect children's health. I thank you for considering this recommendation and have included the previous CHPAC letters for your reference. I would be happy to provide any further information as needed.

Sincerely,

Sheela Sathyanarayana MD MPH
Chair, Children's Health Protection Advisory Committee (CHPAC)

Enclosures: March 23, 2007 CHPAC Letter re: Ozone NAAQS
September 4, 2007 CHPAC Letter re: Ozone NAAQS

cc: Janet McCabe, Office of Air and Radiation
Steve Page, Office of Air Quality Planning and Standards
Khesha Reed, Office of Children's Health Protection

References:

US EPA. 2013. "Integrated Science Assessment for Ozone and Related Photochemical Oxidants (Final)." National Center for Environmental Assessment (NCEA), EPA/600/R–10/076F. 1251p., February.

US EPA. 2014. "Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards (Second External Review Draft)." EPA-452/P-14-002. 510p., January.

CDC 2014. "FastStats: Asthma." http://www.cdc.gov/nchs/fastats/asthma.htm. Accessed 5/19/2014.

The Benefits and Costs of the Clean Air Act from 1990 to 2020

Final Report – Rev. A

U.S. Environmental Protection Agency
Office of Air and Radiation

April 2011

ABSTRACT

Section 812 of the 1990 Clean Air Act Amendments requires the U.S. Environmental Protection Agency to develop periodic reports that estimate the benefits and costs of the Clean Air Act. The main goal of these reports is to provide Congress and the public with comprehensive, up-to-date, peer-reviewed information on the Clean Air Act's social benefits and costs, including improvements in human health, welfare, and ecological resources, as well as the impact of the Act's provisions on the US economy. This report is the third in the Section 812 series, and is the result of EPA's Second Prospective analysis of the 1990 Amendments.

The Clean Air Act Amendments (CAAA) of 1990 augmented the significant progress made in improving the nation's air quality through the original Clean Air Act of 1970 and its 1977 amendments. The amendments built off the existing structure of the original Clean Air Act, but went beyond those requirements to tighten and clarify implementation goals and timing, increase the stringency of some federal requirements, revamp the hazardous air pollutant regulatory program, refine and streamline permitting requirements, and introduce new programs for the control of acid rain and stratospheric ozone depleters. The main purpose of this report is to document the costs and benefits of the 1990 CAAA provisions incremental to those costs and benefits achieved from implementing the original 1970 Clean Air Act and the 1977 amendments.

The analysis estimates the costs and benefits of reducing emissions of air pollutants by comparing a "*with-CAAA*" scenario that reflects expected or likely future measures implemented under the CAAA with a "*without-CAAA*" scenario that freezes the scope and stringency of emissions controls at the levels that existed prior to implementing the CAAA. There are six basic steps undertaken to complete this analysis: 1. air pollutant emissions modeling; 2. compliance cost estimation; 3. ambient air quality modeling; 4. health and environmental effects estimation; 5. economic valuation of these effects; and 6. results aggregation and uncertainty characterization.

The results of our analysis, summarized in the table below, make it abundantly clear that the benefits of the CAAA exceed its costs by a wide margin, making the CAAA a very good investment for the nation. We estimate that the annual dollar value of benefits of air quality improvements will be very large, and will grow over time as emissions control programs take their full effect, reaching a level of approximately $2.0 trillion in 2020. These benefits will be achieved as a result of CAAA-related programs and regulatory compliance actions estimated to cost approximately $65 billion in 2020. Most of these benefits (about 85 percent) are attributable to reductions in premature mortality associated with reductions in ambient particulate matter; as a result, we estimate that cleaner air will, by 2020, prevent 230,000 cases of premature mortality in that year. The

remaining benefits are roughly equally divided among three categories of human health and environmental improvement: preventing premature mortality associated with ozone exposure; preventing morbidity, including acute myocardial infarctions and chronic bronchitis; and improving the quality of ecological resources and other aspects of the environment, the largest component of which is improved visibility.

The very wide margin between estimated benefits and costs, and the results of our uncertainty analysis, suggest that it is extremely unlikely that the monetized benefits of the CAAA over the 1990 to 2020 period reasonably could be less than its costs, under any alternative set of assumptions we can conceive. Our central benefits estimate exceeds costs by a factor of more than 30 to one, and the high benefits estimate exceeds costs by 90 times. Even the low benefits estimate exceeds costs by about three to one.

ESTIMATED MONETIZED BENEFITS AND COSTS OF THE 1990 CLEAN AIR ACT AMENDMENTS

	ANNUAL ESTIMATES			PRESENT VALUE ESTIMATE
	2000	2010	2020	1990-2020
Monetized Direct Compliance Costs (millions 2006$):				
Central [a]	$20,000	$53,000	$65,000	$380,000
Monetized Direct Benefits (millions 2006$):				
Low[b]	$90,000	$160,000	$250,000	$1,400,000
Central	$770,000	$1,300,000	$2,000,000	$12,000,000
High[b]	$2,300,000	$3,800,000	$5,700,000	$35,000,000
Net Benefits - Benefits minus Costs (millions 2006$):				
Low	$70,000	$110,000	$190,000	$1,000,000
Central	$750,000	$1,200,000	$1,900,000	$12,000,000
High	$2,300,000	$3,700,000	$5,600,000	$35,000,000
Benefit/Cost Ratio:				
Low[c]	5/1	3/1	4/1	4/1
Central	39/1	25/1	31/1	32/1
High[c]	115/1	72/1	88/1	92/1
Compliance Costs per Premature Mortality Avoided (2006$):				
Central	$180,000	$330,000	$280,000	Not estimated

[a] The cost estimates for this analysis are based on assumptions about future changes in factors such as consumption patterns, input costs, and technological innovation, which introduce significant uncertainty. The degree of uncertainty associated with many of the key factors, however, cannot be reliably quantified. Thus, we are unable to present specific low and high cost estimates.

[b] Low and high benefits estimates correspond to 5th and 95th percentile results from statistical uncertainty analysis, incorporating uncertainties in physical effects and valuation steps of benefits analysis.

[c] The low benefit/cost ratio reflects the ratio of the low benefits estimate to the central cost estimate, while the high ratio reflects the ratio of the high benefits estimate to the central costs estimate.

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REFERENCES

LIST OF ACRONYMS

ACS	American Cancer Society
AEO	Annual Energy Outlook (from the US Department of Energy)
AERMOD	American Meteorological Society/Regulatory Model
AIM	Architectural and Industrial Maintenance
AMI	Acute myocardial infarction
APEEP	Air Pollution Emissions Experiments and Policy analysis model
AQMS	Air Quality Modeling Subcommittee (of the Council)
AMET	Atmospheric Model Evaluation Tool
ANC	Acid Neutralizing Capacity
BenMAP	Environmental Benefits Mapping and Analysis Program
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CARB	California Air Resources Board
CAVR	Clean Air Visibility Rule
CDC	Centers for Disease Control
CGE	Computable General Equilibrium
CMAQ	Community Multi-scale Air Quality [System]
CO	Carbon monoxide
COI	Cost of illness
CONUS	Continental United States (domain in CMAQ model)
Council	Advisory Council on Clean Air Compliance Analysis
C-R	Concentration-Response
CTG	Control Techniques Guideline
CV	Contingent valuation
DDT	Dichlorodiphenyl-trichloroethane
DOE	United States Department of Energy
EC	Elemental carbon
EE	Expert elicitation
EES	Ecological Effects Subcommittee (of the Council)

EGU	Electric Generating Unit
EMPAX-CGE	Economic Model for Policy Analysis – Computable General Equilibrium
EPA	United States Environmental Protection Agency
EUS	Eastern United States (domain in CMAQ model)
EV	[Hicksian] equivalent variation
eVNA	Enhanced Voronoi Neighbor Averaging
FACA	Federal Advisory Committee Act
FASOM	Forest and Agriculture Sector Optimization Model
FRM	Federal Reference Method
GDP	Gross Domestic Product
GHG	Greenhouse gas
HAP	Hazardous Air Pollutant
HAPEM6	Hazardous Air Pollution Exposure Model, Version 6
HDDV	Heavy-Duty Diesel Vehicle
HES	Health Effects Subcommittee (of the Council)
I&M	Inspection and maintenance
IC/BC	Initial and boundary conditions
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
LEV	Low-Emission Vehicle
LML	Lowest measured level
MACT	Maximum Available Control Technology
MAGIC	Model of Acidification of Groundwater in Catchments
MATS	Modeled Attainment Test Software
MCIP	Meteorology-Chemistry Interface Processor
MM5	Fifth Generation Mesoscale Model
MSA	Metropolitan statistical area
NAA	Non-Attainment Area
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NAPAP	National Acid Precipitation Assessment Program

NEI	National Emissions Inventory
NEMS	National Energy Modeling System
NESHAP	National Emission Standard for Hazardous Air Pollutants
NH_3	Ammonia
NH_4	Ammonium
NMMAPS	National Morbidity, Mortality, and Air Pollution Study
NO_3	Nitrate
NO_x	Nitrogen oxides
NPV	Net present value
NSPS	New Source Performance Standard
O&M	Operation and maintenance
OC	Organic carbon
OTC	Ozone Transport Commission
Pb	Lead
PCB	Polychlorinated biphenyl
PM	Particulate matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than 2.5 microns
PM_{10}	Particulate matter with an aerodynamic diameter less than 10 microns
PPB	Parts per billion
PRB	Powder River Basin
PSU/NCAR	Pennsylvania State University/National Center for Atmospheric Research
RACT	Reasonably Available Control Technology
RADM/RPM	Regional Acid Deposition Model/Regional Particulate Model
REMSAD	Regulatory Modeling System for Aerosols and Acid Deposition
RfC	Reference concentration
RFP	Rate of Further Progress
RIA	Regulatory Impact Analysis
RSM	Response Surface Model
RUM	Random Utility Model
SAB	Science Advisory Board
SANDWICH	Sulfates, Adjusted Nitrates, Derived Water, Inferred Carbonaceous mass, and estimated aerosol acidity (H+)) process

SCAQMD	South Coast Air Quality Management District
SIP	State Implementation Plan
SMAT	Speciated Modeled Attainment Test
SMOKE	Sparse-Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
SOA	Secondary organic aerosol
STN	Speciation Trends Network
SUV	Sport-Utility Vehicle
TAC	Total Annualized Cost
TSP	Total Suspended Particulates
UVb or UVB	Ultraviolet B radiation
VMT	Vehicle miles traveled
VNA	Voronoi Neighbor Averaging
VOC	Volatile organic compound
VSL	Value of statistical life
WTAC	Willingness-to-accept-compensation
WTP	Willingness-to-pay
WUS	Western United States (domain in CMAQ model)
Φgm^{-3} or $\Phi g/m^3$	Micrograms per cubic meter (unit for $PM_{2.5}$ measurement)

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The Project Team for the Second Prospective Study was comprised of EPA staff, and staff from a number of organizations working under contract to EPA. The project manager was Jim DeMocker, Senior Policy Analyst, EPA Office of Air and Radiation. Under EPA direction, Project Team members designed and implemented the study, and authored the study's full report, summary report, and supporting technical reports and technical memoranda. In particular, the full report and summary report of the overall Second Prospective Study were authored by Jim DeMocker of EPA and Jim Neumann of Industrial Economics, Incorporated. Major contributions to the main reports and/or key supporting reports were made by Rob Brenner and Jeneva Craig of EPA; Henry Roman, Jason Price, Maura Flight, Tyra Walsh, Lindsay Ludwig, and Nadav Tanners of Industrial Economics, Incorporated; Leland Deck of Stratus Consulting; Jim Wilson and Frank Divita of E.H. Pechan and Associates; Sharon Douglas and Boddu Venkatesh of ICF International; Neil Wheeler of Sonoma Technologies; and Brooks Depro and Robert Beach of RTI International.

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During all phases of the study, from initial design to final report drafting, the Project Team and the Second Prospective Study benefitted immensely from the thoughtful, rigorous, and expert advice of the Advisory Council on Clean Air Compliance Analysis (Council) and its technical subcommittees. The Council was organized under the auspices of EPA's Science Advisory Board, which provided staff support supervised by Vanessa Vu, Director of the SAB Staff Office. The Designated Federal Official for the final Council reviews was Stephanie Sanzone of the SAB Staff Office. Other SAB Staff Office personnel who assisted in the coordination of Council reviews included Holly Stallworth, Marc Rigas, Ellen Rubin, Angela Nugent, and Anthony Maciorowski.

The Council panel providing final review of the study was chaired by Professor James K. Hammitt of Harvard University. Council members serving during the final review of this report include John Bailar (Chair of the Health Effects Subcommittee), Michelle Bell, Sylvia Brandt, Linda Bui, Dallas Burtraw, Ivan J. Fernandez (Chair of the Ecological Effects Subcommittee), Shelby Gerking, Wayne Gray, D. Alan Hansen, Nathaniel Keohane, Jonathan Levy, Richard L. Poirot, Arden Pope, Armistead (Ted) Russell (Chair of the Air Quality Modeling Subcommittee), and Michael Walsh.

In addition to the Chairs listed above, members of the technical subcommittees serving during the final review of this report included David T. Allen, David Chock, Paulette Middleton, Ralph Morris, James Price, and Chris Walcek; Elizabeth Boyer, Charles T.

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CHAPTER 1 - INTRODUCTION

BACKGROUND AND PURPOSE

Section 812 of the 1990 Clean Air Act Amendments established a requirement that EPA develop periodic reports that estimate the benefits and costs of the Clean Air Act (CAA). The main goal of these reports is to provide Congress and the public with comprehensive, up-to-date, peer-reviewed information on the Clean Air Act's social benefits and costs, including improvements in human health, welfare, and ecological resources, as well as the impact of CAA provisions on the US economy. This report is the third in the Section 812 series, and is the result of EPA's Second Prospective analysis of the 1990 Amendments.

The first report EPA created under this authority, *The Benefits and Costs of the Clean Air Act: 1970 to 1990*, was published and conveyed to Congress in October 1997. This Retrospective analysis comprehensively assessed benefits and costs of requirements of the 1970 Clean Air Act and the 1977 Amendments, up to the passage of the Clean Air Act Amendments of 1990. The results of the Retrospective analysis showed that the nation's investment in clean air was more than justified by the substantial benefits that were gained in the form of increased health, environmental quality, and productivity. The aggregate benefits of the CAA during the 1970 to 1990 period exceeded costs by a factor of 10 to 100.

A second Section 812 report, *The Benefits and Costs of the Clean Air Act: 1990 to 2010*, was completed in November of 1999 and addressed the incremental costs and benefits of the Clean Air Act Amendments (CAAA) enacted by Congress and signed by the President in November of 1990. This First Prospective analysis addressed implementation of the CAAA over the period 1990 to 2010, and found that aggregate benefits of the Amendments alone, excluding provisions in place prior to 1990, exceeded the costs by a factor of four.

Similar to these prior analyses, this document has one primary and several secondary objectives. The main goal is to provide Congress and the public with comprehensive, up-to-date, peer-reviewed information on the CAAA's social costs and benefits, including health, welfare, and ecological benefits. Data and methods derived from the Retrospective and First Prospective analysis have already been used to assist policy-makers in refining clean air regulations over the last several years, and we hope the information continues to prove useful to Congress during future Clean Air Act reauthorizations. Beyond the statutory goals of Section 812, EPA also intends to use the results of this study to help support decisions on future investments in air pollution research. In addition, lessons learned in conducting this analysis will help better target

efforts to improve the accuracy and usefulness of future prospective analyses, generated either as part of this series or as part of EPA's ongoing responsibility to estimate benefits and costs of major rulemakings.

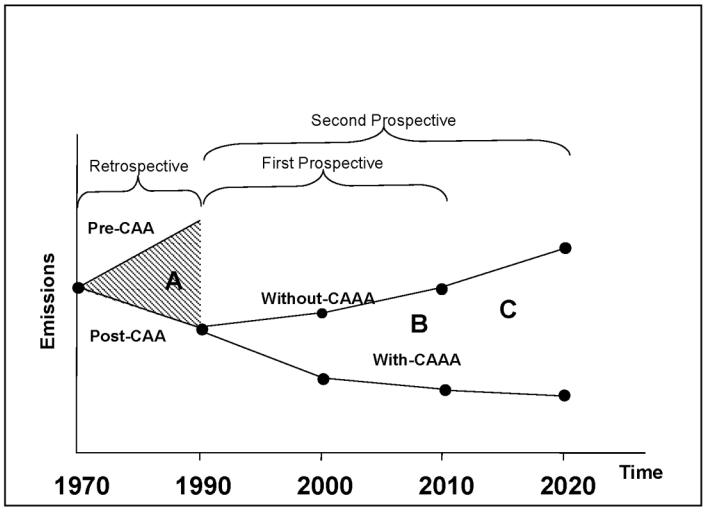
RELATIONSHIP OF THIS REPORT TO OTHER ANALYSES

The Clean Air Act Amendments of 1990 augmented the significant progress made in improving the nation's air quality through the original Clean Air Act of 1970 and its 1977 amendments. The amendments built off the existing structure of the original Clean Air Act, but went beyond those requirements to tighten and clarify implementation goals and timing, increase the stringency of some federal requirements, revamp the hazardous air pollutant regulatory program, refine and streamline permitting requirements, and introduce new programs for the control of acid rain and stratospheric ozone depleters. Because the 1990 Amendments represented an additional improvement to the nation's existing clean air program, the analysis summarized in this report was designed to estimate the costs and benefits of the 1990 CAAA incremental to those costs and benefits assessed in the Retrospective analysis. In economic terminology, this report addresses the marginal costs and benefits of the 1990 CAAA. Figure 1-1 below outlines this relationship among the section 812 Retrospective, the First Prospective, and the Second Prospective.

As illustrated in Figure 1-1, this report effectively updates and augments the First Prospective. This report addresses essentially the same scenario and target variables as the First Prospective, but incorporates a number of significant enhancements. First, this report extends the time period of analysis an additional ten years relative to the First Prospective, covering the period from the signing of the amendments in 1990 through 2020. Second, this report reflects updated cost and emissions estimation methods, including use of a new model suited to nonroad engine regulation and incorporation of the effects of learning-by-doing on projections of direct costs. Third, this report incorporates new information on the benefits of air pollutant regulation, including use of an integrated national-scale air quality model, more comprehensive characterization of ecological benefits, and an air toxics case study. Fourth, the report reflects investments in more comprehensive uncertainty analysis, including quantitative analyses where feasible. Finally, this report incorporates a sophisticated economy-wide model to estimate effects of the CAAA on such measures as GDP, prices, and consumer welfare. The Retrospective analysis employed a similar model for assessing the direct costs of compliance, but for the first time in this study the Agency has explored the economy-wide implications of both the direct costs *and* the health benefits of the CAAA on economic productivity, providing a much more complete picture of the full implications of CAAA regulations.

The scope of this analysis is to estimate the costs and benefits of reducing emissions of criteria pollutants under two scenarios, depicted in schematic form in Figure 1-1 below:

FIGURE 1-1. CLEAN AIR ACT SECTION 812 SCENARIOS: CONCEPTUAL SCHEMATIC



1. An historical, "*with-CAAA*" scenario control case that reflects expected or likely future measures implemented since 1990 to comply with rules promulgated through September 2005[1]; and
2. A counterfactual "*without CAAA*" scenario baseline case that freezes the scope and stringency of emissions controls at their 1990 levels, while allowing for changes in population and economic activity and, therefore, in emissions attributable to economic and population growth.

The Second Prospective analysis required locking in a set of emissions reductions to be used in subsequent analyses at a relatively early date (late 2005), and as a result we were compelled to forecast the implementation outcome of several pending programs. The most important of these was the then-promulgated Clean Air Interstate Rule (CAIR), which took major steps to further reduce SOx and NOx emissions from electric generating units. The rule has subsequently been vacated, and then remanded; EPA is currently considering a proposed rule to modify areas identified by the court as

[1] The lone exception is the Coke Ovens Residual Risk rulemaking, promulgated under Title III of the Act in March 2005. We omitted this rule because it has a very small impact on criteria pollutant emissions (less than 10 tons per year VOCs) relative to the overall impact of the CAAA. The primary MACT rule for coke oven emissions, however, involves much larger reductions and therefore is included in the with-CAAA scenario.

problematic. As a result, the emissions forecasts for electric generating units incorporated in the *with-CAAA* scenario may not reflect the controls that are ultimately implemented in a modified program. We acknowledge and discuss these types of discrepancies and their impact on the outcome of our analysis in the document.

In addition, despite our efforts to comprehensively evaluate the costs and benefits of all provisions of the Clean Air Act and its Amendments, there remain a few categories of effects that are not addressed by the Retrospective or either prospective analysis. For example, this Second Prospective analysis does not assess the effect of CAAA provisions on lead exposures, primarily because the 1990 Amendments did not include major new provisions for the control of lead emissions until the NAAQS for lead was recently revisited and made significantly more stringent; the NAAQS revision was finalized after our emissions inventory development had been completed, too late for inclusion in our analysis. In addition, persistent data and model limitations preclude a full quantitative treatment of some costs and many benefits of other clean air programs. Therefore, while we considered all potentially relevant effects of the Clean Air Act and related programs, the quantitative results we present are not fully comprehensive, even for programs included in our assessment. Other, more modest omissions are acknowledged in the supporting documentation for this effort.[2]

REQUIREMENTS OF THE 1990 CLEAN AIR ACT AMENDMENTS

This Second Prospective analysis, within the limitations discussed above, presents a comprehensive estimate of costs and benefits of the key regulatory titles of the 1990 Clean Air Act Amendments. The 1990 Amendments consist of the following eleven titles:

Title I. Establishes a detailed and graduated program for the attainment and maintenance of the National Ambient Air Quality Standards.

Title II. Regulates mobile sources and establishes requirements for reformulated gasoline and clean fuel vehicles.

Title III. Expands and modifies regulations of hazardous air pollutant emissions; and establishes a list of 189 hazardous air pollutants to be regulated.

Title IV. Establishes control programs for reducing acid rain precursors.

Title V. Requires a new permitting system for primary sources of air pollution.

Title VI. Limits emissions of chemicals that deplete stratospheric ozone.

Title VII. Presents new provisions for enforcement.

Titles VIII through XI. Establish miscellaneous provisions for issues such as disadvantaged business concerns, research, training, new regulation of outer continental

[2] See www.epa.gov/oar/sect812 for a complete list and opportunity to download supporting documentation for this Second Prospective analysis.

shelf sources, and assistance for people whose employment opportunities shift as a result of the Clean Air Act Amendments.

As part of the requirements under Title VIII, section 812 of the Clean Air Act Amendments of 1990 established a requirement that EPA analyze the costs and benefits to human health and the environment that are attributable to the Clean Air Act. In addition, section 812 directed EPA to measure the effects of this statute on economic growth, employment, productivity, cost of living, and the overall economy of the United States.

This analysis does not provide updated information on the costs and benefits of CAAA Title V regulations, which were thoroughly assessed in the First Prospective. Although Title V is believed to have yielded benefits in the efficiency of air permitting, those benefits are largely unquantified – as a result, the main effect of including Title V in the First Prospective was to increase the cost estimate by about $300 million. Similarly, we omit further consideration of Title VI regulation of the emissions of stratospheric ozone depleting substances, which was also assessed in the First Prospective. Although regulations under Title VI are continually updated and refined, the major components of Title VI were in place prior to the First Prospective and were thoroughly analyzed as part of that effort, resulting in the finding that the benefits of Title VI vastly exceeded its cost. As a result, EPA chose to focus resources in the Second Prospective on other areas and refinements. Because Titles V and VI have been previously assessed, and because Titles VII through XI are largely procedural and have mostly modest effects on air pollutant emissions and costs, this Second Prospective analysis is focused on the major emissions regulatory programs of the CAAA, which make up Titles I through IV of the statutory language.[3]

ANALYTICAL DESIGN AND REVIEW

TARGET VARIABLE

The Second Prospective analysis compares the overall health, welfare, ecological and economic benefits of the 1990 Clean Air Act Amendment programs to the costs of these programs. By examining the overall effects of the Clean Air Act, this analysis complements the Regulatory Impact Analyses (RIAs) developed by EPA over the years to evaluate individual regulations. We relied on information about the costs and benefits of specific rules provided by these RIAs, as well as other EPA analyses, in order to use resources efficiently. For this analysis, although costs can be reliably attributed to individual programs, the broad-scale approach adopted in this prospective study largely precludes reliable re-estimation of the benefits on a per-standard or per-program level. Similar to the Retrospective and First Prospective benefits analysis, this study calculates

[3] Note that some elements of Title VII enforcement efforts, such as settlements for historical violations of CAA provisions, particularly in the electric utility and petroleum refining sectors, are included in the emissions inventories of the with-CAAA scenario. For more information, see EPA's detailed emissions report supporting this study at www.epa.gov/oar/sect812

the change in incidences of adverse effects implied by changes in ambient concentrations of air pollutants. However, pollutant emissions reductions achieved contribute to changes in ambient concentrations of those, or secondarily formed, pollutants in ways that are highly complex, interactive, and often nonlinear. Although it would be possible to design specific scenarios that focused analyses only on a subset of regulations (for example, all of Title IV), those policy scenarios are not realistic. For example, exclusion of major components of the Federal rules required under the CAAA would then trigger a much greater need for reductions at the local level, in order to achieve NAAQS standards which apply at the metropolitan area scale. Further, emissions reductions achieved by the provisions of each Title, or more broadly by regulations across the CAAA provisions that apply to a specific category of emitting sources, interact with other regulations to affect the benefits implications of any emissions reduction. Therefore, benefits cannot be reliably isolated or matched to provision-specific changes in emissions or costs. Focusing on the broader target variables of overall costs and overall benefits of the Clean Air Act, the EPA Project Team adopted an approach based on construction and comparison of two distinct scenarios, briefly mentioned above: a "*without-CAAA*" and a "*with-CAAA*" scenario. The *without-CAAA* scenario essentially freezes federal, state, and local air pollution controls at the levels of stringency and effectiveness which prevailed in 1990. The *with-CAAA* scenario assumes that all federal, state, and local rules promulgated pursuant to, or in support of, the 1990 CAAA were implemented. This analysis then estimates the differences between the economic and environmental outcomes associated with these two scenarios. For more information on the specific construction of the scenarios and their relationship to historical trends, see Chapter 2 of this document.

KEY ASSUMPTIONS

Similar to the Retrospective and First Prospective analyses, we made two key assumptions during the scenario design process to avoid miring the analytical process in endless speculation. First, as stated above, we froze air pollution controls at 1990 levels throughout the "*without-CAAA*" scenario. Second, we assumed that the geographic distributions of population and economic activity remain the same between the two scenarios, although these distributions could be expected to change over time under both scenarios in response to differences across scenarios in income and air quality.

The first assumption is an obvious simplification. In the absence of the 1990 CAAA, one would expect to see some air pollution abatement activity, either voluntary or due to state or local regulation. It is conceivable that state and local regulation would have required air pollution abatement equal to – or even greater than – that required by the 1990 CAAA, particularly since some states, most notably California, have in the past done so. If one were to assume that state and local regulations would have been equivalent to 1990 CAAA standards, then a cost-benefit analysis of the 1990 CAAA would be a meaningless exercise since both costs and benefits would equal zero. Any attempt to predict how states' and localities' regulations would have differed from the 1990 CAAA would be too speculative to support the credibility of the ensuing analysis. Instead, the *without-CAAA* scenario has been structured to reflect the assumption that states and localities would not

have invested further in air pollution control programs after 1990 in the absence of the federal CAAA. Thus, this analysis accounts for all costs and benefits of air pollution control from 1990 to 2020 and does not speculate about the fraction of costs and benefits attributable exclusively to the federal CAAA. Nevertheless, it is important to note that state and local governments and private initiatives are responsible for a significant portion of these total costs and total benefits. In the end, the benefits of air pollution controls result from partnerships among all levels of government and with the active participation and cooperation of private entities and individuals.

The second assumption concerns changing demographic patterns in response to air pollution. In the hypothetical *without-CAAA* scenario, air quality is worse than the actual 1990 conditions and the projected air quality in the *with-CAAA* scenario. It is possible that under the *without-CAAA* scenario more people, relative to the *with-CAAA* case, would move away from the most heavily polluted areas. Rather than speculate on the scale of population movement, the analysis assumes no differences in demographic patterns between the two scenarios. Similarly, the analysis assumes no differences between the two scenarios with respect to the level or spatial pattern of overall economic activity. Both scenarios do, however, reflect recent Census Bureau projections of population growth and the distribution of population across the country.

ANALYTIC SEQUENCE

The analysis comprises a sequence of six basic steps, summarized below and described in detail later in this report. These six steps, listed in order of completion, are:

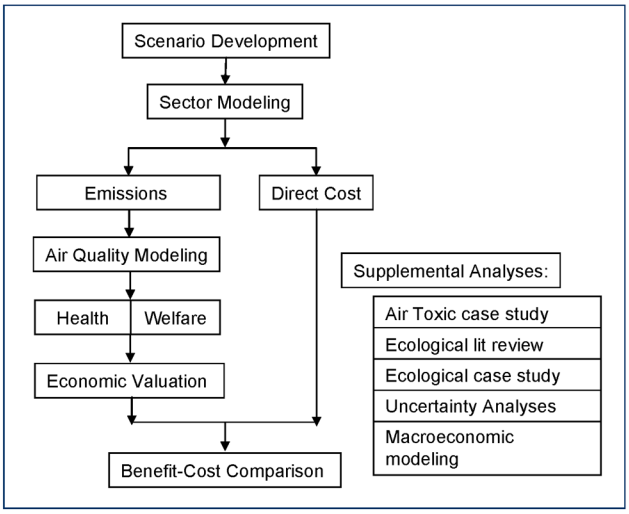
1. emissions modeling
2. direct cost estimation
3. air quality modeling
4. health and environmental effects estimation
5. economic valuation
6. results aggregation and uncertainty characterization

Figure 1-2 summarizes the analytical sequence used to develop the prospective results; we describe the analytic process in greater detail below.

The first step of the analysis is the estimation of the effect of the 1990 CAAA on emissions sources. We generated emissions estimates through a three step process: (1) construction of an emissions inventory for the base year (1990); (2) projection of emissions for the *without-CAAA* case for three target years -- 2000, 2010, and 2020 -- assuming a freeze on emissions control regulation at 1990 levels and continued economic progress, consistent with sector-specific Department of Energy Annual Energy Outlook economic activity projections; and (3) construction of *with-CAAA* estimates for the same three target years, using the same set of economic activity projections used in the *without-CAAA* case but with regulatory stringency, scope, and timing consistent with EPA's CAAA implementation plan (as of late 2005). The analysis reflects application of utility

and other sector-specific emissions models developed and used in various offices of EPA's Office of Air and Radiation. These emissions models provide estimates of emissions of five criteria air pollutants[2] from each of several key emitting sectors. We provide more details in Chapter 2.

FIGURE 1-2. ANALYTIC SEQUENCE FOR THE SECOND PROSPECTIVE ANALYSIS



The emissions modeling step is a critical component of the analysis, because it establishes consistency between the subsequent cost and benefit estimates that we develop. Estimates of direct compliance costs to achieve the emissions reductions estimated in the first step are generated as either an integral or subsequent output from the emissions estimation models, depending on the model used. For example, the Integrated Planning Model used to analyze the utility sector reflects a financially optimal allocation of reductions of sulfur and nitrogen oxides – taking into account the regulatory flexibility

[2] The five pollutants are particulate matter (separate estimates for each of PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). One of the CAA criteria pollutants, ozone (O_3), is formed in the atmosphere through the interaction of sunlight and ozone precursor pollutants such as NO_x and VOCs. We also develop estimates for ammonia (NH_3) emissions. Ammonia is not a criteria pollutant, but is an important input to the air quality modeling step because it affects secondary particulate formation. A sixth criteria pollutant, lead (Pb), is not included in this analysis since airborne emissions of lead were mostly eliminated by pre-1990 Clean Air Act programs - the recent tightening of the Pb NAAQS, necessitated by an enhanced understanding of the effects of even small exposures to airborne lead, was finalized too late to include in our scenarios. However, available estimates of the benefits and costs of the updated Pb NAAQS could be viewed as approximately additive to the results presented here.

inherent in the Title IV trading programs – thereby estimating emissions reductions and compliance costs simultaneously. Direct costs are addressed in Chapter 3.

Emissions estimates also form the first step in estimating benefits. After the emissions inventories are developed, they are translated into estimates of air quality conditions under each scenario. For secondary particulate matter, ozone, and other air quality conditions that involve substantial non-linear formation processes and/or long-range atmospheric transport and transformation, the EPA Project Team employed EPA's Community Multi-scale Air Quality (CMAQ) system. This modeling system, for the first time in the series of Section 812 studies, provides a fully national, integrated analysis of multiple emissions and their interactions. The result is a consistent estimate of air quality for both primary and secondarily formed pollutants, as well as deposition and visibility outcomes that represent the core of the subsequent benefit analyses. Air quality modeling is covered in Chapter 4.

Up to this point of the analysis, modeled conditions and outcomes establish the *without-CAAA* and *with-CAAA* scenarios. However, at the air quality modeling step, the analysis returns to a foundation based on actual historical conditions and data, providing a form of "ground-truthing" of the results. Specifically, actual 2000 historical air quality monitoring data are used to define the baseline conditions from which the *without-CAAA* and *with-CAAA* scenario air quality projections are constructed. We derive air quality conditions under each of the projected years of the *with-CAAA* scenario by scaling the historical data adopted for the base year (2000) by the ratio of the modeled *with-CAAA* and base year air quality. We use the same approach to estimate future year air quality for the *without-CAAA* scenario. This method takes advantage of the richness of the monitoring data on air quality, provides a realistic grounding for the benefit measures, and yet retains analytical consistency by using the same modeling process for both scenarios. The outputs of this step of the analysis are profiles for each pollutant characterizing air quality conditions at each monitoring site in the lower 48 states. This procedure also provided a means for calibrating model results in those grid cells where no monitors exist, combining model results with nearby monitor data to yield a "surface" of air quality that avoids the problems with direct extrapolation of results from monitors not located within a grid cell boundary.

The *without-CAAA* and *with-CAAA* scenario air quality profiles serve as inputs to a modeling system that translates air quality to physical outcomes (e.g., mortality, emergency room visits, or crop yield losses) through the use of concentration-response functions. Scientific literature on the health and ecological effects of air pollutants provides the source of these concentration-response functions. At this point, we derive estimates of the differences between the two scenarios in terms of incidence rates for a broad range of human health and other effects of air pollution by year, by pollutant, and by geographic area.

In the next step, we use economic valuation models or coefficients to estimate the economic value of the reduction in incidence of those adverse effects amenable to monetization. For example, a distribution of unit values derived from the economic

literature provides estimates of the value of reductions in mortality risk. In addition, we compile and present benefits that cannot be expressed in economic terms. In some cases, we calculate quantitative estimates of scenario differences in the incidence of a nonmonetized effect. In many other cases, available data and techniques are insufficient to support anything more than a qualitative characterization of the change in effects. Health effects estimation and valuation are addressed in Chapter 5, and welfare effects, including ecological impacts, visibility, and agriculture and forest productivity effects, and their valuation, are addressed in Chapter 6.

Next, we compare costs and monetized benefits to provide our primary estimate of the net economic benefits of the 1990 CAAA and associated programs, and a range of estimates around that primary estimate reflecting quantified uncertainties associated with the physical effects and economic valuation steps. The monetized benefits used in the net benefit calculations reflect only a portion of the total benefits due to limitations in analytical resources, available data and models, and the state of the science. For example, in many cases we are unable to quantify or monetize the potentially large benefits of air pollution controls that result from protection of the health, structure, and function of ecosystems. In addition, although available scientific studies demonstrate clear links between air quality changes and changes in many human health effects, the available studies do not always provide the data needed to quantify and/or monetize some of these effects. Details are provided in Chapter 7.

In addition to the sequence of analyses outlined in Figure 1-2, which are focused on generating the key target variable of national net monetized benefits, a number of supplemental analyses were also conducted to provide further insights on the impacts of CAAA provisions for natural resources, health, and economic output. The first of these supplemental analyses uses the Second Prospective's national direct cost, health incidence, and health benefits valuation results to conduct further national-scale economy-wide modeling using what is known as a Computable General Equilibrium (CGE) model. The CGE model simulates, in a simplified way, shifts in markets and transactions throughout the economy that might result from CAAA provisions. It is therefore useful in assessing impacts on Gross Domestic Product (GDP), prices, and sector shifts in production (e.g., from "dirty" to "clean" industries). Most past applications of CGEs have focused on the economy-wide implications of the *costs* of complying with regulations – as a result, many prior applications, including the use of CGE in the Retrospective study, tell only half the story. Air pollution regulations not only impose direct costs, but also yield benefits, and at least some of these benefits (e.g., reduced medical expenditures, improved labor productivity owing to better health) affect market transactions in ways that can be assessed in the CGE framework. Not all benefits are amenable to analysis in a CGE, however – for example, nonmarket effects such as willingness-to-pay to avoid pain and suffering of air pollutant-linked disease cannot be incorporated. Nonetheless, this study represents one of the first broad applications of a CGE tool to regulatory costs *and* benefits. More details are provided in Chapter 8.

Two other supplemental analyses represent local-scale case studies of difficult-to-quantify benefits of air pollution regulation. One is a case study of health benefits associated with air toxics control. In prior section 812 studies, benefits of air toxics programs have been largely limited to their effects on criteria pollutant outcomes. For example, many air toxics are also volatile organic compounds, and so contribute to ozone formation, an effect which can be fairly readily quantified. The direct effects of air toxics on health, however, have been more difficult to quantify, partly because of data constraints, and partly because the highly localized effects of air toxics require a level of emissions and air quality modeling resolution that is currently infeasible for a national analysis. The air toxics case study, the results of which are presented in Chapter 5, provides an example of the benefits of air toxics control for a pollutant (benzene) and geographic scope (Houston area) that is both relatively data rich and computationally manageable.

A second case study involves ecological effects, focused on the Adirondack region of New York State. This region was carefully chosen, based on the recommendation of the Advisory Council on Clean Air Compliance Analysis Ecological Effects Subcommittee (Council EES), because of its relatively high sensitivity to the effects of deposited air pollutants, because those same effects are relatively well-studied, and because methods exist to quantify and, in many cases, monetize the benefits of air pollution controls. Using the same emissions and air quality scenarios as in the overall national study, the ecological case study assesses the impact of sulfur and nitrogen deposition in the Adirondack region on aquatic resources, particularly lakes and ponds that support recreational fishing, and on commercial timber resources.

Uncertainty analyses are also conducted at each phase of the analyses. Where applicable, we present the results of a series of quantitative uncertainty analyses that test the effect of alternative methods, models, or assumptions that differ from those we used to derive the primary net benefit estimate. The primary estimate of net benefits and the range around this estimate, however, reflect our current interpretation of the available literature; our judgments regarding the best available data, models, and modeling methodologies; and the assumptions we consider most appropriate to adopt in the face of important uncertainties.

Finally, throughout the report, at the end of each chapter, we discuss the major sources of uncertainty for each analytic step. Although the impact of many of these uncertainties cannot be quantified, we qualitatively characterize the magnitude of effect on our net benefit results by assigning one of two classifications to each source of uncertainty: *potentially major* factors could, in our estimation, have effects of greater than five percent of the total net benefits; and *probably minor* factors likely have effects less than five percent of total net benefits.

The Second Prospective involved a much greater effort in uncertainty analyses than prior reports in this series. Figure 1-3 illustrates the Project Team's approach to uncertainty analysis in the Second Prospective, superimposed on the overall analytic chain for the study presented above. The grey box in Figure 1-3 represents the extent of uncertainty

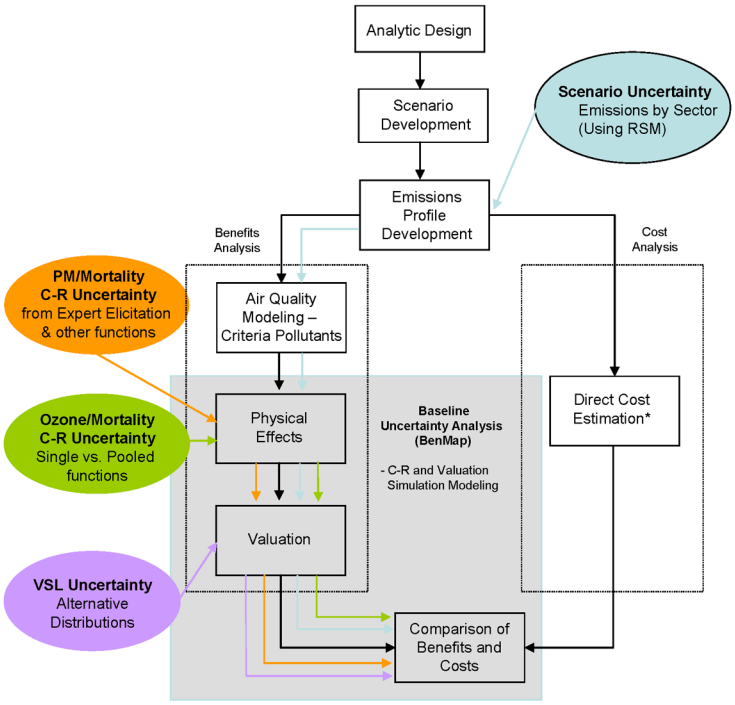
analysis in the first section 812 prospective analysis, which was largely limited to analysis of parameter uncertainty in the concentration-response and valuation steps of the benefits analyses. Those parameter uncertainty analyses have become standard practice in EPA analyses of air pollution program benefits, and are an integral part of the BenMAP benefits assessment tool. The results of the probabilistic modeling of these uncertainties constitute the "primary low" and "primary high" estimates presented in Table 5-7 in Chapter 5 as well as in Chapter 7.

Enhancements employed in the current analysis include both "online" analyses (shown in color), that feed information on uncertainty into the analytical chain at various points and propagate it through the remaining steps in the chain, and separate "offline" analyses and research that provide insights into the uncertainty, sensitivity, and robustness of results to alternative assumptions that are currently most easily modeled outside the main analytical process.

The online analyses consist of the selection of alternative inputs for mortality concentration-response and valuation in BenMAP, as well as an analysis of the effect on benefits of sector specific, marginal changes in PM-related emissions from the core scenarios. This online analysis substitutes EPA's Response Surface Model (RSM) for CMAQ. RSM is a less resource intensive meta-model of CMAQ used to rapidly approximate PM concentrations from alternative emissions inputs. Those analyses are described in much greater detail in the supporting uncertainty analysis report, referenced at the end of this chapter.

The bottom box in Figure 1-3 lists additional offline research and analysis we incorporated into the current study. As with the online analyses, these analyses were chosen because they address uncertainty in key analytical elements or choices that may significantly influence benefit or cost estimates. Most of these are described in this integrated report, some only briefly, but full descriptions of the data, models, and methods applied in these analyses are included in the underlying uncertainty analysis report.

FIGURE 1-3. SCHEMATIC OF UNCERTAINTY ANALYSES



Offline Analyses

1. Dynamic versus Static Population Modeling (Benefits)
2. Cessation lag (Benefits)
3. Differential Toxicity of PM Components (Benefits)
4. Emissions and Air Quality Modeling Uncertainty Literature Review and Qualitative Analysis (Benefits)
5. Unidentified Controls (Costs)
6. Fleet Composition, I&M Failure Rates (Costs)
7. Learning Curve Assumptions (Costs)

* In addition, we perform a computable general equilibrium (CGE) analysis of costs alone and of costs and benefits, but we omit this step from the diagram because we do not conduct uncertainty analyses on the CGE modeling.

REVIEW PROCESS

The 1990 CAA Amendments established a requirement that EPA consult with an outside panel of experts during the development and interpretation of the 812 studies. This panel of experts was originally organized in 1991 under the auspices of EPA's Science Advisory Board (SAB) as the Advisory Council on Clean Air Compliance Analysis (hereafter, the Council). Organizing the review committee under the SAB ensured that highly qualified experts would review the section 812 studies in an objective, rigorous, and publicly open manner consistent with the requirements and procedures of the Federal Advisory Committee Act (FACA). Council review of the present study began in 2003 with a review of the analytical design plan. Since the initial meetings, the Council and its subcommittees have met many times to review proposed data, proposed methodologies, and interim results. While the full Council retains overall review responsibility for the section 812 studies, some specific issues concerning physical effects and air quality modeling were referred to subcommittees comprised of both Council members and members of other SAB committees. The Council's Health Effects Subcommittee (HES), Air Quality Modeling Subcommittee (AQMS), and Ecological Effects Subcommittee (EES) held both in-person and teleconference meetings to review methodology proposals and modeling results and conveyed their findings and recommendations to the parent Council.

REPORT ORGANIZATION

The remainder of the main text of this report summarizes the key methodologies and findings of our prospective study.

Chapter 2 summarizes emissions modeling and provides important additional detail on design of the regulatory scenarios.

Chapter 3 discusses the direct cost estimation.

Chapter 4 presents the air quality modeling methodology and results.

Chapter 5 describes the approaches used and principal results obtained through the human health effects estimation and valuation processes.

Chapter 6 summarizes the ecological and other welfare effects analyses, including assessments of commercial timber, agriculture, visibility, and other categories of effects.

Chapter 7 presents aggregated results of the cost and benefit estimates and describes and evaluates important uncertainties in the results.

Chapter 8 presents estimates of the effect of the Clean Air Act Amendments on economic growth, productivity, prices, household economic welfare, and the overall economy of the United States, through the application of an economy-wide economic simulation model.

Note that additional details regarding the methodologies and results of this study can be found in a series of supporting reports, available at EPA's Section 812 website (www.epa.gov/oar/sect812). These reports include the following:

Emission Projections for the Clean Air Act Second Section 812 Prospective Analysis.

Direct Cost Estimates for the Clean Air Act Second Section 812 Prospective Analysis.

Memorandum to the Files Re Documentation of Second Prospective Study Air Quality Modeling.

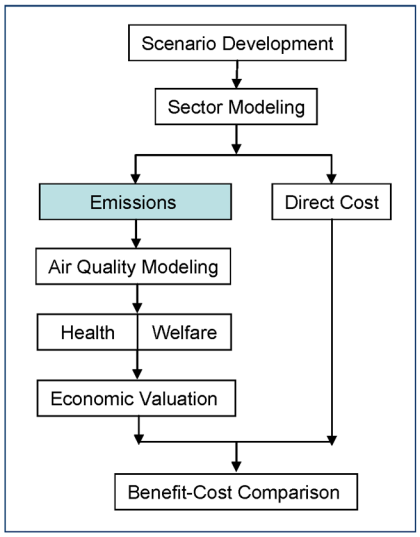
Health and Welfare Benefits Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act.

Effects of Air Pollutants on Ecological Resources: Literature Review and Case Studies.

Section 812 Prospective Study of the Benefits and Costs of the Clean Air Act: Air Toxics Case Study – Health Benefits of Benzene Reductions in Houston, 1990-2020.

Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act.

CHAPTER 2 - EMISSIONS



Estimation of pollutant emissions, a key component of this prospective analysis, serves as the starting point for subsequent benefit and cost estimates. We focused the emissions analysis on six major pollutants that are regulated by the Clean Air Act Amendments: volatile organic compounds (VOCs), nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), and fine particulate matter ($PM_{2.5}$). Estimates of current and future year ammonia (NH_3) emissions are also included in this study because of their importance in the atmospheric formation of fine particles in the ambient air. For each of these pollutants we projected emissions to the years 2010 and 2020 under two different scenarios:

1. An historical "*with-CAAA*" scenario control case that reflects expected or likely future measures implemented since 1990 to comply with rules promulgated through September 2005; and
2. A counterfactual "*without-CAAA*" scenario baseline case that freezes the scope and stringency of emissions controls at their 1990 levels, while allowing for changes in emissions attributable to economic and population growth.[4]

[4] Implementing this approach has occasionally required some difficult decisions on what constitutes 1990 levels of emissions controls. In general, we have interpreted any rules that were promulgated as final prior to 1990 to be part of *the without-CAAA* scenario baseline. The residential wood stove New Source Performance Standard, however, was promulgated in 1988, but is not part of the *without-CAAA* scenario, because EPA did not certify NSPS compliant wood stoves until 1992. In this

We projected emissions for five major source categories: utilities, or electricity generating units (EGUs); non-EGU industrial point sources; onroad motor vehicles; nonroad engines/vehicles; and area sources, which are smaller, more diffuse sources of pollutants that derive from many sources.[5] Table 2-1 gives examples of emissions sources for each of the five categories examined in this analysis and indicates which major pollutants are targeted by CAAA requirements in each category. The primary purpose of emissions analysis in this study is to estimate how emissions change over time and across our scenarios, so we can estimate costs of reducing emissions and the benefits of those emissions reductions for each of our target years.

TABLE 2-1. MAJOR EMISSIONS SOURCE CATEGORIES

SOURCE CATEGORY	EXAMPLES	POLLUTANTS WITH SUBSTANTIAL EMISSIONS REDUCTIONS FROM CAAA COMPLIANCE
Electricity Generating Units (EGUs)	electricity producing utilities	NO_x, SO_2
Non-EGU Industrial Point Sources	boilers, cement kilns, process heaters, turbines	NO_x, VOC, SO_2, PM_{10} $PM_{2.5}$
Onroad Motor Vehicles	buses, cars, trucks (sources that usually operate on roads and highways)	NO_x, VOC, CO
Nonroad Engines/Vehicles	aircraft, construction equipment, lawn and garden equipment, locomotives, marine engines	NO_x, VOC, CO
Area Sources	agricultural tilling, dry cleaners, open burning, wildfires	NO_x, VOC, PM_{10}, $PM_{2.5}$

This chapter consists of four sections. The first section provides an overview of our approach for developing emissions estimates. The second section summarizes our emissions projections for the years 2000, 2010, and 2020, and presents our estimates of changes in future emissions resulting from the implementation of the 1990 Amendments. The third section compares these results with estimates from the First Section 812 Prospective Analysis. Finally, we conclude this chapter with a summary of the key uncertainties associated with estimating emissions.

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case, perhaps incorrectly, we interpreted the effective date of 1992 as the determining factor in whether the level of emissions stringency in 1990 should include the wood stove NSPS.

[5] Area sources are also commonly referred to as nonpoint sources. We estimated utility and industrial point source emissions at the plant/facility level. We estimated nonroad engine/vehicle, motor vehicle, and area source emissions at the county level.

OVERVIEW OF APPROACH

For four out of the five major source categories described in this report—all except electric generating units—we applied the following general method to estimate emissions:

1. Select a "base" inventory for a specific year. This involves selection of an historical year inventory from which projections will be based.
2. Select activity factors to project growth in the level of pollution-generating activity in the target years. The activity factors should provide the best possible means for representing future air pollutant emissions levels in the absence of controls.
3. Develop a database of scenario-specific emissions control factors, to represent emissions control efficiencies under the two scenarios of interest. The control factors are "layered on" to the projected emissions levels absent controls to estimate future emissions levels, taking into account those controls required for CAAA compliance .

Air pollutant emissions for the fifth category, EGUs, were estimated by application of the Integrated Planning Model (IPM), a model developed by ICF Consulting. IPM estimates EGU emissions in the 48 contiguous states and the District of Columbia through an optimization procedure that considers costs of electricity generation, costs of pollution control, and external projections of electricity demand to forecast the fuel choice, pollution control method, and generation for each unit considered in the model. We used IPM to estimate EGU emissions in both the *with-CAAA* and *without-CAAA* scenarios for 2000, 2010, and 2020.

SELECTION OF BASE YEAR INVENTORY

The *without-CAAA* scenario emission projections are made from a 1990 base year, while the *with-CAAA* scenario emission projections use a base year of 2000. The logic for these base year inventory choices relates to the specific definitions of the scenarios themselves. The *with-CAAA* scenario tracks compliance with CAAA requirements over time; as a result, the best basis for projecting the *with-CAAA* scenario is a current emissions inventory that incorporates decisions made since 1990 to comply with the act. The *without-CAAA* scenario, on the other hand, freezes the stringency of regulation at 1990 levels. The analysis therefore uses 1990 emission rates as a base and adjusts those emissions to account for economic activity over time. We determined that this method was less problematic than basing projections on a recent emissions inventory and trying to simulate the effect of removing CAAA emission controls currently in place. Table 2-2 summarizes the key databases that were used in this study to estimate emissions for historic years 1990 and 2000. Note that, in some cases, we determined that the best representation for year 2000 emissions was actually a later year, either 2002 or 2001. Those decisions are explained below.

TABLE 2-2. BASE YEAR EMISSION DATA SOURCES FOR THE *WITH-* AND *WITHOUT-CAAA* SCENARIOS

SOURCE CATEGORY	*WITHOUT-CAAA* SCENARIO - 1990	*WITH-CAAA* SCENARIO - 2000
Electricity Generating Units (EGUs)	1990 EPA Point Source NEI[1]	Estimated by the EPA Integrated Planning Model for 2001
Non-EGU Industrial Point Sources	1990 EPA Point Source NEI	2002 EPA Point Source NEI (Draft)
Onroad Motor Vehicles	MOBILE6.2 Emission Factors and 1990 NEI VMT Database	MOBILE6.2 Emission Factors and 2000 NEI VMT Database[2]
Nonroad Engines/Vehicles	NONROAD 2004 Model Simulation for Calendar Year 1990	NONROAD 2004 Model Simulation for Calendar Year 2000
Area Sources	1990 EPA Nonpoint Source NEI[3]	2002 EPA Nonpoint Source NEI (Final)

[1] The NEI is EPA's National Emissions Inventory, conducted every three years.
[2] The California Air Resources Board (ARB) supplied estimates for California.
[3] Adjustments were made to the 1990 nonpoint source NEI file for priority source categories.

For EGUs and non-EGU industrial point sources, we estimated 1990 emissions using the 1990 EPA National Emission Inventory (NEI) point source file. This file is consistent with the emission estimates used for the First Section 812 Prospective and is thought to be the most comprehensive and complete representation of point source emissions and associated activity in that year. Similarly, the 1990 EPA NEI nonpoint source file – with a few exceptions – was used to estimate 1990 area source sector emissions.[6]

For base year emissions estimates in the *with-CAAA* scenario, we drew emissions from a variety of sources. Due to resource constraints and the quality of available data, we relied on emissions estimates for years other than 2000. In the case of *with-CAAA* emissions from industrial point sources and area sources, we used the point source and nonpoint source files from the 2002 EPA NEI.[7] We chose the 2002 NEI to represent the year 2000 estimates primarily because the 2002 inventory incorporated a number of refinements in emissions estimation methods that were not included in the previous inventory, which covered 1999 emissions. We judged that the improved quality of the 2002 NEI data justified the small expected difference between emissions for these source categories in

[6] The exceptions are where 1990 emissions were re-computed using updated methods developed for the 2002 National Emissions Inventory (NEI) for selected source categories with the largest criteria pollutant emissions and most significant methods changes.

[7] We used the draft NEI point source file because the final version of that file was not available at the time the analysis was performed. For area sources, we used the final NEI nonpoint source file.

2000 and in 2002. To estimate *with-CAAA* EGU emissions, we used data from a modified version of IPM that retrospectively modeled emissions for the year 2001.[8]

The project team estimated 1990 and 2000 emissions for the onroad and nonroad vehicle/engine sectors independently using consistent modeling approaches and activity estimates. For example, emission factors from EPA's MOBILE6.2 model were used together with data from the 1990 and 2000 NEI vehicle miles traveled (VMT) databases to estimate onroad vehicle emissions for 1990 and 2000. Similarly, EPA's NONROAD 2004 model was used to estimate 1990 and 2000 emissions for nonroad vehicles/engines.

SELECTION OF ACTIVITY FACTORS FOR PROJECTIONS

After specifying base year emissions, we projected emissions to 2000 (for the *without-CAAA* scenario), 2010, and 2020. To model emissions in the absence of controls, our general approach was to multiply an emission factor – derived from base year emissions estimates – by the level of emission-generating activity upon which the emission factor is based. These emission-generating activities vary by source category, but they are generally related to economic activity, such as transportation, energy consumption, and industrial output. Specifically, economic growth projections entered the emissions analysis in three places:

- an electricity demand forecast (included in IPM);
- a fuel consumption forecast for non-utility sectors; and
- economic growth projections that serve as activity drivers for several other sources of air pollutants.

For this analysis, we used fully integrated economic growth, energy demand, and fuel price projections to model economic growth in both the *with-CAAA* and the *without-CAAA* scenarios. The primary advantage of this approach is that it allowed us to conduct an internally consistent analysis of economic growth across all emitting sectors. To implement this integrated approach, we chose the Department of Energy's National Energy Modeling System (NEMS), which is used to produce DOE's Annual Energy Outlook (AEO) projections. Our emissions estimates primarily rely on AEO's 2005 "reference case" scenarios. We supplemented these projections with additional forecasts from other data sources for emissions sources where we determined that AEO's energy and socioeconomic forecasts would not adequately represent growth in emissions-generating activities.[9] Table 2-3 presents the values that we used for the AEO 2005 projections for population, GDP, energy consumption, and oil price values in 2010 and 2020. For reference, the table also presents the historical values for each variable in

[8] Due to resource constraints and model limitations, we relied primarily on a validation analysis EPA conducted on 2001 emissions, rather than developing a new analysis for the year 2000.

[9] These emissions sources include agricultural production-crops, fertilizer application, and nitrogen solutions; agricultural tilling; animal husbandry; aircraft; forest wildfires; prescribed burning for forest management; residential wood fireplaces and wood stoves; and unpaved roads.

2002, as reported in AEO 2005. For each variable, the table shows the implied annual growth rate that AEO 2005 used to project population, GDP, energy consumption, and oil prices from 2002 to 2010 and from 2010 to 2020.[10]

TABLE 2-3. SUMMARY OF KEY DRIVER DATA APPLIED IN EMISSIONS PROJECTIONS

VARIABLE	HISTORICAL DATA	AEO 2005 PROJECTIONS		IMPLIED ANNUAL GROWTH RATE	
	2002	2010	2020	2002-2010	2010-2020
Population (millions)	288.6	310.1	337.0	0.90%	0.83%
GDP (billion 2000 chain-weighted dollars)	$10,075	$13,084	$17,634	3.32%	3.03%
Energy Consumption (quadrillion Btu per year)	97.99	111.27	125.60	1.60%	1.22%
World Oil Price (1999$ per barrel)	$22.17	$23.00	$26.22	0.46%	1.32%

One notable exception to the above involves the specification of $PM_{2.5}$ emissions from non-EGU point sources and area sources. After initially attempting to model $PM_{2.5}$ emissions in the *without-CAAA* scenario in 2000, 2010, and 2020 using the process described above, we determined that the resulting estimates over-attributed emissions reductions to the amendments. We applied two separate approaches to correct these emissions estimates: For emissions from area sources, we projected emissions from the two sectors responsible for the majority of emissions – construction and wood stoves – using source-specific data. For emissions from non-EGU point sources, the project team determined that emissions reductions from CAAA-mandated controls would be negligible in 2000, so we set *without-CAAA* $PM_{2.5}$ emissions equal to *with-CAAA* emissions in that year.

APPLYING CONTROLS TO THE *WITH-CAAA* SCENARIO

To estimate the impact of CAAA controls on projected emissions in the *with-CAAA* scenario, we modeled the application of controls required by CAAA programs, including (among others):

- Title I VOC and NO_x reasonably available control technology (RACT) requirements in ozone nonattainment areas (NAAs);
- Title II on-road vehicle and nonroad engine/vehicle provisions;
- Title III National Emission Standards for Hazardous Air Pollutants (NESHAPs);
- Title IV programs focused on emissions from EGUs.

[10] The table presents 2002 data in order to be consistent with EPA's 2002 NEI, which we used to estimate emissions from industrial point sources and area sources.

- Additional EGU regulations, such as the Clean Air Interstate Rule (CAIR), the Clean Air Mercury Rule (CAMR), and the Clean Air Visibility Rule (CAVR).

As a general rule, we incorporated the effects of CAAA rules promulgated through September 2005.[11] As such, we did not account for the impacts of rules promulgated after that date, such as the revised NAAQS for lead. Additionally, we modeled reductions from rules that have since been vacated, like the Clean Air Mercury Rule (CAMR) and the Clean Air Interstate Rule (CAIR), though CAIR has since been remanded. Rather than attempting to estimate the impacts of whatever rules might replace CAMR and CAIR, we modeled the rules as promulgated because that was the best information available when we made analytic commitments.

A full list of the CAAA programs modeled for each source category is presented in Table 2-4, together with the pollutants targeted by each program. For each source category, we identified factors to use in modeling the effect of emission controls required by the CAAA. For EGUs, onroad motor vehicles, and nonroad engines/vehicles, we used control factors included in the three EPA models we used to estimate base year emissions: IPM, MOBILE, and NONROAD, respectively. For non-EGU industrial point sources and area sources, we relied on control factors developed by the five Regional Planning Organizations funded by EPA to address regional air pollution issues, as well as factors developed by the California Air Resources Board.

[11] One exception is the Coke Ovens Residual Risk rulemaking, promulgated under Title III of the Act in March 2005. We omitted this rule because it has a very small impact on criteria pollutant emissions (less than 10 tons per year VOCs) relative to the *with-CAAA* scenario. The primary Maximum Achievable Control Technology (MACT) rule for coke oven emissions, however, involves much larger reductions and therefore is included in the *with-CAAA* scenario. In addition, we also modeled emissions reductions from local controls implemented to comply with the 8-hour Ozone NAAQS, the $PM_{2.5}$ NAAQS, and the Clean Air Visibility Rule, using the proposed or promulgated forms of these rules as of January 2008.

TABLE 2-4. MAJOR CAAA PROGRAMS MODELED IN THE *WITH-CAAA* SCENARIO

SECTOR	POLLUTANT	CAAA PROGRAMS
Electricity Generating Units (EGUs)	NO_x/SO_2	Title IV acid rain emission allowance program; Clean Air Interstate Rule (CAIR); Clean Air Mercury Rule (CAMR); Cases and Settlements; Additional measures to meet PM and ozone NAAQS;
	NO_x	NOx SIP Call post-2000
Non-EGU Industrial Point Sources	$NO_x/VOC/SO_2$	Measures required to meet PM and ozone National Ambient Air Quality Standards (NAAQS)
	NO_x	Ozone Transport Commission (OTC) small NOx source model rule (where adopted); NOx SIP Call
	VOC	2-, 4-, 7-, and 10-year maximum achievable control technology (MACT) standards;
Onroad Motor Vehicles	$NO_x/VOC/SO_2$	Tier 1 tailpipe standards (Title II); Tier 2 tailpipe standards;
	NO_x/VOC	National and California low-emission vehicle (LEV) program (Title I); Federal and California reformulated gasoline for ozone NAAQS NAAs (Title I); I/M programs for ozone and CO NAAQS NAAs (Title I); NOx and VOC measures included in ozone NAAQS SIPs
	PM/SO_2	Heavy-duty diesel vehicle (HDDV) standards; Diesel fuel sulfur content limits (Title II) (1993); Gasoline fuel sulfur limits; Additional measures to meet new PM NAAQS
Nonroad Engines/ Vehicles	$NO_x/VOC/PM$	Federal Phase I and II compression ignition (CI) and spark-ignition (S-I) engine standards; Federal commercial and recreational marine vessel standards
	NO_x/PM	Federal locomotive standards
	$NO_x/PM/SO_2$	Nonroad Diesel Rule
Area Sources	$NO_x/VOC/PM$	RACT requirements; NOx and VOC measures included in ozone SIPs; Additional measures to meet PM and ozone NAAQS
	NO_x/VOC	Ozone Transport Commission (OTC) model rules (where adopted)
	VOC	2-, 4-, 7-, and 10-year MACT Standards; Federal VOC rules for architectural and industrial maintenance (AIM) coatings, autobody refinishing, and consumer products
Note: See Hubbell et al. (2010) for additional information regarding rules and regulations attributed to the 1990 CAAA.		

EMISSIONS ESTIMATION RESULTS

Table 2-5 summarizes the national emission estimates by pollutant for each of the scenario years evaluated in this study: 2000, 2010, and 2020. As a reference, the table also presents total emissions for each pollutant in 1990. Figures 2-1 through 2-4 provide a detailed breakdown of the emissions reductions in each target year by source category for NO_x, VOC, SO_2, and primary $PM_{2.5}$. We show the breakdown of emissions reductions by source category for these pollutants because they constitute (or are precursors of) the two main air quality impacts that drive the analysis of the benefits of the CAAA: ozone and particulate matter pollution. The table and figures also incorporate our estimates of emissions reductions from local controls required to meet attainment requirements for 8-hour ozone and $PM_{2.5}$ national ambient air quality standards (NAAQS). Reductions needed for compliance, but for which we have not identified a specific pollutant reducing measure or sector to achieve the reduction, are incorporated in Table 2-5 and are presented as a separate category in Figures 2-1 through 2-4, labeled "unidentified measures."

For five of the pollutants examined—NO_x, SO_2, PM_{10}, $PM_{2.5}$, and NH_3—we estimate that emissions in the absence of the amendments would increase steadily from 1990 through 2000, 2010, and 2020, suggesting that emissions controls in place by 1990 would not be sufficient to prevent increases in pollutant emissions due to projected growth in economic activity. For the remaining two pollutants—VOC and CO—emissions decrease between 1990 and 2000 as a result of automobile tailpipe controls enacted prior to 1990, but which have delayed effects through the 1990s, before increasing from 2000 onward.

In the *with-CAAA* scenario, we estimate that emissions of SO_2 and NO_x will decrease steadily from 1990 to 2020, while emissions of VOC, CO, PM_{10}, and $PM_{2.5}$ will decrease from 1990 to 2010 before leveling off between 2010 and 2020. We also estimate that emissions of NH_3 will increase even in the presence of CAAA regulations, though at a slightly slower pace than in the *without-CAAA* scenario. NH_3 is not a specific target of CAAA regulations, but some reductions result from efforts to control other pollutants. The net result of these trends in the two scenarios is that we estimate that emissions reductions, relative to the *without-CAAA* scenario, will increase for all pollutants throughout the 2000 to 2020 period.

As Figure 2-1 shows, we estimate that reductions in NO_x emissions will increase substantially from 2000 to 2010 and from 2010 to 2020. All five major source categories contribute to these reductions in 2010 and 2020, though the largest reductions come from EGUs and on-road motor vehicles. Reductions in NO_x emissions from EGUs are driven largely by cap-and-trade programs, such as Phase II of the Ozone Transport Commission memorandum of understanding and the Clean Air Interstate Rule.[12] In the motor vehicle sector, the large reductions in NO_x emissions in 2010 and 2020 reflect both the delayed

[12] Under Phase II of the OTC memorandum of understanding, eleven eastern states committed themselves to achieving regional reductions in NO_x emissions through a cap-and-trade system similar to the SO_2 trading program established under Title IV of the amendments.

impact of Tier 1 NO_x tailpipe standards as well as the impact of Tier 2 standards, which went into effect in 2004.

Figure 2-2 shows increasing VOC emissions reductions from 2000 to 2020, with contributions from all source categories, with the exception of EGUs. The figure also shows a marked increase in on-road and nonroad emissions reductions between 2000 and 2010, reflecting both the delayed impact of Tier 1 VOC standards and the effect of low-sulfur gasoline regulations. Additionally, about half of the rules affecting nonroad sources came into effect between 2000 and 2010, explaining the increase in emissions reductions during that time. Area sources also show large emissions reductions across all three target years, driven primarily by regulations controlling evaporative emissions from solvents, though residential fireplace and woodstove emissions are also projected to decline as obsolete woodstoves are replaced with low-emitting models required by the CAAA.[13]

In Figure 2-3, SO_2 emissions reductions increase by more than 60 percent between 2000 and 2010, with a smaller increase between 2010 and 2020. Most reductions in SO_2 emissions in all three target years come from EGUs, with smaller contributions from non-EGU point sources and area sources as well. As with reductions in NO_x emissions, the CAIR and the Title IV cap and trade program are partly responsible for SO_2 reductions from EGUs, along with the revised $PM_{2.5}$ NAAQS.

Figure 2-4 presents reductions in $PM_{2.5}$ emissions for the three target years, with a steady increase in reductions from 2000 through 2020, as $PM_{2.5}$ NAAQS requirements ramp up. Reductions in primary fine particulate emissions are expected to come from area sources, nonroad and onroad vehicles, and EGUs. Reductions from area sources are driven largely by the replacement of obsolete residential fireplaces and wood stoves, as well as local controls on construction sites for PM NAAQS compliance. As noted above, we set $PM_{2.5}$ emissions at non-EGU industrial point sources in the *without-CAAA* scenario to be equal to emissions in the *with-CAAA* scenario, so we do not estimate that there will be any significant direct $PM_{2.5}$ emissions reductions from that source category.

[13] As noted earlier in this chapter, the woodstove NSPS was interpreted as part of the differential between the with- and without-CAAA scenarios. NSPS compliance is required only for new units, which in practice are replaced very slowly. We estimate that, almost 20 years after NSPS implementation, in 2010, about 70 percent of the wood stoves in use are pre-NSPS uncertified models; by 2020, we estimate that turnover will reduce non-certified unit usage to just under 65 percent.

TABLE 2-5. EMISSION TOTALS AND REDUCTIONS BY POLLUTANT - ALL SECTORS (THOUSAND TONS PER YEAR)

POLLUTANT	1990	2000			2010			2020		
		WITHOUT-CAAA	*WITH-CAAA*	REDUCTION	*WITHOUT-CAAA*	*WITH-CAAA*	REDUCTION	*WITHOUT-CAAA*	*WITH-CAAA*	REDUCTION
VOC	25,790	24,477	17,798	*6,679*	26,742	14,117	*12,626*	31,288	13,704	*17,584*
NO_x	25,917	26,688	20,837	*5,851*	28,517	13,640	*14,877*	31,740	10,092	*21,647*
CO	154,513	127,093	107,691	*19,403*	134,151	86,705	*47,447*	155,970	84,637	*71,332*
SO_2	23,143	25,129	15,319	*9,810*	26,831	10,347	*16,484*	27,912	8,272	*19,640*
PM_{10}	25,454	26,418	21,143	*5,275*	26,405	20,413	*5,992*	28,280	20,577	*7,702*
$PM_{2.5}$[1]	5,527	5,822	5,489	*333*	5,924	5,241	*682*	6,368	5,297	*1,072*
NH_3	3,656	4,136	3,983	*153*	4,405	4,224	*181*	4,787	4,587	*200*

[1] $PM_{2.5}$ without-CAAA emissions were adjusted from previously reported values by reducing emissions from non-EGU industrial point sources and area sources.

FIGURE 2-1. NO_X REDUCTIONS ASSOCIATED WITH CAAA COMPLIANCE BY SOURCE CATEGORY

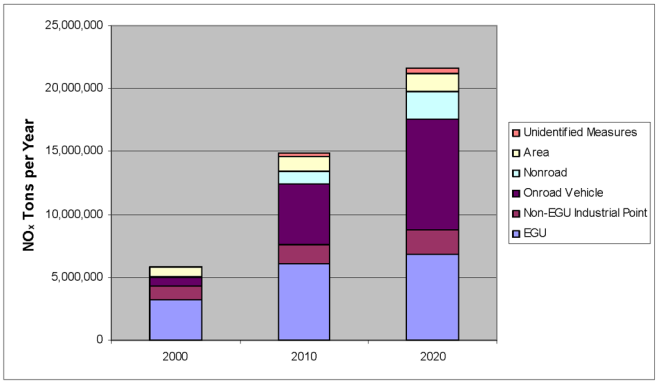


FIGURE 2-2. VOC REDUCTIONS ASSOCIATED WITH CAAA COMPLIANCE BY SOURCE CATEGORY

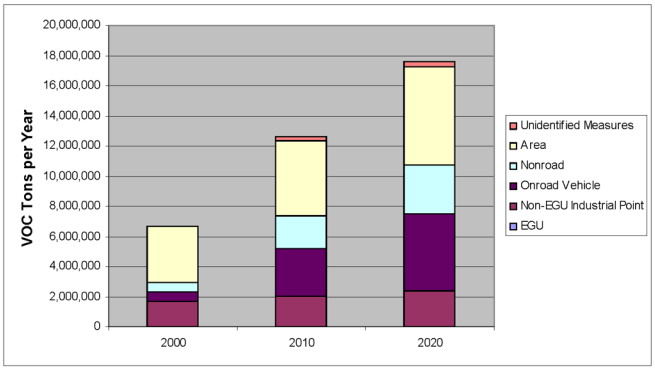


FIGURE 2-3. SO_2 REDUCTIONS ASSOCIATED WITH CAAA COMPLIANCE BY SOURCE CATEGORY

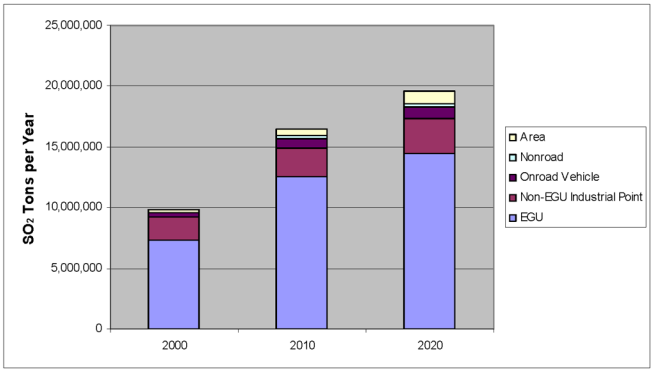
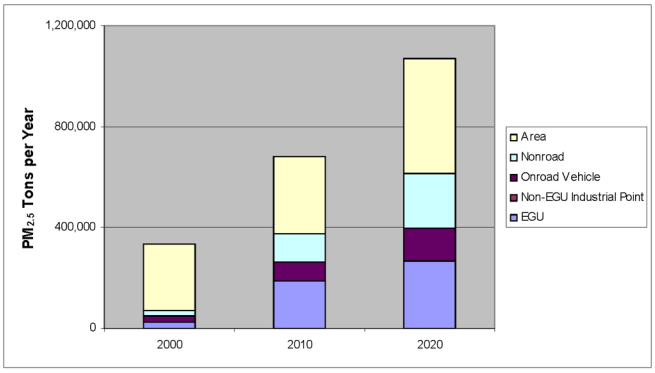


FIGURE 2-4. PRIMARY $PM_{2.5}$ REDUCTIONS ASSOCIATED WITH CAAA COMPLIANCE BY SOURCE CATEGORY



COMPARISON OF EMISSIONS ESTIMATES WITH THE FIRST PROSPECTIVE ANALYSIS

DIFFERENCES IN METHODOLOGY

In comparison with the First Prospective 812 Analysis, the Second Prospective includes a number of refinements and improvements in emissions estimation methods, as well as a different set of regulatory assumptions.

1. *Updated Emissions and Economic Activity Data*: Because the Second Prospective analysis was developed ten years after the First Prospective, it incorporates additional information that was not available when the First Prospective was developed. This information includes *with-CAAA* emissions estimates for the historical year 2000 as well as additional historical trend data used to project economic activity from 1990 to 2000.
2. *Additional Regulatory Requirements*: The Second Prospective Analysis accounts for several major CAA regulations that were not yet promulgated in 1996, when decisions were made about which regulations to include in the First Prospective. These regulations include, but are not limited to, the Clean Air Interstate Rule (CAIR); the Clean Air Visibility Rule (CAVR); Tier II vehicle rules and heavy-duty diesel vehicle rules, and the local controls required for the revised 8-hour ozone and $PM_{2.5}$ NAAQS. Because of this difference, the Second Prospective Analysis models greater emissions reductions in 2000 and 2010 than were predicted in the First Prospective, as we discuss in the following section.
3. *Integrated Economic Modeling Approach*: In the First Prospective Analysis, we relied on a number of modeling tools to project future emissions, including projections of economic activity and population growth from the Bureau of Economic Analysis, and vehicle miles traveled from EPA's MOBILE fuel consumption model. By using fully-integrated economic growth, energy demand, and fuel price projections from DOE's AEO 2005, we were able to achieve a greater degree of internal consistency in the Second Prospective Analysis.

DIFFERENCES IN EMISSIONS RESULTS

Figures 2-5 and 2-6 show estimates from the First and Second Prospective Analyses of cumulative criteria pollutant emissions and emissions reductions for 2000 and 2010, the two years that were modeled in both analyses. The figures present emissions data for the four pollutants presented in Figures 2-1 through 2-4: VOC, NO_x, SO_2, and primary $PM_{2.5}$. As Figure 2-5 shows, the Second Prospective Analysis estimates slightly higher 2000 emissions in the *without-CAAA* scenario, and slightly lower emissions in the *with-CAAA* scenario. VOC and primary $PM_{2.5}$ emissions estimates are approximately the same in both analyses, but the Second Prospective estimates reductions in combined emissions of NO_x and SO_2 of about three million tons more than in the First Prospective. As noted above, most of the difference in SO_2 emissions reductions is attributable to SO_2 controls from CAIR, but there are also substantial additional reductions attributable to reduced

fuel sulfur content regulations. The difference in NO_x emissions reductions is due primarily to differences in the onroad and nonroad engine and EGU rules included in the Second Prospective, but also to corrections made in the Second Prospective to more accurately characterize the impact of the NO_x SIP Call provisions for electric generating units.

In Figure 2-6, the difference between emissions estimates in the First and Second Prospective Analyses is much more noticeable. Although the *without-CAAA* scenario emissions estimates for VOC, NOx, and SO_2 are virtually identical for the two analyses, estimates of *with-CAAA* emissions of these pollutants are all substantially lower in the Second Prospective Analysis than in the First Prospective, yielding a difference in cumulative emissions reductions of about 15 million tons. As discussed above, the Second Prospective estimates much larger emissions reductions primarily because it accounts for a number of major control programs that were not yet in place when the last analysis was published.

FIGURE 2-5. FIRST AND SECOND PROSPECTIVE 2000 EMISSIONS AND EMISSIONS REDUCTIONS (EXCLUDING CO AND PM_{10})

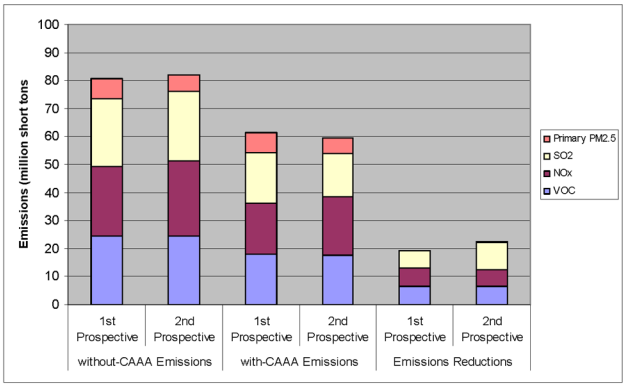
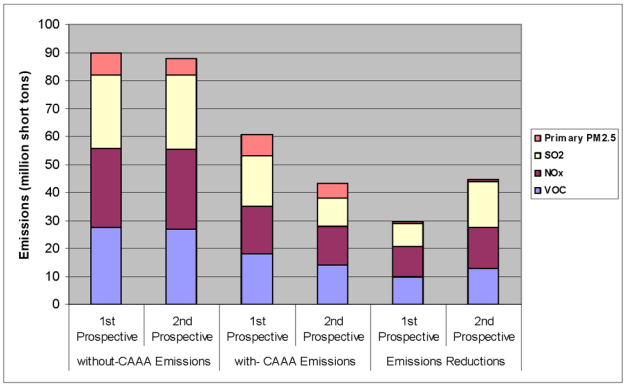


FIGURE 2-6 . FIRST AND SECOND PROSPECTIVE 2010 EMISSIONS AND EMISSIONS REDUCTIONS (EXCLUDING CO AND PM_{10})



UNCERTAINTY IN EMISSIONS ESTIMATES

Table 2-6 lists several sources of uncertainty associated with generating the emissions estimates discussed in this chapter, as well as the expected direction of bias introduced by each uncertainty (if known), and the relative significance of each uncertainty in the overall 812 benefits analysis. These uncertainty sources are organized by the three factors that drive our results: identifying base-year emissions, forecasting growth in emissions-related activity, and modeling emissions controls in future years.

UNCERTAINTIES RELATED TO BASE-YEAR EMISSIONS

We estimated emissions from onroad motor vehicles, nonroad engines, and area sources at the county level, since these source categories are generally not tied to a specific location. Accordingly, our estimates of the spatial location of these emissions are less precise than for EGUs and industrial point sources. This uncertainty affects our ability to model changes in air quality associated with emissions reductions attributed to the CAAA. However, we expect that this uncertainty has a minor impact on the overall net benefit projections of the analysis.

A potentially major factor contributing to uncertainty in emissions estimates is our specification of the *without-CAAA* scenario. The Project Team tested the influence of an alternative scenario specification by first developing a *with-CAAA* scenario using continuous CEM data available on EPA's Clean Air Markets website.[14] Working from this scenario as a base emissions estimate for each EGU, we estimated EGU data for the

[14] U.S. Environmental Protection Agency. Clean Air Markets - Data and Maps <http://camddataandmaps.epa.gov/gdm/> Accessed March 2009.

without-CAAA scenario using an alternative counterfactual approach based on work done by Dr. A. Denny Ellerman of Massachusetts Institute of Technology.[15] The *with-CAAA* results using the alternative EGU data appear very similar to the results using the IPM EGU data, but air quality difference maps indicate that overall $PM_{2.5}$ exposures are slightly lower using the CEM data for the *with-CAAA* scenario in 2000, and $PM_{2.5}$ exposures are substantially higher using the data derived using the Ellerman counterfactual method for the *without-CAAA* scenario compared to the corresponding core scenarios.

These exposure differences carry over into benefits calculations. The health benefits of the CAAA in 2000 arrived at using the alternative EGU emissions are approximately 50 percent greater than the benefits in the 2000 core scenario. For the alternative EGU emissions scenarios, the substantial, 50 percent difference in air quality outcomes and benefits results appears to be derived from our construction of a substantially different *without-CAAA* scenario. The original motivation of the analysis was concern that the spatial pattern of emissions for the *with-CAAA* scenario for 2000 predicted by an IPM run for a historical year differed from the spatial pattern observed in the emissions monitor data for the same year. The analysis illustrated that the difference in benefits results is instead due primarily to differences in the *without-CAAA* scenario among the two alternative scenario specifications. Not surprisingly, uncertainty in estimating a counterfactual scenario is much larger than uncertainty in estimating the factual case, at least for the EGU sector.

UNCERTAINTIES RELATED TO GROWTH FACTORS

When projecting future growth in economic activity, even the most thorough projection model must tolerate a high amount of uncertainty. The factors we used to model growth in this analysis reflect uncertainty both in the economic activity forecasted and in how this activity translates into emissions of criteria pollutants. For example, because the AEO 2005 economic growth projection predates the recent economic downturn, it is possible that we overestimate emissions in both the *with-CAAA* and *without-CAAA* scenarios. However, because we use the same growth factors to project emissions under the *with-CAAA* and *without-CAAA* scenarios, this source of uncertainty probably has a minor effect on our overall net benefits estimates. In addition, we considered projecting emissions under high-growth and low-growth AEO projection scenarios, but we did not find sufficient variation in our conclusions to justify such an analysis. For these reasons, we do not believe this is a significant factor in our results.

[15] Dr. A. Denny Ellerman's approach relies on multiplying a "baseline" pre-Title IV emissions rate by 2001 CEM heat input observations for each electric generating unit.

Similarly, our projected emissions from on-road motor vehicles are based on vehicle fleet compositions included in the MOBILE6.2 model. Any change in fuel prices that might cause a shift away from low-fuel-efficiency vehicles could cause us to overestimate emissions from this sector. However, we expect that the impact of this uncertainty on our estimate of net benefits is minor.

UNCERTAINTIES RELATED TO EMISSIONS CONTROL MODELING

When modeling the *with-CAAA* scenario, we incorporated the effects of rules promulgated through September 2005. Accordingly, we did not fully account for rules promulgated since that time, such as the revised NAAQS for lead, and we modeled reductions from rules that have since been vacated, like the Clean Air Mercury Rule (CAMR) and the Clean Air Interstate Rule (CAIR), though CAIR has since been remanded. We estimated that CAMR would have only a modest impact on the pollutants we examined in this analysis, since mercury controls do not have large co-control benefits with other pollutants. However, our analysis projects that CAIR would have a large impact on NO_x and SO_2 emissions at EGUs in 2010 and 2020. Ultimately, a new rule will be promulgated to replace CAIR, and the emissions reductions, compliance costs, and locations of emissions reductions could all be different from what we modeled in this analysis. As a result, it is unclear whether our analysis overestimates or underestimates the net benefits of CAAA provisions on EGU emissions.

Estimates of emissions of volatile organic compounds are also a source of uncertainty because VOCs can be emitted through fuel combustion—like SO_2 and NO_x—as well as evaporation of volatile materials. Because evaporation rates depend largely on temperature, our estimates of future VOC emissions are influenced by the inherent difficulty of predicting future temperatures. The analysis uses projections of average daily minimum and maximum temperatures in order to predict average VOC emissions, but the resulting estimates do not adequately capture the variability of such emissions. The likely significance of this uncertainty, in terms of its impact on the overall net benefits estimated in this analysis, is probably minor.

Our future-year control assumptions are also a source of uncertainty. The flexibility allowed by the CAAA in achieving air quality standard target emission levels allows for emissions control schemes that may differ significantly from the controls modeled in this analysis. This is particularly true in the case of reductions needed for NAAQS compliance for which we have not identified a specific sector target. This analysis treats those reductions as if they come from area sources, but they could come from any of the five source categories we consider. We are not able to determine the direction of any possible bias caused by this uncertainty, but we do not expect it to have a major effect on our net benefits estimate.

TABLE 2-6. KEY UNCERTAINTIES ASSOCIATED WITH EMISSIONS ESTIMATION

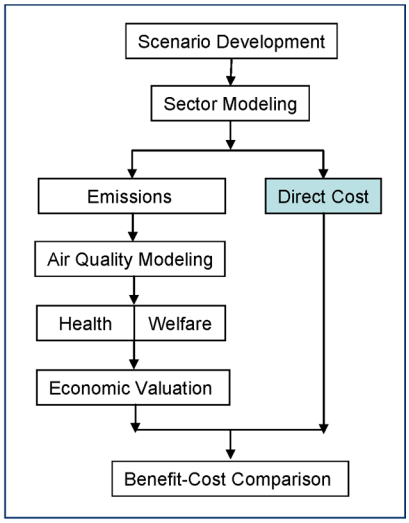
POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Uncertainties Related To Base-Year Emissions		
Uncertainties in modeling a counterfactual emissions scenario. Estimating EGU emissions using an alternate counterfactual projection approach yielded increases in air quality impacts and health benefits of 50% relative to the core scenario's IPM-generated estimates.	Underestimate. The IPM-based counterfactual generated substantially lower benefits than the alternative counterfactual scenario specification we tested, which was based on published and readily replicated methodologies. It is possible, however, that other counterfactual specifications would yield lower benefits. It is also possible that the direction of effect might be different for other pollutant source categories where this is no accepted basis to generate an alternative counterfactual scenario estimate.	Potentially major. Analysis confirmed that IPM performs well when estimating with-CAAA emissions, but also highlighted a high degree of uncertainty in estimating counterfactual emissions. Similar uncertainties exist for emissions from other emitting sectors. There is no clear way, however, to determine what approach to estimating counterfactual emissions is superior.
Uncertainties in biogenic emissions inputs increase uncertainty in the air quality modeling estimates. Uncertainties in biogenic emissions may be large (± 80%). The biogenic inputs affect the emissions-based VOC/NOx ratio and, therefore, potentially affect the response of the modeling system to emissions changes.	Unable to determine based on current information. The biogenic emissions change overall reactivity, leading to either an underestimate or overestimate of the model's response to emission reductions.	Probably minor. Impacts for ozone and $PM_{2.5}$ results. Both oxidation potential and secondary organic aerosol formation could influence $PM_{2.5}$ formation significantly. However, biogenic emissions are assumed to be unaffected by the CAAA, so this uncertainty should not significantly affect net benefits. Furthermore, ozone benefits contribute only minimally to net benefit projections in this study.
Emissions estimated at the county level (e.g., low-level source and motor vehicle NO_x and VOC emissions) are spatially and temporally allocated based on land use, population, and other surrogate indicators of emissions activity. Uncertainty and error are introduced to the extent that area source emissions are not perfectly spatially or temporally correlated with these indicators.	Unable to determine based on current information.	Probably minor. Potentially major for estimation of ozone, which depends largely on VOC and NO_x emissions; however, ozone benefits contribute only minimally to net benefit projections in this study.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Uncertainties Related To Growth Factors		
Economic growth factors used to project emissions are an indicator of future economic activity. These growth factors reflect uncertainty in economic forecasting as well as uncertainty in the link to emissions. IPM projections may be reasonable regionally but may introduce significant biases locally. Also, the Annual Energy Outlook 2005 growth factors do not reflect the recent economic downturn or the volatility in fuel prices since the fall of 2005.	Unable to determine based on current information.	Potentially major. The same set of growth factors are used to project emissions under both the *Without-CAAA* and *With-CAAA* scenarios, mitigating to some extent the potential for significant errors in estimating differences in emissions. Some specific locations may be more significantly influenced. We estimated gross benefits using AEO low-growth and high-growth scenarios and found differences of ±20%. However, due to nonlinearities in the benefits estimation model, we could not reliably determine in what direction over- or underestimating growth might bias net benefits estimates.
The on-road source emissions projections reflect MOBILE6.2 data on the composition of the vehicle fleet. If recent volatility in fuel prices persists or if fuel prices rise significantly (like they did in 2007 and 2008), the motor vehicle fleet may include more smaller, lower-emitting automobiles and fewer small trucks (e.g., SUVs).	Overestimate	Probably minor. Overall, fuel prices affect fleet composition at the margin, and we expect changes in fleet composition to occur gradually over long periods, suggesting that any effect would take several years to fully manifest.
Uncertainties Related To Emissions Control Modeling		
The *With-CAAA* scenario includes implementation of the Clean Air Mercury Rule (CAMR), which has been vacated, and Clean Air Interstate Rule (CAIR), which was vacated but has since been remanded.	Unable to determine based on current information.	Potentially major. Significance in 2020 will depend on the speed and effectiveness of implementing potential alternatives to CAIR and CAMR. In some areas, emissions reductions are expected to be overestimated, but in other areas, NO_x inhibition of ozone leads to underestimates of ozone benefits (e.g., some urban centers).
VOC emissions are dependent on evaporation, and future patterns of temperature are difficult to predict.	Underestimate. Higher temperatures in the future are more likely than lower temperatures because of climate change, and higher temperature would lead to more emissions in the *without-CAAA* case but controls would keep the *with-CAAA* emissions roughly constant.	Probably minor. The analysis uses meteorological data from 2002 to characterize temperatures during the 30-year period from 1990 to 2020. An acceleration of climate change (warming) could increase emissions but the increase relative to 2002 levels would not likely be significant.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Use of average temperatures (i.e., daily minimum and maximum) in estimating motor-vehicle emissions artificially reduces variability in VOC emissions.	Unable to determine based on current information.	Probably minor. Use of averages will overestimate emissions on some days and underestimate on other days. Effect is mitigated in *With-CAAA* scenarios because of more stringent evaporative controls that are in place by 2000 and 2010.
Uncertainties in the stringency, scope, timing, and effectiveness of *With-CAAA* controls included in projection scenarios.	Unable to determine based on current information.	Probably minor. Future controls could be more or less stringent, widely applicable, or effective than projected. Timing of emissions reductions may also be affected.
The location of the emissions reductions achieved from unidentified measures is uncertain. We currently treat these reductions as if they are achieved from non-point sources, but this may not be correct in all cases.	Unable to determine based on current information.	Probably minor. Impacts from these uncertainties would be localized and would not significantly change the overall net benefit estimate.

CHAPTER 3 - DIRECT COSTS

The costs of complying with the requirements of the Clean Air Act Amendments (CAAA) of 1990 will affect all levels of the U.S. economy. The impact, initially experienced through the direct costs imposed by regulations promulgated under the amendments, will also be seen in patterns of industrial production, research and development, capital investment, productivity, employment, and consumption. The purpose of the analysis summarized in this chapter is to estimate the incremental change in direct annual compliance costs from 1990 to 2020 that are attributable to the 1990 Clean Air Act Amendments.



As a measure of the direct expenditures associated with CAAA compliance, the estimates presented here represent a key stand-alone output of the Second Prospective Analysis. In addition, we use the direct cost estimates presented in this chapter to generated estimates of CAAA-related private costs that will serve as inputs in the computable general equilibrium (CGE) model used to estimate the net social costs of the CAAA on the economy as a whole.[16] Use of a CGE model allows us to estimate how compliance costs—along with expected benefits of the CAAA, such as increased labor supply—

[16] Private costs differ from the direct cost estimates presented in this chapter in two important ways: (1) they reflect private interest rates rather than the 5 percent social discount rate used throughout this report and (2) they reflect transfers (e.g., excise taxes on fuel) not included in our direct cost estimates.

have a net impact on social welfare through interactions with labor markets and other areas of the economy. Further discussion of the CGE modeling conducted to estimate the impacts of the CAAA on net social welfare is presented in Chapter 8.

This chapter consists of four sections. The first section summarizes our approach to estimating direct compliance costs. In the second section we present the results of the cost analysis. In the third section, we discuss how cost estimates in the Second Prospective Analysis differ from those generated for the First Prospective Analysis. We conclude the chapter with a discussion of the major analytic uncertainties, including a summary of the results of quantitative sensitivity tests of key data and assumptions.

OVERVIEW OF APPROACH

The scope of this analysis is to estimate the incremental direct costs for all criteria and hazardous air pollutant regulations issued under CAAA programs. Our approach to estimating the direct costs of CAAA compliance is closely integrated with our estimates of emissions reductions attributable to the amendments. In general, our analysis of compliance costs is driven by the results of our analysis of CAAA-related emissions reductions, and in some cases, costs and emissions reductions are measured concurrently. As with the emissions analysis presented in the previous chapter, we modeled CAAA compliance costs in 2000, 2010, and 2020 by comparing the costs of air pollution abatement in two scenarios:

- An historical "*with-CAAA*" scenario control case that reflects expected or likely future measures implemented since 1990 to comply with rules promulgated through September 2005; and
- A counterfactual "*without-CAAA*" scenario baseline case that freezes the scope and stringency of emissions controls at their 1990 levels, while allowing for changes in emissions attributable to economic and population growth.[17]

In addition, we also estimated costs separately for five major source categories: utilities, or electricity generating units (EGUs); non-EGU industrial point sources; onroad motor vehicles; nonroad engines/vehicles; and area sources. Table 2-1 gives examples of emissions sources for each of the six categories examined in this analysis. Additionally, the cost analysis considers the costs of local controls required to achieve further progress with the 8-hour Ozone NAAQS and the $PM_{2.5}$ NAAQS as a separate category. Another difference between the emissions analysis and the direct cost analysis discussed in this chapter is that, whereas the emissions analysis considered emissions of six major criteria pollutants (VOCs, NO_x, SO_2, CO, PM_{10}, and $PM_{2.5}$) and one other pollutant which is not currently regulated under the CAAA in any form (NH_3), the cost analysis addresses CAAA provisions issued to control emissions of both criteria pollutants and hazardous air pollutants (HAPs).[18]

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[17] A full list of the regulations incorporated in the *with-CAAA* scenario is presented in Table 2-3.

[18] Except to the extent they are co-controlled by VOC limits or other measures focused on criteria pollutants, reductions in emissions of hazardous air pollutants were omitted because our benefits analysis focuses on the effect of criteria

We estimated direct compliance costs in each source category using one of two approaches:

1. ***Cost Estimates Based on Unit Costs*** – Costs were estimated by collecting information on the costs associated with specific control measures required by CAAA regulations, or costs were calculated using estimates of the average cost per ton of pollutant emission reduced.
2. ***Cost Estimates Based on Optimization*** – Costs were estimated concurrently with emissions estimation through a cost minimizing algorithm that modeled attainment with specified emissions reduction targets. This approach was used for electric generating units, for example, where costs and emissions outcomes are outputs of the Integrated Planning Model.

COST ESTIMATES BASED ON UNIT COSTS

To estimate the cost of compliance CAAA regulations for most source categories, we obtained unit costs of control devices and other measures from various sources. For costs related to the 1-hour Ozone and PM_{10} National Ambient Air Quality Standards (NAAQS), we used cost data from EPA's AirControlNET database. AirControlNET links detailed data on control technologies and pollution prevention measures with EPA's National Emissions Inventory (NEI) to compute the costs associated with source- and pollutant-specific emission reductions. To calculate the cost of emissions controls on nonroad engines and vehicles, we multiplied unit cost estimates by estimates of vehicle/equipment sales and fuel consumption from the 2004 edition of EPA's NONROAD model. The NONROAD model was also used to estimate CAAA-related emissions reductions in this sector, and direct cost estimates were developed consistent with those results. For these nonroad engine and fuel rules, as well as for controls required under other parts of the CAAA, we obtained unit cost estimates from EPA's regulatory impact analyses (RIAs) as well as analyses commissioned by other organizations, such as the Ozone Transport Commission and the California Air Resources Board. Additional details on the specific data sources used to estimate unit costs for each source category are provided in the Second Prospective Cost Report.[19]

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pollutants. Benefits of HAP emissions reductions are discussed in the context of a limited case study, however, in Chapter 5 of this document. In addition, no CAAA emissions control measures are currently targeted to control NH_3 emissions, so no costs for NH_3 control are included in our overall CAAA cost estimates.

[19] See the report, Direct Cost Estimates for the Clean Air Act Second Section 812 Prospective Analysis. Available at www.epa.gov/oar/sect812.

COST ESTIMATES BASED ON OPTIMIZATION

We estimated control costs for EGUs using EPA's Integrated Planning Model (IPM), which determines the utility sector's least-cost strategy for meeting energy and peak demand requirements over a specified period of time, accounting for CAAA-mandated emissions caps. In the process of estimating the SO_2 and NO_x emissions that we discussed in the previous chapter, IPM also produced cost estimates for NO_x, SO_2, and mercury controls at EGUs.

We also used a least-cost optimization process to estimate the costs of local controls required to achieve further progress toward and, ultimately, approximate attainment of the 8-hour Ozone NAAQS. For each designated nonattainment area, we first modeled the application of reasonably available control technology (RACT) and inspection and maintenance (I/M) programs. Then, in areas where further emission reductions were necessary, a least-cost algorithm was used to identify and apply the control measures to meet progress and attainment requirements.[20]

Table 3-1 summarizes the cost estimation methods that we used for each source category, organized by major rules within each category.

ADDITIONAL COST ESTIMATION CONSIDERATIONS

In addition to the general cost estimation methods described above, we also considered additional factors when estimating CAAA compliance costs, such as how to account for cost savings from "learning by doing," how to represent the annual costs of control measures requiring initial capital investment, and how to estimate the costs of required emissions reductions for which control measures have not yet been identified.

Learning – A significant body of literature suggests that the per unit cost of producing or using a given technology declines as experience with that technology increases over time.[21] The mechanism through which these reductions occur is not well understood, as decreases in costs may reflect several different effects, including returns to research and development, productivity spillovers from outside an industry, economies of scale, or efficiency improvements associated with increased experience with a given technology (i.e., learning-curve impacts). Given the multitude of factors that may lead to cost reductions over time, it is unclear whether such reductions should be modeled as learning-curve effects or as some other form of technological change. Nordhaus (2008) suggests that it is difficult to distinguish learning-curve effects from exogenous

[20] For PM NAAQS compliance, an optimization approach was not possible, because target emissions reductions were not available for each non-attainment area. Instead, we developed a model SIP for all PM nonattainment areas, and estimated costs for those measures in the model SIP for each nonattainment area.

[21] These studies include John M. Dutton and Annie Thomas, "Treating Progress Functions as a Managerial Opportunity," Academy of Management Review, 1984, Vol. 9, No. 2, 235-247; Dennis Epple, Linda Argote, and Rukmini Devadas, "Organizational Learning Curves: A Method for Investigating Intra-plant Transfer of Knowledge Acquired Through Learning by Doing," Organizational Science, Vol. 2, No. 1, February 1991; International Energy Agency, Experience Curves for Energy Technology Policy, 2000; and Paul L. Joskow and Nancy L. Rose, "The Effects of Technological Change, Experience, and Environmental Regulation on the Construction Cost of Coal-Burning Generating Units," RAND Journal of Economics, Vol. 16, Issue 1, 1-27, 1985.

technological change and that learning effects, as estimated separately from technological change, will typically be overestimated. Nevertheless, the most detailed peer-reviewed empirical studies examining these cost reductions quantify a "learning rate" for different technologies and industries that represents the percentage reduction in costs associated with each doubling in the cumulative production of a technology. Based on the strength of the evidence in this literature, we incorporated the concept of the learning effect into our assessment of CAAA costs.

TABLE 3-1. COST ESTIMATION METHODS BY SOURCE CATEGORY AND RULE (WHERE APPLICABLE)

SOURCE CATEGORY	COST ESTIMATION METHOD
EGUs	IPM Least-cost optimization
Non-EGU Industrial Point Sources	
Ozone Transport Commission State Model Rules (NO_x/VOC):	Ozone Transport Commission -sponsored 2001 analysis AirControlNET
NO_x SIP Call:	EPA cost estimates (from 1987-1998)
MACT Rules:	AirControlNET
Refinery Cases & Settlements:	
1-hour Ozone NAAQS:	Cost/ton from 1st Prospective
Federal Rules (RACT, Control Technique Guidelines, National VOC Rules):	AirControlNET Least Cost Module SIP control cost estimates;
Additional Measures:	
PM_{10} SIP Measures:	AirControlNET
Onroad Engines and Fuels	
Title I NAAQS Tailpipe & Evaporative Control Standards:	EPA RIA unit costs
California and National LEV:	California Air Resources Board (CARB) unit cost estimates
Fuels:	Unit costs from First Prospective Analysis, EPA RIAs, CARB (for California standards)
I/M Programs:	Costs based on information from current I/M programs
Nonroad Engines and Fuels	EPA RIA Unit Costs applied to sales and fuel consumption data provided by the NONROAD model, consistent with growth projections used to estimate emissions
Area Sources	
Ozone Transport Commission State Model Rules (NO_x/VOC):	Ozone Transport Commission-sponsored 2001 analysis
1-hour Ozone NAAQS:	
RACT & Control Technique Guidelines:	Cost/ton from 1st Prospective
Additional Measures:	AirControlNET
Local Controls	
8-hour Ozone NAAQS:	
RACT & I/M:	AirControlNET
Additional (Identified) Measures:	AirControlNET using a least-cost algorithm
Unidentified Measures:	Assumed $15,000/ton
$PM_{2.5}$ NAAQS:	Model SIP approach with AirControlNET unit costs
Note: Unit costs taken from earlier EPA analyses are inflated to 2006$ and adjusted to account for cost savings from learning curve impacts. Some cost estimates for onroad and nonroad engines and fuel also reflect costs and/or savings from changes in fuel economy. These costs and savings are estimated using AEO 2005 fuel price projections.	

Where possible, we based our learning curve adjustments on learning rates presented in the empirical literature. For some sectors, however, empirical estimates of learning rates were not available. We identified learning rate estimates for SO_2 and NO_x control technologies in the EGU sector and in the onroad vehicle sector, where we used learning rates for vehicle production to estimate the impact of learning on motor vehicle engine controls. For other technologies and industries affected by the amendments, we applied a default learning rate of 10 percent, consistent with the recommendation of the Council that advised EPA on this study.[22,23]

Cost Accounting – The costs presented in this analysis are expressed as total annualized costs (TAC) in 2000, 2010, and 2020. Annualized costs include both operation and maintenance (O&M) costs and, for CAAA provisions that require investment in pollution control equipment, capital investment costs. In order to make appropriate comparisons of costs in 2000, 2010, and 2020, we annualized these investment costs over the expected life of the control equipment, rather than assigning total capital investment costs to the year in which the investment is expected to be made. We applied a discount rate of five percent to annualize capital costs over an estimated equipment life.[24] These annualized capital costs, combined with the annual O&M costs for a given pollution control measure, make up the total annualized cost estimates that we present for the three target years. Because some control measures require more capital investment than others, the degree to which our discount rate assumption affects our cost estimates varies by source category.

For CAAA-related rules that affect fuel economy, we also incorporate fuel savings or losses into our cost estimates. Where possible, we estimate the value of these benefits or costs based on fuel price projections presented in the Energy Information Administration's *Annual Energy Outlook 2005* (AEO 2005). In addition, for rules that affect the fuel economy of an engine over a period of several years, we estimate these benefits or costs as the present value of the fuel economy impacts realized over the entire life of the engine.

Local Controls for NAAQS Compliance – When estimating the costs of compliance with the 8-Hour Ozone and $PM_{2.5}$ NAAQS, we first estimated the cost of applying known and commercially available control technologies in nonattainment areas. We limited the application of these known controls to those with an estimated cost not exceeding $15,000 per ton for PM and ozone precursors (i.e., SO_2, NO_x, and VOCs). The rationale for incorporating this threshold into the analysis is that controls more costly than $15,000

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[22] The Council recommended that we apply a default learning rate of 5 to 10 percent to sectors for which no empirical data are available. We chose 10 percent as a default learning rate because this value is more consistent with the learning rates presented in the empirical literature than the low end of the Council's recommended range.

[23] The Project Team makes no learning curve adjustments for motor vehicle inspection and maintenance programs. Because most states either run centralized inspection centers themselves or regulate the fees charged by decentralized inspection centers, it is unclear whether the learning curve impacts for I&M programs would be significant.

[24] Note that the discount rate we use to annualize capital investment costs is distinct from the discount rate used to calculate the total net present value of costs and benefits incurred through the full 1990 to 2020 study period. The net present value of costs and benefits is examined separately in Chapter 7 where we compare total costs to total benefits.

per ton may not be cost effective. Thus, local air quality agencies would seek reductions from other (unidentified) control measures. This is roughly consistent with the practice of the South Coast Air Quality Management District (SCAQMD 2006) in California, which attempts to identify viable alternatives for any control requirements with an estimated cost exceeding $16,500 per ton. When costs are above this threshold, the SCAQMD also conducts more detailed cost-effectiveness and economic impact analyses of the controls.

For areas projected to remain in nonattainment with the 8-Hour Ozone NAAQS with identified controls, we estimated the costs associated with reducing emissions using additional controls not yet identified. To estimate the cost of these unidentified controls, we assumed that the cost of implementing these measures is $15,000 per ton of pollutant reduced, consistent with the cost threshold for identified controls.

DIRECT COMPLIANCE COST RESULTS

In this section we summarize the compliance cost analysis results by source category. As noted above, the control measures included in this analysis are consistent with our assumptions in the emissions analysis and reflect any post-1990 regulations promulgated (or reasonably anticipated, such as controls to meet RFP requirements) after passage of the 1990 CAAA. In general, the emissions analysis and this cost analysis reflect all of the regulations that were promulgated before September 2005. Similar to the emissions projection analysis, regulations promulgated after September 2005 (e.g., the revised Lead NAAQS) are not reflected in this report, in an effort to make the costs and benefits analyses as consistent as possible.

Table 3-2 summarizes the estimated costs of the CAAA by sector for the three analysis years: 2000, 2010 and 2020. The table shows that the direct compliance costs in 2000 are estimated to be approximately $20 billion and that these costs are dominated by the costs of motor vehicle-related provisions of the CAAA as well as MACT standards and electric utility controls. The major components of motor vehicle-related control costs in 2000 are for emission standards, fuel standards, and vehicle emission inspection programs in nonattainment areas. Motor vehicle emissions standard costs in 2000 are primarily for low emission vehicle programs, Tier 1 tailpipe standards, and on-board diagnostics. Prominent motor vehicle fuel control programs in 2000 include Federal and California reformulated gasoline. These two reformulated gasoline programs are focused primarily in serious, severe and extreme 1-hour ozone NAAQS nonattainment areas.

Table 3-2 shows that the estimated costs of complying with 1990 CAAA provisions are expected to more than double between 2000 and 2010 as areas develop and implement 8-hour ozone and $PM_{2.5}$ NAAQS State Implementation Plans (SIPs). One of the major components of CAAA compliance costs in 2010 is the estimated cost to achieve sufficient reductions of ozone precursor emissions to demonstrate 8-hour ozone NAAQS attainment. As noted above, we estimated 8-hour ozone compliance costs in two phases: first, we estimated the cost of applying known and commercially available control technologies in nonattainment areas; second, we estimated the costs associated with additional emissions reductions required to reach NAAQS attainment using controls not

yet identified, at an assumed cost of $15,000 per ton. There is considerable uncertainty in this element of the cost analysis because it is unclear how individual areas will approach this issue. Because of the significant degree of uncertainty associated with estimating the costs of unidentified controls, this component of the cost analysis is reported separately in Table 3-2.

TABLE 3-2. SUMMARY OF 1990 CAAA COMPLIANCE COSTS BY SECTOR

SOURCE CATEGORY	ANNUAL COST (MILLION 2006$)		
	2000	2010	2020
Electric Utilities	**$1,370**	**$6,640**	**$10,400**
Non-EGU Industrial Point Sources	**$3,130**	**$5,190**	**$5,140**
NO_x SIP Call	$0	$134	$133
MACT	$1,500	$3,010	$2,920
National VOC Rules, RACT, and New CTGs	$439	$464	$534
Refinery Settlements	$0	$295	$324
1-Hour Ozone SIP Measures	$1,030	$1,130	$1,090
PM_{10} SIP Measures	$163	$152	$146
Onroad Vehicles and Fuels	**$14,400**	**$25,700**	**$28,300**
Motor Vehicle Emission Standards	$4,400	$7,650	$7,760
California and National LEV	$562	$2,030	$2,090
Fuels	$4,820	$9,830	$11,200
Motor Vehicle I/M programs	$4,630	$6,250	$7,260
Nonroad Vehicles and Fuels	**$298**	**$359**	**$1,150**
Nonroad Engines/Vehicle Standards	$298	$219	$320
Fuels	$0	$140	$831
Area Sources	**$663**	**$693**	**$766**
RACT and New CTGs	$446	$442	$490
Ozone Transport Commission Model Rules	$134	$181	$212
1-Hour Ozone NAAQS	$82	$70	$64
Local Controls	**$0**	**$5,260**	**$6,180**
8-Hour Ozone NAAQS	$0	$4,270	$4,390
$PM_{2.5}$ NAAQS	$0	$977	$687
Clean Air Visibility Rule	$0	$0	$1,100
Sub-Total Excluding Unidentified Measures	**$19,900**	**$43,900**	**$52,000**
Additional Estimated Costs for Unidentified Controls for 8-Hour Ozone Compliance			
Non-California areas		$8,700	$8,500
California areas		$318	$5,030
TOTAL	**$19,900**	**$53,000**	**$65,500**

Note: All values are rounded to no more than three significant digits.

The growth in costs between 2000 and 2020 partially reflects population growth during this period and the corresponding increase in emissions-generating activity (e.g., increased vehicle miles traveled). Normalized for population growth, annual costs increase from approximately $70 per capita in 2000 to $170 per capita in 2010 and $190 per capita in 2020. These results suggest that annual costs per capita grow by approximately 170 percent between 2000 and 2020, whereas annual costs (not normalized for population) grow by approximately 230 percent during this period.

COMPARISON OF COST ESTIMATES WITH THE FIRST PROSPECTIVE ANALYSIS

In many areas, cost estimation methods in the Second Prospective Analysis were identical to those in the First Prospective, even to the point of using the same unit costs (adjusted for inflation). In general, the Second Prospective improves on the First Prospective by using more current cost estimates (where available) and more advanced least-cost optimization tools. In addition, a major methodological innovation included in the Second Prospective is the adjustment of compliance costs to account for the learning curve effects of increased experience with pollution control measures.

Figure 3-1 shows the estimated compliance costs in 2000 and 2010 from the First and Second Prospective Analyses, organized by source category. Overall, the year 2000 cost estimate presented in Table 3-2 is considerably lower than the corresponding cost estimate in the First Prospective ($27.6 billion), while the 2010 cost estimate presented in Table 3-2 is higher than the corresponding First Prospective estimate ($37.8 billion). Costs for electric utilities and area sources are significantly lower than were estimated in the First Prospective. The significant difference for utilities likely reflects differences in assumptions about the cost of obtaining low-sulfur coal from the Powder River Basin (PRB) in Wyoming. Although the Project Team was aware of the downward trend in PRB coal costs when the First Prospective was completed, this effect was not fully addressed in the data and models available at the time of the First Prospective study.

It is useful to note that the Second Prospective's $1.37 billion estimate for EGU compliance cost in 2000, which represent the pre-CAIR Title IV program requirements, fits well within the range of costs estimated in a series of *ex-post* econometric studies of compliance cost, which yield results of costs in 2000 of $1 to $1.4 billion.[25] In addition, the National Acid Precipitation Assessment Program's (NAPAP) 2005 assessment of the Clean Air Act Title IV requirements provides another basis for evaluating the reasonableness of the EGU cost estimates presented in this report (NSTC 2005). The 2005 NAPAP assessment summarizes the findings of several economic studies that estimated the cost of fully implementing the Title IV SO_2 provisions. According to

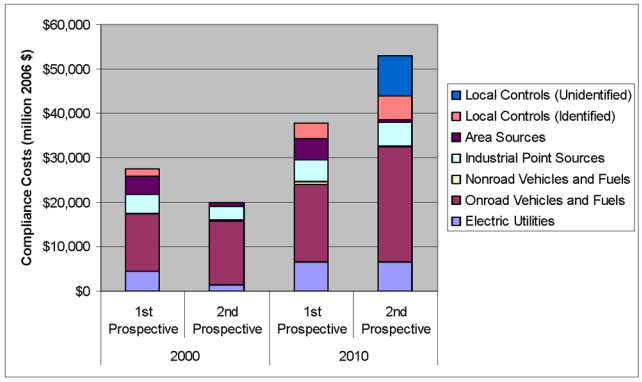
[25] See, for example, A Denny Ellerman, 2003, "Ex Post Evaluation of Tradable Permits: The U.S. SO2 Cap-and-Trade Program," MIT Center for Energy and Environmental Policy Research Working Paper number WP-2003-003, available at: web.mit.edu/ceepr/www/publications/workingpapers_2000_2004.html#2003. Ellerman cites two papers for these estimates: Curtis P. Carlson, Dallas Burtraw, Maureen Cropper, and Karen Palmer, (2000) "SO2 Control by Electric Utilities: What are the Gains from Trade?" Journal of Political Economy, 108 (6):1292-1326; and A. Denny Ellerman, Paul L. Joskow, Richard Schmalensee, Juan-Pablo Montero, and Elizabeth Bailey (2000). Markets for Clean Air: The U.S. Acid Rain Program. Cambridge University Press.

NAPAP, these studies estimate annual costs ranging from $1.2 billion to $2.3 billion for full implementation in 2010, but these estimates exclude the cost of CAIR, CAMR, and some other regulations that are part of the Second Prospective estimate for 2010.[26]

Overall, the Second Prospective cost estimates for 2010 are higher than those estimated for the First Prospective mainly because many federal motor vehicle control programs not included in the First Prospective study *with-CAAA* scenario have been promulgated since the First Prospective was completed. For the same reason, the Second Prospective cost estimates are also higher for motor vehicles in 2000, though to a lesser degree. In addition, cost estimates in the current analysis are higher than in the First Prospective because they include the costs of meeting the 8 hour ozone, $PM_{2.5}$ NAAQS and Clean Air Visibility Rule requirements in 2010. In both 2000 and 2010, estimated costs at area sources are higher in the First Prospective than in the Second Prospective, by roughly a factor of three, even though estimated emissions reductions are roughly a factor of three greater in the Second Prospective. This difference is due primarily to a much lower estimated cost per ton to reduce $PM_{2.5}$ emissions in the Second Prospective – on average, cost per ton of $PM_{2.5}$ reduced is approximately $2,000 in the Second Prospective, and was almost $20,000 in the First Prospective. One reason for the reduction is that the controls in the Second Prospective are better targeted at fine particulate control - controls in the First Prospective were actually focused on sources of PM_{10}, with $PM_{2.5}$ emissions reductions as a co-benefit. In addition, we have learned that pre-2002 NEI emissions estimates for $PM_{2.5}$ were very uncertain, suggesting that perhaps the estimated $PM_{2.5}$ emissions reductions in the First Prospective were understated.

[26] The NAPAP assessment cites a range of $1 billion to $2 billion, in year 2000 dollars. Adjusting for inflation using the GDP deflator, this range increases to $1.2 billion to $2.3 billion in year 2006 dollars.

FIGURE 3-1. FIRST AND SECOND PROSPECTIVE ANNUAL CAAA COMPLIANCE COSTS: 2000 AND 2010



First Prospective cost estimates from U.S. EPA, The Benefits and Costs of the Clean air Act 1990 to 2010, EPA-410-R-99-001, November 1999.

UNCERTAINTY IN DIRECT COST ESTIMATES

In a broad analysis of prospective regulatory impacts it is not possible to verify the accuracy of the full range of assumptions regarding changes in consumption patterns, input costs, and technological innovation used to estimate costs in future scenarios. Moreover, for many of the factors contributing to uncertainty, the degree or even direction of the bias is unknown or cannot be determined. Nevertheless, uncertainties and/or sensitivities can be identified and in many cases the potential measurement errors can be quantitatively characterized. In this section of the chapter, we first discuss several quantitative sensitivity analyses undertaken to characterize the impact of key assumptions on the ultimate cost analysis. The quantitative analyses presented below were chosen either because the parameter in question was a topic of discussion in the Council's review of the direct cost analysis or because we identified the parameter as potentially influential and/or uncertain. We then conclude the chapter with a qualitative discussion of the impact of both quantified and unquantified sources of uncertainty.

QUANTITATIVE SENSITIVITY TESTS

We performed four quantitative sensitivity tests to estimate the impact of alternate assumptions on our overall cost estimates. These tests covered our assumptions regarding the cost of unidentified controls, the composition of motor vehicle sales and fleet fuel efficiency, the failure rate of I/M tests, and the default learning rate applied to

sectors for which we could not identify a rate in the empirical literature. The results of these sensitivity tests on our 2020 cost estimates are presented in Table 3-3.[27]

Local Controls Analysis – Unidentified Controls

As indicated above, when estimating the cost of local controls required for further progress with the 8-hour Ozone and $PM_{2.5}$ NAAQS, we used a cost cap of $15,000 per ton to estimate the costs of identified local controls and also applied a cost of $15,000 per ton to unidentified controls. To assess the sensitivity of the local controls analysis to changes in these values, we estimated the costs of local controls based on a $10,000-per-ton cost cap for identified controls and a $10,000-per-ton estimated cost for unidentified controls. As indicated in Table 3-3, this alternative approach would yield lower cost estimates for both identified local controls and unidentified measures. The estimated costs of identified controls decline when the $10,000 cap is applied because controls that cost between $10,000 and $15,000 per ton are not implemented. In addition, although the application of the $10,000 cost cap increases the emissions reductions to be achieved through unidentified controls (relative to when the $15,000 cost cap is used), reducing the cost of unidentified controls to $10,000 per ton more than offsets the costs associated with these additional emissions reductions. Based on preliminary analyses conducted early in the development of the direct cost estimates, we found that in general higher thresholds do not change the emissions reductions to be achieved by unidentified controls, because few identified controls have a cost per ton higher than the $15,000 threshold used in the analysis. Accordingly, the major effect of increasing the cost cap would be to increase the estimated cost of reductions achieved by unidentified controls, whose cost is estimated based on the dollar per ton cap.

Composition of Motor Vehicle Sales and Fleet Fuel Efficiency

Our analysis of the costs associated with motor vehicle tailpipe and fuel rules is based on sales and fuel efficiency projections from the 2005 version of DOE's *Annual Energy Outlook*. Since the release of AEO 2005, however, fuel prices have been more volatile than in previous years, leading many consumers to shift to more fuel efficient vehicles, and the Department of Transportation revised the Federal Corporate Average Fuel Economy (CAFE) standards. Given these developments, AEO 2008 projects that passenger cars will make up a greater portion of light-duty vehicle sales in 2010 and 2020 than is projected by AEO 2005. AEO 2008 also assumes that the light-duty vehicle fleet will be nearly 15 percent more fuel efficient relative to the projections in AEO 2005. To assess the extent to which our cost estimates for the on-road sector would change under the alternative AEO 2008 assumptions, we estimated the cost of motor vehicle tailpipe and fuel rules for both the 2010 and 2020 target years based on the AEO 2008 data. As indicated in Table 3-3, using AEO 2008 projections increases the estimated cost of motor vehicle tailpipe standards and reduces the estimated cost of motor vehicle fuel rules in 2020. Although the alternative estimated cost of fuel rules is about 9 percent less than the

[27] We present sensitivity test results for 2020 estimates because the differences between the primary cost estimates and the alternative cost estimates discussed in this section are most pronounced in 2020.

primary estimate presented in Table 3-2, the reduction in estimated costs of both tailpipe and fuel CAAA motor vehicle programs in aggregate is more modest, at 3.6 percent.[28]

Vehicle Inspection Failure Rate

Our estimates of the repair costs associated with motor vehicle I&M programs employed program- and year-specific inspection failure rates derived from 2003 and 2004 data for Wisconsin I&M programs. In its June 2007 review of the Draft Direct Cost Report, the Council noted that a 2001 National Research Council report referenced a failure rate about one-seventh the value derived from the Wisconsin data.[29] To assess the sensitivity of the I&M cost analysis to the assumed failure rate for annual dynamometer-based programs, we developed alternative cost estimates for CAAA-mandated I&M programs based on the failure rate reported by the NRC. We found that the estimated cost of these programs declined by more than 40 percent when the alternative failure rates were used in place of those supporting the Second Prospective Cost Report. In addition, as indicated in Table 3-3, using these alternative values reduced total CAAA-related costs for the on-road sector by about 12 percent in 2020. This suggests that the cost estimates for the on-road sector are fairly sensitive to the assumed failure rate for I&M programs, in light of the range of failure rates obtained from readily available data sources.

Default Learning Rate

As discussed above, we adjusted total program costs to account for "learning curve" impacts (i.e., the extent to which the costs of a technology decline as experience with that technology increases over time). Wherever possible, we employed technology- or industry-specific learning rates obtained from the literature. Where industry-specific learning rates were not readily available in the empirical literature, we applied a default rate of 10 percent to the following technologies:

- Selective non-catalytic reduction at electric generating units (EGUs) (O&M costs only);
- Activated carbon injection at EGUs;
- Motor vehicle fuel rules;
- Non-road engine and fuel rules;
- Non-EGU point source controls;
- Area source controls; and
- Local controls: EGU, non-EGU point source, and area source.

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[28] Note that in both our central case estimates and in our sensitivity analysis for fleet composition, the same fleet composition is assumed in the *with-CAAA* and *without-CAAA* scenarios. It is likely that, as compliance costs increase, the CAAA could have a significant effect on fleet composition, but our current analysis does not address that factor.

[29] Committee on Vehicle Emission Inspection and Maintenance Programs, Board on Environmental Studies and Toxicology, Transportation Research Board, National Research Council. *Evaluating Vehicle Emissions Inspection and Maintenance Programs*. 2001.

We tested the sensitivity of the cost analysis to the choice of a default learning rate by re-estimating the total costs of the amendments using alternative default learning rates of 5 and 20 percent for the program areas listed above. The five percent default rate represents the low end of the range recommended by the Council, while the 20 percent value represents the central tendency presented in the peer-reviewed literature for several technologies.[30] For the sensitivity test, we did not adjust the cost estimates of program areas where the empirical literature supplied specific and applicable learning rates. As indicated in Table 3-3, the use of alternative default learning rates had only a small effect on the estimated costs of the amendments in 2020. Using a five percent default learning rate in 2020 increased the estimated cost of the amendments by 3.2 percent, while a 20 percent default learning rate reduced costs by six percent.

TABLE 3-3. RESULTS OF QUANTITATIVE SENSITIVITY TESTS

PROVISION	PRIMARY ANNUAL COST ESTIMATE FOR 2020 (BILLIONS 2006 $)	STRATEGY FOR SENSITIVITY ANALYSIS	ALTERNATIVE 2020 ESTIMATE FROM SENSITIVITY TEST (BILLIONS 2006 $)	PERCENT CHANGE FROM PRIMARY COST ESTIMATE
Local Controls (Identified and Unidentified)	$20.39	$10,000/ton cap on identified controls and $10,000/ton for unidentified controls	$16.79	-17.6%
Motor Vehicle Costs	$28.28	Use AEO 2008 projections of motor vehicle sales and fleet fuel efficiency	$27.25	-3.6%
Motor Vehicle Costs	$28.28	Use Inspection Failure Rates reported by the National Research Council	$24.82	-12.2%
Total Costs (All Source Categories)	$65.48	Use alternate default learning rate of 5 percent	$67.60	3.2%
Total Costs (All Source Categories)	$65.48	Use alternate default learning rate of 20 percent	$61.54	-6.0%

[30] For an analysis of the learning rates estimated in the empirical literature, see John M. Dutton and Annie Thomas, "Treating Progress Functions as a Managerial Opportunity," *Academy of Management Review*, Vol 9, No. 2, 1984.

QUALITATIVE ANALYSIS OF KEY FACTORS CONTRIBUTING TO UNCERTAINTY

In addition to the uncertainties outlined above, we identified several other areas of uncertainty related to the direct compliance costs of the amendments that we did not address quantitatively. These include the Project Team's projections of economic activity, the impact of CAAA compliance on productivity, product quality degradation resulting from the CAAA, the influence of technological innovation on CAAA compliance costs, and the impact of input substitution on the costs of complying with the amendments.

Economic Activity Projections: The cost of the amendments in 2010 and 2020 will depend in large part on the future size and composition of the U.S. economy. If the AEO 2005 economic growth projections used to estimate emissions reductions in 2010 and 2020 underestimate or overestimate economic activity, we could likewise overestimate or underestimate the costs of CAAA compliance. In addition, the particular composition of economic output in 2010 and 2020 may deviate from the AEO 2005 projections, which would also cause our cost projections to differ from the actual costs of the amendments.

Industrial Productivity: As stated in the introduction to this chapter, our cost estimates represent the direct costs of the CAAA, i.e., the expected expenditures of regulated facilities to comply with the amendments. Several peer-reviewed studies have suggested, however, that the direct costs of pollution control measures do not adequately represent the total costs of environmental protection, due to the effects of pollution abatement on industrial productivity.[31] Although our cost estimates do not capture these productivity effects, the literature is not clear on the magnitude and direction of these effects. While some studies have found that pollution control negatively affects productivity, others have found that the productivity impact is positive or ambiguous.[32]

Effects of the CAAA on Product Quality: In addition to increasing the cost of producing goods and services, CAAA requirements may also affect product quality. For example, motor vehicle emission control requirements may reduce the performance of automobiles, and changes in paint formulations (to reduce VOC emissions) may adversely affect how well paint adheres to unfinished surfaces. On the other hand, changes in product quality may also have unquantified benefits – while we capture the fuel saving benefits of many motor vehicle engine changes, the benefits of low-VOC paint in improving indoor air quality and human health are not captured in our estimates. As a result, product quality

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[31] Barbera, A.J. and McConnell, V.D. (1986) "Effects of Pollution Control on Industry Productivity: A Factor Demand Approach." *The Journal of Industrial Economics*. Vol. XXXV, 161-172.

Barbera, A.J. and McConnell, V.D. (1990) "The Impact of Environmental Regulations on Industry Productivity: Direct and Indirect Effects." *Journal of Environmental Economics and Management*. Vol. 18, 50-65.

Gray, W.B. and Shadbegian, R.J. (1994) "Pollution Abatement Costs, Regulation, and Plant-Level Productivity." Center for Economic Studies.

Morgenstern, R.D., Pizer, W.A., and Shih, J-S. (2001) "The Cost of Environmental Protection." *Review of Economics and Statistics* Vol. 83, No. 4, 732-738. (doi:10.1162/003465301753237812).

[32] Barbera and McConnell (1986) found a negative impact of pollution control on productivity, while Barbera and McConnell (1990) and Gray and Shadbegian (1994) found an ambiguous impact, and Morgenstern et al. (1998) found a positive impact.

effects may reduce the welfare of households that consume products affected by the CAAA, or they may improve welfare. Households that substitute to other products due to CAAA-related quality changes (e.g., households that substitute from automobiles to light-duty trucks due to CAAA requirements that affect the performance of automobiles more than light-duty trucks) may also experience welfare losses or gains, as they would have otherwise preferred the product(s) that they would have consumed in the absence of the CAAA but may, in the balance, experience previously unrecognized gains.

Technological Innovation: The CAAA could serve as in impetus for technological innovation in the development of new, low-cost technologies or processes to reduce emissions. As indicated above, our cost estimates reflect the impact of experience-driven improvements in the productivity of existing control technologies—by accounting for learning curve impacts—but not the impact of technological innovation. Because we did not attempt to model technological innovation that might be spurred by incentives to minimize compliance costs, the Second Prospective Analysis may overestimate costs.

Input Substitution: To minimize the cost of complying with the amendments, regulated facilities may alter the mix of inputs used in the production of goods and services. With the exception of fuel switching by EGUs (as part of compliance with the Title IV Acid Rain Program and CAIR), we did not capture input substitution as a control strategy in the Second Prospective Cost Report. Ignoring the possible impact of input substitution could also cause our estimates to overstate CAAA compliance costs.

Table 3-4 lists the key sources of uncertainty noted in the quantitative and qualitative discussions above and indicates—where possible—the expected impact of the uncertainty on the net benefits estimate of the Second Prospective Analysis.

TABLE 3-4. KEY UNCERTAINTIES ASSOCIATED WITH COST ESTIMATION

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE[1]
Uncertainty in the maximum per ton costs for local controls to comply with the 8-hour Ozone and $PM_{2.5}$ NAAQS.	Unable to determine based on current information	Probably minor. Our analysis of local controls assumes a maximum cost of $15,000 per ton for local controls implemented to comply with 8-hour Ozone and $PM_{2.5}$ NAAQS requirements.[5] Local areas may implement more costly controls to comply with the NAAQS, but technological innovation may lead to the development of less expensive controls.
Uncertainty in the projected composition of motor vehicle sales and the fuel efficiency of the motor vehicle fleet.	Unable to determine based on current information	Probably minor. We projected the composition of motor vehicle sales and the fuel efficiency of the motor vehicle fleet based on AEO 2005 data. The sensitivity analysis of alternative sales and fuel efficiency projections presented in this report suggests that this uncertainty has a small impact on net benefits.
Uncertainty regarding failure rates for motor vehicle inspections.	Unable to determine based on current information	Probably minor. The repair costs for vehicles that fail emission inspections represent a small fraction of the estimated net benefits of the amendments. The failure rate sensitivity analysis presented in this report suggests that alternative failure rate assumptions could have a large effect on the costs for this component of the CAAA, but only a minor effect on the estimated net benefits of the amendments as a whole.
Costs for some technologies and emissions sectors reflect default assumptions about the rates at which learning affects costs because empirical information is unavailable.	Underestimate	Probably minor. Based on the advice of the Council on Clean Air Compliance Analysis, we used a conservative learning rate of 10 percent for those sectors where no empirical data were available.[2] In contrast, the learning curve literature suggests that the average learning rate is approximately 20 percent, suggesting that learning will reduce costs more than is reflected in the present analysis.[3]
Uncertainties in the economic growth projections that form the basis of the cost analysis.	Unable to determine based on current information	Probably minor. The project team used AEO 2005 economic growth projections, which suggest that the economy will grow at an annual rate of 3.1 percent through 2025.[4] This growth rate is in line with historical GDP growth.
Incomplete characterization of certain indirect costs, such as productivity impacts for regulated industry.	Unable to determine based on current information	Probably minor. The literature on the productivity impacts of the CAAA is unclear with respect to the direction and magnitude of these effects.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE[1]
Product quality degradation associated with emission control technology.	Unable to determine based on current information	Unable to determine based on current information. Conceptually, the potential for CAAA requirements to affect product quality could result in an underestimate or overestimate of the welfare effects of compliance costs, and therefore an indeterminate effect on net benefits. Unfortunately, few studies exist that address the potential product quality effects of CAAA regulations.
Exclusion of the impact of technological innovation and input substitution on compliance costs.	Underestimate	Probably minor. Minimal information is available on the potential effects of technological innovation on costs. Though input substitution is a potential source of cost savings, the analysis primarily models mature industries and compliance strategies which have been established as least-cost compliance paths. In addition, many regulations, such as RACT, are technology-based and may not allow for much input substitution.
Partial estimation of costs for compliance with the $PM_{2.5}$ NAAQS, due to the unavailability of emission reduction targets for non-attainment areas.	Overestimate	Probably minor. The 2006 $PM_{2.5}$ NAAQS RIA estimates that the incremental costs of residual non-attainment (i.e., costs of additional reductions from unidentified controls needed to reach attainment) are approximately $4.3 billion in 2020, yielding total cost estimates that exceed the estimates presented here by a factor of five or more.[6] However, we estimate that the costs of the $PM_{2.5}$ NAAQS represent less than 5 percent of the net benefits of the amendments.[7]
Uncertainty in the emission reduction estimates used to estimate the costs for select rules.	Unable to determine based on current information	Probably minor. Costs for many rules are not dependent on the corresponding emissions reductions (e.g., fuel sulfur limits, tailpipe standards, etc.)
Exclusion of the impact of economic incentive provisions, including banking, trading, and emissions averaging provisions.	Underestimate	Probably minor. Economic incentive provisions can substantially reduce costs, but the major economic programs for trading of sulfur and nitrogen dioxide emissions are reflected in the analysis.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE[1]
Potential for overestimation biases in engineering cost estimates.	Underestimate	Probably minor. A study by Harrington, Morgenstern, and Nelson (1999) evaluated the accuracy of EPA and OSHA estimates of 25 *ex ante* regulatory cost estimates relative to *ex post* studies of actual costs, and concluded that initial cost estimates by EPA tend to overstate costs. The source of these biases include a built-in conservative bias, inaccuracies in estimating the size of the affected universe, the effect of learning on reducing costs, the effect of innovation on reducing costs, and cost-reducing features of regulatory design. Some of these factors are discussed elsewhere in this table. The magnitude of these biases varies substantially, but in no case would we expect the overall impact to exceed five percent of overall net benefits.

[1] The classification of each potential source of error reflects the best judgment of the section 812 Project Team. The Project Team assigns a classification of "potentially major" if a plausible alternative assumption or approach could influence the overall monetary benefit estimate by approximately five percent or more; if an alternative assumption or approach is likely to change the total benefit estimate by less than five percent, the Project Team assigns a classification of "probably minor."

[2] U.S. Environmental Protection Agency Science Advisory Board, EPA-SAB-COUNCIL-ADV-07-002, "Benefits and Costs of Clean Air Act - Direct Costs and Uncertainty Analysis", Advisory Letter, June 8, 2007. Available at http://www.epa.gov/sab/pdf/council-07-002.pdf.

[3] For an analysis of the learning rates estimated in the empirical literature, see John M. Dutton and Annie Thomas, "Treating Progress Functions as a Managerial Opportunity," *Academy of Management Review*, Vol 9, No. 2, 1984.

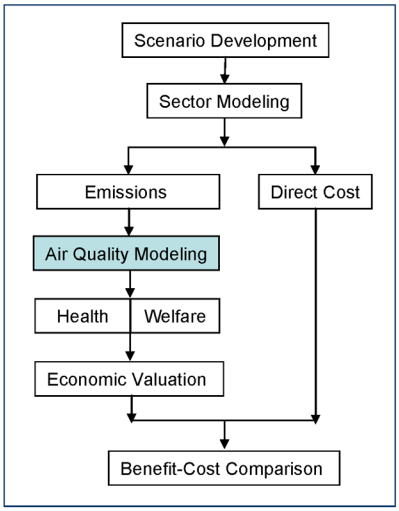
[4] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2005*, February 2005.

[5] The Project Team uses this maximum unit cost value in two ways. First, the Project Team assumes that local areas would not implement identified controls costing more than $15,000 per ton. Second, the Project Team assumes a cost of $15,000 per ton for unidentified controls.

[6] U.S. Environmental Protection Agency. *Regulatory Impact Analysis for the Particulate Matter NAAQS*. October, 2006.

[7] For detailed estimates of the costs of $PM_{2.5}$ NAAQS compliance, see E.H. Pechan and Associates, Inc. and Industrial Economics, Inc., *Direct Cost Estimates for the Clean Air Act Second Section 812 Prospective Analysis*, prepared for U.S. EPA, March 2009.

CHAPTER 4 - AIR QUALITY BENEFITS



Air quality modeling links changes in emissions to changes in the atmospheric concentrations of pollutants that may affect human health and the environment. A crucial analytical step, air quality modeling is one of the more complex and resource-intensive components of the prospective analysis. This chapter outlines how we estimated future-year pollutant concentrations under both the *with-CAAA* and *without-CAAA* scenarios.

The first section of the chapter begins with a discussion of some of the challenges faced by air quality modelers and a brief description of the models we used in this analysis. The following section provides more details on the specific air quality modeling tools we deployed to estimate future-year ambient concentrations. This methodology section includes a description of how we use modeling results to adjust monitor concentration data and estimate ambient concentrations for years and scenarios where no monitoring yet exists – the projected and counterfactual (*without-CAAA*) target years and scenarios. The third section of this chapter summarizes the results of the air quality modeling and presents the expected effects of the CAAA on future-year pollutant concentrations. A brief discussion of the key uncertainties associated with air quality modeling concludes the chapter.

OVERVIEW OF APPROACH

As we outlined in the First Prospective, air quality modelers face two key challenges in attempting to translate emission inventories into pollutant concentrations. First, they must model the dispersion and transport of pollutants through the atmosphere. Second, they must model pertinent atmospheric chemistry and other pollutant transformation processes. These challenges are particularly acute for those pollutants that are not emitted directly, but instead form through secondary processes. Ozone is the best

example; it forms in the atmosphere through a series of complex, non-linear chemical interactions of precursor pollutants, particularly certain classes of volatile organic compounds (VOCs) and nitrogen oxides (NO_x). We faced similar challenges when estimating PM concentrations. Atmospheric transformation of gaseous sulfur dioxide and nitrogen oxides to particulate sulfates and nitrates, respectively, contributes significantly to ambient concentrations of fine particulate matter. In addition to recognizing the complex atmospheric chemistry relevant for some pollutants, air quality modelers also must deal with uncertainties associated with variable meteorology and the spatial and temporal distribution of emissions.

Air quality modelers and researchers have responded to the need for scientifically valid and reliable estimates of air quality changes by developing sophisticated atmospheric dispersion and transformation models. Some of these models have been employed in support of the development of federal clean air programs, national assessment studies, State Implementation Plans (SIPs), and individual air toxic source risk assessments. In this analysis, we focused our air quality modeling efforts on estimating the impact of with- and without-CAAA emissions on ambient concentrations of ozone, PM_{10}, and $PM_{2.5}$, as well as acid deposition and visibility for each of the target years: 2000, 2010, and 2020. The focus on these pollutants is consistent with the result in the First Prospective that most of the quantified benefits of the CAAA are attributable to PM and ozone. The ideal model for this analysis is a single integrated air quality model capable of estimating ambient concentrations for all of these key pollutants throughout the U.S. In the prior First Prospective study, such a model had not yet been sufficiently developed and tested. This analysis is the first Section 812 prospective analysis to use an integrated modeling system, the Community Multiscale Air Quality (CMAQ) model, to simulate national and regional-scale pollutant concentrations and deposition. The CMAQ model (Byun and Ching, 1999) is a state-of-the-science, regional air quality modeling system that is designed to simulate the physical and chemical processes that govern the formation, transport, and deposition of gaseous and particulate species in the atmosphere.

The emissions data were processed for input to the CMAQ modeling using the Sparse-Matrix Operator Kernel Emissions (SMOKE) emissions processing system (CEP, 2004). The model-ready emission inventories for each scenario and year were then used to obtain base year and target year estimates of the key criteria pollutants, as well as many other species. The air quality modeling analysis was designed to make use of tools and databases that have recently been developed and evaluated by EPA for other national- and regional-scale air quality modeling studies. In particular, model-ready meteorological input files for 2002 were provided by EPA for use in this study. For fine particulate matter ($PM_{2.5}$) and related species, the CMAQ model was applied for an annual simulation period (January through December). A 36-km resolution modeling domain that encompasses the contiguous 48 states was used for the annual modeling. For ozone and related species, the CMAQ model was applied for a five-month simulation period that captures the key ozone-season months of May through September. Two 12-km resolution modeling domains (that when combined cover the key, ozone-significant areas of the contiguous 48 U.S. states) were used for the ozone-season modeling. Altogether,

model-ready emission inventories were prepared and the CMAQ model was applied for a total of 21 simulations (comprising seven core scenarios and three modeling domains).

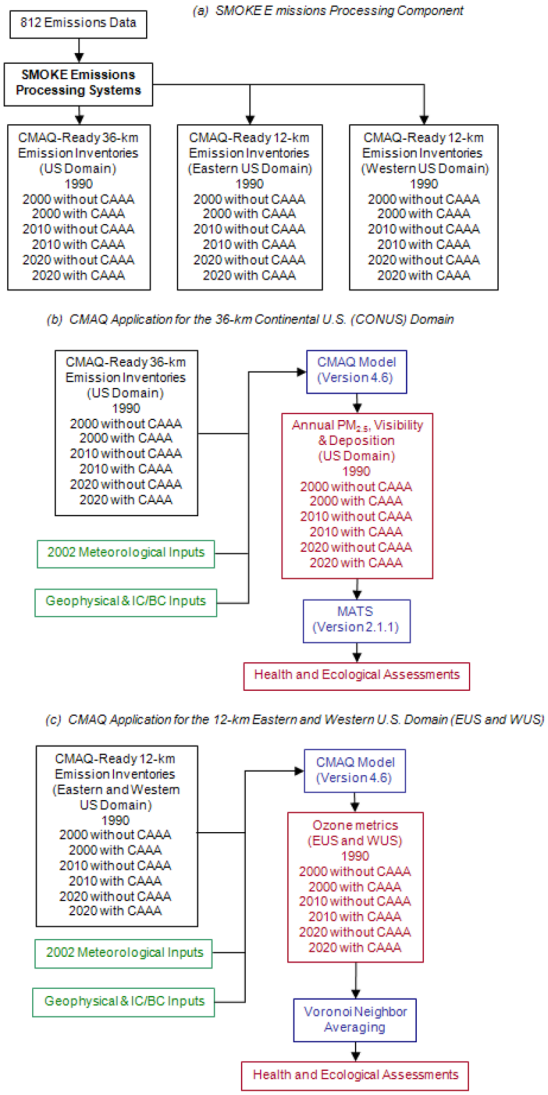
The outputs from the CMAQ model provide the basis for the calculation of health and ecological benefits of the CAA. The airborne criteria pollutants of interest include ozone and fine particulate matter ($PM_{2.5}$), where $PM_{2.5}$ consists of particles less than 2.5 microns in diameter. For health benefits analysis, it has become standard EPA practice to calibrate the CMAQ results monitor data, rather than use the CMAQ results directly – the process is sometimes called, "monitor and model relative adjustment." We follow that approach in this analysis as well, applying a tool called the Modeled Attainment Test Software (MATS) to develop and apply the calibration factors for particulate matter results relative to nearby monitors. For ozone, the MATS procedure is not necessary; instead we use an inverse distance squared weighting procedure called Enhanced Voronoi Neighbor Averaging (eVNA), which calibrates the CMAQ model ozone results by weighing data from monitors closer to the grid cell more heavily than monitors that are further away. The eVNA interpolation and model to monitor calibration process is accomplished within the BenMAP benefits analysis tool, which is described in Chapter 5. Visibility is also an air quality parameter of interest and this was calculated using a variety of the CMAQ output species. In addition, deposition of nitrogen and sulfur was also extracted from the model outputs. An overview of the modeling approach is provided in Figure 4-1, which summarizes the emissions processing and air quality components. The CMAQ modeling components and application of the MATS tool are explained in further detail in the next section.

AIR QUALITY MODELING TOOLS DEPLOYED

THE CMAQ MODELING SYSTEM

The Community Multiscale Air Quality (CMAQ) model is a state-of-the-science, regional air quality modeling system that can be used to simulate the physical and chemical processes that govern the formation, transport, and deposition of gaseous and particulate species in the atmosphere (Byun and Ching, 1999). The CMAQ tool was designed to improve the understanding of air quality issues (including the physical and chemical processes that influence air quality) and to support the development of effective emissions control strategies on both the regional and local scale. The CMAQ model was designed as a "one-atmosphere" model and this concept refers to the ability of the model to dynamically simulate ozone, particulate matter, and other species in a single simulation which captures interaction effects among these pollutants. In addition to addressing a variety of pollutants, CMAQ can be applied to a variety of regions with varying geographical, land-use and emissions characteristics, and for a range of different space and time scales.

FIGURE 4-1. SCHEMATIC DIAGRAM OF SECTION 812 AIR QUALITY MODELING ANALYSIS



The CMAQ model numerically simulates the physical processes that determine the magnitude, temporal variation and spatial distribution of the concentrations of ozone and particulate species in the atmosphere and the amount, timing, and distribution of their deposition to the earth's surface. The simulation processes include advection, dispersion (or turbulent mixing), chemical transformation, cloud processes, and wet and dry deposition. The CMAQ science algorithms are described in detail in Byun and Ching (1999).

The CMAQ model requires several different types of input files. Gridded, hourly emission inventories characterize the release of anthropogenic, biogenic and, in some cases, geogenic emissions from sources within the modeling domain. The emissions represent both low-level and elevated sources and a variety of source categories (including, for example, point, onroad mobile, nonroad mobile, area, and biogenic emissions). The amount, spatial distribution, and temporal distribution of each emitted pollutant or precursor species are key determinants to the resultant simulated air quality values.

The CMAQ model also requires hourly, gridded input fields of several meteorological parameters including wind, temperature, mixing ratio, pressure, solar radiation, fractional cloud cover, cloud depth, and precipitation. A full list of the meteorological input parameters is given in Byun and Ching (1999). The meteorological input fields are typically prepared using a data-assimilating prognostic meteorological model, the output of which is processed for input to the CMAQ model using the Meteorology-Chemistry Interface Processor (MCIP). The prescribed meteorological conditions influence the transport, vertical mixing, and resulting distribution of the simulated pollutant concentrations. Particular meteorological parameters, such as mixing ratio, can also influence the simulated chemical reaction rates. Rainfall and near-surface meteorological characteristics govern the wet and dry deposition, respectively, of the simulated atmospheric constituents.

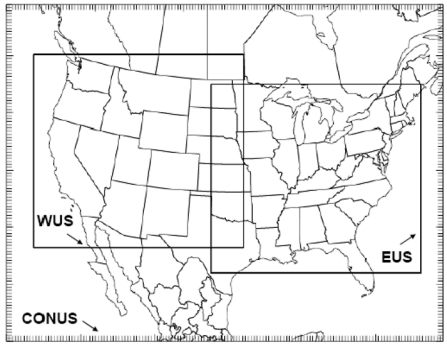
Initial and boundary conditions (IC/BC) files provide information on pollutant concentrations throughout the domain for the first hour of the first day of the simulation, and along the lateral and top boundaries of the domain for each hour of the simulation. Photolysis rates and other chemistry related input files supply information needed by the gas-phase and particulate chemistry algorithms.[33]

[33] The latest available version of CMAQ, version 4.6, was used for this study. This version of the model supports several different gas-phase chemical mechanism, particle treatment, aerosol deposition, and cloud treatment options. All simulations conducted as part of this study used the CB05 chemical mechanism. For particles, the AERO4 particle treatment, which includes sea salt, was applied. Finally, the plume-in-grid feature of CMAQ was not used for this study. More details are available in *Second Prospective Analysis of Air Quality in the U.S.: Air Quality Modeling*, available at www.epa.gov/oar/sect812

CMAQ APPLICATION PROCEDURES FOR THE SECOND PROSPECTIVE ANALYSIS

This specific application of CMAQ includes modeling domain specification and key input files. The three modeling domains that were used for this analysis are shown in Figure 4-2.

FIGURE 4-2. CMAQ MODELING DOMAINS FOR THE 812 MODELING STUDY



NOTE: CONUS IS THE CONTINENTAL US GRID USED FOR PM MODELING; WUS IS THE WESTERN US GRID AND EUS IS THE EASTERN US GRID USED FOR OZONE MODELING.

The 36-km resolution continental U.S. (CONUS) domain is the large area that is covered by the outer grid box in Figure 4-2. The CONUS domain includes 148 x 112 grid cells (the total number of cells is 16,576). The tick marks denote the 36-km grid cells. For this domain, the model was run for the entire 2002 calendar year, using 2002 meteorology but varying the emissions inputs as outlined in each of the Second Prospective scenarios listed in Figure 4-1. In running the model, the annual simulation period was divided into two parts covering January through June and July through December, respectively. Each part of the simulation also includes an additional five start-up simulation days, which are intended to reduce the influence of uncertainties in the initial conditions on the simulation results.

The Eastern U.S. (EUS) domain is comprised of 213 x 188 grid cells (total = 40,044 cells) and the Western U.S. (WUS) domain includes 213 by 192 grid cells (total = 40,896 cells). Together these two domains cover most of the continental U.S. with 12-km horizontal resolution. There is some overlap in the central part of the country. For both the EUS and WUS domains, the CMAQ model was run for the months of May through September. This five-month period is intended to represent the ozone season – runs using this domain provide the ozone inputs for subsequent steps of the analysis. The seasonal simulation period was also divided into two parts covering May and June and July

through September, respectively. Each part of the simulation also includes an additional ten start-up simulation days.

The 36- and 12-km resolution meteorological input files to support modeling in these domains were prepared using the Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Fifth Generation Mesoscale Model (MM5). The MM5 outputs were postprocessed by EPA for input to CMAQ using the Meteorology-Chemistry Interface Processor (MCIP) program. The meteorological input preparation methodology and some information on MM5 model performance are provided by Dolwick et al. (2007). Existing initial condition, boundary condition, land-use and photolysis rate input files prepared by EPA for use in CMAQ modeling for the selected modeling domains and simulation period were used.

After the initial CMAQ results were generated, the original primary PM emissions estimates generated for area and non-EGU point sources were found to be inaccurate due to two issues:

1) As described in Chapter 2, some of the fine particulate emissions estimates derived from the 1990 NEI, on which the *without-CAAA* emissions estimates were based, were discovered to be inconsistent with those from the 2002 NEI, on which the *with-CAAA* emissions estimates were based.

2) The original emissions estimates did not include application of transport factors for area source fine particulate emissions. These transport factors are county-specific adjustment factors that are applied to specific types of emissions estimates to account for the fact that only a fraction of total fugitive dust emissions remain airborne and are available for transport away from the vicinity of the source after localized removal (i.e., some of the particles are captured by the local vegetation or other surface obstructions).

To correct these two errors, we first made the necessary adjustments to the primary PM2.5 emissions estimates for the affected non-EGU point and area sources, focusing on the PM2.5 species that contribute most significantly to primary PM emissions: elemental carbon (EC), organic carbon (OC), and crustal material. We then calculated species-specific adjustment factors for the CMAQ data, re-compiled the species-specific estimates to generate an adjusted version of the original CMAQ results, and then generated new MATS input files. All details of the procedure are described in a memorandum prepared by the Project Team, which was reviewed in detail by the Council's Air Quality Modeling Subcommittee.[34]

[34] Memorandum of June 14, 2010 to Jim DeMocker, EPA, from Tyra Walsh, Henry Roman, and Jim Neumann, Industrial Economics, Inc. (IEc), "Description of the Adjustment to the Primary Particulate Matter Emissions Estimates and the Modeled Attainment Test Software Analysis (MATS) Procedure for the 812 Second Prospective Analysis." The memo is available at www.epa.gov/oar/sect812.

MATS PROCEDURE

Rather than using the direct CMAQ results as the basis for the health and ecological effects analyses, the Project Team conducted additional analyses using a speciated monitor and model calibration technique to generate $PM_{2.5}$ air quality estimates. The $PM_{2.5}$ estimates used in the Second Prospective health analysis were prepared using EPA's Modeled Attainment Test Software (MATS, Version 2.1.1, Build 807). MATS estimates quarterly mean $PM_{2.5}$ chemical component concentrations at monitor locations by conducting a Speciated Modeled Attainment Test (SMAT) analysis. MATS can also estimate quarterly mean concentration estimates for each $PM_{2.5}$ chemical component concentrations at all grid cells in a grid model such as CMAQ.

Five of the six MATS $PM_{2.5}$ concentration estimates for the Second Prospective scenarios were prepared using the MATS' spatial and temporal relative adjustment method. The MATS estimates for the 2000 *with-CAAA* scenario, which represents a historical year for which monitor data are available, used a spatial only relative adjustment method, relying on available monitor data and a single year of CMAQ modeling. The MATS procedure was not applied for the 1990 base year scenario.

MATS estimates the $PM_{2.5}$ concentrations in CMAQ grid cells by interpolating values from nearby monitors using the inverse distance squared weighting option in the Voronoi Neighbor Averaging (VNA) procedure in MATS. This is an algorithm that identifies a set of monitors close to the grid cell (called "neighbors") and then estimates the PM species concentration in that grid cell by calculating an inverse-distance weighted average of the monitor values (i.e., the concentration values at monitors closer to the grid cell are weighted more heavily than monitors that are further away). As noted above, for calibrating ozone model results to nearby monitors, only the VNA component of the procedure is used, because there is no need for the speciated interpolation approach required for PM.

The spatial MATS analysis conducted for the $PM_{2.5}$ estimates used the following input information:

- observed quarterly $PM_{2.5}$ data from 1,232 Federal Reference Method (FRM) monitors with sufficient data in 2002 – sufficient data is defined as at least one quarter of $PM_{2.5}$ data. The year 2002 was used because it corresponds to the vintage of the emissions estimates, which, as described in Chapter 2, were derived from the 2002 National Emissions Inventory;
- observed daily chemically speciated fine particle mass data from both the $PM_{2.5}$ Speciation Trends Network (STN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network, providing a total of 273 monitors with sufficient data in 2002[35];

[35] Most FRM monitors (about 75 percent) are not co-located with a speciation monitor. Therefore, we also used data providing speciated PM mass from the STN and IMPROVE monitors. The MATS analysis used speciated data from 273 STN or IMPROVE monitors with at least two valid quarters of speciated data in 2002.

- speciated CMAQ estimates for 6 $PM_{2.5}$ species (SO_4, NO_3, elemental carbon, organic carbon, NH_4, and crustal material) at the 36 kilometer $PM_{2.5}$ CMAQ grid cell level for each of the Second Prospective scenarios (from CMAQ speciated output data files).

The MATS procedure enables the use of monitor data to effectively calibrate the results of air quality modeling for use in subsequent steps of the analysis. To illustrate the effects of the MATS procedure, compare Figure 4-3, which is a scatter plot comparing the direct CMAQ results for those 1,058 $PM_{2.5}$ monitors with at least two quarters of data for 2002, and Figure 4-4, which is a similar scatter plot, comparing the MATS results to the same set of $PM_{2.5}$ monitors. The agreement between monitor and model values in Figure 4-4 is greatly improved by the MATS procedure.

FIGURE 4-3. SCATTER PLOT OF DIRECT CMAQ ESTIMATES AND 2002 $PM_{2.5}$ FEDERAL REFERENCE METHOD (FRM) MONITORS

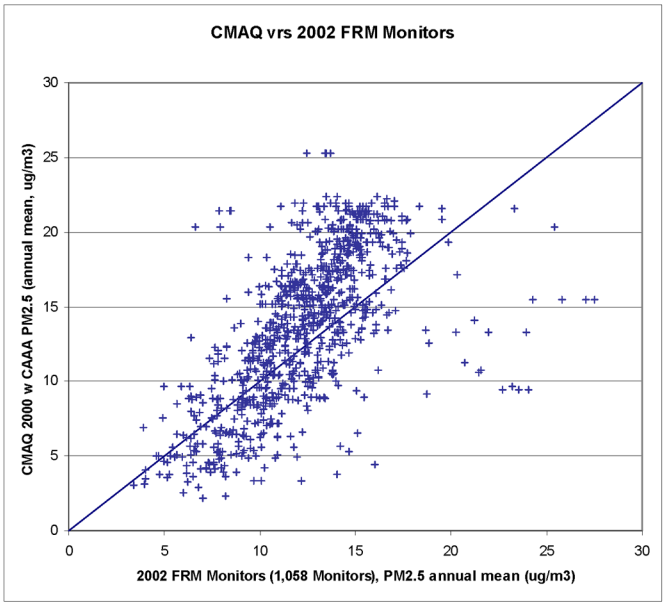
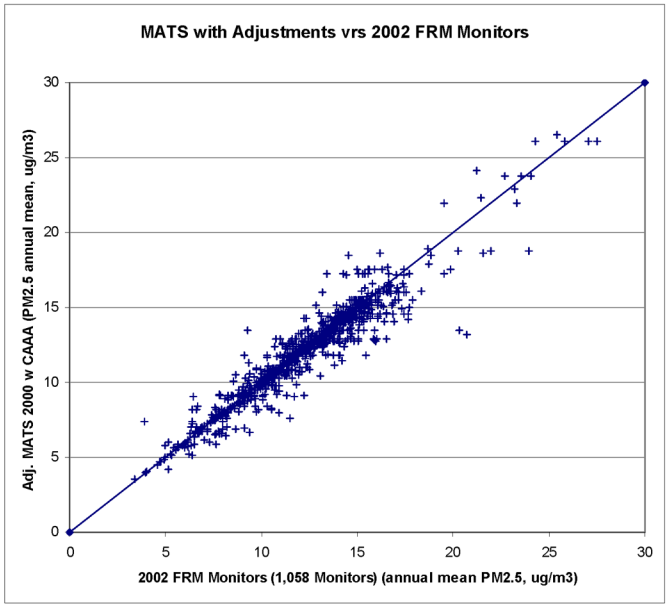


Figure 4-5 provides a further illustration of the effect of the MATS procedure, and the importance of individual PM species in achieving an effective calibration of the CMAQ results to monitor data. The figure provides detailed species-specific CMAQ and MATS results for a CMAQ grid cell in the three largest cities and metropolitan areas in the US – New York, Los Angeles, and Chicago – and for Tucson, Arizona, a much smaller city but

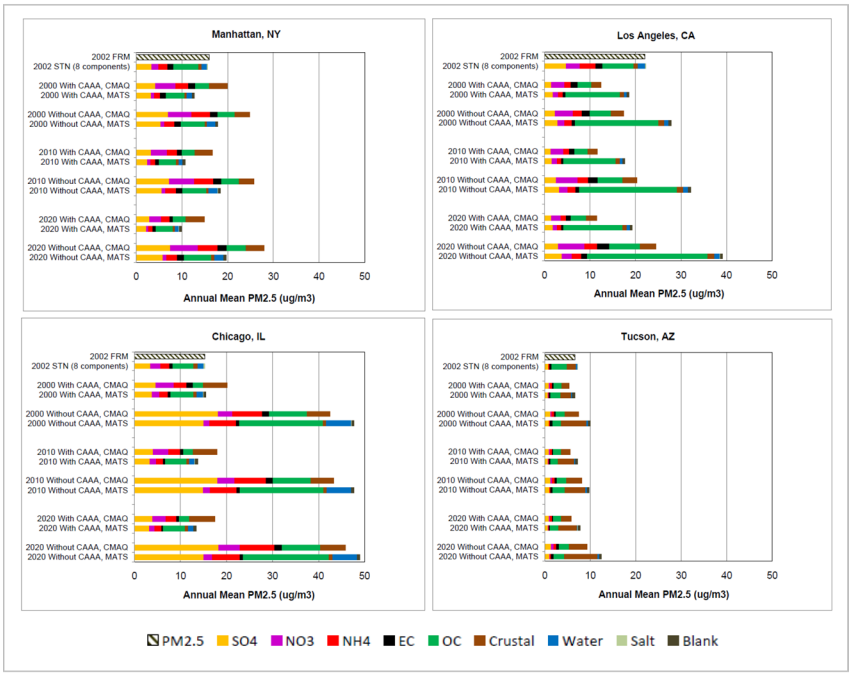
one for which one component of PM, crustal (shown in brown), plays a critical role in our analysis. For each city, the two leftmost bars provide the 2002 FRM and STN annual average $PM_{2.5}$ monitor data for a monitor of that type within the grid cell. FRM monitors provide only total $PM_{2.5}$ mass, while the STN monitors provide data for the seven PM species (plus estimated water) indicated at the bottom of each graph.[36] The remaining 12 bars in each panel show the CMAQ and MATS-adjusted results for the grid cell for the *with-CAAA* and *without-CAAA* scenarios, for target years 2000, 2010, and 2020.

FIGURE 4-4 SCATTER PLOT OF MATS-ADJUSTED CMAQ ESTIMATES AND 2002 $PM_{2.5}$ FEDERAL REFERENCE METHOD (FRM) MONITORS



[36] The STN bar charts include an estimated water component, which the MATS input monitor files include to make STN and IMPROVE monitor data consistent with FRM monitor data. The water component is not an STN component, but was estimated using the SANDWICH (Sulfates, Adjusted Nitrates, Derived Water, Inferred Carbonaceous mass, and estimated aerosol acidity (H+)) process.

FIGURE 4-5. COMPARISON OF CMAQ, MATS, AND MONITOR DATA FOR FOUR SELECTED CITIES



The Manhattan panel in the upper left corner shows that both the FRM and STN monitors indicate a total PM concentration just greater than 15 μg/m^3. The next bar shows that the CMAQ data for the 2000 *with-CAAA* simulation overestimates the PM concentration, by about 4 μg/m^3. Comparing the 2002 STN bar with the 2000 *with-CAAA* CMAQ bar, we see that the CMAQ simulation overestimates most constituents in this location, compared to the monitor data, but underestimates organic matter (or OC, shown in green). The MATS procedure, applied to the STN and CMAQ data, generates species-specific scaling factors that result in a MATS-adjusted concentration for the 2000 *with-CAAA* scenario,

shown in the next bar. As a result, the species-specific constituents in the MATS adjusted bar are in very nearly the same proportion as they appear for the STN monitor.

It would also appear from this figure that MATS "overcorrects" in Manhattan because the 2000 *with-CAAA* MATS bar is lower than the 2002 STN monitor bar. However, the MATS procedure is estimating the concentration at the center of the grid cell, not at the location of the STN monitor. In a 36 km grid cell, the monitor location can be many kilometers away from the center of the grid cell. MATS considers not only monitors in the same grid cell, but also the data at other nearby FRM and STN monitors, and makes a spatial interpolation to estimate concentrations at the grid centroid. The Manhattan STN monitor is near the intersection of four grid cells, which contain a total of 25 FRM and STN monitors, all of which influence the MATS result.

The remaining MATS estimates for Manhattan, for the 2000 *without-CAAA* and the 2010 and 2020 projections, are based on scaling of the corresponding CMAQ simulation by the species-specific factors developed from the 2000 *with-CAAA* to 2002 STN monitor comparison. The effect of MATS in Manhattan is to adjust the CMAQ simulation concentrations downward. Interestingly, the opposite is generally true in Los Angeles, because in that city CMAQ tends to underestimate the monitor data for 2002. The mix of species in both cities is similar in 2002, but strikingly different over time, particularly in the *without-CAAA* scenario, where organic carbon (shown in green) in Los Angeles derives from mobile sources, and sulfates (shown in yellow) in Manhattan derives from long-range transport from coal-burning electric generating units.

In Chicago, the effect of MATS is more complex, and the importance of considering PM species is highlighted. In the *with-CAAA* scenarios, MATS yields a downward adjustment to the CMAQ simulations, because the 2000 *with-CAAA* CMAQ simulation is higher than the 2002 STN monitor value. In the *without-CAAA* scenarios, however, there are much higher *emissions* of organic carbon, because certain OC emissions controls are not in place in the *without-CAAA* simulations that are in place in the *with-CAAA* scenario. Because CMAQ underestimates the ambient OC component in the 2000 *with-CAAA* (shown in green), the factor for OC that is applied to other scenarios yields an increase in concentration in the MATS-adjusted values. That increase is large enough to dominate the overall adjustment across all eight species, yielding an overall $PM_{2.5}$ mass increase for the *without-CAAA* scenarios relative to the CMAQ data.

The data for Tucson also illustrates the importance of the species-specific scaling factors. If it were not for changes to one PM species, crustal (shown in brown), there would be only a relatively modest difference between the *with-CAAA* and *without-CAAA* scenarios in future years. In Tucson the crustal component derives largely from construction activity, which in this relatively fast growing area of Arizona, and absent more stringent dust control measures, could become a larger issue in the projection years. CAAA controls on fugitive dust emissions in the construction sector, however, yield a substantial difference in this component of PM concentrations, when comparing the *with-CAAA* and *without-CAAA* scenario results. Other species differ much less across scenarios. In many other places like Tucson, the species-specific MATS procedure likely yields a more

accurate projection of the impact of the CAAA than a calibration procedure that did not take into account the impact of these species-specific control strategies.

AIR QUALITY RESULTS

PARTICULATE MATTER

As mentioned above, the CMAQ modeling results for the 36-km continental U.S. (CONUS) modeling domain provide the basis for particulate matter air quality used in the calculation of PM-related health effects and to calculate visibility, as well as sulfur and nitrogen deposition. Summary results are presented in the maps in Figure 4-6 below, representing annual average concentrations across the CONUS domain for each of the seven scenario/target year combinations modeled. The rows of Figure 4-6 show modeled $PM_{2.5}$ concentrations for 2000, 2010, and 2020, contrasting the *without-CAAA* results on the left and the *with-CAAA* results on the right.

As the figure indicates, over the thirty-year 1990-2020 simulation period air quality is projected to worsen somewhat in the absence of CAAA regulations, particularly in the Midwest and California, but with CAAA regulations in place air quality is estimated to improve markedly as early as the year 2000 and to show continued improvements through 2020. In general, the *with-CAAA* results reflect a calibration of the 2002 model year results to monitor values, but as the accompanying Box 4-1 illustrates, such direct comparisons are not possible for the counterfactual *without-CAAA* results. We conclude for the analyses described in the text box that the *without-CAAA* results, with a few exceptions, seem to imply a return of air quality conditions comparable to those that prevailed in the 1980-1990 period prior to implementation of the CAAA. Such comparisons are limited, however, by the sparse $PM_{2.5}$ monitoring data for this period and the uncertainty in adjusting available monitor data for other species. Although the improvements attributed to the CAAA are nationwide, the most substantial gains are made in those areas that had the worst PM air quality in 1990, suggesting the CAAA has been and will continue to be effective in targeting improvements to the areas that would have experienced the worst air quality in the absence of the amendments.

BOX 4-1: EVALUATING THE *WITHOUT-CAAA* SCENARIO RESULTS

The two scenarios used in this study, the *with-CAAA* and *without-CAAA* scenarios, are designed to simulate and forecast air quality conditions in the US as we expect them to unfold with full implementation of the CAAA (the *with-CAAA*), and alternatively as if regulations authorized by the CAAA had not been implemented. In effect, the methods we use tie the *with-CAAA* scenario to monitored air quality in the year 2000, providing some measure of credibility for the air quality conditions reflected in our *with-CAAA* simulation. It is more difficult to evaluate the credibility of the *without-CAAA* scenario, because that scenario simulates hypothetical air quality conditions that cannot be observed. The plausibility of the *without-CAAA* scenario and its differences from the *with-CAAA* scenario nevertheless can be assessed through comparison to other similar air quality conditions.

One possible analog for conditions in the *without-CAAA* scenario is areas outside the US that have not implemented air quality regulations that match the stringency of those in the US. The problem with comparing US to non-US areas is the difficulty of standardizing factors which define air quality, such as meteorology, terrain, and the distribution of air pollutant emission sources. Another major challenge is that monitoring networks for fine particle species are sparse or not available for the annual average measure.

A preferable, though still imperfect, comparison is between *without-CAAA* forecasts and historical concentrations in US cities. A key issue arising for within-US comparisons is that prior to 1990 particulate matter monitors measured total suspended particulates (TSP), or PM_{10}, rather than $PM_{2.5}$. The new PM standard is based on $PM_{2.5}$, which is now recognized as better correlated with adverse health effects. $PM_{2.5}$ is therefore the focus of our air quality simulations. Furthermore, the ratios of TSP and/or PM_{10} to $PM_{2.5}$ vary considerably by location and over time, so a simple transformation of the available monitor data may not be reliable. Nonetheless, it is possible to find times and locations in the historical monitor data where at least two and sometimes all three of these measures were simultaneously collected, providing a means to estimate a time and location-specific ratio that can be used to infer $PM_{2.5}$ values. We use this type of information to develop estimates of historical $PM_{2.5}$ concentration in selected U.S. cities for comparison to our *without-CAAA* scenario projected values.

The table suggests that our estimates of *without-CAAA* $PM_{2.5}$ concentrations in New York, Pittsburgh, and Los Angeles are reasonably consistent with estimated historical concentrations in the 1980 to 1990 pre-CAAA period. In Chicago, however, the *without-CAAA* case yields estimates that are much higher than historical estimates. One reason may be the potentially strong influences of projected uncontrolled sulfur dioxide emissions from electric power plants near Chicago in the *without-CAAA* case. In the absence of Title IV these plants are projected in our study to use relatively high sulfur, locally mined coal and would not have been required to install scrubber technology.

(ANNUAL AVG MICROGRAMS PER CUBIC METER)	ESTIMATED $PM_{2.5}$ CONCENTRATIONS FOR THIS STUDY						ESTIMATED HISTORICAL $PM_{2.5}$		
	2000		2010		2020				
CITIES	W-CAAA	W/O-CAAA	W-CAAA	W/O-CAAA	W-CAAA	W/O-CAAA	1980 (EST)	1990 (EST)	MAXIMUM 1980-90
New York - Manhattan	12.9	20.6	10.9	21.0	10.0	22.1	N/A	22.4	N/A
New York - Queens/Brooklyn	13.2	24.8	11.0	25.2	10.1	26.7	N/A	21.5	N/A
Pittsburgh	14.0	19.2	11.0	19.7	10.0	20.3	29.3	22.3	29.8
Chicago	15.5	47.7	13.7	47.6	13.4	48.9	25.7	20.4	25.7
Los Angeles	18.5	25.5	17.1	29.7	17.5	35.5	38.5	29.4	41.9

FIGURE 4-6. CMAQ SIMULATED AND MATS ADJUSTED ANNUAL AVERAGE $PM_{2.5}$ SPECIES CONCENTRATION (MICROGRAMS PER CUBIC METERS) FOR THE CONUS DOMAIN OUTPUTS FOR THE 1990 TO 2020 PERIOD

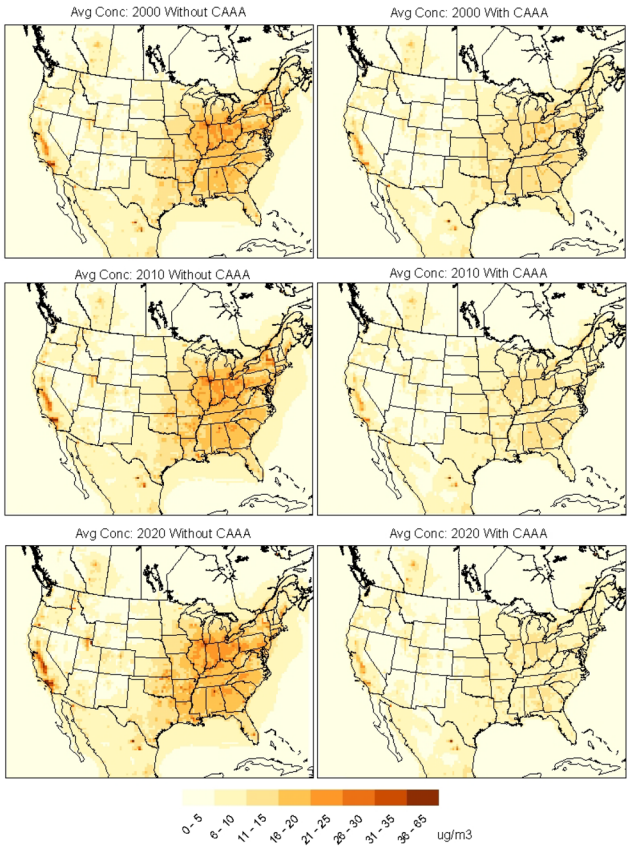
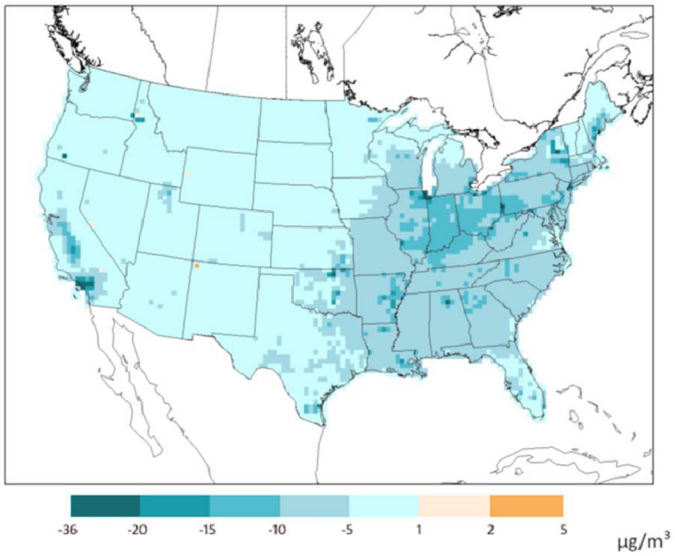


Figure 4-7 makes the gains in 2020 more clear, by illustrating the differences in $PM_{2.5}$ concentrations between the *with-CAAA* and *without-CAAA* scenarios in 2020. The gains in some areas, particularly in the eastern half of the US, in California, and in urban centers nationwide, are dramatic, with reductions of more than 20 $\mu g/m^3$ in some areas. These are consistent with the large decreases in PM precursor emissions for those areas, described in Chapter 2. In some of these areas, the *without-CAAA* scenario concentrations also reach high levels because of the absence of *without-CAAA* controls

(see accompanying text box for a discussion of the *without-CAAA* scenario). There are also some surprisingly large reductions in a few less populous areas, such as, west central Idaho and central Virginia. The reductions in Idaho, as well as in a few other isolated areas of the rural West, are associated with CAAA requirements to limit emissions from agricultural burning operations. The reductions in central Virginia are attributable to local controls on a large coal-burning industrial boiler.

FIGURE 4-7. DIFFERENCE IN CMAQ SIMULATED MATS ADJUSTED ANNUAL AVERAGE $PM_{2.5}$ SPECIES CONCENTRATION (MICROGRAMS PER CUBIC METER) FOR THE CONUS DOMAIN: 2020 WITH-CAAA MINUS 2020 WITHOUT CAAA SCENARIOS



Some areas also experience modest increases in PM concentrations with the CAAA – these areas show up in light orange on the map. Some of the smallest estimated increases, less than 1 $\mu g/m^3$, can be introduced by the MATS adjustment procedure, particularly when the locations are far from monitors and/or have very low modeled or monitored concentrations of a PM species. We interpret very small increases such as these as effectively "no change" so adjusted the map legend to group these cells with others where are small benefits.[37] There remain five cells with disbenefits greater than 1

[37] There is one area in northeastern Utah where the MATS procedure yields results for the *without-CAAA* scenario that are so large as to be not plausible. The result was associated with increases in agricultural burning in the *without-CAA* scenario,

$\mu g/m^3$. The three cells of these five with the smallest disbenefit estimates did not have disbenefits in the CMAQ modeling – we therefore conclude that the disbenefit result was introduced by the MATS procedure.

In the remaining two cells, we conclude that implementation of the CAAA led to negative benefits, associated with actual increases in emissions resulting in the with-CAAA case relative to the *without-CAAA* case. The largest disbenefit, of 4.1 $\mu g/m^3$, is in the northwestern corner of New Mexico, in the cell which includes the Four Corners Power Plant, one of the largest coal-burning power plants in the West. The emissions data indicate sulfur dioxide emissions for that plant that are 14,000 tons greater in the 2020 *with-CAAA* case, probably as a combined result of changes in dispatch and sulfur content of coal for this plant, which as of December 2010 does not have a sulfur scrubber. The other cell shows a disbenefit of 1.25 $\mu g/m^3$, and is located in Sweetwater County in south central Wyoming, which includes the Pacificorp-Jim Bridger Power Plant. The air quality result here is also attributable to a difference in sulfur dioxide emissions from a power plant, in this case 2,000 tons greater in the 2020 *with-CAAA* scenario. The dispatch of this unit appears to be identical in both scenarios, so the result is most likely attributable to a marginal reallocation of higher sulfur coal. Note that, as indicated in the *with-CAAA* maps in Figure 4-6, these are areas that nonetheless would continue to experience $PM_{2.5}$ concentrations below the 15 $\mu g/m^3$ $PM_{2.5}$ annual standard. These relatively modest and geographically limited exceptions notwithstanding, it is clear that by 2020 the air quality benefits of the CAAA in reducing ambient concentrations of particulate matter are large and widespread.

OZONE

Figures 4-8 through 4-11 present similar CMAQ output data for ozone, with two important differences: (1) the ozone results are reported for the Eastern (EUS) and Western (WUS) 12-km modeling domains; and (2) the results presented are the average of daily maximum 8-hour ozone concentration, in ppb, over the course of a modeled ozone season (May 1 through September 30). The average daily 8-hour maximum may seem like an odd metric for evaluating ozone concentrations, but because this is the metric used in epidemiological estimation of mortality risks of ozone this metric is closely correlated with the major mortality incidence and economic benefits associated with ozone precursor controls. Results for the Eastern US are in Figures 4-8 and 4-9, and for the Western US in Figures 4-10 and 4-11.

For the Eastern US, Figure 4-8 shows a similar pattern for ozone as was illustrated for particulate matter in Figure 4-6. That is, while there are relatively modest increases in

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coupled with otherwise low organic carbon monitor values in nearby monitors - the application of MATS therefore led to unusually high organic carbon and PM2.5 measures for that area. For those three cells, we performed a moving average smoothing procedure to re-estimate the without-CAAA concentrations, using PM estimates from adjoining cells. The adjustment is used only for the purposes of generating the maps in this chapter; for the purposes of health benefits modeling and valuation of benefits, we excluded these three suspect cells. The cells represent very rural, sparsely populated areas in the Wasatch Mountains, and so we believe that excluding them from the benefits calculations is both prudent and has only a modest underestimation effect on the overall health benefits estimates.

ozone concentrations in the absence of the CAAA, the *with-CAAA* maps on the right side of the graphic show significant and widespread gains in air quality throughout the region, with air quality benefits increasing over time. By 2020, Figure 4-9 shows that the difference in ozone concentrations is large in most areas of the east, with gains as large as 30 ppb for this simulated day.

Two other patterns in Figure 4-9 are also worth noting. First, although the region-wide benefits of the CAAA are large, in many urban areas concentrations in the *with-CAAA* case are higher than in the *without-CAAA* case, in some cases near the Gulf Coast and in New York City by as much as 15 to 20 ppb. Second, some of the areas with the largest improvements, such as those in the heart of the Midwest, include pockets of much smaller gains, particularly in some urban centers. In both cases, these results are not unexpected. The complex chemistry of ozone includes a phenomenon known as "NO_x-scavenging", whereby nitrogen oxides, while participating as an ozone precursor, can also serve to scavenge or reduce ozone, particularly during the peak ozone season and in urban centers where ozone levels might otherwise be quite high. The CAAA, in reducing the nitrogen oxide precursors, may in some cases reduce ozone on a regional level while leading to much smaller reductions or even increases in ozone in the center of certain urban areas. This effect explains both these results. Nonetheless, as Figure 4-9 makes clear, the overall area (and population exposed) of ozone reductions is far greater than the corresponding areas with ozone increases.

Ozone results in the Western US, in Figures 4-10 and 4-11, indicate a similar pattern to those for the Eastern US when examining concentrations in urban areas, although in the West the largest ozone air quality gains are restricted to a smaller area, centered in the areas in California that have historically struggled with ozone attainment. In addition, in the Western US there are some more extensive areas in Figure 4-11 with ozone disbenefits attributed to the CAAA, particularly in Los Angeles.[38] Another interesting result, not shown in Figure 4-10, is that we estimate that ozone concentrations will actually increase from 1990 to 2000 in most parts of California, in both the *without-CAAA* and *with-CAAA* scenarios, before reductions in 2010 and 2020 bring ambient levels below those seen in 1990, at least in most areas. This result is largely attributable to the longer attainment deadlines for the severe non-attainment areas in California – our scenario assumes that emissions will increase for some period before aggressive regional mobile source tailpipe standards and non-road fuel and engine standards, and local-scale ozone attainment plans, have their full effect later in our simulation period.

[38] We examined this result further and found that, in cells with the largest disbenefits, the 2020 *without-CAAA* scenario yields concentrations of approximately 45 ppb, while concentrations in outlying areas are as high as 100 ppb or slightly higher. One effect of CAAA controls is to suppress NO_x-scavenging in the city center, where disbenefits are largest, yielding *with-CAAA* concentrations in the 60 to 65 ppb range. The main effect of the CAAA, however, is large decreases in ozone in the outlying areas, to concentrations of 60 to 75 ppb. The net effect on a population weighted basis remains a lowering of overall exposures.

FIGURE 4-8. CMAQ SIMULATED AND VNA ADJUSTED DAILY MAXIMUM 8-HOUR OZONE (PPB) FOR THE EUS DOMAIN

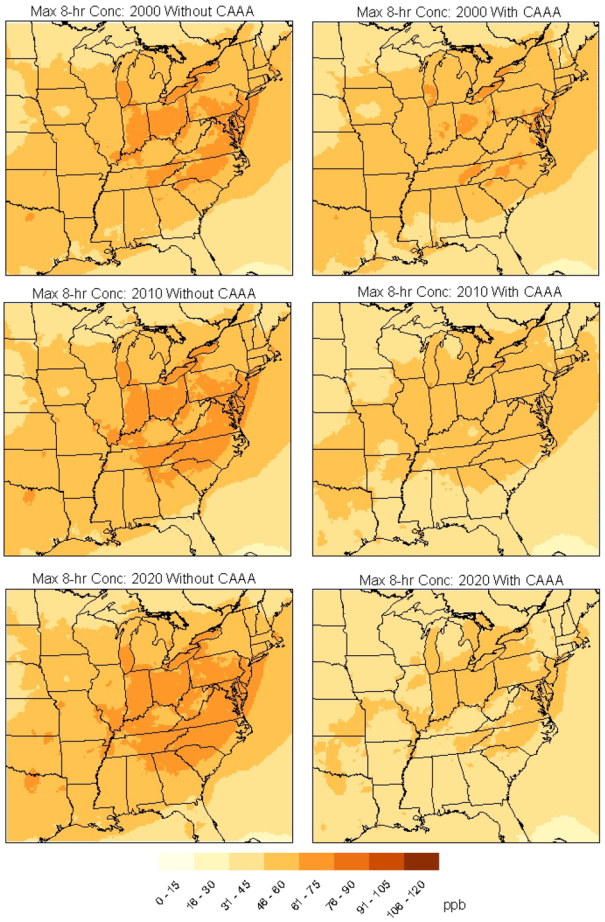


FIGURE 4-9. DIFFERENCE IN SIMULATED DAILY MAXIMUM 8-HOUR OZONE CONCENTRATION (PPB) FOR THE EUS DOMAIN FOR 15 JULY: 2020 WITH-CAAA MINUS 2020 WITHOUT-CAAA SCENARIOS

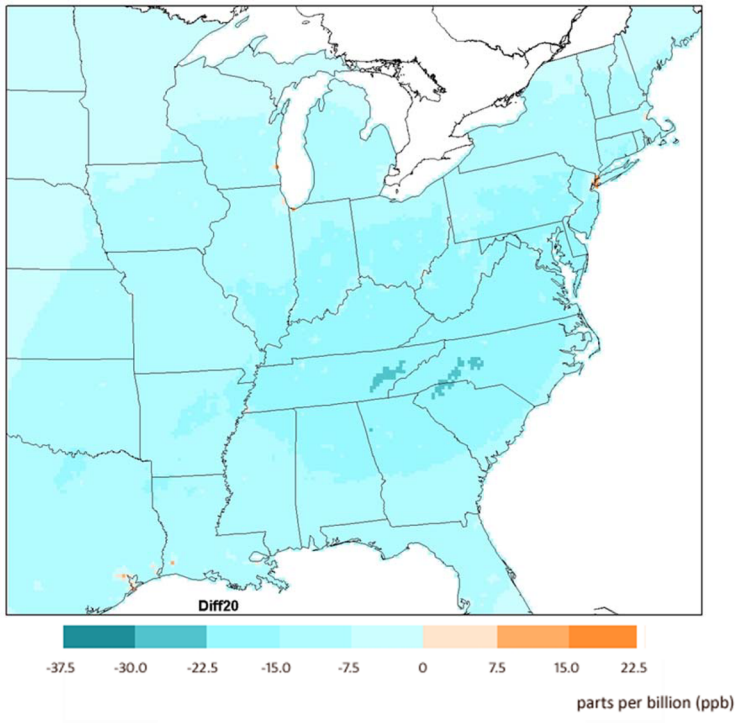


FIGURE 4-10. CMAQ SIMULATED AND VNA ADJUSTED DAILY MAXIMUM 8-HOUR OZONE (PPB) FOR THE WUS DOMAIN

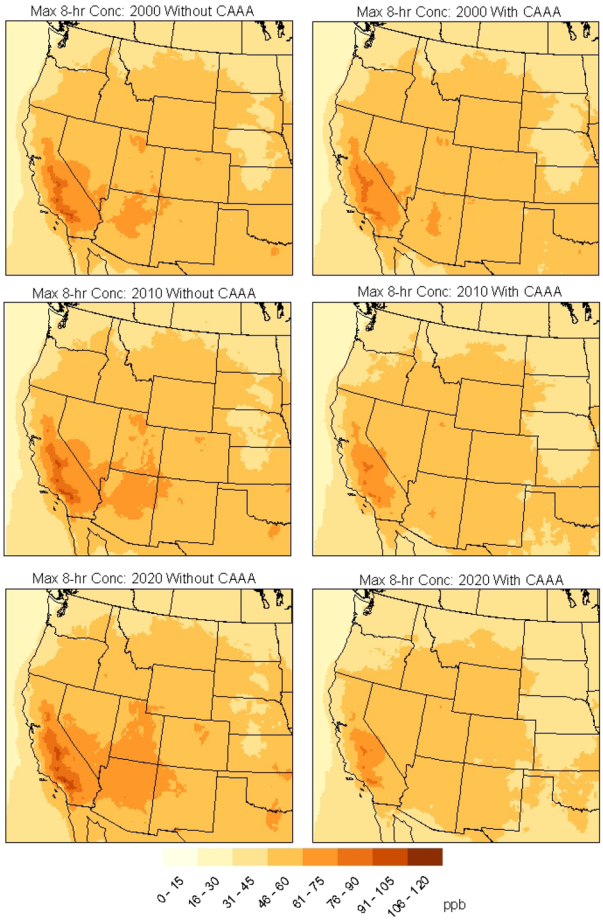
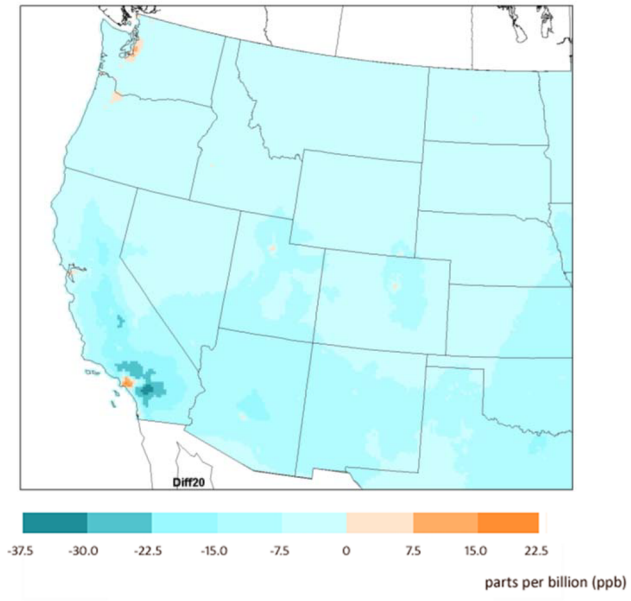


FIGURE 4-11. DIFFERENCE IN SIMULATED DAILY MAXIMUM 8-HOUR OZONE CONCENTRATION (PPB) FOR THE WUS DOMAIN FOR 15 AUGUST: 2020 WITH-CAAA MINUS 2020 WITHOUT-CAAA SCENARIOS



UNCERTAINTY IN AIR QUALITY ESTIMATES

Unlike the air quality modeling conducted over a decade ago for the first Section 812 prospective analysis, which used two different models for ozone and particulate matter, the modeling conducted for the Second Prospective analysis utilized EPA's Community Multiscale Air Quality (CMAQ) model, a "one-atmosphere" model that simulates the chemical formation, transport, and deposition of ozone and particulate matter together in one comprehensive system.[39] The use of this comprehensive air quality modeling system provides a consistent platform for evaluating the expected responses to changes in precursor emissions, reducing many of the uncertainties which pertained in the First Prospective as a result of the limited ability of the models to capture important interaction effects among the ozone and PM precursor pollutants.

[39] Use of an integrated model such as CMAQ for the current study was one of the recommendations made by the Council in their review of the First Prospective analysis.

Nonetheless, air quality modeling is a complex process and, as such, involves many uncertainties. We provide a summary of some of the more important classes of air quality modeling uncertainties in Table 4-1 below. These include a known meteorological bias in the 12-km eastern MM5 domain, which leads to a general tendency to underestimate the monthly observed precipitation; uncertainties in secondary organic aerosol (SOA) chemistry which lead to underestimation of SOA formation in the CMAQ simulations; issues in the detailed CMAQ modeling of some PM precursors; reliance for ozone modeling on a 12-km grid, suggesting NO_x inhibition of ambient ozone levels may be under-represented in some urban areas; and some emissions estimation geographic scale/resolution issues. In all cases but the ozone grid resolution and modeling of SOA formation, the effect of these uncertainties on our estimate of net benefits is of uncertain direction. In addition, in all but one case, modeling of SOA formation, we believe the impact of these uncertainties is probably minor, or of an influence less than five percent of the total net benefits, based on current information. Use of the CMAQ model platform, which has been evaluated in many contexts and used extensively by EPA for broad regulatory analyses such as the Second Prospective, has been a major factor enhancing our understanding of the impact of air quality modeling exercises such as this.

Another factor contributing to our understanding of key uncertainties is that the air quality modeling analysis conducted for the second Section 812 prospective study used national-scale modeling databases originally prepared by EPA for use in other recent modeling exercises conducted to support national rulemaking, including the latest available meteorological and other input databases (for 2002). Given that the modeling databases were originally prepared and utilized by EPA in other analyses, a comprehensive performance evaluation was not undertaken as part of this Section 812 prospective analysis; though the overall projections were assessed using the Atmospheric Model Evaluation Tool (AMET), which showed bias and error statistics for our results were within the acceptable range for model performance.[40] As noted in Table 4-1, biases or uncertainties could be manifest in the simulated concentration fields due to the use of the 36- and 12-km resolution grids, which might not be sufficiently detailed to resolve certain sub-grid scale processes in portions of the modeling domain. All air quality modeling exercises are affected by inherent uncertainties in model formulation, meteorological inputs, and emission inventory estimates. Nevertheless, the modeling was conducted following current EPA guidelines and in a manner consistent with EPA approaches/practice for similar national-scale modeling exercises.

One factor identified in Table 4-1 involves uncertainties associated with corrections to the air quality outputs completed coincident with the Council review of the study outputs. These corrections, reflecting the need to adjust some categories of direct fine particulate emissions for the *without-CAAA* scenario, and to incorporate adjustments to take account of processes that remove fugitive dust from the ambient air at or close to the source of emissions, owing to the effect of forests, vegetation, and urban structures on fugitive dust,

[40] ICF International, Evaluation of CMAQ Model Performance for the 812 Prospective II Study, November 24, 2009, page 31

were necessary because of issues identified through quality control assessments the Project Team completed. As noted in the table, we believe these factors have been addressed through carefully designed *post-hoc* adjustment of the CMAQ results, however in both cases it would have been preferable to have made the adjustments prior to running the CMAQ model. Resource and time limitations unfortunately prevented the Project Team from re-estimating the CMAQ results to account for these adjustments.

Perhaps surprisingly, our assessment is that only one of these factors, uncertainty in secondary organic aerosol formation, constitutes a major source of uncertainty. This result could reflect our inability to apply alternative quantitative air quality modeling tools in this already resource-intensive step in the analytic chain, although it is also clear that the CMAQ model best reflects the state-of-the-art for the type of national scale air quality modeling necessary to support this benefit-cost analysis. As we discuss in Chapter 7, the overall contribution of this step in the analytic chain to uncertainty in net benefits, compared to other steps, may be considerably less, because of the ability to calibrate model results to monitor values for at least the year 2000 *with-CAAA* scenario. It is worth noting, however, that as a whole the air quality modeling process very likely contributes a greater than 10 percent uncertainty, of indeterminate direction, to the overall uncertainty in benefits estimates. In addition, it is clear there are uncertainties introduced by the *ex post* adjustment of some primary PM emissions estimates and the procedure used to re-calibrate the CMAQ air quality to account for this emissions adjustment. Although we argue that the overall effect of this source of uncertainty on the net benefits is probably minor, in some locations ambient PM from primary PM emissions can be more important than secondarily formed fine particles. Overall, we believe that our application of the MATS monitor calibration procedure, which provides a speciated calibration to ensure better agreement between air quality modeling results and comparable monitor data, provides the best attainable consistency between our air quality simulation results and monitored values – the ability to calibrate our results to detailed monitor data in this step of the analytic chain provides considerably greater confidence that our results are "ground-truthed" as much as possible to real world conditions.

TABLE 4-1. KEY UNCERTAINTIES ASSOCIATED WITH AIR QUALITY MODELING

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Unknown meteorological biases in the 12-km western and 36-km MM5 domains due to the lack of model performance evaluations.	Unable to determine based on current information.	Probably minor. Other evaluations using 2002 and similar meteorology and CMAQ have shown reasonable model performance, but significant effects on nitrate results in western areas with wintertime $PM_{2.5}$ problems.

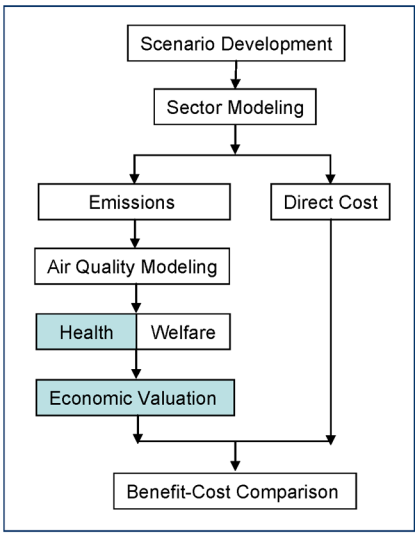
POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Known metrological biases in the 12-km eastern MM5 domain. MM5 has a cold bias during the winter and early spring, and has a general tendency to underestimate the monthly observed precipitation. MM5's under prediction was greatest in the fall and least in the spring months.	Unable to determine based on current information.	Probably minor. These biases would likely influence $PM_{2.5}$ formation processes, which was modeled on the 36-km domain.
Secondary organic aerosol (SOA) chemistry. CMAQ version 4.6 has known biases (underprediction) in SOA formation.	Underestimate.	Possibly major. The modeling system underpredicts SOA, which has both biogenic and anthropogenic components. Reductions in NOx can reduce both biogenic and anthropogenic SOA and reductions in VOC will reduce anthropogenic SOA. Since both of these precursors are significantly impacted by the CAAA, there may be large benefits from SOA related reductions that are not currently captured by the modeling system.
The CMAQ modeling relies on a modal approach to modeling $PM_{2.5}$ instead of a sectional approach. The modal approach is effective in modeling sulfate aerosol formation but less effective in modeling nitrate aerosol formation than the sectional approach.	Unable to determine based on current information.	Probably minor in the eastern U.S. where annual $PM_{2.5}$ is dominated by sulfate. Potentially major in some western U.S. areas where $PM_{2.5}$ is dominated by secondary nitrate formation.
Limited model performance evaluation of CMAQ for 2002.	Unable to determine based on current information.	Probably minor. While a comprehensive model evaluation was not completed, the overall results of the CMAQ runs for the Second Prospective were assessed using AMET, and bias and error statistics were within acceptable ranges. Further, our application of the MATS procedure provides further assurance that air quality results used in the subsequent health assessments are consistent with available monitor data.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Ozone modeling relies on a 12-km grid, suggesting NO_x inhibition of ambient ozone levels may be under-represented in some urban areas. Grid resolution may affect both model performance and response to emissions changes.	Unable to determine based on current information.	Probably minor. Though potentially major ozone results in those cities with known NO_x inhibition, ozone benefits contribute only minimally to net benefit projections in this study. Grid size affects chemistry, transport, and diffusion processes, which in turn determine the response to changes in emissions, and may also affect the relative benefits of low-elevation versus high-stack controls.
Emissions estimated at the county level (e.g., low-level source and motor vehicle NO_x and VOC emissions) are spatially and temporally allocated based on land use, population, and other surrogate indicators of emissions activity. Uncertainty and error are introduced to the extent that area source emissions are not perfectly spatially or temporally correlated with these indicators.	Unable to determine based on current information.	Probably minor. Potentially major for estimation of ozone, which depends largely on VOC and NO_x emissions; however, ozone benefits contribute only minimally to net benefit projections in this study.
Use of MATS relative response factors to calculate changes in PM2.5	Indeterminate	Probably minor. Using MATS, air quality modeling results were projected in a "relative" sense. In this approach, the ratio of future year model predictions to base year model predictions are used to adjust ambient measured data up or down depending on the relative (percent) change in model predictions for each location. The use of ambient data as part of the calculation helps to reduce uncertainties in the future year predictions, especially if the absolute model concentrations are over-predicted or under-predicted.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Modeling artifacts created by changes in emissions inventory estimation methods between the 1990 inventories used for the *without-CAAA* scenario and the 2002 inventories used for the *with-CAAA* scenarios were mitigated through application of adjustment factors for primary PM from non-EGU point sources, and for the certain subsectors of area sources, in the *without-CAAA* case. Application of these adjustments may result in overestimated or underestimated changes in primary PM contributions to ambient concentrations for these particular sources.	Unable to determine based on current information.	Probably minor. While primary PM can make a significant contribution to ambient PM2.5 in some locations, secondarily formed fine particles dominate the estimates for ambient concentration change in this analysis. In addition, the effect of the inventory adjustments was to significantly reduce the differentials between the control and counterfactual scenarios, implying any residual error is more likely to reflect an underestimation bias than an overestimation bias, particularly since the non-EGU primary PM reductions were adjusted to a scenario differential of zero.
Adjustments to take account of processes that remove fugitive dust from the ambient air at or close to the source of emissions, owing to the effect of forests, vegetation, and urban structures on fugitive dust. Analysis of the chemical species collected by ambient air samplers suggests that the modeling process may overestimate PM-2.5 from fugitive dust sources by as much as an order of magnitude, if not adjusted for this effect. The Project Team incorporated adjustments post-CMAQ modeling but prior to use of PM air quality estimates in subsequent steps of the analysis.	Unable to determine based on current information.	Probably minor. If adjustment factors had been applied as part of the CMAQ modeling, evidence suggests the entrainment effect would have been adequately accounted for. The largely linear processes of direct PM emissions to air quality suggest that our *post-hoc* adjustment should also be adequate to account for this factor. Further assurance that this factor has been accounted for is our application of the MATS monitor calibration procedure, which provides a speciated calibration to ensure better agreement between air quality modeling results and comparable monitor data, and the fact that the adjustment applies to both scenarios, further mitigating the impact of this source of uncertainty.

* The classification of each potential source of error is based on those used in the First Prospective Analysis. The classification of "potentially major" is used if a plausible alternative assumption or approach could influence the overall monetary benefit estimate by approximately 5% or more; if an alternative assumption or approach is likely to change the total benefit estimate by less than 5%, the classification of "probably minor" is used.

CHAPTER 5 - ESTIMATION OF HUMAN HEALTH EFFECTS AND ECONOMIC BENEFITS



A large portion of the overall benefits of the Clean Air Act Amendments (CAAA) of 1990 are due to human health benefits from improved air quality. As part of the Second Prospective analysis of these amendments, we identified and, where possible, estimated the magnitude of health benefits Americans are likely to realize in future years as a result of the CAAA. We express these health benefits as avoided cases of air pollution-related health effects, such as premature mortality, heart disease and respiratory illness. Human health benefits of the 1990 CAAA can be attributed to reduced emissions of criteria pollutants (Titles I through IV), and reduced emission of ozone depleting substances (Title VI), however as highlighted in Chapter 1 the Second Prospective focuses primarily on human health effects attributed to the reduction of criteria pollutants, and within that category, health benefits associated with reduced exposure to fine particulate matter ($PM_{2.5}$) and ozone, as these are the largest contributors to the overall health benefits estimates.

The goal in a benefit-cost analysis such as the Second Prospective is to develop estimates of the monetary value of benefits wherever possible – doing so facilitates comparison and aggregation of monetized health benefits across endpoints. Therefore, we assigned a dollar value to avoided incidences of each health effect. We obtained valuation estimates from the economic literature and report them in "dollars per case avoided." We report each of the monetary values of benefits applied in this analysis in terms of a central estimate and a probability distribution around that value. The statistical form of the probability distribution varies by endpoint.

This chapter presents an overview of our approach to modeling changes in adverse health effects and applying monetary value to these benefits, summarizes the results for major health effect categories and discusses key uncertainties related to the analysis. As noted above, the chapter focuses primarily on the human health effects associated with exposure to criteria pollutants, however we also present the methodology and results of a case study of health benefits from a single air toxic pollutant (benzene) for a particular area of the United States (the Houston metropolitan area).

OVERVIEW OF APPROACH

We estimate the impact of the CAAA on human health by analyzing the difference in the expected incidence of adverse health effects between a "*with*-" and a "*without-CAAA*" regulatory scenario. As described in Chapter 1, the *without-CAAA* scenario assumes no further controls on criteria pollutant emissions aside from those already in place in 1990, while the *with-CAAA* scenario assumes full implementation of the 1990 CAAA. The analysis uses a sequence of linked analytical models to estimate health benefits, also described in Chapter 1, which includes forecasts of implementation activities undertaken in response to the CAAA, estimates of pollutant emissions associated with each scenario (see Chapter 2) and air quality modeling of criteria pollutant emissions under each scenario (see Chapter 4).

Estimating health effects benefits from air quality modeling results involves three key steps, described in greater detail below. The first step involves estimating the exposure of individuals to air pollutants. Although exposure to air pollutants can occur in both outdoor and indoor environments, for our purposes it is appropriate to focus on outdoor air pollution concentrations as a measure of human exposure. The main reason is that, in the second step of our approach, estimating the human response to exposure, the exposure measures used in the epidemiological studies used to derive human response are typically based on outdoor concentrations. These "concentration-response functions" were developed to relate outdoor concentrations to changes in the incidence of health effects and mortality in response to pollutant exposure. The third step, valuation of avoided human health risk, is accomplished by application of estimates from the literature to characterize unit values per case avoided.

A critical tool in EPA's analyses of health benefits is the Environmental Benefits Mapping and Analysis Program (BenMAP), developed and continuously maintained by EPA's Office of Air and Radiation.[41] BenMAP is capable of accepting a wide range of air quality inputs, and then performing exposure analysis that includes calibration of model results to monitor data for historical years, assessing the changes in health effects incidence resulting from those exposures, and estimating the monetized value of those avoided health effects. Health effects in BenMAP are based on differences in two scenarios of exposure, and health effects and valuation estimates reflect the implications of the difference in exposure across scenarios, rather than absolute estimates of incidence

[41] For more information, see the BenMAP *User's Manual and Appendices*, September 2008, Prepared for the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, by Abt Associates Inc.

associated with in any given scenario. BenMAP required three types of inputs for this analysis: 1) forecasted changes in air quality from the *without-CAAA* to the *with-CAAA* scenarios in 2000, 2010 and 2020; 2) health impact functions that quantify the relationship between the forecasted changes in exposure and expected changes in adverse health effects; and 3) health valuation functions that assign a monetary value to changes in specific health effects. We describe each of these inputs in greater detail below. The outputs of BenMAP for this analysis include central estimates and distributions of health effects incidence and valuation, at the national and county level, for each of the three target years of analysis.

The Project Team also estimates two other outputs related to avoided premature mortality attributed to the CAAA: life-years lost, and changes in life expectancy. EPA developed a separate model, the Population Simulation model, to generate these outputs. As described below, the population simulation approach provides some advantages over the BenMAP model in terms of simulation of the dynamic effects of mortality across a population through time, but also has several significant disadvantages relative to BenMAP in terms of the spatial resolution of pollutant exposure estimates. As a result, the population simulation approach operates as a supplement to the BenMAP-based primary estimates for selected measures of the impact of reducing risks of premature mortality.

EXPOSURE ASSESSMENT

As described in Chapter 4, the Project Team used the Community Multi-scale Air Quality (CMAQ) integrated modeling system to simulate the physical and chemical processes that govern the formation, transport, and deposition of gaseous and particulate species in the atmosphere. The CMAQ results serve as the basis of the air quality inputs required for BenMAP. For particulate matter, the CMAQ model was applied for an annual simulation period (January through December) and utilized a 36-km resolution modeling domain that encompasses the contiguous 48 states. For ozone and related species, the CMAQ model was applied for a five-month simulation period that captures the key ozone-season months of May through September, and used two 12-km resolution modeling domains (that when combined cover the contiguous 48 U.S. states).
We also described in Chapter 4 the adjustment of the CMAQ results generated by combining those results with observed monitoring data, using a method known as the monitor and model relative adjustment procedure. This technique was applied for the PM estimates using a program called the Modeled Attainment Test Software (MATS) (see Chapter 4 for a detailed description of this process). The resulting 36 km grid cell concentrations for PM were then used as inputs for BenMAP. For ozone, a similar adjustment process was completed, but the analysis was done directly within BenMAP, using the enhanced Voronoi Neighbor Averaging (eVNA) procedure.[42] The eVNA and

[42] As noted in Chapter 4, eVNA and VNA are procedures for interpolating values from nearby monitors using inverse distance squared weighting using Voronoi Neighbor Averaging. This is an algorithm that identifies a set of monitors close to the grid cell (called "neighbors") and then estimates the PM species concentration in that grid cell by calculating an inverse-distance weighted average of the monitor values (i.e., the concentration values at monitors closer to the grid cell are weighted more heavily than monitors that are further away). See the BenMAP manual for further information on the eVNA

MATS procedures provide gridded estimates of outdoor air quality at the same grid resolution as the CMAQ results. These procedures also provide a means for calibrating model results in those grid cells where no monitors exist, combining both model results with nearby monitor results to yield a "surface" of air quality that avoids the problems with direct extrapolation of results from monitors not located within a grid cell boundary.

HEALTH IMPACT FUNCTIONS

Health impact functions estimate the change in a health endpoint of interest, such as hospital admissions, for a given change in ambient pollutant concentration. A standard health impact function has four components: 1) the size of the potentially affected population; 2) a baseline incidence rate for the health effect (obtained from a source of public health statistics, such as the Centers for Disease Control, or sometimes from an epidemiological study itself); 3) a concentration-response (C-R) function (derived from epidemiological studies), which relates the change in the number of individuals in a population exhibiting a "response" to a change in pollutant concentration experience to the size of the exposed population; and 4) the estimated change in the relevant pollutant concentration. The first three of these components are discussed in further detail below. The fourth is generated through the air quality modeling and exposure estimation procedure discussed above.

Potentially Affected Populations

Health benefits resulting from the CAAA are related to the change in air pollutant exposure experienced by individuals. Because the expected changes in pollutant concentrations vary from location to location, individuals in different parts of the country may not experience the same level of health benefits. This analysis apportions benefits among individuals by matching the change in air pollutant concentration in a grid cell with the size of the population that experiences that change.

BenMAP incorporates 2000 U.S. Census Bureau block-group population data to determine the specific populations potentially affected by ozone and $PM_{2.5}$. For future years (2010 and 2020), BenMAP scales the 2000 Census-based population estimates using the ratio of forecasted and 2000 county-level population estimates provided by Woods and Poole (2007).[43]

procedure. Abt Associations (2008). *BenMAP: Environmental Benefits Mapping and Analysis Program User's Manual*. Prepared for the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards, Research Triangle Park, NC, September.

[43] Woods & Poole Economics Inc., 2007. Complete Demographic Database. Washington, DC. http://woodsandpoole.com/index.php.

Baseline Incidence Rates

Baseline incidence rates are needed to convert the relative changes of a health effect in relation to a specific change in air pollution, which are reported in epidemiological studies, into the number of avoided cases. For instance, an epidemiological study might report that for a 10 ppb decrease in daily ozone levels, hospital admissions decrease by three percent. This estimate must then be multiplied by a baseline incidence rate (i.e., an estimate of the number of cases of the health effect per year) and the total population to determine how this three percent decrease translates into the number of fewer cases.

For this analysis, we used nationally-representative age-specific incidence and prevalence rates, where available, for each health endpoint. We obtained these data from a variety of sources, such as the CDC, the National Center for Health Statistics and the American Lung Association. Information from individual epidemiological studies was used if data from other sources were not available, as these data are often specific to the study population and location and therefore may not be as nationally representative.[44] For future years, mortality rates are projected based on available Bureau of the Census projections – other projected baseline incidence rates are generated to be consistent with the projections of population growth incorporated into BenMAP.

Concentration-Response Functions

We calculate the benefits attributable to the CAAA as the avoided incidence of adverse health effects. Such benefits can be measured using C-R functions specific to each health effect. C-R functions are equations that relate the change in the number of individuals in a population exhibiting a "response" (in this case an adverse health effect such as respiratory disease) to a change in pollutant concentration experienced by that population.

$PM_{2.5}$ and ozone have been associated with a number of adverse health effects in the epidemiological literature, such as premature mortality, hospital admissions, emergency room visits, and respiratory and cardiovascular disease. The published scientific literature contains information that supports the estimate of some, but not all, of these effects. Thus, it is not possible currently to estimate all of the human health benefits attributable to the CAAA. In addition, for some of the health effects we do quantify, the current economic literature does not support the estimation of the economic value of these effects. Table 5-1 lists the human health effects of these pollutants that have been identified, indicating which have been included in our benefits estimates and those that we did not quantify. See Chapter 2 of *Health and Welfare Benefits Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, for a specific list of the C-R functions used for each health endpoint.

[44] See *Health and Welfare Benefits Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, February 2011, for a list of data sources and average baseline incidence rates for each health effect.

TABLE 5-1. HUMAN HEALTH EFFECTS OF OZONE AND $PM_{2.5}$

POLLUTANT/EFFECT	QUANTIFIED AND MONETIZED IN BASE ESTIMATES[A]	UNQUANTIFIED EFFECTS[G,H]—CHANGES IN:
PM/Health[b]	Premature mortality based on both cohort study estimates and on expert elicitation[c,d] Bronchitis: chronic and acute Hospital admissions: respiratory and cardiovascular Emergency room visits for asthma Nonfatal heart attacks (myocardial infarction) Lower respiratory symptoms Minor restricted-activity days Work loss days Asthma exacerbations (asthmatic population) Upper Respiratory symptoms (asthmatic population) Infant mortality	Subchronic bronchitis cases Low birth weight Pulmonary function Chronic respiratory diseases other than chronic bronchitis Morphological changes Altered host defense mechanisms Cancer Non-asthma respiratory emergency room Visits UVb exposure (+/-)[e]
Ozone/Health[f]	Premature mortality: short-term exposures Hospital admissions: respiratory Emergency room visits for asthma Minor restricted-activity days School loss days Outdoor worker productivity	Cardiovascular emergency room visits Asthma attacks Respiratory symptoms Chronic respiratory damage Increased responsiveness to stimuli Inflammation in the lung Premature aging of the lungs Acute inflammation and respiratory cell damage Increased susceptibility to respiratory infection Non-asthma respiratory emergency room Visits UVb exposure (+/-)[e]

a Primary quantified and monetized effects are those included when determining the primary estimate of total monetized benefits of the alternative standards.

b In addition to primary economic endpoints, there are a number of biological responses that have been associated with PM health effects including morphological changes and altered host defense mechanisms. The public health impact of these biological responses may be partly represented by our quantified endpoints.

c Cohort estimates are designed to examine the effects of long-term exposures to ambient pollution, but relative risk estimates may also incorporate some effects due to shorter term exposures (see Kunzli et al., 2001 for a discussion of this issue).

d While some of the effects of short-term exposure are likely to be captured by the cohort estimates, there may be additional premature mortality from short-term PM exposure not captured in the cohort estimates included in the primary analysis.

e May result in benefits or disbenefits.

f In addition to primary economic endpoints, there are a number of biological responses that have been associated with ozone health including increased airway responsiveness to stimuli, inflammation in the lung, acute inflammation and respiratory cell damage, and increased susceptibility to respiratory infection. The public health impact of these biological responses may be partly represented by our quantified endpoints.

g The categorization of unquantified health effects is not exhaustive.

h Health endpoints in the unquantified benefits column include both a) those for which there is not consensus on causality and b) those for which causality has been established but empirical data are not available to allow calculation of benefits.

We rely on the most recently available, published scientific literature to ascertain the relationship between air pollution and adverse human health effects. We use a set of criteria outlined in Table 5-2 to evaluate potential studies to use as the basis for the C-R function. These criteria include consideration of whether the study was peer-reviewed, the study design and location, and characteristics of the study population, among others. In addition, we consider the input of the Council advising EPA for this study, as well the specific advice of the Health Effects Subcommittee (HES) of the Council, which explicitly focused on the health effects estimation component of the study. Overall, the selection of C-R functions for benefits analysis is guided by the goal of achieving a balance between comprehensiveness and scientific defensibility.

Epidemiological studies provide the basis for the C-R functions used in the health impact functions for assessing benefits of the CAAA. These studies also provide an indication of a portion of the uncertainty associated with the C-R function, by reporting a confidence interval around the mean value, which we use to derive a low, central and high estimate of avoided cases. However, this range only represents the statistical error in the estimates, which is related to the study population size and frequency of outcome. Several other sources of uncertainty exist in the relationship between ambient pollution and the health outcomes, including model uncertainty, potential confounding by factors that are both correlated with the health outcome and each other, and potential misclassification of the study population exposures. For a full list of uncertainties related to application of a C-R function to estimate benefits, see the Uncertainty section of this chapter and the Second Prospective Uncertainty Report, *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*.

EPA recently conducted an expert elicitation (EE) study, which is the formal elicitation of subjective judgments, in order to more fully characterize the uncertainty surrounding the $PM_{2.5}$/mortality C-R function. This study allowed experts to consider and integrate several sources of uncertainty in the form of a probability distribution of the C-R function. As discussed further below, the EE study results helped to inform our selection of a primary C-R function to estimate avoided premature mortality due to CAAA-related $PM_{2.5}$ exposure reductions.

Avoided premature mortality is the largest contributor to the monetized health benefits of $PM_{2.5}$ and ozone. Therefore, we describe below in further detail the specific C-R functions selected to quantify CAAA-related avoided deaths.

TABLE 5-2. SUMMARY OF CONSIDERATIONS USED IN SELECTING C-R FUNCTIONS

CONSIDERATION	COMMENTS
Peer-Reviewed Research	Peer-reviewed research is preferred to research that has not undergone the peer-review process.
Study Type	Among studies that consider chronic exposure (e.g., over a year or longer), prospective cohort studies are preferred over ecological studies because they control for important individual-level confounding variables that cannot be controlled for in ecological studies.
Study Period	Studies examining a relatively longer period of time (and therefore having more data) are preferred, because they have greater statistical power to detect effects. More recent studies are also preferred because of possible changes in pollution mixes, medical care, and lifestyle over time. However, when there are only a few studies available, studies from all years will be included.
Population Attributes	The most technically appropriate measures of benefits would be based on impact functions that cover the entire sensitive population but allow for heterogeneity across age or other relevant demographic factors. In the absence of effect estimates specific to age, sex, preexisting condition status, or other relevant factors, it may be appropriate to select effect estimates that cover the broadest population to match with the desired outcome of the analysis, which is total national-level health impacts. When available, multi-city studies are preferred to single city studies because they provide a more generalizable representation of the C-R function.
Study Size	Studies examining a relatively large sample are preferred because they generally have more power to detect small magnitude effects. A large sample can be obtained in several ways, either through a large population or through repeated observations on a smaller population (e.g., through a symptom diary recorded for a panel of asthmatic children).
Study Location	U.S. studies are more desirable than non-U.S. studies because of potential differences in pollution characteristics, exposure patterns, medical care system, population behavior, and lifestyle.
Pollutants Included in Model	When modeling the effects of ozone and PM (or other pollutant combinations) jointly, it is important to use properly specified impact functions that include both pollutants. Using single-pollutant models in cases where both pollutants are expected to affect a health outcome can lead to double-counting when pollutants are correlated.
Measure of PM	For this analysis, impact functions based on PM2.5 are preferred to PM10 because of the focus on reducing emissions of PM2.5 precursors, and because air quality modeling was conducted for this size fraction of PM. Where PM2.5 functions are not available, PM10 functions are used as surrogates, recognizing that there will be potential downward (upward) biases if the fine fraction of PM10 is more (less) toxic than the coarse fraction.
Economically Valuable Health Effects	Some health effects, such as forced expiratory volume and other technical measurements of lung function, are difficult to value in monetary terms. These health effects are not quantified in this analysis.
Non-overlapping Endpoints	Although the benefits associated with each individual health endpoint may be analyzed separately, care must be exercised in selecting health endpoints to include in the overall benefits analysis because of the possibility of double-counting of benefits.

PM Mortality C-R Function

The estimated relationship between particulate matter exposure and premature mortality is one of the most important parameters in the overall quantified and monetized benefit estimate for this study. An extensive base of literature exists to support development of the C-R function linking fine particulate matter exposure with premature mortality. Our knowledge of both the potential biological mechanisms linking $PM_{2.5}$ exposure with mortality and the potential magnitude of this effect has grown since the First Prospective was completed as the result of continued research and follow-up of existing study populations. Both short-term and long-term epidemiological studies have been conducted to examine the PM/mortality relationship. Short-term exposure studies attempt to relate short-term (often day-to-day) changes in PM concentrations and changes in daily mortality rates up to several days after a period of elevated PM concentrations. Long-term exposure studies examine the potential relationship between longer-term (e.g., annual) changes in exposure and annual mortality rates. Although positive, significant results have been reported using both of these study types, we rely exclusively on long-term studies to quantify PM mortality effects. This is because cohort studies are able to discern changes in mortality rates due to long-term exposure to elevated air pollution concentrations. This provides a better match to the benefits of air pollution control programs under the CAAA, which are also focused on reducing long-term exposure. These effect estimates may also include some of the mortality changes due to short-term peak exposures.[45] Therefore, the use of C-R functions from long-term studies is likely to yield a more complete assessment of the effect of PM on mortality risk.

Among long-term PM studies, we prefer those using a prospective cohort design to those using an ecologic or population-level design. Prospective cohort studies follow individuals forward in time for a specified period, periodically evaluating each individual's exposure and health status. Population-level ecological studies assess the relationship between population-wide health information (such as counts of daily mortality) and ambient levels of air pollution. Prospective cohort studies are preferred because they are better at controlling a source of uncertainty known as "confounding." Confounding is the mis-estimation of an association that results if a study does not control for factors that are correlated with both the outcome of interest (e.g., mortality) and the exposure of interest (e.g., PM exposure). For example, smoking is associated with mortality. If populations in high PM areas tend to smoke more than populations in low PM areas, and a PM exposure study does not include smoking as a factor in its model, then the mortality effects of smoking may be erroneously attributed to PM, leading to an overestimate of the risk from PM. Prospective cohort studies are better at controlling for confounding than ecologic studies because the former follow a group of individuals forward in time and can gather individual-specific information on important risk factors such as smoking.

[45] See Kunzli et al. (2001) for a discussion of this issue.

Two major prospective cohort studies have been conducted in the U.S.: the American Cancer Society (ACS) study and the Six Cities study. These two cohorts are large, produce consistent results, provide broad geographic coverage and have been independently reexamined and reanalyzed. Strengths of the ACS study over the Six Cities study include greater geographic coverage (50 U.S. cities) and larger sample size. However, a key limitation of this study is a recruitment method that led to a study population with higher income, more education, and greater proportion of whites than the general U.S. population. In addition, available monitoring data was often assigned to all of the individuals within a large metropolitan area, potentially allowing for exposure misclassification.[46] Both of these limitations could imply that the ACS results are potentially biased low. The Six Cities study included a more representative sample of subjects within each community and set up monitors purposefully for the study. It was therefore able to assign exposures at a finer geographic scale. However, this study only included six cities and therefore may not be representative of the entire U.S. population, mix of air pollutants, and other potentially important factors.

The extensive epidemiological literature is complemented by EPA's 2006 expert elicitation (EE) study that asked 12 leading experts in PM health effects to integrate this pool of knowledge with the various sources of uncertainty that hinder our ability to precisely identify the true mortality impact of a unit change in annual $PM_{2.5}$ concentration (IEc, 2006). The results of the expert elicitation study showed three important findings: first, that advances in the scientific literature led many of the interviewed scientists to espouse greater confidence in the linkage between $PM_{2.5}$ exposure and mortality; second, that many of the experts believed that the central estimate of the mortality effect was considerably higher than the Pope et al. (2002) result used in the First Prospective; and third, that most of the experts' uncertainty distributions of the mortality effect reflected a much wider range of possible values, both high and low, than were used in the First Prospective study. The expert elicitation study does not, however, provide an integrated distribution across all 12 experts of possible values for the PM-mortality C-R function.

Based on consultations with the Council's Health Effects Subcommittee (HES), the 812 Project Team developed a distribution of C-R function coefficients (i.e., the percent change in annual all-cause mortality per one $\mu g/m^3$ change in annual average $PM_{2.5}$) for use in the PM-mortality C-R function for the Second Prospective study. This distribution is rooted in the epidemiological studies that most inform our understanding of the PM-mortality C-R function, but reflects the broader findings of the EE study. We based the primary C-R coefficient estimate of the Second Prospective study on a Weibull distribution with a mean of 1.06 percent decrease in annual all-cause mortality per one $\mu g/m^3$. This mean is roughly equidistant between the results of the two most well-studied PM cohorts, the ACS cohort (0.58, as derived from Pope et al., 2002) and the Six Cities cohort (1.5, as derived from Laden et al., 2006), both of whose results have been robust to continued follow-up and extensive re-analysis. Half of the coefficient values in this

[46] Studies have shown that greater spatial resolution of exposures can result in increased effect estimates (Jerrett et al., 2005).

distribution fall between these two studies, one-quarter are higher than the Laden mean estimate, and one-quarter are lower than the Pope mean estimate; however all coefficient values are greater than zero. This distribution is consistent with the EE results described above, showing considerable support for higher values based on results from more recent studies (e.g., the Laden et al. (2006) Six Cities follow-up) and concerns cited by the Council HES that the ACS cohort results may underestimate the true effect. The use of all positive values is consistent with both the increased confidence in a causal link between $PM_{2.5}$ exposure and mortality shown in the EE study and the lack of evidence in general to support a threshold for mortality effects of $PM_{2.5}$ in the U.S. population.[47]

The results of two recently published cohort studies provide additional support for the selection of the Weibull distribution as the primary estimate for the PM Mortality C-R function. The first is a large retrospective cohort study of over 13 million Medicare participants (i.e., those aged 65 and above) throughout the US (Eftim et al. 2008; Zeger et al. 2008). When the entire Medicare cohort was analyzed, authors found a 6.8 percent change in annual all-cause mortality in the eastern US (95% CI: 4.9-8.7) and a 13.2 percent change in the central US (95% CI: 9.5-16.9) per 10 $\mu g/m^3$ change in the long-term (six-year) average annual $PM_{2.5}$. There was no association found in the western US (Zeger et al., 2008). These results are similar to the interquartile range of the Weibull distribution selected for the primary estimate for the Second Prospective. An analysis restricted to those living in the locations corresponding to the ACS and Six Cities cohort study analyses yielded percent changes in annual all-cause mortality per 10 $\mu g/m^3$ of $PM_{2.5}$ of 10.9 (95% CI: 9.0-12.8) and 20.8 (95%CI: 14.8-27.1) respectively, which are somewhat higher than the estimates reported in the original studies (Eftim et al., 2008).[48] One possible explanation for this difference is the lack of control for lifestyle factors in the analyses by Eftim et al., such as smoking, potentially leading to confounded results.

The second study is a prospective cohort of female nurses in the Northeastern and Midwestern regions of the US (Puett et al. 2008 and 2009). An increase of 10 $\mu g/m^3$ of $PM_{2.5}$ in the previous year was associated with a 26 percent increase in annual all-cause mortality (a hazard ratio of 1.26 with a 95% CI ranging from 1.02 to 1.54).[49] This estimate is at the upper end of our primary estimate Weibull distribution (roughly equivalent to the 95th percentile). However, this study covered only two regions of the country and included only females and therefore may not be generalizable to the general population of the US.

A final topic concerns EPA's choice to estimate avoided mortality and morbidity associated with reductions in fine particles using estimates of changes in exposure to fine

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[47] See "Health Effects Subcommittee of the Council. Review of EPA's Draft Health Benefits of the Second Section 812 Prospective Study of the Clean Air Act." (EPA-COUNCIL-10-001), available at http://www.epa.gov/advisorycouncilcaa

[48] Note that these results are based on a slightly different air quality dataset than the analysis of the full cohort. The nationwide estimate is based on a six-year average (2000-2005) and the ACS and Six Cities location-specific results are based on two years of data (2000-2002).

[49] Biennial questionnaires on lifestyle factors were administered to participants, allowing for control of a number of individual-level confounders.

particle mass as the exposure input in the damage function. The implication of this approach is that we assume that all fine particles, regardless of their chemical composition, are equally potent per unit concentration in producing premature mortality and other health outcomes. If it could be shown that fine particle species exhibit significantly differentiated toxicity, then from a benefits analysis perspective, treatment of all fine particle species as equally toxic would lead to biased benefits estimates, because the composition of fine particle mass varies over space and time, as do the fine particle reductions resulting from different air pollutant control strategies. We believe that these biases would likely be minor in an analysis such as the 812 study, which evaluates a blended particle reduction strategy targeting multiple particle types across the entire spectrum of control programs authorized under the Clean Air Act Amendments. Nonetheless, we conducted a careful evaluation of the potential for characterizing uncertainty in the differential toxicity of the components of fine particle pollution.

There exists a limited but growing literature addressing the health effects of various fine particle components, including sulfate, nitrate, elemental carbon (EC), organic carbon (OC), and metals.[50] A number of epidemiological studies, mostly time-series studies, have associated one or more of the components of fine particle pollution individually with mortality; however, so far no clear picture has emerged to implicate specific components as being consistently more toxic than fine particles in general or to classify any individual components of fine particle pollution as non-toxic. However, the epidemiological evidence base is limited by the high correlations among many fine particle components (and between those components and fine particles as a whole). It is difficult to corroborate this evidence toxicologically, given the fact that human exposure to single particle components is not a realistic scenario. The literature base continues to expand, but significant investments in both epidemiological and toxicological research are needed to understand the potentially complex systems of particle interactions that may be responsible for the observed health effects of fine particle pollution.

Thus, while treatment of all fine particle components as equally toxic may lead to biases in benefits estimates, we also acknowledge that any arbitrary assumption about the differential toxicities of specific fine particle types may also lead to biases in benefits estimates. Any of these biases may mask important spatial variation in the distribution of benefits of Clean Air Act programs across the U.S. due to regional variation in fine particle species mixes, which could affect selection of the most health beneficial measures to meet Clean Air Act requirements such as the National Ambient Air Quality Standards. However, the "equal toxicity" fine particle approach is rooted in both biological considerations (i.e., the importance of particle size to toxicity) and in largely consistent findings across an extensive set of epidemiological studies conducted across countries, states, and cities that show $PM_{2.5}$ concentrations are associated with increased mortality and morbidity rates. This consistency of results across a variety of fine particle

[50] For specific examples of research addressing differential toxicity of PM components, see Chapter 5 of *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*. http://www.epa.gov/oar/sect812/may10/IEc_Uncertainty.pdf

mixes in different locations implies an equivalence of risk resulting from exposure to fine particle masses with different concentrations of component species. We conclude that the current evidentiary base from the epidemiological and toxicological literatures supports the use of an equal toxicity assumption for the present study, especially since the fine particle pollution reductions estimated herein reflect a variety of fine particle mixtures across different locations and time frames. Furthermore, we conclude that current information does not support specification of alternative concentration-response functions that would be both scientifically sound and useful for development of policy-relevant insights.

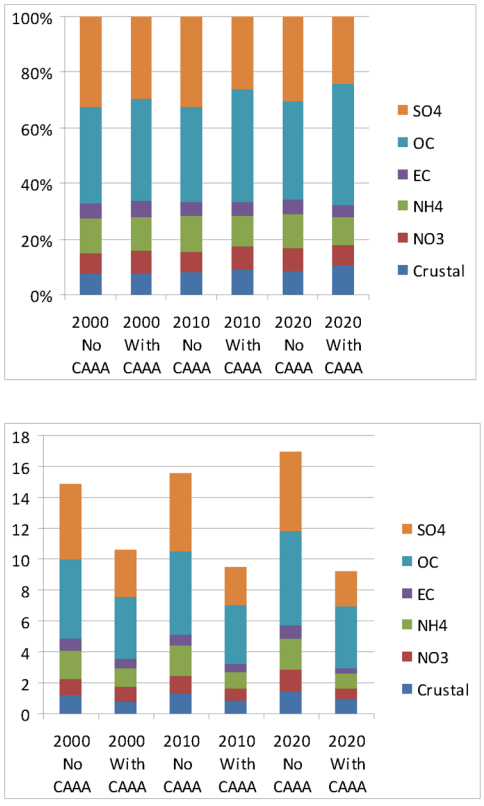
To provide further confidence that the results presented in this chapter are not likely to be substantially affected by the possibility that $PM_{2.5}$ species exhibit differential toxicity, the Project Team developed and evaluated estimates of the overall population-weighted exposure to PM species. The results are presented in Table 5-3 below, and graphically in the two panels of the accompanying Figure 5-1. The results in Figure 5-1indicate that the population-weighted composition of fine particulate matter is affected by the control strategies applied in the CAAA, but the changes are relatively modest.[51] We therefore conclude that, even if species-specific toxicity estimates could be derived from the existing literature, applying them in this study would not have a large effect on the mortality results presented later in this chapter.

TABLE 5-3. ESTIMATED POPULATION WEIGHTED EXPOSURE FOR $PM_{2.5}$ SPECIES (MICROGRAMS PER CUBIC METER)

	2000 NO CAAA	2000 WITH CAAA	2010 NO CAAA	2010 WITH CAAA	2020 NO CAAA	2020 WITH CAAA
Crustal	1.18	0.82	1.27	0.86	1.51	0.96
NO_3	1.06	0.89	1.17	0.81	1.32	0.69
NH_4	1.87	1.26	1.96	1.03	2.05	0.92
EC	0.74	0.62	0.77	0.48	0.9	0.41
OC	5.18	3.94	5.36	3.86	6.02	3.99
SO_4	4.84	3.11	5.02	2.48	5.17	2.22

[51] Note that data presented in Table 5-3 are for the most important PM2.5 components; some less important species, with lower concentrations, are omitted.

FIGURE 5-1. DISTRIBUTION OF POPULATION WEIGHTED EXPOSURE TO $PM_{2.5}$ SPECIES AS PERCENTAGE OF TOTAL (TOP PANEL) AND IN MICROGRAMS PER CUBIC METER (BOTTOM PANEL)



Ozone Mortality C-R Function

Several recent epidemiological studies suggest that ozone exposure likely contributes to premature mortality.[52] Epidemiological data are also supported by recent human and

[52] See, for example, National Research Council, 2008, *Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution*. A key recommendation of this NAS panel was that ozone mortality estimates from available epidemiological studies represent a separate and additive effect to those from PM/mortality epidemiological studies.

animal experimental data, which suggestive evidence for plausible pathways by which the risk of respiratory or cardiovascular mortality could be increased by ambient ozone.

Multiple time-series epidemiological studies explore the relationship between short-term ozone exposure and premature mortality. Most notably, a large multi-city study known as the National Morbidity, Mortality, and Air Pollution Study (NMMAPS) was designed to explore the association between several pollutants, including ozone, and daily mortality that focused on large cities across the US where levels of pollutants were varied (Samet et al., 2000). Two recently published studies based on the NMMAPS database that focus on the ozone/premature mortality relationship are Bell et al. (2004) (95 U.S. cities) and Huang et al. (2005) (19 U.S. cities). Another multi-city study by Schwartz (2005) examined the relationship between short-term ozone exposure and mortality in 14 U.S. cities.

In addition to these multi-city estimates, C-R functions for short-term ozone mortality can be derived from meta-analyses, which combine the results of several studies. Three meta-analyses were performed to obtain a summary estimate of ozone-related mortality risks and to attempt to describe heterogeneity in risk estimates (Ito et al., 2005; Levy et al., 2005; Bell et al., 2005). Each of these studies used different statistical techniques and datasets and examined statistical concerns, such as confounding, collinearity and possible interaction effects.[53]

In general, effect estimates from the meta-analyses are higher than the multi-city results. This could potentially be due to publication bias, as the meta-analyses relied solely on published studies, which could be more likely to contain statistically significant results. NMMAPS generally produces lower estimates than other epidemiological time-series studies, however, which could reflect specific methodological choices made by these investigators. Since these studies are associated with different strengths and limitations and no single study emerges as the most suitable to use as the basis for our primary estimate, we opted to use a pooled estimate, equally weighting the C-R functions from all six of these studies.

In addition to time-series epidemiological studies, a limited number of studies examine the cumulative effect of long-term exposure to ozone on mortality. One such recent study (Jerrett et al., 2009) used study population data from the ACS cohort study along with ozone monitoring data and reported a significant association between deaths from respiratory causes and long-term ozone exposure. In a recent review of the 812 Second Prospective Analysis methodology, the Council HES found the use of the Jerrett et al. estimate as the primary estimate premature at this time, due to a lack of corroboration from other cohort studies .[54]

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[53] National Research Council (NRC) (2008). Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution. The National Academies Press, Washington, DC.

[54] See "Health Effects Subcommittee of the Council. Review of EPA's Draft Health Benefits of the Second Section 812 Prospective Study of the Clean Air Act." (EPA-COUNCIL-10-001), available at http://www.epa.gov/advisorycouncilcaa

HEALTH VALUATION FUNCTIONS

In environmental benefit-cost analyses, the dollar value of an environmental benefit, such as improved health or avoidance of a case of illness, is the dollar amount necessary such that the person would be indifferent between experiencing the benefit and possessing the money. In most cases, the dollar amount required to compensate a person for exposure to an adverse effect is roughly the same as the dollar amount a person is willing to pay to avoid the effect. Therefore, in economic terms, the "willingness-to-pay" (WTP) is the appropriate measure of the value of avoiding an adverse effect. For example, the value of an avoided respiratory symptom would be a person's WTP to avoid that symptom.

For most goods, WTP can be observed by examining actual market transactions. For example, if a gallon of bottled drinking water sells for one dollar, it can be observed that at least those persons who choose to purchase that good are willing to pay at least one dollar for the water. For goods that are not exchanged in the market, such as most environmental goods, valuation is not so straightforward. Nevertheless, a value may be inferred from observed behavior, such as through estimation of the WTP for mortality risk reductions based on observed sales and prices of products that result in similar effects or risk reductions, (e.g., non-toxic cleaners or bike helmets). Alternatively, surveys may be used in an attempt to directly elicit WTP for an environmental improvement. Wherever possible in this analysis, we use estimates of mean WTP. In cases where WTP estimates are not available, we use the cost of treating or mitigating the effect as an alternative estimate.

For example, for the valuation of hospital admissions we use the avoided medical costs as an estimate of the value of avoiding the health effects causing the admission. These costs of illness (COI) estimates generally understate the true value of avoiding a health effect. They tend to reflect the direct expenditures related to treatment and not the utility an individual derives from improved health status or avoided health effect. We use a range of values for most environmental effects, to support the primary central estimate of net benefits. Table 5-4 summarizes the mean unit value estimates that we use in this analysis.

Valuation of Premature Mortality

Some forms of air pollution increase the probability that individuals will die prematurely. We use C-R functions for mortality that express the increase in mortality risk as cases of "excess premature mortality" per year. The benefit provided by air pollution reductions, however, is the avoidance of small increases in the risk of mortality. By summing individuals WTP to avoid small increases in risk over enough individuals, we can infer the value of a statistical premature death avoided.[55] For expository purposes, we express this valuation as "dollars per mortality avoided," or "value of a statistical life" (VSL),

[55] Because people are valuing small decreases in the risk of premature mortality, it is expected deaths that are inferred. For example, suppose that a given reduction in pollution confers on each exposed individual a decrease in mortal risk of 1/100,000. Then among 100,000 such individuals, one fewer individual can be expected to die prematurely. If the average individual's WTP for that risk reduction is $50, then the implied value of a statistical premature death avoided in that population is $50 x 100,000 = $5 million.

even though the actual valuation is of small changes in mortality risk experienced by a large number of people. The economic benefits associated with avoiding premature mortality were the largest category of monetized benefits in the First Prospective Analysis and continue to be the largest source of monetized benefits for this Second Prospective Analysis. Mortality benefits, however, are also the largest contributor to the range of uncertainty in monetized benefits.

Because avoided premature mortality benefits are such an important part of this study's results and findings, the remainder of this section provides an expanded discussion of some of the issues in valuing the avoidance of mortality risks from air pollution. We first discuss some characteristics of an "ideal" measure of the value of mortality risk reductions from air pollution, and then review several dimensions in which the current estimates fall short of the ideal measure for this study. For a more detailed discussion of the factors affecting the valuation of premature mortality see the Uncertainty section of this chapter and the *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*.

The health science literature on air pollution indicates that several human characteristics affect the degree to which mortality risk affects an individual. For example, some age groups appear to be more susceptible to air pollution than others (e.g., the elderly and children). Health status prior to exposure also affects susceptibility. At-risk individuals include those who have suffered strokes or are suffering from cardiovascular disease and angina (Rowlatt, et al. 1998). An ideal economic benefits estimate of mortality risk reduction would reflect these human characteristics, in addition to an individual's WTP to improve one's own chances of survival plus WTP to improve other individuals' survival rates.[56] The ideal measure would also take into account the specific nature of the risk reduction that is provided to individuals, as well as the context in which risk is reduced. To measure this value, it is important to assess how reductions in air pollution reduce the risk of dying from the time that reductions take effect onward, and how individuals value these changes. Each individual's survival curve, or the probability of surviving beyond a given age, should shift as a result of an environmental quality improvement. For example, changing the current probability of survival for an individual also shifts future probabilities of that individual's survival. This probability shift will differ across individuals because survival curves are dependent on such characteristics as age, health state, and the current age to which the individual is likely to survive.

[56] For a more detailed discussion of altruistic values related to the value of life, see Jones-Lee (1992).

TABLE 5-4. UNIT VALUES FOR ECONOMIC VALUATION OF HEALTH ENDPOINTS (2006$)

HEALTH ENDPOINT	CENTRAL ESTIMATE OF VALUE PER STATISTICAL INCIDENCE		DERIVATION OF DISTRIBUTIONS OF ESTIMATES
	1990 INCOME LEVEL	2020 INCOME LEVEL	
Premature Mortality (Value of a Statistical Life)	$7,400,000	$8,900,000	Mean Value of Statistical Life (VSL) based 26 wage-risk and contingent valuation studies. A Weibull distribution, with a mean of $7.4 million (in 2006$), provided the best fit to the 26 estimates. Note that VSL represents the value of a small change in mortality risk aggregated over the affected population.
Chronic Bronchitis (CB)	$399,000	$490,000	The WTP to avoid a case of pollution-related CB is calculated as $WTP_x = WTP_{13} \cdot e^{-\beta \cdot (13-x)}$, where x is the severity of an average CB case, WTP13 is the WTP for a severe case of CB, and ß is the parameter distribution of WTP for an air pollution-relevant, average severity-level case of CB was generated by Monte Carlo methods, drawing from each of three distributions: (1) WTP to avoid a severe case of CB is assigned a 1/9 probability of being each of the first nine deciles of the distribution of WTP responses in Viscusi et al. (1991); (2) the severity of a pollution-related case of CB (relative to the case described in the Viscusi study) is assumed to have a triangular distribution, with the most likely value at severity level 6.5 and endpoints at 1.0 and 12.0; and (3) the constant in the elasticity of WTP with respect to severity is normally distributed with mean = 0.18 and standard deviation = 0.0669 (from Krupnick and Cropper (1992)). This process and the rationale for choosing it is described in detail in the Costs and Benefits of the Clean Air Act, 1990 to 2010 (EPA, 1999).
Nonfatal Myocardial Infarction (heart attack) 7% discount rate Age 0-24 Age 25-44 Age 45-54 Age 55-65 Age 66 and over	 $84,171 $93,802 $98,366 $166,222 $84,171		No distributional information available. Age-specific cost-of-illness values reflect lost earnings and direct medical costs over a 5-year period following a nonfatal MI. Lost earnings estimates are based on Cropper and Krupnick (1990). Direct medical costs are based on simple average of estimates from Russell et al. (1998) and Wittels et al. (1990). Lost earnings: Cropper and Krupnick (1990). Present discounted value of 5 years of lost earnings (2006$): age of onset: at 7%[a] 25-44 $9,631 45-54 $14,195 55-65 $82,051 Direct medical expenses: An average of (2006$): 1. Wittels et al. (1990) ($141,124—no discounting) 2. Russell et al. (1998), 5-year period ($28,787 at 3% discount rate; $27,217 at 7% discount rate)

HEALTH ENDPOINT	CENTRAL ESTIMATE OF VALUE PER STATISTICAL INCIDENCE		DERIVATION OF DISTRIBUTIONS OF ESTIMATES
	1990 INCOME LEVEL	2020 INCOME LEVEL	
Hospital Admissions			
All respiratory (ages 65+)	$23,711	$23,711	No distributions available. The COI point estimates (lost earnings plus direct medical costs) are based on ICD-9 code level information (e.g., average hospital care costs and average length of hospital stay) reported in Agency for Healthcare Research and Quality, 2000 (www.ahrq.gov). As noted in the text, no adjustments are made to cost of illness values for income growth.
All respiratory (ages 0-2)	$10,002	$10,002	
Chronic Obstructive Pulmonary Disease (COPD) (ages 65+)	$17,308	$17,308	
Asthma Admissions (ages <65)	$10,040	$10,040	
Pneumonia Admissions (ages 65+)	$23,004	$23,004	
COPD, less asthma (ages 20-64)	$15,903	$15,903	
All Cardiovascular (ages 65+)	$27,319	$27,319	
All Cardiovascular (ages 20-64)	$29,364	$29,364	
Ischemic Heart Disease (ages 65+)	$33,357	$33,357	
Dysrhythmia (ages 65+)	$19,643	$19,643	
Congestive Heart Failure (ages 65+)	$19,619	$19,619	
Emergency Room Visits for Asthma	$369	$369	No distributional information available. Simple average of two unit COI values (2006$): (1) $401.62, from Smith et al. (1997) and (2) $336.03, from Stanford et al. (1999). As noted in the text, no adjustments are made to cost of illness values for income growth.

HEALTH ENDPOINT	CENTRAL ESTIMATE OF VALUE PER STATISTICAL INCIDENCE		DERIVATION OF DISTRIBUTIONS OF ESTIMATES
	1990 INCOME LEVEL	2020 INCOME LEVEL	
Respiratory Ailments Not Requiring Hospitalization			
Upper Respiratory Symptoms (URS)	$28.8	$30.7	Combinations of the three symptoms for which WTP estimates are available that closely match those listed by Pope et al. result in seven different "symptom clusters," each describing a "type" of URS. A dollar value was derived for each type of URS, using mid-range estimates of WTP (IEc, 1994) to avoid each symptom in the cluster and assuming additivity of WTPs. In the absence of information surrounding the frequency with which each of the seven types of URS occurs within the URS symptom complex, we assumed a uniform distribution between $10.8 and $50.5 (2006$).
Lower Respiratory Symptoms (LRS)	$18	$19	Combinations of the four symptoms for which WTP estimates are available that closely match those listed by Schwartz et al. result in 11 different "symptom clusters," each describing a "type" of LRS. A dollar value was derived for each type of LRS, using mid-range estimates of WTP (IEc, 1994) to avoid each symptom in the cluster and assuming additivity of WTPs. The dollar value for LRS is the average of the dollar values for the 11 different types of LRS. In the absence of information surrounding the frequency with which each of the 11 types of LRS occurs within the LRS symptom complex, we assumed a uniform distribution between $8.1 and $28.6 (2006$).
Asthma Exacerbations	$50	$54	Asthma exacerbations are valued at $50 per incidence, based on the mean of average WTP estimates for the four severity definitions of a "bad asthma day," described in Rowe and Chestnut (1986). This study surveyed asthmatics to estimate WTP for avoidance of a "bad asthma day," as defined by the subjects. For purposes of valuation, an asthma exacerbation is assumed to be equivalent to a day in which asthma is moderate or worse as reported in the Rowe and Chestnut (1986) study. The value is assumed have a uniform distribution between $18.3 and $82.9 (2006$).
Acute Bronchitis	$416	$512	Assumes a 6-day episode, with the distribution of the daily value specified as uniform with the low and high values based on those recommended for related respiratory symptoms in Neumann et al. (1994). The low daily estimate of $20.5 (2006$) is the sum of the mid-range values recommended by IEc (1994) for two symptoms believed to be associated with acute bronchitis: coughing and chest tightness. The high daily estimate was taken to be twice the value of a minor respiratory restricted activity day, or $118 (2006$). The low and high daily values are multiplied by six to get the 6-day episode values.
Work Loss Days (WLDs)	Variable (U.S. median = $149)		No distribution available. Point estimate is based on county-specific median annual wages divided by 50 (assuming 2 weeks of vacation) and then by 5—to get median daily wage. U.S. Year 2000 Census, compiled by Geolytics, Inc.
Minor Restricted Activity Days (MRADs)	$59	$64	Median WTP estimate to avoid one MRAD from Tolley et al. (1986). Distribution is assumed to be triangular with a minimum of $24 and a maximum of $94, with a most likely value of $59 (2006$). Range is based on assumption that value should exceed WTP for a single mild symptom (the highest estimate for

HEALTH ENDPOINT	CENTRAL ESTIMATE OF VALUE PER STATISTICAL INCIDENCE		DERIVATION OF DISTRIBUTIONS OF ESTIMATES
	1990 INCOME LEVEL	2020 INCOME LEVEL	
			a single symptom—for eye irritation—is $24) and be less than that for a WLD. The triangular distribution acknowledges that the actual value is likely to be closer to the point estimate than either extreme.
School Loss Days	$89	$89	No distribution available. Point estimate is based on (1) the probability that, if a school child stays home from school, a parent will have to stay home from work to care for the child, and (2) the value of the parent's lost productivity. Calculated using U.S. Bureau of Census data. School loss days, similar to cost of illness estimates for emergency room visits and hospital admissions, are not adjusted for changes in longitudinal income.
a These values are presented using a seven percent discount rate for this draft report, however these results will be presented using a five percent discount rate in the final report.			

A survival curve approach provides a theoretically preferred method for valuing the economic benefits of reduced risk of premature mortality associated with reducing air pollution, but the approach does not align well with current estimates of individual willingness to pay to avoid mortal risks. We have adopted the survival curve approach in the population simulation model that we use to generate estimates of life years lost and reduced life expectancy associated with air pollution, but implementing that approach requires that we use a national measure of the change in air pollution exposure, and also does not include a valuation component. As a result, the population simulation model results are not used for the primary results.

The Project Team also considered whether other evidence might support an adjustment to the VSL used in this study, particularly to account for the age of individuals affected. In general, studies of WTP to reduce mortality risk do not provide information on how VSL varies with life expectancy, but there are a few studies that attempt to assess the impact of age on VSL.[57] Some economic models in the theoretical literature suggest that VSL follows an inverted U, rising through middle age and falling at older ages, though this model is only partially supported by the relevant empirical evidence (Johansson 2002, Hammitt 2007). For example, revealed preference studies of the wage-risk literature support the inverted-U hypothesis (Aldy and Viscusi, 2007). These studies are limited, however, in that they necessarily include only employed workers and thereby exclude the elderly and those in poor health. Stated-preference studies, which can include a broader population, yield mixed results. Some suggest little or no effect of age on VSL and others suggest a modest decrease at older ages (Krupnick, 2007). Some studies, such as those by DeShazo (with Cameron, 2004), Chestnut (et al., 2004), and Alberini (et al., 2004) have found the effect of age on VSL to be statistically weak, suggesting a flatter relationship of VSL and age with a decline in VSL at much older ages. Consistent with Hammitt (2007), we conclude that there is insufficient evidence in the empirical VSL literature at this time to support an adjustment to the base VSL for the age of the affected population.

In sum, the economic valuation literature does not yet include good estimates of the value of this particular risk reduction commodity. As a result, in this study we value avoided premature mortality risk using the value of statistical life approach. As in the First Prospective Analysis, we use a mortality risk valuation estimate which is based on an analysis of 26 policy-relevant value-of-life studies (see Table 5-5). Five of the 26 studies are contingent valuation (CV) studies, which directly solicit WTP information from subjects; the remaining studies are wage-risk studies, which base WTP estimates on estimates of the additional compensation demanded in the labor market for riskier jobs.

[57] For a review of these studies, and this issue in particular see, for example, Hammitt (2007), Aldy and Viscusi (2007), and Krupnick (2007).

We used the best estimate from each of the 26 studies to construct a distribution of mortality risk valuation estimates for the section 812 study. A Weibull distribution, with a mean of $7.4 million (in 2006$), provided the best fit to the 26 estimates.

An additional uncertainty that is pertinent for this study's results is the potential bias in using estimates of VSL that correspond to small changes in risk for the relatively larger changes in mortality risk estimated in this study. As the results section below indicates, the large changes in $PM_{2.5}$ that represent the difference between the *with-CAAA* and *without-CAAA* scenarios by 2020 lead to a change in annual mortality risk of approximately 1 in one thousand for adults aged 25 and older, or 7 in ten thousand for all ages, which corresponds to a roughly ten percent change from the national baseline mortality risk of approximately 1 in one hundred.[58] This risk change is large compared to the mean mortality risk faced by subjects in the wage-risk studies that underlie our estimate of VSL – the mean risk for individual studies in our group of 26 varies from 4 in 10,000 to 5 in 100,000, although clearly some individuals in those samples face higher individual risks.[59] Economic theory suggests that individuals' incremental willingness to pay to reduce mortality risk declines with an increasing size of the risk increment, but the rate at which it declines is uncertain.[60] Estimates of differences in VSL across individuals in wage-risk study samples are also not informative, because they reflect variability in individuals' risk tolerance rather than differences in WTP across a population for varying increments of risk reduction. Further, it is not clear whether, in this context, the external risk imposed by air polluters on the exposed population implies that willingness-to-accept-compensation (WTAC) to forgo air quality improvement may be the more relevant measure. There is some theoretical work which suggests that, while valuation of a large risk increment may lead WTP estimates to be overestimated, it may lead WTAC estimates to be underestimated.[61] Although the Project Team remains concerned that there may be a potentially important disparity between the large increment of risk valued in this study and relatively smaller increments of risk valued in the underlying VSL literature, we conclude that the current literature does not provide a sufficient basis to make a quantitative adjustment to our base VSL values to account for this factor.

When valuing premature mortality for PM, we assume a lag between reduced PM exposure and the resulting reductions in incidences of premature mortality.[62] This lag

[58] Note that we are here reporting the total risk change that results from changes in 2020 exposures. As outlined below, this risk is not immediate - instead we model this risk as occurring with latency over the course of the ensuing 20 years.

[59] See W. Kip Viscusi, 1992, *Fatal Tradeoffs*, (Oxford University Press: New York), Table 4-1.

[60] This issue is discussed to some extent in Thomas J. Kniesner, W. Kip Viscusi, and James P. Ziliak (2010), "Policy relevant heterogeneity in the value of statistical life: New evidence from panel data quantile regressions," *Journal of Risk and Uncertainty* 40:15-31.

[61] See discussion papers provided in support of a recent EPA risk valuation workshop at http://www.epa.gov/air/toxicair/2009workshop.html (accessed November 24, 2010) in particular the papers and presentations by W. Kip Viscusi.

[62] Note that we do not employ a cessation lag for ozone mortality due to our reliance on short-term studies to estimate these benefits.

does not affect the number of estimated incidences, but does alter the monetization of benefits. Because we value the "event" rather than the present risk, in this analysis we assume that the value of avoided future premature mortality should be discounted. The primary estimate reflects a 20-year distributed lag structure, which was recommended by the Council HES (2004). Under this scenario, 30 percent of the mortality reductions occur in the first year, 50 percent occur equally in years two through five, and the remaining 20 percent occur equally in years six through 20. Our valuation of avoided premature mortality applies a five percent discount rate to the lagged estimates over the periods 2000 to 2020, 2010 to 2030 and 2020 to 2040. We discount over the period between the initial PM exposure change (2000, 2010, or 2020) and the timing of the resulting change in incidence.

TABLE 5-5. SUMMARY OF MORTALITY VALUATION ESTIMATES PER STATISTICAL INCIDENCE OF PREMATURE MORTALITY (MILLIONS OF 2006$)

STUDY	TYPE OF ESTIMATE	VALUATION (MILLIONS 2006$)
Kneisner and Leeth (1991) (US)	Labor Market	$ 0.9
Smith and Gilbert (1984)	Labor Market	$ 1.1
Dillingham (1985)	Labor Market	$ 1.4
Butler (1983)	Labor Market	$ 1.7
Miller and Guria (1991)	Contingent Valuation	$ 1.9
Moore and Viscusi (1988a)	Labor Market	$ 3.9
Viscusi, Magat, and Huber (1991b)	Contingent Valuation	$ 4.2
Gegax et al. (1985)	Contingent Valuation	$ 5.1
Marin and Psacharopoulos (1982)	Labor Market	$ 4.3
Kneisner and Leeth (1991) (Australia)	Labor Market	$ 5.1
Gerking, de Haan, and Schulze (1988)	Contingent Valuation	$ 5.2
Cousineau, Lacroix, and Girard (1988)	Labor Market	$ 5.6
Jones-Lee (1989)	Contingent Valuation	$ 5.9
Dillingham (1985)	Labor Market	$ 6.0
Viscusi (1978, 1979)	Labor Market	$ 6.3
R.S. Smith (1976)	Labor Market	$ 7.1
V.K. Smith (1976)	Labor Market	$ 7.2
Olson (1981)	Labor Market	$ 8.0
Viscusi (1981)	Labor Market	$ 10.0
R.S. Smith (1974)	Labor Market	$ 11.1
Moore and Viscusi (1988a)	Labor Market	$ 11.3
Kneisner and Leeth (1991) (Japan)	Labor Market	$ 11.7
Herzog and Schlottman (1987)	Labor Market	$ 14.0
Leigh and Folson (1984)	Labor Market	$ 15.0
Leigh (1987)	Labor Market	$ 16.0
Garen (1988)	Labor Market	$ 20.8
Source: Viscusi, 1992 and EPA analysis.		

HEALTH EFFECTS MODELING RESULTS

This section presents a summary of the differences in health effects resulting from improvements in air quality between the *with-CAAA* and the *without-CAAA* scenarios. Table 5-6 summarizes the CAAA-related avoided health effects in 2020 for each health endpoint included in the analysis and the associated monetary benefits. The mean estimate is presented as the primary central estimate, the 5th percentile observation is presented as the primary low estimate and the 95th percentile is presented as the primary high estimate.[63] In general, because the differences in air quality between the *with-* and *without-CAAA* scenarios are expected to increase from 1990 to 2020 and because population is also expected to increase during that time, the health benefits attributable to the CAAA are expected to increase consistently from 1990 to 2020. More detailed results can be found in *Health and Welfare Benefits Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, February 2011.

AVOIDED PREMATURE MORTALITY ESTIMATES

Our analysis indicates that the benefit of avoided premature mortality risk reduction dominates the overall net benefit estimate. This is, in part, due to the high monetary value assigned to the avoidance of premature mortality relative to the unit value of other health endpoints. As described in detail in this chapter, there are also significant reductions in other short-term and chronic health effects and a substantial number of health benefits that we could not quantify or monetize. Mean results for all three target years are provided in Table 5-6, and the mean, primary low, and primary high estimates for 2020 are presented in Table 5-7.

As shown in Table 5-7, our primary central estimate implies that PM and ozone reductions due to the CAAA in 2020 will result in 230,000 avoided deaths, with a primary low and primary high bound on this estimate of 45,000 and 490,000 avoided deaths, respectively. These avoided deaths are valued at $1.8 trillion (2006$), with primary low and primary high bounds on this estimate of $170 billion to $5.5 trillion. To provide some context for these large values, we estimated the per capita risk change and monetized benefits. The estimated 230,000 avoided deaths in 2020 are equivalent to a total annual mortality risk reduction of 6.8×10^{-4} for the full estimated US population in 2020. With approximately 2.4 million estimated deaths in 2002, the avoided deaths in 2020 would increase total deaths by about 9.5 percent. The 230,000 avoided deaths are about 16 percent of the total mortality from the top four causes of death in the US in 2002: heart disease (over 600,000 deaths); cancer (over 550,000 deaths); stroke (over 130,000 deaths); and chronic lower respiratory disease (just less than 130,000 deaths). The monetized benefit per capita in 2020 is about $6,000, increasing from $2,700 in 2000 and $4,200 in 2010. Monetized benefits per household would be approximately $16,000 in 2020, increasing from $7,300 in 2000 and $11,000 in 2010.

[63] The distribution of incidence results represent the uncertainty associated with the coefficient of the C-R function for each health endpoint. The distribution around the monetized benefits estimate reflects both uncertainty in the incidence as well as uncertainty associated with the valuation estimate.

TABLE 5-6. MEAN CAAA-RELATED AVOIDED ANNUAL INCIDENCE OF HEALTH EFFECTS AND ASSOCIATED MONETARY VALUATION IN 2000, 2010, AND 2020

		INCIDENCE			VALUATION (MILLIONS 2006$)		
ENDPOINT	POLLUTANT	2000	2010	2020	2000	2010	2020
Mortality							
Mortality - adults 30 and older	PM	110,000	160,000	230,000	$710,000	$1,200,000	$1,700,000
Mortality - infant	PM	160	230	280	$1,300	$1,900	$2,500
Mortality - all ages	Ozone	1,400	4,300	7,100	$10,000	$33,000	$55,000
Morbidity							
Chronic Bronchitis	PM	34,000	54,000	75,000	$14,000	$24,000	$36,000
Non-fatal Myocardial Infarction	PM	79,000	130,000	200,000	$8,100	$14,000	$21,000
Hospital Admissions, Respiratory	PM, Ozone	20,000	41,000	66,000	$290	$640	$1,100
Hospital Admissions, Cardiovascular	PM	26,000	45,000	69,000	$760	$1,300	$2,000
Emergency Room Visits, Respiratory	PM, Ozone	58,000	86,000	120,000	$21	$32	$44
Acute Bronchitis	PM	96,000	130,000	180,000	$42	$61	$94
Lower Respiratory Symptoms	PM	1,200,000	1,700,000	2,300,000	$22	$30	$42
Upper Respiratory Symptoms	PM	980,000	1,400,000	2,000,000	$30	$42	$60
Asthma Exacerbation	PM	1,200,000	1,700,000	2,400,000	$61	$90	$130
Minor Restricted Activity Days	PM, Ozone	49,000,000	84,000,000	110,000,000	$2,900	$4,900	$6,700
Work Loss Days	PM	8,000,000	13,000,000	17,000,000	$1,300	$2,000	$2,700
School Loss Days	Ozone	1,200,000	3,200,000	5,400,000	$110	$290	$480
Outdoor Worker Productivity	Ozone	N/A	N/A	N/A	$30	$100	$170

Note: All incidence and valuation results are rounded to two significant figures. All estimates are annual estimates for individual target years of the analysis. Mortality valuation estimates reflect a delay in mortality incidence from the time of the exposure change in the target year, reflecting application of a 20-year distributed cessation lag as described in the text and a 5 percent discount rate.

It may also be worth noting that most of the changes in mortality risk we estimate occur in locations where both the *with-CAAA* and *without-CAAA* concentrations are above the lowest measured level (LML) in the underlying epidemiological studies. As noted above, standard EPA practice is to estimate PM-related mortality without applying an assumed concentration threshold, and the LML is itself not a threshold either. The LML approach summarizes the distribution of avoided PM mortality impacts according to the baseline $PM_{2.5}$ levels experienced by the population receiving the $PM_{2.5}$ mortality benefit. Unlike an assumed threshold, the LML is a characterization of the fraction of benefits that are more uncertain. In general, our confidence in the estimated PM mortality decreases as we

consider air quality levels further below the LML in the two underlying PM-mortality epidemiological studies, Pope et al. (2002) and Laden et al. (2006).

TABLE 5-7. CAAA-RELATED AVOIDED ANNUAL INCIDENCE OF HEALTH EFFECTS AND ASSOCIATED MONETARY VALUATION IN 2020

		INCIDENCE			VALUATION (MILLIONS 2006$)		
ENDPOINT	POLLUTANT	5TH %ILE	MEAN	95TH %ILE	5TH %ILE	MEAN	95TH %ILE
Mortality							
Mortality[1]	PM, Ozone	45,000	230,000	490,000	$170,000	$1,800,000	$5,500,000
Morbidity							
Chronic Bronchitis	PM	12,000	75,000	130,000	$3,100	$36,000	$130,000
Non-fatal Myocardial Infarction	PM	80,000	200,000	300,000	$6,200	$21,000	$48,000
Hospital Admissions, Respiratory	PM, Ozone	24,000	66,000	110,000	$320	$1,100	$1,800
Hospital Admissions, Cardiovascular	PM	52,000	69,000	84,000	$1,400	$2,000	$2,600
Emergency Room Visits, Respiratory	PM, Ozone	64,000	120,000	180,000	$22	$44	$69
Acute Bronchitis	PM	-7,000	180,000	340,000	-$4	$94	$220
Lower Respiratory Symptoms	PM	1,200,000	2,300,000	3,300,000	$18	$42	$76
Upper Respiratory Symptoms	PM	620,000	2,000,000	3,300,000	$17	$60	$130
Asthma Exacerbation	PM	270,000	2,400,000	6,700,000	$15	$130	$390
Minor Restricted Activity Days	PM, Ozone	91,000,000	110,000,000	140,000,000	$3,800	$6,700	$10,000
Work Loss Days	PM	15,000,000	17,000,000	19,000,000	$2,300	$2,700	$3,000
School Loss Days	Ozone	2,200,000	5,400,000	8,600,000	$190	$480	$770
Outdoor Worker Productivity	Ozone	N/A	N/A	N/A	$170	$170	$170

Notes:
[1] Includes adult and infant mortality for PM and all ages for ozone.
All incidence and valuation results are rounded to two significant figures. Mortality valuation estimates reflect a delay in mortality incidence from the time of the exposure change in the target year, reflecting application of a 20-year distributed cessation lag as described in the text and a 5 percent discount rate.

Using the Pope et al. (2002) study, approximately 98 percent of the mortality impacts occur among populations with exposure to annual mean $PM_{2.5}$ levels at or above the LML of 7.5 $\mu g/m^3$. Using the Laden et al. (2006) study, approximately 91 percent of the mortality impacts occur at or above the LML of 10 $\mu g/m^3$. These analyses confirm that the great majority of the mortality benefits occur at or above the cohort study LMLs.

Avoided premature mortality is one of the more commonly cited results of benefits analyses for air pollution control. However, as noted in the valuation section of this chapter, a more accurate description of the benefit of clean air is a reduction in the risk of mortality for the exposed population over many years, which results in the extension of lives (sometimes referred to as "lives saved"). Other useful metrics of the benefit of cleaner air are the number of life years that are gained through the reduction of mortal risks, and the number of years of life expectancy gained on average throughout the population. We estimated these metrics through the application of a population simulation tool – effectively, we simulated the process of gradually reducing mortality risk from air pollution across all individuals in the US 30 years old and older, starting in 1990 and continuing through 2020. In addition, we tracked the impact of these effects, held constant at the 2020 levels, for an additional 30 years, through 2050. Running the simulation beyond 2020 allows us to estimate the full effect of changes that begin in 2020, which because of the cessation lag are not fully realized until many years after the end of the study period. Comparing the estimated population in each age cohort across the two scenarios allows us to estimate gains in life-years (i.e., one additional person in a cohort for one year yields a life year gained), and summing across cohorts and years yields cumulative estimates. In addition, analysis of the changes in mortality risk among cohorts older than a specific age yields estimates of life expectancy gains at specific ages.[64]

The results of these calculations are presented in Table 5-8 below, and provide further evidence of the substantial benefits of CAAA during and after the 1990-2020 period. The first panel of the table provides estimates of life-years gained for 2020 and 2040 – these are estimates of the life-years gained only in that year of the simulation, but reflect the cumulative effect of mortality risk reductions in prior years. The next panel provides estimates of cumulative life years gained overall all years since 1990, first for the 1990-2020 period, and then for the 1990-2040 period, inclusive.

As expected, life-years gained are largest in the older cohorts, particularly cohorts 60 years and older, and they increase over time as the effect of mortality risk reduction in successive years increases survival rates among all individuals age 30 and over. By 2020, the cumulative effects indicate 22 million life-years are gained from the air pollution mortality risk reduction.

The last panel provides the life expectancy results. As early as 2010, the CAAA increased life expectancy at 30 years by 0.65 years, with somewhat smaller gains among older cohorts. By 2040, the full effect of the CAAA on life expectancy is realized, with a total gain in life expectancy of almost one year at age 30 across the entire US population.

[64] For a detailed description of the model, see the related report, *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, March 2010, and Industrial Economics, Inc. (2006).

TABLE 5-8. LIFE YEARS GAINED AND LIFE EXPECTANCY GAIN ESTIMATES FROM THE POPULATION SIMULATION MODEL

AGE COHORT		LIFE-YEARS GAINED IN SPECIFIC YEARS (ANNUAL)		CUMULATIVE LIFE YEARS GAINED THROUGH TARGET YEAR		LIFE EXPECTANCY GAINS (YEARS)		
START AGE	END AGE	2020	2040	2020	2040	2010	2020	2040
30	39	17,000	18,000	260,000	620,000	0.65	0.87	0.91
40	49	60,000	71,000	910,000	2,300,000	0.63	0.84	0.88
50	59	150,000	180,000	2,000,000	5,400,000	0.59	0.79	0.84
60	69	330,000	380,000	3,500,000	11,000,000	0.53	0.71	0.76
70	79	470,000	840,000	5,000,000	20,000,000	0.44	0.59	0.64
80	89	470,000	1,200,000	6,000,000	23,000,000	0.32	0.43	0.48
90	99	320,000	800,000	3,600,000	14,000,000	0.19	0.25	0.27
100+		60,000	200,000	490,000	3,100,000	0	0	0
Total		1,900,000	3,800,000	22,000,000	80,000,000			

Note: Column entries to not add to totals due to rounding. Life expectancy results are incremental period conditional life expectancy gains at the start age of the cohort.

NON-FATAL HEALTH IMPACTS

We report non-fatal health effects estimates in a similar manner to estimates of premature mortality – as a range of estimates for each quantified health endpoint, with the range dependent on the quantified uncertainties in the underlying C-R functions. The range of results for 2020 is characterized in Table 5-6 with 5th percentile, mean, and 95th percentile estimates which correspond to the primary low, central, and high estimates. All estimates are expressed as new cases avoided in 2020, with the following exceptions. Hospital admissions reflect admissions for a range of respiratory and cardiovascular diseases and these results, along with emergency room visits for respiratory disease, do not necessarily represent the avoidance of new cases of disease (i.e., air pollution may simply exacerbate an existing condition, resulting in an emergency room visit or hospital admission). Further, each admission is only counted once, regardless of the length of stay in the hospital. Minor restricted activity days, school loss days, and work loss days are expressed in terms of person-days. For instance, one "case" of a school loss day represents one person out of school for one day.

AVOIDED HEALTH EFFECTS OF AIR TOXICS

The prior discussion focuses on the effects of the 1990 CAAA on particulate matter and ozone health effects, but the Amendments also address the control of air toxics or hazardous air pollutants (HAPs). HAPs are pollutants regulated under Title III of the CAAA that can cause adverse effects to human health and ecological resources. The Amendments establish a list of HAPs to be regulated, require EPA to establish air toxic

emissions standards based on Maximum Achievable Control Technology (MACT) standards, and include a provision that requires EPA to establish more stringent air toxics standards if MACT controls do not sufficiently protect the public health against residual risks. Control of air toxics is expected to result both from these changes and from incidental control due to changes in criteria pollutant programs, such as controls on volatile organic compounds (VOCs) necessary to achieve the NAAQS for ambient tropospheric ozone.

Both the Retrospective analysis and the First Prospective analysis omitted a quantitative estimation of the benefits of reduced concentrations of air toxics, citing gaps in the toxicological database, difficulty in designing population-based epidemiological studies with sufficient power to detect health effects, limited ambient and personal exposure monitoring data, limited data to estimate exposures in some critical microenvironments, and insufficient economic research to support valuation of the types of health impacts often associated with exposure to individual air toxics. Based on a recommendation by the Council, EPA developed a case study of the benefits of CAAA controls on benzene emissions in the Houston area (USEPA, 2001).[65] The purpose of the case study was to demonstrate a methodology that could be used to generate human health benefits from CAAA controls on a single HAP in an urban setting, while highlighting key limitations and uncertainties in the process. In addition, EPA hoped to gain insight into the use of the case study methodology for characterizing benefits nationwide. The case study was not intended, however, to provide a comprehensive assessment of the benefits of benzene reductions due to the CAAA.

The case study involved calculating the reduction in the annual number of cases of leukemia due to reductions in benzene levels resulting from the 1990 CAAA through the year 2020 in the Houston metropolitan area. Benzene was selected for the case study due to the availability of human epidemiological studies linking its exposure with adverse health effects. The case study focused on Houston because of the presence of significant large benzene emitting sources, such as petroleum refineries, as well as sources more typical of other urban areas, such as gasoline refueling stations.

We conducted the case study using the same five steps used in the main 812 criteria pollutant analysis:

1. **Scenario Development**: We assessed benefits from the reduction in benzene concentrations between a *without-CAAA* scenario, which essentially freezes federal, state, and local air pollution controls at the levels of stringency and effectiveness that existed in 1990, and a *with-CAAA* scenario, which assumes that all federal, state, and local rules promulgated pursuant to, or in support of, the 1990 CAAA were implemented.

[65] A detailed report of the case study methodology and results was completed by Industrial Economics, Inc (IEc, 2009). This report can be downloaded from the following website: www.epa.gov/oar/sect812

2. **Emissions Estimation**: We estimated benzene emissions in the Houston area under both the *with-CAAA* and *without-CAAA* scenarios by extrapolating data based on expected growth in emissions-generating activities over time, adjusted for the impact of future year control assumptions under each scenario.

3. **Air Quality and Exposure Modeling**: We then applied EPA's American Meteorological Society/Regulatory Model (AERMOD) dispersion modeling system (USEPA, 2004) to convert emissions estimates to ambient benzene concentrations at the Census block group level. The AERMOD output was then run through EPA's Hazardous Air Pollutant Exposure Model, Version 6 (HAPEM6; ICF International, 2007) to generate benzene exposure concentrations for the study population at the Census tract level, which reflect average benzene concentrations likely experienced by the study population as they carry out their daily activities.

4. **Health Effects Modeling**: We next estimated avoided cases of leukemia using a life-table based risk assessment model. The life-table model assessed age-specific risks at the Census tract level, based on county-level background rates of leukemia, age-specific benzene exposure data from HAPEM6 and an epidemiological dose-response function derived from a study of occupational benzene exposures (Crump, 1994).[66] The model yielded annual age-specific Census tract-level avoided cases of leukemia (fatal and non-fatal) for each target year. We also estimated the number of cases expected to occur after the end of the study period resulting from CAAA-related benzene changes within the study period, due to lagging effects of these changes on leukemia risks.

5. **Valuation**: We then applied valuation methods from the current economic literature to assign monetary value to the avoided leukemia cases. This included valuing fatal cancers using the VSL estimate used in the primary 812 analysis (i.e., the Weibull distribution based on 26 studies) with an adjustment for medical costs associated with the period of cancer illness leading up to death (i.e., "pre-mortality morbidity").[67] We valued non-fatal cancers using two bounding estimates, a WTP value for chronic bronchitis and one from a health risk tradeoff study that provided a value for avoiding a case of non-fatal lymphoma.[68]

Table 5-9 presents our primary estimate for avoided fatal and non-fatal cases of leukemia due to CAAA-related changes in ambient benzene levels in the Houston area. It includes the number of expected annual cases avoided in each study year as well as the total cumulative avoided cases throughout the study period and the total cumulative avoided cases expected to occur after 2020, due to changes in benzene occurring within the study

[66] This study is also the basis for the Inhalation Unit Risk (IUR) published on EPA's Integrated Risk Information System (IRIS) (USEPA, 1998).

[67] This estimate was based on a value presented in EPA's Cost of Illness Handbook (USEPA, 1999) for a "typical" cancer case.

[68] The chronic bronchitis value is the same as that used in EPA's Regulatory Impact Analysis (RIA) for the PM National Ambient Air Quality Standards (NAAQS) (USEPA, 2006). The non-fatal lymphoma value was derived by using the risk-risk ratio from Magat et al. (1996) along with our primary VSL estimate.

period. It also shows the monetary value (the 1990 net present value (NPV), using a five percent discount rate) of these avoided leukemia cases.

Our results indicate that by the year 2020, the change in benzene-related population risk due to the 1990 CAAA programs would be equivalent to a total of four cases of leukemia in the Houston area, with three of those occurring in Harris County, the most densely populated county included in the analysis. We estimated two of the four cases to be fatal and two to be non-fatal. Our primary central estimate of total benefits due to CAAA-related reductions in benzene is $8.9 to 13 million (in 2006$), $8.5 million of which is due to fatal cases of leukemia, and $0.4 to 4.1 million of which is due to non-fatal cases.

In addition to the leukemia analysis, we evaluated the numbers of individuals likely to be exposed to benzene at levels exceeding EPA's chronic reference concentration (RfC) for benzene, which is based on changes in white blood cell counts, under the *with-CAAA* and *without-CAAA* scenarios. We found no individuals exposed to benzene at concentrations exceeding the RfC in either the *with-CAAA* or *without-CAAA* scenario. We also conducted illustrative analyses of exposure and risk reductions to highly exposed subpopulations in the study area, and found potentially significant individual risk reductions due to the CAAA for individuals in these groups. For instance, a back-of-the envelope calculation of residents living in homes with attached garages, who are expected to have higher benzene exposures, suggests that adding attached garage-related benefits to our primary estimate could result in an approximate doubling of our primary estimate.

The effect of the CAAA on lifetime risks of benzene-induced leukemia for Houston residents at the Census tract level is explored in Figure 5-2. The map on the left displays the distribution of leukemia risks based on benzene exposures levels expected in 2020 under the *without-CAAA* scenario. The highest risk levels (i.e., greater than one-in-one hundred thousand) occur in Harris County in the downtown Houston area (within the rings of the interstate), in the Texas City area of Galveston County where a number of refineries and chemical facilities are located and in southeastern Brazoria County, which also features major chemical manufacturing and petroleum refining facilities. The map on the right shows the distribution in the magnitude of CAAA-related risk reductions throughout the Houston area. The highest risk reductions (i.e., greater than a factor of three) coincide with the areas identified as those with the highest risks in the first map. For instance, the CAAA is expected to reduce risks significantly in the highly populated downtown Houston area, where residents are expected to have risks on the order of one-in-one hundred thousand or greater.

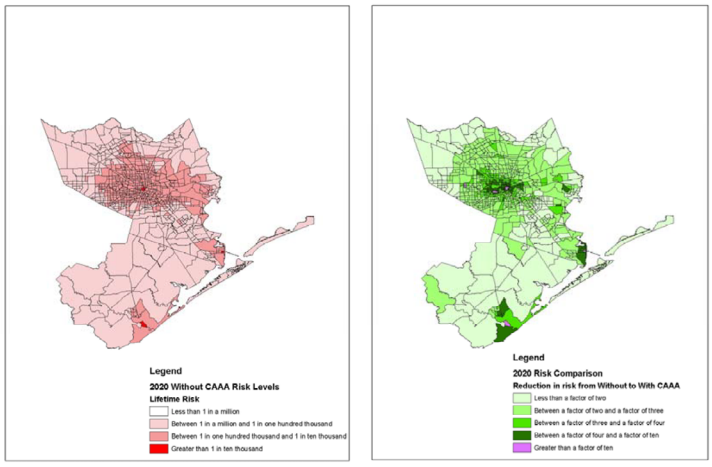
TABLE 5-9. TOTAL ANNUAL BENEFITS FOR EACH STUDY YEAR FROM CAAA-RELATED CHANGES IN BENZENE EXPOSURE IN THE HOUSTON AREA

	ANNUAL AVOIDED CASES OF LEUKEMIA			TOTAL MONETARY BENEFITS, 1990 TO 2010 (1990 NPV, MILLIONS OF 2006$, 5% DISCOUNT RATE)		
	AVOIDED FATAL CASES	AVOIDED NON-FATAL CASES	TOTAL AVOIDED CASES	BENEFITS FROM FATAL CASES OF LEUKEMIA	BENEFITS FROM NON-FATAL CASES OF LEUKEMIA	TOTAL BENEFITS
Results by Study Year						
2000	0.03	0.02	**0.05**	$0.12	$0.01 - 0.06	**$0.13 - 0.18**
2010	0.09	0.07	**0.2**	$0.27	$0.01 - 0.13	**$0.28 - 0.40**
2020	0.2	0.1	**0.3**	$0.31	$0.01 - 0.15	**$0.32 - 0.46**
Cumulative Results						
Cumulative Cases Occurring Within the Study Period	**2**	**2**	**4**	**$6.7**	**$0.32 - 3.3**	**$7.0 - 10**
Additional Cumulative Cases Occurring After 2020*	**1**	**1**	**2**	**$1.8**	**$0.08 - 0.8**	**$1.9 - 2.6**
Total Cumulative Cases	**3**	**3**	**6**	**$8.5**	**$0.40 - 4.1**	**$8.9 - 13**

* Note: These avoided cases are due to changes in benzene exposure that took place within the study period. However, the cases occurred after 2020 due to lagging effects of these changes on leukemia risks, as described in the text.

In summary, this case study demonstrates that the 1990 CAAA controls on benzene emissions are expected to result in reductions in the incidence of leukemia in the greater Houston area over the period 1990 to 2020. The case study does have some limitations, including possible underestimation of benzene emissions from large point sources (e.g., refineries), possible exclusion of unquantifiable adverse health effects of benzene (e.g., Hodgkin's and non-Hodgkin's Lymphoma), and exclusion of new programs established after the case study (e.g., Mobile Source Air Toxics Rule). However, it successfully demonstrates a methodology that can serve as a useful tool in EPA's evolving HAP benefits assessment strategy. It can provide a comprehensive assessment of the impact of benzene controls from multiple CAAA Titles on cancer incidence in an urban population, using a combination of national and local data to conduct urban-scale modeling of air quality and health impacts. Further, the life-table model allows for more careful assessment of risk changes over time at the Census tract level, incorporating local, age-specific baseline incidence data with age-specific exposure data and information on the lag between exposure changes and risk reductions.

FIGURE 5-2. EFFECT OF THE CAAA ON LIFETIME RISKS OF BENZENE-RELATED LEUKEMIA IN THE HOUSTON AREA



Determining where this approach might fit within EPA's HAP benefits assessment strategy will require additional analysis and evaluation to determine the added value of the detailed, urban-scale approach, as well as the potential pool of HAPs suitable for assessment via the damage-function approach for cancer and/or non-cancer effects.

COMPARISON OF HEALTH EFFECTS MODELING WITH FIRST PROSPECTIVE ANALYSIS

DIFFERENCES IN METHODOLOGY

In comparison with the First Prospective 812 Analysis, the Second Prospective includes a number of refinements and improvements in health benefits estimation methods.

- *Targeted Criteria Pollutant Analysis:* The Second Prospective excludes benefits of CAAA-related reductions in carbon monoxide, nitrogen oxides, and sulfur dioxide, which were included in the First Prospective, in an effort to streamline the quantitative analysis to focus on the two criteria pollutants that yield the greatest benefits – $PM_{2.5}$ and ozone.
- *New Cessation Lag Structure for PM Mortality:* The Second Prospective relies on the use of a 20-year distributed lag structure assumption for the cessation lag between changes in PM exposure and resulting changes in premature mortality. This estimate represents a shift from the First Prospective, which applied a 5-year distributed lag based on smoking cessation literature. The 20-year distributed lag is based on recommendations from the Council HES, is derived from air pollution literature and attempts to more closely reflect the disease processes that occur from PM exposure.[69]
- *New C-R Function for PM Mortality:* The First Prospective relied upon a C-R function derived from the most recently published ACS cohort study at the time (Pope et al., 1995). Since this time, additional follow-up has occurred for both the ACS and Six Cities cohort studies. In addition, new evidence has emerged on the ACS study results that suggest that this estimate is potentially underestimated. Our new primary C-R function mean is based on the follow-up literature, specifically the Pope et al. (2002) update of the ACS cohort and the Laden et al. (2006) update of the Six Cities cohort. Our new C-R function also reflects the results of an expert elicitation study, which allowed experts to incorporate multiple sources of uncertainty in the C-R function and to adjust the C-R function estimates to account for known biases.
- *Ozone Mortality Benefits Estimates:* The Second Prospective includes ozone-related premature mortality. This additional endpoint, which was not included in the First Prospective, was added because of advances that have occurred in the epidemiological literature that provide consistent evidence for this health endpoint.[70]

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[69] Science Advisory Board (2004). *Advisory on Plans for Health Effects Analysis in the Analytical Plan for EPA's Second Prospective Analysis—Benefits and Costs of the Clean Air Act, 1990-2020: Advisory by the Health Effects Subcommittee of the Advisory Council on Clean Air Compliance Analysis.* EPA-SAB-COUNCIL-ADV-04-002.

[70] As noted earlier, a key recommendation of NRC (2008) was that ozone mortality estimates from available epidemiological studies represent a separate and additive effect to those from PM/mortality epidemiological studies.

- *New Health Benefits Modeling Program:* The Second Prospective relies on EPA's BenMAP health benefits modeling program. Key advantages of the updated model are ease of use, allowing us to more readily perform multiple sensitivity tests; updated population and baseline incidence estimates; new C-R function options; and the ability to perform integrated exposure analysis using the eVNA method described earlier.
- *Air Toxics Case Study:* The Second Prospective includes the results of a case study demonstrating a methodology for assessing health benefits from a single hazardous air pollutant.

DIFFERENCES IN HEALTH EFFECTS MODELING RESULTS

The health effects estimates for the Second Prospective are much larger than the estimates EPA developed for the First Prospective. The 2020 estimates are new to the Second Prospective, but the comparable mean estimate of health benefits in 2000 and 2010 for the First Prospective were $71 billion in 2000 and $110 billion in 2010, in 1990$[71] - if updated to 2006$, these estimates would be $110 billion in 2000 and $170 billion in 2010. The Second Prospective results are larger by roughly a factor of 10. There are four key reasons we have identified for the increase in benefits:

1. ***Scenario differences*:** The *with-CAAA* scenario, especially for the 2010 target year, includes new rules with substantial additional pollutant reductions that were not included in the comparable First Prospective scenario, such as the Clean Air Interstate Rule (CAIR).
2. ***Improved air quality models*:** The First Prospective relied on the Regional Acid Deposition Model/Regional Particulate Model (RADM/RPM) for PM and deposition estimates in the eastern U.S., the Regulatory Modeling System for Aerosols and Acid Deposition (REMSAD) for PM estimates in the western U.S., and the Urban Airshed Model (versions V and IV) at various regional and urban scales to generate ozone estimates. The Second Prospective relies on the integrated CMAQ modeling tool, which reflects substantial improvements in air quality modeling, provides more comprehensive spatial coverage, and achieves improved model performance.
3. ***Better, more comprehensive exposure estimates*:** The First Prospective relied on first generation exposure extrapolation tools to generate monitor-adjusted exposure estimates away from monitors. Since then, the monitor network, availability of speciated data, and the performance of speciated exposure estimation tools have improved substantially.
4. ***Updated dose-response estimates***: Since 1999, some concentration response functions have been updated, most notably the PM-premature mortality C/R function, whose central estimate of the mortality impact of fine PM has nearly doubled. In

[71] See The Benefits and Costs of the Clean Air Act 1990 to 2010, USEPA Office of Air and Radiation and Office of Policy, EPA-410-R-99-001, November 1999.

addition, health effects research has addressed endpoints that were not covered in the First Prospective, including premature mortality associated with ozone exposure.

Although the Agency has not yet conducted a rigorous quantitative analysis to assess the impact of these methodology and data improvements, and the differences in study design between the first and Second Prospective made such an analysis difficult to perform, the impact of most of these factors is to increase the estimates of benefits, in some cases very substantially.

UNCERTAINTY IN HEALTH BENEFITS ESTIMATES

A number of important assumptions and uncertainties in the health benefits analysis may influence the estimate of monetary benefits presented in this study. In this section of the chapter, we first discuss several quantitative sensitivity analyses undertaken to characterize the impact of key assumptions on the ultimate health benefits estimates. We then conclude with a qualitative discussion of the impact of both quantified and unquantified sources of uncertainty.

QUANTITATIVE SENSITIVITY TESTS

We performed three quantitative sensitivity tests to estimate the impact of alternate assumptions on our overall benefits estimates due to avoided premature mortality, the largest contributor to our overall health benefits estimates. The three focal areas for sensitivity analysis were: (1) the C-R function estimate; (2) the PM/mortality cessation lag structure; and (3) the mortality valuation estimate (including both the VSL and the discount rate). These are influential assumptions in our analysis and those for which plausible alternative quantitative estimates are available. Table 5-10 below provides the results of these sensitivity analyses.

Concentration-Response Function

Our monetized estimate of the benefits of reducing premature mortality from CAAA-related pollution reductions is based on a single primary estimate C-R function for each of the criteria pollutants included in our analysis, $PM_{2.5}$ and ozone. This selection is associated with uncertainty related to potential across-study variation. That is, different published studies of the same pollutant/health effect relationship often do not report identical findings; in some instances, the differences are substantial. These differences can arise from differences in factors such as study design, random sampling for subject populations, or modeling choices, such as inclusion of potential confounders.

In order to estimate the effect of across-study variation on our CAAA-related mortality benefits from reductions in $PM_{2.5}$ and ozone, we performed a sensitivity analysis on the C-R functions selected. For $PM_{2.5}$, our primary estimate is based on a Weibull distribution of C-R coefficients with a mean of 1.06 percent decrease in annual all-cause mortality per 1 $\mu g/m^3$ and an interquartile range bracketed by the Pope et al. (2002) ACS estimate (0.55 percent) on the low end and the Six Cities Laden et al. (2006) extended follow-up estimate (1.5 percent) at the high end. We conducted a sensitivity analysis by

first substituting the primary C-R distribution with alternative C-R functions, one based on the Pope et al. (2002) ACS study, one based on the Laden et al. (2006) Six Cities cohort study as well as the C-R distributions provided by each of the 12 experts included in the PM/mortality expert elicitation study.

For ozone, our primary estimate consists of a pooled estimate of six studies, three multi-city studies (Schwartz, 2005; Bell et al., 2004; Huang et al., 2005) and three meta-analyses (Ito et al., 2005; Levy et al., 2005; Bell et al., 2005). We conducted a sensitivity analysis by substitute this primary C-R function with the C-R functions reported in each of these six individual studies, and separately for the Jerrett et al. (2009) cohort study.

As shown in Table 5-10, substituting alternate PM C-R functions results in total mortality benefits estimates that range from between 81 percent lower up to 78 percent higher than the primary estimate. Substituting alternative ozone C-R function does not affect the total mortality benefits estimate, since ozone does not contribute significantly to this estimate. However, the C-R function selection does affect the ozone mortality estimates, ranging from 63 percent lower up to 66 percent higher than the primary estimate for ozone mortality incidence. As expected, the Jerrett et al. study yields estimates higher than the primary pooled estimate. Cohort studies measure the effects of cumulative exposure and so should reasonably yield higher estimates than the comparably parameterized time-series study - but within the range of underlying six studies, albeit at the high end of that range.

PM/Mortality Cessation Lag

The timing of the cessation lag between PM exposure and mortality remains uncertain. Our primary monetized estimate of PM/mortality benefits assumes a 20-year distributed lag (30 percent of the mortality reductions occur in the first year, 50 percent occur equally in years two through five, and the remaining 20 percent occur equally in years six through 20). We tested the sensitivity of this assumption by calculating monetized mortality benefits based on alternative cessation lag structures. We selected two alternative lag structures – a 5-year distributed lag (which was employed in the First Prospective) and a smooth function (which assumes an exponential decay model and is based on an analysis by Roosli et al., 2005; see Chapter 6 of *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act* for further details). We also calculated benefits assuming no cessation lag. Application of alternative cessation lag structures had a smaller impact on the benefits estimates than the C-R function, resulting in benefits estimates that range from 22 percent lower up to 16 percent higher than the primary estimate.

Mortality Valuation

We apply a VSL value to reductions in premature mortality based on a Weibull distribution of 26 study estimates. The literature on VSL is extensive, and studies have measured VSL using different methodological approaches (e.g., revealed versus stated preference) on a variety of study populations (e.g., workers versus a general population sample) in a variety of different risk contexts (e.g., fatal workplace accidents versus

mortality risk from disease). In addition, several meta-analyses of the literature have been conducted in an attempt to synthesize the literature. As a result, there are many options for alternative VSL estimates. We selected several alternative VSL estimates derived from the literature for sensitivity testing, including two estimates from a meta-analysis by Viscusi and Aldy (2003), an estimate used in past EPA regulatory analyses in the form of a normal distribution, and an estimate from a wage-risk study by Viscusi (2004). VSL did not affect the benefits results to the same degree as the C-R function, with alternative monetized benefits ranging from 21 percent lower to approximately equivalent to our primary estimate.

TABLE 5-10. RESULTS OF QUANTITATIVE SENSITIVITY TESTS

FACTOR	STRATEGY FOR SENSITIVITY ANALYSIS	RANGE OF PERCENT CHANGES FROM MEAN PRIMARY MORTALITY BENEFITS ESTIMATE[1]
PM C-R Function	Alternative C-R functions - two from empirical literature (Pope et al., 2002 and Laden et al., 2006) and 12 subjective estimates from the expert elicitation study	-81% to 78%, Based on most extreme estimates from PM expert elicitation study. Rest of alternatives range from -41% to 40%.
Ozone C-R Function	Alternative C-R functions - three from multi-city studies, three meta-analyses, and the Jerrett et al. (2009) cohort long-term exposure study	0% for total mortality benefits. -63% to 66% For ozone-related mortality.
PM/Mortality Cessation Lag	Alternative lag structures - one step function and one smooth function (based on an exponential decay function)	-22% to 16%
VSL	Alternative VSL estimates	-21% to 0%
Discount Rate	Alternative discount rates	-6% to 6%

[1] All values in the table represent the percent change from the mean primary estimate. Percent change estimates to not vary by target year.

Our primary monetized benefits estimate of avoided premature mortality also assumes a discount rate of five percent. We tested the sensitivity of our primary results by substituting alternative discount rates of three and seven percent.[72] This assumption has a small effect on the benefits estimates; applying a discount rate of seven percent results in benefits that are 6 percent lower than the default and applying a three percent discount rate results in a benefits estimate 6 percent higher than the default.

[72] Alternative discount rates of three and seven percent are recommended in U.S. Environmental Protection Agency (2000). *Guidelines for Preparing Economic Analyses*, EPA 240-R-00-003, September.

QUALITATIVE ANALYSIS OF KEY FACTORS CONTRIBUTING TO UNCERTAINTY

In addition to the uncertainties outlined above, we identified several other areas of uncertainty related to our health benefits analysis that we did not address quantitatively. This includes sources of uncertainty in our estimation of avoided mortality, not related to across-study variation; application of C-R functions for national benefits estimation; projection of population and baseline incidence rates; and health valuation.

Table 5-11 provides a summary of the key uncertainties related to the Second Prospective health effects modeling analysis. The first column provides a brief description of each key assumption made in the analysis. The second column indicates the direction of the potential bias with respect to the overall net benefits estimate. The third indicates the magnitude of the impact of the potential bias on the net benefits. The Project Team assigns a classification of "potentially major" if a plausible alternative assumption or approach could influence the overall monetary benefit estimate by approximately five percent or more. If an alternative assumption or approach is likely to change the total benefit estimate by less than five percent, the Project Team assigns a classification of "probably minor."73 This assessment is intended to provide readers with a sense for the quantitative impact on the net benefits estimate if an alternate assumption to that selected by the Project Team were to be implemented. Finally, the fourth column provides our level of confidence in the selected assumption, based on our assessment of the available body of evidence. That is, based on the given available evidence, how certain we are that the selected assumption is the most plausible of the alternatives. The Project Team uses the following four qualitative categories to express the degree of confidence in the chosen assumption:

- "High" – the current evidence is plentiful and strongly supports the selected assumption;
- "Medium" – some evidence exists to support the assumption, but data gaps are present; and
- "Low" – there are limited data to support the selected assumption.
- The Project Team uses "N/A" to indicate that the data was so limited that it was excluded from the analysis entirely.

[73] If the quantitative magnitude of the assumption's effect on the net benefits cannot be assessed, the Project Team indicates that this is "Unknown."

TABLE 5-11. KEY UNCERTAINTIES ASSOCIATED WITH HUMAN HEALTH EFFECTS MODELING

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
UNCERTAINTIES RELATED TO PREMATURE MORTALITY BENEFITS ESTIMATES			
Analysis assumes a causal relationship between PM exposure and premature mortality based on strong epidemiological evidence of a PM/mortality association. However, epidemiological evidence alone cannot establish this causal link.	Overestimate	Potentially major. PM/mortality effects are the largest contributor to the net benefits estimate. If the PM/mortality relationship is not causal, it would lead to a significant overestimation of net benefits.	High. The assumption of causality is suggested by the epidemiologic and toxicological evidence and is consistent with current practice in the development of a best estimate of air pollution-related health benefits. At this time, we can identify no basis to support a conclusion that such an assumption results in a known or suspected overestimation bias.
Analysis assumes a causal relationship between ozone exposure and premature mortality based on strong epidemiological and experimental evidence of an ozone/mortality association.	Overestimate	Probably minor. Ozone mortality effects are a large contributor to the net benefits estimate, but total monetized ozone mortality benefits remain less than five percent of total net benefits. If the ozone mortality relationship is not causal, it would lead to an overestimation of net benefits.	Medium. Several epidemiological studies provide strong evidence for associations between ozone and mortality. This data is supported by human and animal experimental studies that provide suggestive evidence for plausible mechanisms. Overall, the evidence is highly suggestive, but additional research is needed to more fully establish underlying mechanisms.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
It is possible that the PM/mortality relationship is modified by socioeconomic status (SES).	Unable to determine based on current information. Consideration of both the Pope and Laden studies avoids the possible underestimation effect from the ACS cohort, owing to the demographics of that study population, and the possible overestimation bias associated with the more limited geographic scope of the Six Cities cohort.	Potentially major. Sensitivity analyses reported in this chapter indicate the high sensitivity of benefits results to the choice of the PM/mortality C/R function.	Medium. Studies have found effect modification of the PM/mortality effect by SES, as assessed through education attainment (Krewski et al., 2000). However, this effect is likely to affect only the Pope et al. estimate. Our inclusion of both the Pope et al. and Laden et al. (which does includes a more diverse population) helps account for the possible significance of this uncertainty.
Exposure misclassification due to reliance on ambient monitoring data to estimate $PM_{2.5}$ exposures rather than measuring personal exposures.	Underestimate. Concentrations measured at central site monitors may not accurately reflect exposure experienced by the population due to variation in ambient concentrations over space within a geographic area, incomplete penetration of ambient pollution into homes and workplaces, patterns of population activity and indoor sources that can contribute significantly to individual $PM_{2.5}$ exposures. Reducing exposure error can result in stronger associations between pollutants and health effects than generally observed in studies having less exposure detail.	Potentially major. Recent analyses reported in Krewski et al. (2009) demonstrate the relatively significant effect that this source of uncertainty can have on effect estimates.	High. The results from Krewski et al. (2009) and Jerrett et al. (2005) suggest that exposure error may underestimate effect estimates (PM ISA).

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
Exclusion of C-R functions from short-term exposure studies in PM mortality calculations.	Underestimate	Potentially major. PM/mortality is the top contributor to the net benefits estimate. If short-term functions contribute substantially to the overall PM-related mortality estimate, then the net benefits could be underestimated.	Medium. Long-term PM exposure studies likely capture a large part of the impact of short-term peak exposure on mortality; however, the extent of overlap between the two study types is unclear.
Assumption that PM-related mortality occurs over a period of 20 years following the critical PM exposure. Analysis assumes that 30% of mortality reductions in the first year, 50% over years 2 to 5, and 20% over the years 6 to 20 after the reduction in $PM_{2.5}$	Unable to determine based on current information	Potentially major. PM/mortality is the largest contributor to monetary benefits. Our quantitative sensitivity analysis indicated that alternative plausible cessation lag structures could alter the benefits estimate between 23% lower to 16% higher than the primary estimate.	Medium. Recent epidemiological studies (e.g., Schwartz, 2008) have shown that the majority of the risk occurs within 2 years of reduced exposure. However, our default lag assumes 43% of mortality reductions would occur within the first 2 years. The evidence directly informing the cessation lag structure is somewhat limited, but the current lag is supported by the Council HES.
Assumption of a linear, no-threshold model for PM and ozone mortality	Overestimate	Probably minor. Although consideration for alternative model forms (Krewski et al., 2009) does suggest that different models can impact risk estimates to a certain extent, generally this appears to be a moderate source of overall uncertainty.	High. The current scientific literature does not support a population-based threshold, which consistently shows effects down to the lowest measureable levels. If a threshold does exist, it is likely below the range of concentrations of regulatory interest.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
Mortality health impact did not include pollutants other than PM or ozone.	Unable to determine based on current information	Probably minor. If other criteria pollutants correlated with PM contribute to mortality, that effect may be captured in the PM estimate. This uncertainty does make it difficult to disaggregate avoided mortality benefits by pollutant.	High. PM and ozone are the two pollutants most strongly linked to mortality in the epidemiological literature. It is likely that we've captured the majority of mortality benefits due to criteria pollutants in our analysis.
Pooling with equal weights of ozone mortality incidence estimates to present a primary estimate.	Unable to determine based on current information	Probably minor. Pooling with equal weights provides a central estimate of ozone mortality benefits, but it is not clear that the six ozone mortality incidence studies should be combined in this manner. Relying on a particular single study or another combination of studies may result in significantly different estimated benefits from ozone reductions. However, ozone-related avoided mortality benefits are a minor contributor to total monetized benefits.	Medium. All six studies are associated with different strengths and limitation. No single study has emerged as solely suitable to support a primary estimate. Therefore, a pooled estimate provides a central estimate of the available literature.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
No cessation lag was used for ozone mortality.	Overestimate	Probably minor. If there is a time lag between changes in ozone exposure and the total realization of changes in health effects then benefits occurring in the future should be discounted. The use of no lag assumes that all mortality benefits are realized in the year of the exposure change and therefore no discounting occurs. This may lead to an overestimate of benefits.	High. Due to the use of short-term studies of ozone mortality, use of a no lag structure is appropriate and supported by the Council HES.
UNCERTAINTIES RELATED TO APPLICATION OF C-R FUNCTIONS			
Application of C-R relationships only to those subpopulations matching the original study population.	Underestimate	Probably minor. The C-R functions for several health endpoints (including PM-related premature mortality) were applied only to subgroups of the U.S. population (e.g. adults 30+) and thus may underestimate the whole population benefits of reductions in pollutant exposures. However, the background incidence rates for these age groups are likely low and therefore would not contribute many additional cases.	High. The baseline mortality and morbidity rates for PM-related health effects are significantly lower in those under the age of 30 (other than neonates).

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
Application of regionally derived C-R estimates to entire U.S.	Unable to determine based on current information	Probably minor. This is likely to affect morbidity estimates rather than mortality, as mortality estimates are based on studies that include multiple cities. Since morbidity is not as large of a contributor to overall benefits, this is not likely to have a large impact on net benefits.	Medium. The differences in the expected changes in health effects calculated using different underlying studies can be large. If differences reflect real regional variation, applying individual C-R functions throughout the U.S. could result in considerable uncertainty in health effect estimates.
UNCERTAINTIES RELATED TO HEALTH VALUATION			
Use of a Value-of-a-Statistical-Life (VSL) estimate based on a Weibull distribution of 26 studies	Unable to determine based on current information	Potentially major. Mortality valuation generally dominates monetized benefits.	Medium. The VSL used in this analysis is based on 26 labor market and stated preference studies published between 1974 and 1991. Although there are many more recent studies, including meta-analyses, sensitivity analyses reported above suggest that these alternative sources generate results that are close to the estimates used in the analysis.
Use of cost of illness (COI) estimates to value some morbidity endpoints	Underestimate	Probably minor. Mortality valuation generally dominates monetized benefits; therefore specific estimates used to generate morbidity benefits likely would not have a large impact on net benefits.	Low. Morbidity benefits such as hospital admissions and heart attacks are calculated using COI estimates, which some studies have shown are generally half as much as WTP to avoid the illness. However, WTP estimate are currently not available for all health endpoints.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
Benefits transfer for mortality risk valuation, including differences in age, income degree of risk aversion, the nature of the risk, and treatment of latency between mortality risks presented by PM/ozone and the risks evaluated in the available economic studies.	Unable to determine based on currently available information	Potentially major. The mortality valuation step is clearly a critical element in the net benefits estimate, so any uncertainties can have a large effect.	Medium. Information on the combined effect of these known biases is relatively sparse, and it is therefore difficult to assess the overall effect of multiple biases that work in opposite directions. However, our VSL estimate is based on a distribution of the results of 26 individual studies, which cover a range of characteristics.
Inability to value some quantifiable morbidity endpoints, such as impaired lung function.	Underestimate	Probably minor. Reductions in lung function are a well-established effect, based on clinical evaluations of the impact of air pollutants on human health, and the effect would be pervasive, affecting virtually every exposed individual. However, the lack of a clear symptomatic presentation of the effect, however, could limit individual WTP to avoid lung function decrements.	Low. There currently is no evidence to determine the monetary value of the benefits of avoided lung function reductions.

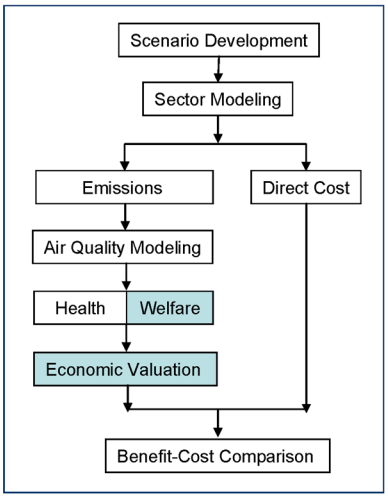
POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
UNCERTAINTIES IN FORECASTED DATA SUPPORTING HEALTH EFFECTS ESTIMATES			
Uncertainty in projecting baseline incidence rates	Both	Probably minor. The magnitude varies with the health endpoint. Mortality baseline incidence is at the county level and projected for 5-year increments. Morbidity baseline incidence has varying spatial resolution for year 2000 only.	Medium. The county-level baseline incidence and population estimates were obtained from databases where the relative degree of uncertainty is low. The baseline data for other endpoints are not location specific (e.g., those taken from studies) and therefore may not accurately represent the actual location-specific rates.
Income growth adjustments	Both	Potentially major. Income growth increases willingness-to-pay valuation estimates, including mortality, over time.	Medium It is difficult to forecast future income growth, owing to unpredictability of future business and employment cycles. These can have a substantial effect on short term growth rate projections, although over longer periods economic growth rates have tended to converge. The use of data from AEO 2005, however, omits the effect of the most recent economic downturn.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
Population projections	Both	Probably minor. The demographics of population forecasting are relatively well-established, however migration estimates are quite uncertain, particularly for specific locations. Overall, we believe that population projections are not likely to vary more than 5 percent at the national level.	Medium. Population projections cannot adequately account for future population migration due to catastrophic events. Projected population and demographics may not well represent future-year population and demographics.
OTHER UNCERTAINTIES			
Variation in effect estimates reflecting differences in $PM_{2.5}$ composition	Unable to determine based on current information	Unable to determine based on current information	Medium. Epidemiology studies examining regional differences in $PM_{2.5}$-related health effects have found differences in the magnitude of those effects. While these may be the result of factors other than composition (e.g., different degrees of exposure misclassification), composition remains one potential explanatory factor.
Very limited quantification of health effects associated with exposure to air toxics.	Underestimate	Probably minor. Studies have found air toxics cancer risks to be orders of magnitude lower than those of criteria pollutants.	N/A Current data and methods are insufficient to develop (and value) national quantitative estimates of the health effects of these pollutants.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS ESTIMATE	MAGNITUDE OF IMPACT ON NET BENFITS ESTIMATE	DEGREE OF CONFIDENCE
CAAA fugitive dust controls implemented in PM non-attainment areas would reduce lead exposures by reducing the re-entrainment of lead particles emitted prior to 1990. This analysis does not estimate these benefits.	Underestimate	Probably minor. The health and economic benefits of reducing lead exposure can be substantial (e.g., see section 812 Retrospective Study Report to Congress). However, most additional fugitive dust controls implemented under the *with-CAAA* scenario (e.g., unpaved road dust suppression, agricultural tilling controls, etc.) tend to be applied in relatively low population areas.	N/A

CHAPTER 6 - ECOLOGICAL AND OTHER WELFARE BENEFITS

OVERVIEW OF APPROACH



Air pollution has important impacts not only on human health, but on a wide range of ecological and environmental resources. Clean Air Act provisions are designed to be protective of human health and the environment, but as a practical matter, because human health impacts are more readily quantified, many of EPA's air pollution analyses have focused much more on human health than on ecological health, aesthetic effects, or natural resource productivity. In general, as science and economics have provided greater insights into the effects of anthropogenic stressors on ecological systems, pursuit of environmental programs targeted on reductions of damage to the environment have become more common. For example, as we noted in the First Prospective, the original motivation for Title IV of the CAAA was addressing the effects of acid rain on ecological resources – it was only after passage that it became clear that these provisions also provide very large human health benefits.

In this chapter, we provide quantitative results for the effects of air pollution on ecological health and natural resources where the science and economic base is strongest, including the lake acidification effects that motivated Title IV, as well as a broad qualitative characterization of effects that are more difficult to quantify. The first portion of this chapter involves taking a broad view of pollutants controlled under the CAAA and their documented effects on ecological systems, both as individual pollutants and, to the extent possible, as one component in multiple-stressor effects on ecosystems and their components. We organize our analysis in terms of major pollutant classes and by the level of biological organization at which impacts are measured (e.g., regional ecosystem, local ecosystem, community, population, organism, etc.). We used a similar strategy in the First Prospective, which has been updated here to reflect new scientific literature published since 1999, but we also supplement the literature review with a new mapping

of air pollutant stressors relative to ecological systems that are most sensitive to those stressors – for example, we relate atmospheric deposition of nitrogen to estuarine systems that have been classified as sensitive to marginal nitrogen inputs.

The second portion of the chapter presents the results of a wide range of analyses that quantitatively characterize specific effects of air pollution on ecological systems, as well as other effects on natural and human systems that contribute to economic welfare. We provide quantitative estimates of the benefits of the 1990 CAAA for the following effects:

- Enhanced forest and agricultural plant growth associated with reduced exposure to tropospheric ozone, on a national scale;
- Enhanced visibility in recreational and residential settings associated with reduced particulate matter concentrations, also on a national scale;
- Reduced damage to certain building and structural materials associated with reduced exposure to corrosive air pollutants, such as acid deposition, on a national scale;
- Acidification of freshwater bodies and impairment of timber growth associated with atmospheric nitrogen and sulfur deposition, for a case study area in New York's Adirondack region.

The categories of effects ultimately chosen for quantitative assessment here are necessarily limited by available methods and data. The scope is largely consistent with the recommendations of the Ecological Effects Subcommittee (EES) of the Council, which supported EPA's plans for qualitative characterization of the ecological effects of CAA-related air pollutants, an expanded literature review, national analyses where possible, and a quantitative, ecosystem-level case study of ecological service benefits. As scientific understanding and impact assessment methods grow more comprehensive, however, we expect that the focus of subsequent analyses will continue to broaden, and also yield greater insight on which effects that can be avoided by air pollution controls have the greatest potential ecological and/or economic value.

Because the breadth and complexity of air pollutant-ecosystem interactions do not allow for comprehensive quantitative analysis of all the ecological benefits of the CAAA, we stress the importance of continued consideration of those impacts not valued in this report in policy decision-making and in further technical research. Judging from the geographic breadth and magnitude of the relatively modest subset of impacts that we find sufficiently well-understood to quantify and monetize, it is apparent that the economic benefits of the CAAA's reduction of air pollution impacts on ecosystems are substantial.

QUALITATIVE CHARACTERIZATION OF EFFECTS

The First Prospective summarized available information on the ecological effects of criteria pollutants and hazardous air pollutants regulated under the 1990 Clean Air Act Amendments. In this Second Prospective analysis we expand that effort, updating the

literature review to reflect published and peer-reviewed research that has become available since the development of the 1999 analysis, through 2008. As data limitations prevent the quantitative assessment of all potential ecological benefits, the goal of this effort is to provide a broad characterization of the range of effects of major air pollutants on ecological endpoints.

Ecosystem impacts can be organized by the pollutants of concern and by the level of biological organization at which impacts are directly measured. We address both dimensions of categorization in this overview. Table 6-1 summarizes the major pollutants of concern, and the documented acute and long-term ecological impacts associated with them.

The following discussion provides more specific information on ecological effects of each pollutant class, including information on sources, sensitive ecosystems, and summary tables of effects organized by level of biological organization.

ACIDIC DEPOSITION

The predominant chemicals associated with acidic precipitation are sulfuric and nitric acid (H_2SO_4 and HNO_3). These strong mineral acids are formed from sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the atmosphere. Sulfur compounds are emitted from anthropogenic sources in the form of SO_2 and, to a lesser extent, primary sulfates, principally from coal and residual-oil combustion and a few industrial processes. The principal anthropogenic source of NO_x emissions is fuel combustion. In the atmosphere, SO_2 and NO_x are converted to sulfates and nitrates, transported over long distances, and deposited over large areas downwind of urban areas or point sources.

TABLE 6-1. CLASSES OF POLLUTANTS AND ECOLOGICAL EFFECTS

POLLUTANT CLASS	MAJOR POLLUTANTS AND PRECURSORS	ACUTE EFFECTS	LONG-TERM EFFECTS
Acidic deposition	Sulfuric acid, nitric acid Precursors: Sulfur dioxide, nitrogen oxides	Direct toxic effects to plant leaves and aquatic organisms.	Progressive deterioration of soil quality due to nutrient leaching. Forest health decline. Acidification of surface waters. Reduction in acid neutralizing capacity in lakes and streams. Enhancement of bioavailability of toxic metals (aluminum) to aquatic biota.
Nitrogen Deposition	Nitrogen compounds (*e.g.*, nitrogen oxides)		Nitrogen saturation of terrestrial ecosystems, causing nutrient imbalances and reduced forest health. Soil and water acidification. Reduction in acid neutralizing capacity in lakes and streams. Progressive nitrogen enrichment of coastal estuaries causing eutrophication. Changes in the global nitrogen cycle.
Ozone	Tropospheric ozone Precursors: Nitrogen oxides and volatile organic compounds (VOCs)	Direct toxic effects to plants.	Alterations of ecosystem wide patterns of energy flow and nutrient cycling; community changes.
Hazardous Air Pollutants (HAPs)	Mercury, dioxins	Direct toxic effects to animals.	Conservation of mercury and dioxins in biogeochemical cycles and accumulation in the food chain. Sublethal impacts.

Acidification of ecosystems has been shown to cause direct toxic effects on sensitive organisms as well as long-term changes in ecosystem structure and function. The effects of acidification can be seen at all levels of biological organization in both terrestrial and aquatic ecosystems. Adverse effects in terrestrial ecosystems include acutely toxic impacts of acids on terrestrial plants and, more commonly, chronic acidification of terrestrial ecosystems leading to nutrient deficiencies in soils, aluminum mobilization, and decreased health and biological productivity of forests. These effects can lead to changes in individual plant survival, as well as changes in forest populations and communities.

In aquatic ecosystems, acidification-induced effects are mediated by changes in water chemistry including reductions in Acid Neutralizing Capacity[74] (ANC) and increased availability of aluminum (Al^{3+}), which in turn can cause increased mortality in sensitive species, changes in community composition, and changes in nutrient cycling and energy flows. Acidic deposition has resulted in increased acidity in surface waters, especially in areas where acid buffering capacity of soils is reduced and nitrate and sulfate have

[74] Acid Neutralizing Capacity (ANC) is a measure of overall buffering capacity of a solution or surface waterbody. A well-buffered system will resist rapid changes in pH, while a poorly buffered system responds quickly to changes in pH. Reductions in ANC put waterbodies at risk of acidification due to this inability to buffer excess H^+ ions.

leached from upland areas. While many fish species are acid-sensitive, the main lethal agent is the increase in dissolved aluminum that occurs with falling pH levels.

Acid-sensitive ecosystems include those with high acidic deposition and low acid neutralizing capacity. Many of these ecosystems occur downwind of emission sources, often in mountainous areas where soils are thin and poorly buffered. High elevation sites are also more vulnerable because mountain fog is often more acidic than rain.

Table 6-2 provides a summary of the potential ecological effects of acidification.

NITROGEN DEPOSITION

Along with its role in acidification of ecosystems, nitrogen deposition also affects nitrogen biogeochemistry, which in turn affects the health of forest and coastal ecosystems. Nitrogen is a naturally occurring element, and is essential to both plant and animal life, but combustion processes cause this nitrogen to be "fixed" – that is, converted from the unreactive N_2 form to a reactive form such as nitrate (NO_3) or ammonia (NH_3). The availability of reactive nitrogen limits plant growth in many terrestrial ecosystems and is generally the limiting nutrient in marine and coastal waters as well.

By 1990, human activities had more than doubled the amount of reactive nitrogen available annually to living organisms. At present, more than 50 percent of the annual global reactive nitrogen emissions are generated directly or indirectly by human activities. Ammonia emissions to the atmosphere occur largely via volatilization from animal wastes. Anthropogenic nitrogen oxide (NO_x) emissions to the atmosphere are generally a result of fossil fuel combustion, with electric power generation and automobiles as the largest two sources.

Because most terrestrial and coastal ecosystems are nitrogen limited, increased supply of nitrogen in terrestrial systems can stimulate uptake by plants and microorganisms, and increase biological productivity. Moderate levels of nitrogen input can have a "fertilizing" effect, similar to the application of nitrogen fertilizer frequently used in timber production or agriculture. In the long run, however, chronic nitrogen deposition adversely affects organisms, communities, and biogeochemical cycles of watersheds and coastal waters. Biogeochemical cycles change when the nutrient balance is disrupted by excess nitrogen because nitrogen is an important nutrient in biological systems.

TABLE 6-2. EFFECTS OF ACIDIFICATION ON NATURAL SYSTEMS AT VARIOUS LEVELS OF ORGANIZATION

SPATIAL SCALE	TYPE OF INTERACTION	EXAMPLES OF EFFECTS	
		FOREST ECOSYSTEMS	STREAMS AND LAKES
Molecular and cellular	Chemical and biochemical processes	Damages to epidermal layers and cells of plants through deposition of acids; alteration of stomatal activity.	Decreases in pH and increases in aluminum ions cause pathological changes in structure of gill tissue in fish.
Organism	Direct physiological response	In trees, increased loss of nutrients via foliar leaching.	Hydrogen and aluminum ions in the water column impair regulation of body ions.
	Indirect effects: Acidification can indirectly affect response to altered environmental factors or alterations of the organism's ability to cope with other kinds of stress.	Cation depletion in the soil causes nutrient deficiencies in plants. Concentrations of aluminum ions in soils can reach phytotoxic levels. Increased sensitivity to other stress factors including pathogens and frost. In birds, possible calcium limitation and growth reduction.	Aluminum ions in the water column can be toxic to many aquatic organisms through impairment of gill regulation.
Population	Change of population characteristics like productivity or mortality rates.	Decrease of biological productivity of sensitive organisms. Selection for less sensitive organisms. Microevolution of resistance.	Decrease of biological productivity and increased mortality of sensitive organisms. Selection for less sensitive organisms. Microevolution of resistance.
Community	Changes of community structure and competitive patterns.	Alteration of competitive patterns. Selective advantage for acid-resistant species. Loss of acid sensitive species and organisms. Decrease in productivity. Decrease of species richness and diversity. Decline in Sugar Maple and red spruce in Eastern U.S. and Canadian forests.	Alteration of competitive patterns. Selective advantage for acid-resistant species. Loss of acid sensitive species and organisms. Decrease in productivity. Decrease in species richness and diversity.
Local Ecosystem (e.g., landscape element)	Changes in nutrient cycle, hydrological cycle, and energy flow of lakes, wetlands, forests, grasslands, etc.	Progressive depletion of nutrient cations in the soil. Increase in the concentration of mobile aluminum ions in the soil.	Acidification of lakes and streams. Decrease in acid neutralizing capacity. Persistent acidic conditions in lakes and streams in some regions, despite reduction in sulfate deposition.
Regional Ecosystem (e.g., watershed)	Biogeochemical cycles within a watershed. Region-wide alterations of biodiversity.	Leaching of sulfate, nitrate, aluminum, and calcium to streams and lakes. Change in sulfur and nitrogen biogeochemistry in northeastern forests.	Regional acidification of aquatic systems due to high deposition rates and nitrogen saturation of terrestrial ecosystems and increased nitrate leaching to surface waters. Persistent acidic conditions in lakes and streams in some regions, despite reduction in sulfate deposition.

Because fresh waters are generally not nitrogen limited, the addition of nitrogen does not lead to excessive eutrophication as it does in coastal waters. Coastal waters are an extraordinarily important natural resource, providing spawning grounds/nurseries for fish and shellfish, foraging and breeding habitat for birds, and generally contributing greatly to the productivity of the marine environment. Critical to the health of coastal waters is an appropriate balance of nutrients. If present in mild or moderate quantities, nitrogen enrichment of coastal waters can cause moderate increases in productivity, leading to neutral or positive changes in the ecosystem. However, because coastal waters are generally nitrogen limited, too much nitrogen leads to excess production of algae, decreasing water clarity and reducing concentrations of dissolved oxygen, a situation referred to as eutrophication.

Table 6-3 summarizes the potential effects of nitrogen deposition on ecosystem structure and function.

TROPOSPHERIC OZONE

Ozone is a secondary pollutant formed through the oxidation of volatile organic compounds (VOCs) in the presence of oxides of nitrogen. Ozone is one of the most powerful oxidants known but its impacts have been little studied in faunal species. The limited available research has shown a variety of pulmonary impacts to specific mammalian and avian species. In contrast, ozone's impacts on plants are much better understood. Documented effects on forest trees include visible foliar damage, decreased chlorophyll content, accelerated leaf senescence, decreased photosynthesis, increased respiration, altered carbon allocation, water balance changes, and damage to epicuticular wax. These can lead to changes in canopy structure, carbon allocation, productivity, and fitness of trees.

Ozone sensitivity of plants varies between species, with evergreen species tending to be less sensitive to ozone than deciduous species, and with most individual deciduous trees being less sensitive than most annual plants. However, there are exceptions to this broad ranking scheme, and there can be variability not only between species but even between clones of some trees and within cultivars. Life stage also matters: in general, mature deciduous trees tend to be more sensitive than seedlings, while the reverse is more typical for evergreen trees.

TABLE 6-3. EFFECTS OF NITROGEN DEPOSITION ON NATURAL SYSTEMS AT VARIOUS LEVELS OF ORGANIZATION

SPATIAL SCALE	TYPE OF INTERACTION	EXAMPLES OF EFFECTS	
		FOREST ECOSYSTEMS	ESTUARINE ECOSYSTEMS
Molecular and cellular	Chemical and biochemical processes.	Increased uptake of nitrogen by plants and microorganisms. With chronic exposure, reduced stomatal activity and photosynthesis in some species.	Increased assimilation of nitrogen by marine plants, macroalgae, and microorganisms.
Organism	Direct physiological response.	Increases in leaf size of terrestrial plants. Increase in foliar nitrogen concentration in major canopy trees. Change in carbon allocation to various plant tissues.	Increase in algal growth.
	Indirect effects: Response to altered environmental factors or alterations of the organism's ability to cope with other kinds of stress.	Decreased resistance to biotic and abiotic stress factors including pathogens, insects, and frost. Disruption of plant-symbiont relationships with mycorrhizal fungi.	Injuries to marine fauna through depletion of oxygen in the water column. Loss of physical habitat due to increased macroalgal biomass and loss of seagrass beds. Injury and habitat loss through increased shading by macroalgae.
Population	Change of population characteristics like productivity or mortality rates.	Increase in biological productivity and growth rates of some species. Increase in pathogens.	Increase in algal and macroalgal biomass.
Community	Changes of community structure and competitive patterns.	Alteration of competitive patterns. Selective advantage for fast growing species and organisms that efficiently use additional nitrogen. Loss of species adapted to nitrogen-poor or acidic environments. Increase in weedy species or parasites.	Excessive algal growth. Changes in species composition with increase in algal and macroalgal species and decrease or loss of seagrass beds. Loss of species sensitive to low oxygen conditions.
Local Ecosystem (e.g., landscape element)	Changes in nutrient cycle, hydrological cycle, and energy flow of lakes, wetlands, forests, grasslands, etc.	Changes in the nitrogen cycle. Progressive nitrogen saturation. Mobilization of nitrate and aluminum in soils. Loss of calcium and magnesium from soil. Change in organic matter decomposition rate.	Changes in the nitrogen cycle. Increased algal growth leading to depletion of oxygen, increased shading of seagrasses. Reduced water clarity and dissolved oxygen levels.

SPATIAL SCALE	TYPE OF INTERACTION	EXAMPLES OF EFFECTS	
		FOREST ECOSYSTEMS	ESTUARINE ECOSYSTEMS
Regional Ecosystem (e.g., watershed)	Changes in biogeochemical cycles within a watershed. Region-wide alterations of biodiversity.	Leaching of nitrate and aluminum from terrestrial sites to streams and lakes. Acidification of soils and waterbodies. Increased emission of greenhouse gases from soils to atmosphere. Change in nutrient turnover and soil formation rates.	Additional input of nitrogen from nitrogen-saturated terrestrial sites within the watershed. Regional decline in water quality in waterbodies draining large watersheds (e.g. Chesapeake Bay). Changes in the regional-scale nitrogen cycle.
Global Ecological System	Changes in global biogeochemical cycles; increased availability of reactive nitrogen to plants.	Increased input of reactive nitrogen; loss of soil nutrients. Nitrogen saturation and leaching throughout forests in northeastern United States and Western Europe. Acidification of surface waters.	Greatly increased transfer of nitrogen to coastal ecosystems; change in structure and function of estuarine and nearshore systems.

Impacts to plant communities may occur as a result of ozone exposure, although such effects have not been studied as extensively due to ecosystem complexity and the long timeframes involved. Experiments with an early successional plant community found that ozone reduced vegetative cover, vertical density, species richness, and evenness relative to the control, although differences were less pronounced in a drought year. Other observed community level effects include reduced competitive ability of sensitive species, changed soil microbial communities, and altered species composition and relative abundance.

Table 6-4 summarizes the potential effects of ozone exposure on ecosystems.

HAZARDOUS AIR POLLUTANTS

Hazardous air pollutants (HAPs) are a general category of toxic substances covered under Title III of the Clean Air Act, which lists 189 HAPs. Of these 189 substances, the best understood in terms of the potential for adverse ecological impacts include mercury, polychlorinated biphenyls (PCBs), dioxins, and dichlorodiphenyl-trichloroethane (DDT). The use of PCBs and DDT was effectively illegal in the United States prior to 1990 (EPA 1992), and there are currently no plans for additional CAAA regulations of these compounds (Federal Register Unified Agenda 1998). With respect to mercury and dioxins, regulatory actions have reduced, but have not eliminated, anthropogenic emissions. This section discusses environmental effects associated with these two HAPs.

TABLE 6-4. EFFECTS OF OZONE ON NATURAL SYSTEMS AT VARIOUS LEVELS OF ORGANIZATION

SPATIAL SCALE	TYPE OF INTERACTION	EXAMPLES OF EFFECTS
Molecular and cellular	Chemical and biochemical processes.	Oxidation of enzymes of plants, generation of toxic reactive oxygen species (hydroxyl radicals). Disruption of the membrane potential. Reduced photosynthesis and nitrogen fixation. Increased apoptosis.
Organism	Direct physiological response.	Visible foliar damage, premature needle senescence, altered carbon allocation, and reduced growth rates.
	Indirect effects: Response to altered environmental factors or alterations of the organism's ability to cope with other kinds of stress.	Increased sensitivity to biotic and abiotic stress factors such as pathogens and frost. Disruption of plant-symbiont relationship (mychorrhizae), and symbionts.
Population	Change of population characteristics like productivity or mortality rates.	Reduced biological productivity and reproductive success. Selection for less sensitive organisms. Potential for microevolution for ozone resistance.
Community	Changes of community structure and competitive patterns.	Alteration of competitive patterns. Loss of ozone sensitive species and organisms leading to reduced species richness and evenness. Reduction in productivity. Changes in microbial species composition in soils.
Local Ecosystem (e.g., landscape element)	Changes in nutrient cycle, hydrological cycle, and energy flow of lakes, wetlands, forests, grasslands, etc.	Alteration of ecosystem-wide patterns of energy flow and nutrient cycling (e.g., via alterations in litter quantity, litter nutrient content, and degradation rates; also via changing carbon fluxes to soils and carbon sequestration in soils).
Regional Ecosystem (e.g., watershed)	Biogeochemical cycles within a watershed. Region-wide alterations of biodiversity.	Potential for region-wide phytotoxicological impacts and reductions in net primary production.

Mercury

Mercury (Hg) is a toxic element found ubiquitously throughout the environment. About 50-80 percent of total emissions originate from anthropogenic sources, including fossil fuel combustion, leaks from industrial activities, and the disposal or incineration of wastes.

Mercury is generally released in its elemental and inorganic forms. However, it can undergo various transformations in the environment, and its chemical form determines not only its environmental fate but also its potency as a toxicant. From a biological perspective, the most hazardous form of mercury is methylmercury both because of its

bioaccumulation and biomagnification potential, and also because organic forms of mercury (including methylmercury) are the most toxic. Adverse effects on wildlife include neurotoxicity as well as reproductive, behavioral, and developmental effects. These types of effects have been observed in laboratory studies of mammals, birds, fish, and aquatic invertebrates. While species sensitivity varies, within a species the early life stages are generally the most sensitive.

Dioxins

Polychlorinated dibenzo-p-dioxins (PCDDs) are a group of 75 organochlorine compounds, often referred to as dioxins. Although dioxins can be produced through natural events such as forest fires and volcanic eruptions, most environmental inputs are anthropogenic in origin. EPA categorizes dioxin sources into five broad groups: combustion; metals smelting, refining, and processing sources; chemical manufacturing; biological and photochemical processes; and reservoir sources (for example urban runoff).

Dioxins and related compounds are thought to exert most of their toxic effects through interaction with the aryl hydrocarbon receptor (AhR). In laboratory studies, particularly of rodents, some dioxins have been shown to cause reproductive toxicity, neurotoxicity, immune suppression, increased inflammatory responses, and cancer. Fish are among the most sensitive species to the effects of dioxin, and early life stages are the most vulnerable. The risk that dioxins pose to other wildlife is difficult to assess because both laboratory and field studies are few.

Dioxins are extremely stable chemicals with a persistence that is measured in decades. Dioxins are subject to photochemical degradation, but since the penetration of light into soils and many natural water bodies is limited, this degradation is slow. Because of dioxins' toxicity and persistence, their presence is likely to be an issue of concern for decades.

DISTRIBUTION OF AIR POLLUTANTS IN SENSITIVE ECOSYSTEMS OF THE UNITED STATES

This section describes the spatial and temporal trends of air pollutants regulated by the CAAA, highlighting their distribution against sensitive ecosystems across the United States. This information provides useful context regarding the geographic distribution of potential ecological benefits of the CAAA, particularly for the ecological endpoints described above for which data are not available to quantify impacts.

The maps presented illustrate changes in forecast pollutant levels under the current, baseline scenario (with the CAAA) as compared to the counterfactual scenario (without the CAAA). The three pollutant classes considered are: acidic deposition, nitrogen deposition, and tropospheric ozone. Data are not available to map the distribution of HAPs. The pollutant exposure maps presented in this discussion were created using data from the Community Multiscale Air Quality Modeling System (CMAQ) Version 4.6,

which estimates tropospheric ozone concentrations as well as deposition in kilograms per hectare for acidic deposition and total nitrogen.[75]

ACIDIC DEPOSITION

As described in the previous section, ecosystem sensitivity to acid deposition occurs in areas with low ANC. High elevation sites tend to be more vulnerable because of thin, poorly buffered soils coinciding with acidic deposition from rain, snow, and fog. Acid-sensitive areas in the U.S. include the southern Blue Ridge Mountains of eastern Tennessee, western North Carolina and northern Georgia; the mid Appalachian Region of eastern West Virginia, western Virginia and central Pennsylvania; New York's Catskill and Adirondack Mountains; the Green Mountains of Vermont; the White Mountains of New Hampshire, and areas of the Upper Midwest (Wisconsin and Michigan).[76] Montane areas in the Adirondacks, Northern New England, and the Appalachian region have experienced acidification of surface waters and soils, as well as forest decline.

Figure 6-1 presents acidic deposition from 1990 through 2020 for both *with-* and *without-CAAA* scenarios. Acid deposition estimates are expressed as equivalents per hectare (eq/ha).[77] Under both regulatory scenarios, acidic deposition is highest in western Pennsylvania, southern Ohio and Indiana, western West Virginia, and northern Kentucky. Without the CAAA, acidic deposition in these areas increases over time. Further, acidic deposition increases over time in the areas surrounding these hotpots. By 2020, significant portions of the Northeast, Midwest, and South are projected to have elevated levels of acidic deposition. Hotspots also exist in eastern Texas and southern Louisiana.

As shown in the right column of Figure 6-1, with the CAAA acidic deposition levels lessen in and around the areas with the highest acidic deposition. By 2020, elevated acidic deposition levels are primarily limited to much smaller areas in the Midwest, Northeast, and Gulf Coast.

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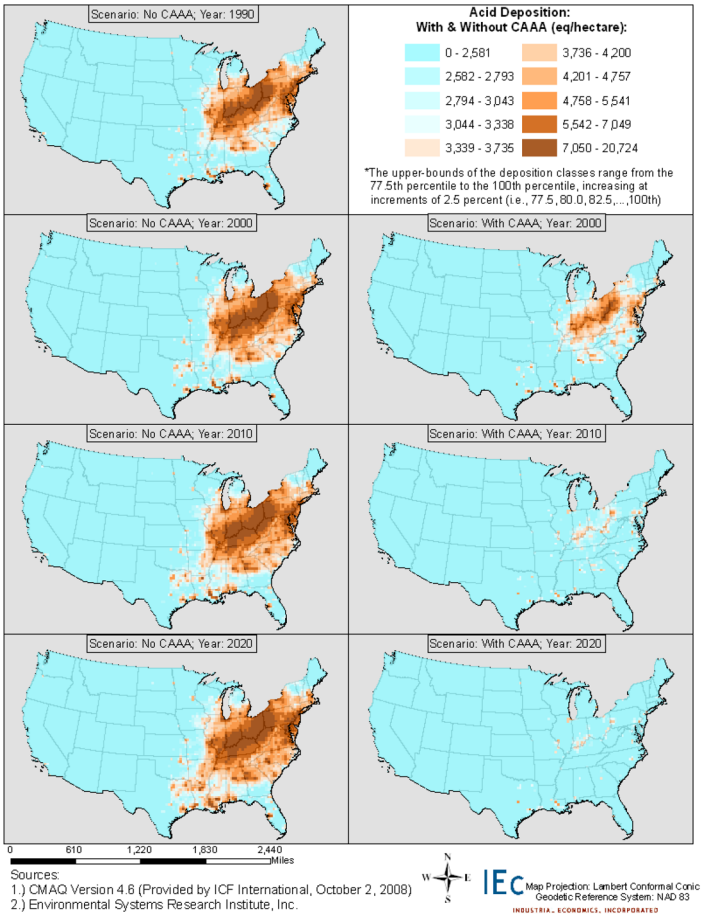
[75] The CMAQ tool is described in more detail in Chapter 4 of this document.

[76] U.S. Environmental Protection Agency (EPA). October 2003. *Response of surface water chemistry to the Clean Air Act Amendments of 1990*. EPA 620/R-03/001.

[77] Acid deposition is calculated using the hydrogen deposition derived from both sulfur and nitrogen deposition as described in: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region. January 2000. Screening Methodology for Calculating ANC Change to High Elevation Lakes: User's Guide. The deposition estimates in Figures 6-2 and 6-3 include combined wet and dry deposition for the stated years as estimated by the CMAQ modeling system version 4.6. These modeled estimates are not calibrated with monitored deposition data such as the National Atmospheric Deposition Program (NADP) data

FIGURE 6-1. COMBINED NO_X AND SO_X DEPOSITION ESTIMATES FOR 1990, 2000, 2010, AND 2020 WITH AND WITHOUT THE CAAA



NITROGEN DEPOSITION

Atmospheric nitrogen deposition is highest in the northeastern and eastern central regions of the U.S. Elevated nitrogen deposition in the western and southern United States is limited to areas in the vicinity of large nitrogen sources (e.g., livestock production areas), high-elevation areas on which cloud droplet deposition may contribute substantial nitrogen inputs, and urban areas with relatively high levels of NOx emissions.

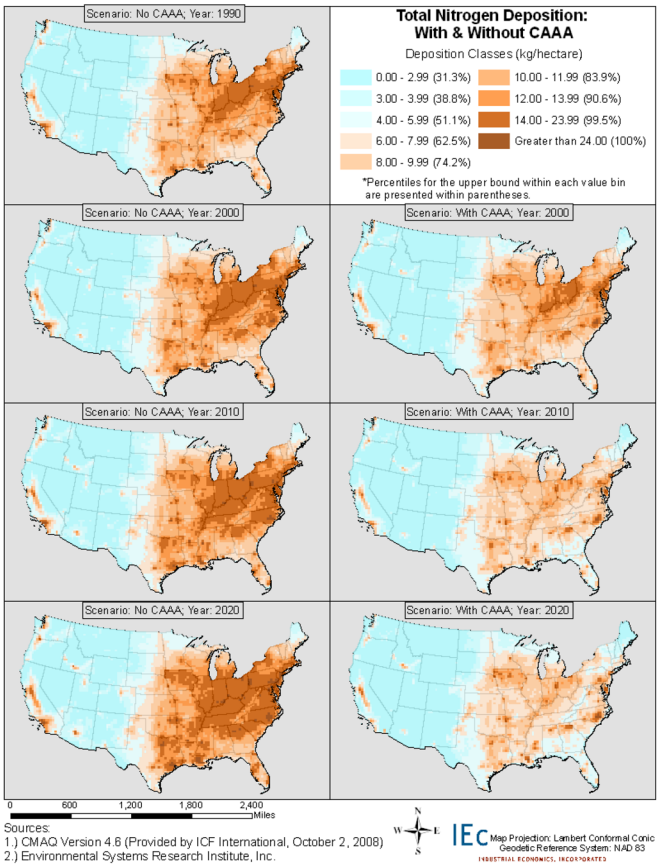
Figure 6-2 presents total nitrogen deposition from years 1990 through 2020 for both the *with-CAAA* and *without-CAAA* scenarios. In general, total nitrogen deposition is less than 24 kg/hectare in the conterminous U.S. for each year and regulatory scenario presented. However, "hot spots" exist across the U.S. where meteorological conditions and/or high nitrogen emissions contribute to relatively high deposition rates. Two particularly significant hot spots for nitrogen deposition are located in southern Louisiana and eastern North Carolina. Total nitrogen deposition is estimated to increase in both hot spots over time regardless of the regulatory scenario. Outside of the two hot spots, total nitrogen deposition is highest without the CAAA in the Ohio River Valley (i.e., western Pennsylvania, southern Ohio and Indiana, western West Virginia, and northern Kentucky). Over time, the total nitrogen deposition increases around the Ohio River Valley without the CAAA and decreases slightly with the CAAA. Outside of the Ohio River Valley, nitrogen deposition with the CAAA decreases slightly over time in the eastern U.S. In the western U.S., total nitrogen deposition with the CAAA remains relatively constant over time.

Estuarine areas in the Northeast are less susceptible to injury from nitrogen loading than estuaries in other parts of the country due to the rapid flushing characteristics of estuaries in this region. Estuaries along the Southeastern Coast, Gulf Coast, and Southern California Coast experience the greatest reduction in total nitrogen deposition. Total nitrogen deposition along the West Coast, with the exception of southern California, is relatively low in the absence of the CAAA.

TROPOSPHERIC OZONE

Areas within the U.S. with elevated tropospheric ozone levels include the Northeast, mid-Atlantic, Midwest, and California. Combined ozone concentrations are reported for the May through September period as ozone levels tend to increase during the spring and summer. Figure 6-3 presents combined cumulative ozone season (W126) values for the May through September period for both the *with-CAAA* and *without-CAAA* scenarios. The W126 metric is a weighted sum of hourly concentrations observed between 8 a.m. and 8 p.m. where hourly weights are a function of the hourly ozone concentration observed.

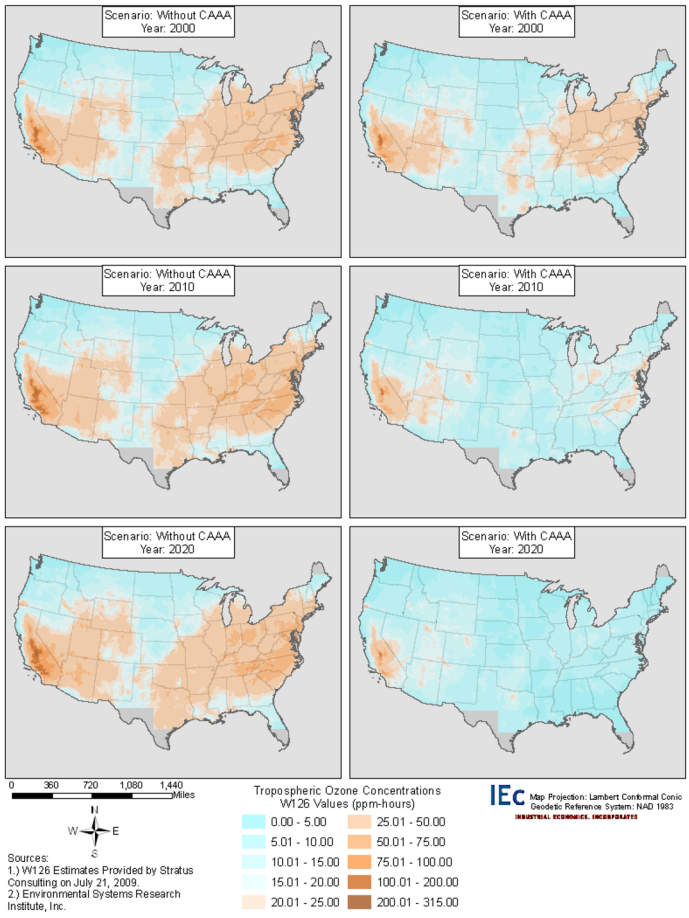
FIGURE 6-2. TOTAL NITROGEN DEPOSITION ESTIMATES FOR 1990, 2000, 2010, AND 2020 WITH AND WITHOUT THE CAAA[78,79]



[78] Value bins for nitrogen deposition taken from: Rea, A., J. Lynch, R. White, G. Tennant, J. Phelan and N. Possiel. 2009. Critical Loads as a Policy Tool: Highlights of the NOx/SOx Secondary National Ambient Air Quality Standard Review. Slide 6: Nationwide Total Reactive Nitrogen Deposition (2002). Available online at: http://nadp.sws.uiuc.edu/meetings/fall2009/post/session4.html.

[79] Percentiles are calculated using the combined nitrogen deposition data for all years and scenarios presented in the map.

FIGURE 6-3. W126 CUMULATIVE TROPOSPHERIC OZONE SEASON MEASURES FOR 2000, 2010, AND 2020 WITH AND WITHOUT THE CAAA



In general, tropospheric ozone concentrations increase over time without the CAAA and decrease over time with the CAAA. Elevated ozone concentrations are present in California, mid-Atlantic states, and Corn Belt states in 2000 both with and without the CAAA; ozone concentrations are, however, slightly less with the CAAA in 2000. In 2000, ozone hot spots are present in southern California, central Ohio, portions of Virginia, North Carolina, and South Carolina, and western Tennessee. Without the CAAA, these hot spots grow in size and magnitude. Under the *with-CAAA* scenario, the hot spots decrease in size and magnitude. By 2020, the combined W126 values for nearly the entire conterminous U.S. (outside of California) are less than 15 ppm-hours. Tropospheric ozone concentrations within the California hot spot are reduced to 25 to 75 ppm-hours.[80]

As noted in the previous section, elevated tropospheric ozone levels may negatively affect plants in a number of ways, including reducing plant photosynthesis and increasing leaf senescence leading to reduced plant growth and productivity. Given the potential effects of elevated tropospheric ozone concentrations on plant growth, forested and cropland areas across the U.S. are considered particularly sensitive to the effects of elevated tropospheric ozone. It follows that these same areas also stand to benefit the most from reduced tropospheric ozone concentrations due to the implementation of the CAAA. In particular, forested ecosystems in the San Bernardino and Sierra Nevada Mountains of California have suffered ecological damages attributed to elevated ozone levels. Forests in the southern portions of the Midwest and Northeast regions and the Southeast region (except the southernmost areas where ozone concentrations are relatively low without the CAAA) are also expected to benefit from reductions in tropospheric ozone due to the implementation of the CAAA. In addition, crops in California are expected to benefit the most from the implementation of the CAAA. The cropland areas in California are located almost entirely within the tropospheric ozone hot spot. Other cropland areas expected to benefit from reduced tropospheric ozone concentrations associated with the implementation of the CAAA include the Corn Belt region, the southern portion of the Midwest region, the Mississippi Valley, Texas, and Oklahoma.

QUANTIFIED RESULTS: NATIONAL ESTIMATES

AGRICULTURE AND FOREST PRODUCTIVITY EFFECTS

A significant body of literature exists addressing the effects of tropospheric ozone on plants, including commercial tree species and agricultural crops, as noted in the previous section. In general, elevated levels of tropospheric ozone have been shown to reduce

[80] Within the California hot spot, the modeled CMAQ ozone concentration estimates were low compared to the ozone monitoring data. This may have resulted in the eVNA analysis overestimating future ozone concentrations. This overestimate is expected to have occurred in this region for both the *with-CAAA* and *without-CAAA* scenarios, however, and therefore the effect on the difference in ozone concentrations between the two scenarios is uncertain.

overall plant health and growth by reducing photosynthesis and altering carbon allocation. Methods and data also exist to estimate the magnitude of plant growth reductions due to elevated tropospheric ozone levels, based on laboratory studies that developed exposure-response functions describing the functional relationship between plant yield and ozone exposure for a variety of plant species.[81] Applying exposure-response functions, this analysis estimates yield losses in agricultural crops and commercial tree species under the counterfactual, *without-CAAA* scenario relative to the baseline, *with-CAAA* scenario. Relative yield losses (i.e., reductions in crop and tree yield under the counterfactual scenario relative to the baseline scenario) measure the amount crop and tree yields would be reduced in the absence of CAAA regulations, and therefore, indicate a benefit of the CAAA.[82]

Table 6-5 provides a summary of estimated relative yield losses by crop/forest type and year. Relative yield losses indicate a benefit of the CAAA; the larger the relative yield loss without the CAAA, the greater the crop or tree yield with the CAAA. In addition, Figures 6-4 and 6-5 provides maps of the crop-subregion-specific and tree-region-specific relative yield losses for two representative species: potatoes and softwood trees. The results presented generally follow the temporal and spatial pattern of ozone concentration reductions attributable to the CAAA, as outlined in Chapter 4, with reductions in tropospheric ozone concentrations being greatest along the East Coast, particularly the Southeast, in the Midwest (within the Ohio River Valley), and in California. Several other factors also affect yield changes in crops and trees, including sensitivity to ozone, geographic distribution, growing period length, and the specific time of year the growing period occurs. Potatoes and softwoods, as indicated in Table 6-5, suffer relatively larger changes in growth than some other species in our analysis, and yield losses tend to increase over time as differences in ozone concentrations increase between the *with-CAAA* and *without-CAAA* scenarios. Across all crops, the largest relative yield losses for both crops and trees occur in the Southeast, frequently in Virginia, North Carolina, South Carolina, and Tennessee.

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[81] See, for example, E.H. Lee and W.E. Hogsett. 1996. Methodology for Calculating Inputs for Ozone Secondary Standard Benefits Analysis: Part II. Prepared for the U.S. EPA, Office of Air Quality Planning and Standards, Air Quality Strategies and Standards Division. The application of laboratory-derived functions is less preferable than functions developed from field studies. However, the laboratory-derived functions frequently provide the best available information regarding the relationship between ozone exposure and crop or tree growth. The exposure-response functions applied in this report have been used in other EPA studies, such as: USEPA. July 2007. Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical information. EPA-452/R-07-007.

[82] Relative yield losses are estimated instead of relative yield gains because the baseline (with CAAA) scenario in this analysis defines current conditions, whereas the counterfactual (no CAAA) scenario defines a change in current conditions. The models applied in this analysis forecast changes in yield relative to current conditions (i.e., relative to the baseline scenario).

TABLE 6-5. MINIMUM, MAXIMUM, AND AVERAGE ANNUAL RELATIVE YIELD LOSSES ACROSS ALL FASOM SUBREGIONS FOR CROPS AND ALL FASOM REGIONS FOR TREES BY YEAR (2000, 2010, 2020)

CROP/FOREST TYPE	2000			2010			2020		
	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM	AVERAGE
Barley	0.00%	0.02%	0.01%	0.00%	0.06%	0.02%	0.00%	0.07%	0.02%
Corn	0.00%	1.12%	0.18%	0.00%	3.07%	0.44%	0.00%	3.45%	0.56%
Cotton	0.00%	6.60%	1.15%	0.00%	16.67%	3.00%	0.00%	20.31%	3.81%
Oranges	0.00%	1.95%	0.09%	0.00%	4.68%	0.25%	0.00%	7.87%	0.43%
Potato	0.00%	6.17%	1.76%	0.00%	17.54%	4.99%	0.00%	20.80%	6.50%
Rice	-0.08%	0.14%	0.00%	0.00%	1.03%	0.11%	0.00%	1.66%	0.18%
Sorghum	0.00%	0.87%	0.14%	0.00%	2.17%	0.35%	0.00%	2.65%	0.47%
Soybean	0.00%	3.60%	1.24%	-0.55%	11.73%	3.07%	0.00%	12.74%	4.26%
Processing Tomatoes	0.00%	1.82%	0.31%	0.00%	5.54%	0.96%	0.00%	8.21%	1.47%
Spring Wheat	0.00%	1.50%	0.06%	0.00%	3.67%	0.15%	0.00%	6.98%	0.28%
Winter Wheat	0.00%	6.53%	1.00%	0.00%	18.23%	2.49%	0.00%	19.23%	3.29%
Hardwood Forests	1.60%	7.16%	5.06%	4.20%	19.12%	13.86%	6.61%	23.04%	16.68%
Softwood Forests	0.06%	3.85%	1.77%	0.25%	10.49%	4.88%	0.42%	12.27%	6.11%

Note: Negative relative yield losses indicate yield reductions with the CAAA. For example, the minimum estimate for soybeans in 2010 reflects an estimated relative yield loss of -0.55 percent. The negative relative yield loss is due to reductions in W126 ozone metric values under the counterfactual, no CAAA scenario in Florida in September of 2010 (the growing period for soybeans in Florida is roughly mid-July through September). In other words, ozone exposure is greater under the with-CAAA scenario for that month and region and, therefore, a net increase in soybean yield occurs assuming a rollback of the CAAA. Ozone concentrations are lower under the baseline, with CAAA scenario in Florida for all other months in 2010.

FIGURE 6-4. RELATIVE ANNUAL YIELD LOSSES IN POTATOES UNDER THE COUNTERFACTUAL (NO CAAA) SCENARIO BY FASOM SUBREGION AND YEAR BASED ON SUBREGIONAL-SPECIFIC OZONE CONCENTRATIONS AND GROWING PERIODS

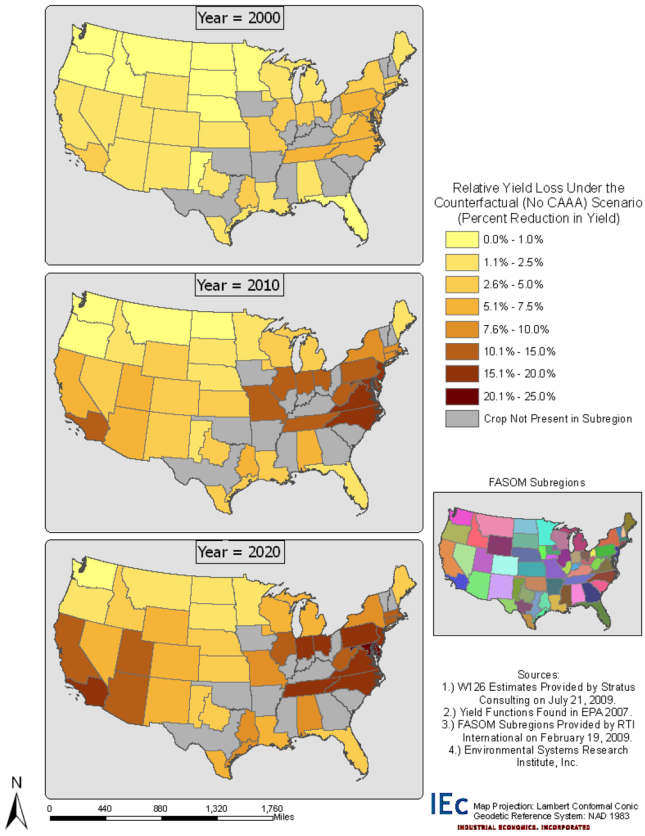
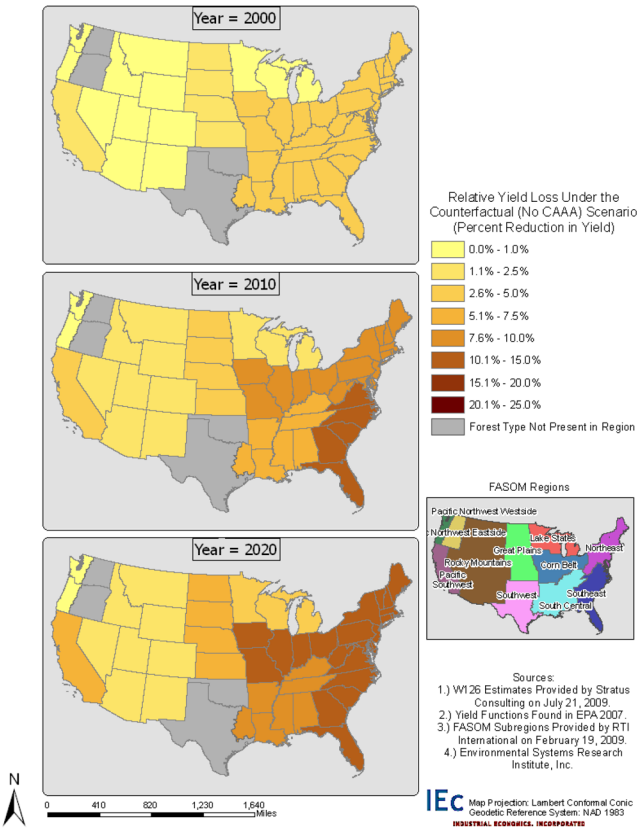


FIGURE 6-5. RELATIVE ANNUAL YIELD LOSSES IN SOFTWOOD FOREST TYPES UNDER THE COUNTERFACTUAL (NO CAAA) SCENARIO BY FASOM REGION AND YEAR BASED ON REGIONAL-SPECIFIC OZONE CONCENTRATIONS AND GROWING PERIODS



Commercial timber and agriculture operations generally manage their land to maximize profits. As such, changes in crop yields between the baseline and counterfactual scenarios may affect the distribution of commercial species planted; for example, landowners may shift production towards plants that are less sensitive to elevated ozone concentrations under the counterfactual scenario. This may occur at the individual plant level, replacing one crop or tree species for another with a higher growth rate; or, it may occur at the community level, converting agricultural lands to timberlands, or vice versa, to adjust for combined yield losses to agricultural crops and commercial tree species.

Changes in the distribution and yield of crop and tree species may in turn affect the supply of and demand for agricultural crops and commercial tree species, resulting in changes in the welfare of consumers and within agricultural and timber sectors of the economy. To quantify this economic benefit of cleaner air, we used the Forest and Agriculture Sector Optimization Model (FASOM). FASOM development was funded by EPA's Climate Economics Branch (CEB) and other EPA, U.S. government, and non-governmental funders over several decades as a partial equilibrium tool to evaluate the welfare and market impacts of public policies affecting agriculture and forestry. The model simulates biophysical and economic processes affecting land management and land allocation decisions over time to potentially competing agriculture and forest activities. Although the latest version of FASOM was developed to evaluate climate and biofuels policies, the model is capable of assessing a broad range of factors that might affect plant growth; for this project, we worked with the model's developers to develop input files to characterize the impact of ozone on plant and tree growth at a regional and crop-specific level, using the exposure-response results described above.[83]

Although FASOM has been widely applied to agricultural sector analysis and has been peer reviewed in many contexts, it has not to date been subject to a validation exercise comparing the model results for an historical period to historical data for that period.[84] As a result, the performance of the model in forecasting future agricultural sector effects, such as those estimated for this study, has not yet been assessed. Two other potential limitations may pertain in EPA's application of FASOM for this study. First, FASOM adopts a model simulation approach which assumes perfect foresight by economic actors in the agricultural sector. A perfect foresight assumption may be of concern for some

[83] Note that we performed two runs of the FASOM model, one where the response to ozone for those crop/region combinations without specific individual concentration-response functions are assumed to be zero, and a second where impacts on crop/region combinations without specific concentration-response functions were set to the values used in adjacent regions and/or proxy crops where possible (for example, soft white wheat was used for barley and sugarbeets; tomatoes for processing were used for potatoes; soybeans for fresh tomatoes; corn for fresh tomatoes if there is not a value for soybeans; etc.). We found that the difference in the overall national results between these two runs was negligible, however. As a result, in this chapter we report the results from the run that applies proxy crop/region concentration-response functions. Note further that the version of FASOM used for this analysis is the version current as of July 21, 2010.

[84] See, for example, a review commissioned by USEPA for its application of FASOM to support regulatory analysis of renewable fuels standards, concluded in July of 2010 and available at the following web site (accessed November 26, 2010): http://www.epa.gov/otaq/fuels/renewablefuels/regulations.htm

long-term analyses, but is likely to be less problematic for this study because our time horizon extends only to 2020. Furthermore, USDA projections of commodity prices and outputs also extend nearly to 2020, and FASOM's projections for their base case agree well with the USDA projections. As a result, the effect of perfect foresight on model outcomes in the present study is reduced.[85] A second potential limitation of FASOM is its approach to estimating the sensitivity of imports to changes in domestic prices. Although FASOM is not a full international model, it does incorporate an import elasticity estimate for the largest and most important commodity crops. This allows the model to capture, for example, increases in agricultural imports to the US under a scenario in which domestic crop prices are projected to rise. For a number of minor crops, traded in very small quantities, however, FASOM holds imports fixed. The effect of this factor on our results is not clear, but we estimate that a more flexible import sector for these much less important crops would have only a minor effect on our estimates of the net benefits of reducing ozone exposure for US crops. We expect the directional bias of holding minor crop imports fixed, while small, would be to slightly reduce our estimates of the net welfare benefit of reducing ozone exposure, and thereby improving productivity, of domestic agricultural crops.

The economic welfare results of the FASOM modeling are presented in Table 6-6. FASOM generates total welfare estimates for the agricultural and forest sectors for each of our scenarios, for each target year, reflecting the sum of total consumer and producer surplus derived from agriculture and forest production. In general, higher ozone concentrations in the *without-CAAA* scenario lead to reduced agricultural and forest productivity, raising prices for these products, which in turn increases producer surplus but reduces consumer surplus by a larger amount. As a result, FASOM estimates the net welfare benefits of the CAAA to be approximately $1 billion in 2000, $5.5 billion in 2010, and $10.7 billion in 2020, increasing over time as the differences in ozone concentrations grows.[86]

[85] Perfect foresight is a basic assumption of the modeling approach on which FASOM is based. Structuring the model based on perfect foresight rather than a myopic (recursive) approach allows an expanded array of policy simulations and potential insights, which is the main purpose of this type of model.

[86] Note that the year 2000 in FASOM represents average annual activity over the 5-year period from 2000 to 2004; 2010 represents 2010 through 2014; and 2020 represents 2020 through 2024. Values provided for ozone impacts in 2000, 2010, and 2020 were applied to the 2000, 2010, and 2020 model periods in FASOM, respectively. The results presented here do not includes losses Canada and the rest of the world; for example, in 2020, higher US prices in the without-CAAA scenario result in additional consumer surplus losses to non-US consumers of $1.7 billion in the forest sector and $3.3 billion in the agricultural sector.

TABLE 6-6. SUMMARY OF FASOM RESULTS: TOTAL CONSUMER AND PRODUCER SURPLUS VALUES FOR THE AGRICULTURAL AND FOREST SECTORS

VARIABLE	MODEL RUN	2000	2010	2020
Annual Welfare, US Forest Sector	With Clean Air Act ($ billion)	$637	$877	$1426
	Without Clean Air Act ($ billion)	$636	$875	$1426
	Damage Estimate ($ billion)	**$1.5**	**$1.7**	**$0**
	Percent change	0.24%	0.20%	0%
Annual Welfare, US Agriculture Sector	With Clean Air Act ($ billion)	$1706	$1831	$1916
	Without Clean Air Act ($ billion)	$1706	$1828	$1905
	Damage Estimate ($ billion)	**−$0.5**	**$3.8**	**$10.6**
	Percent change	-0.03%	0.21%	0.55%
Annual Welfare, Forest and Agriculture Sector Combined	With Clean Air Act ($ billion)	$2343	$2708	$3341
	Without Clean Air Act ($ billion)	$2242	$2703	$3331
	Damage Estimate ($ billion)	**$1.0**	**$5.5**	**$10.7**
	Percent change	0.05%	0.20%	0.32%

Notes:

1. Results are expressed in year 2006 dollars.

In general, FASOM forecasts a relative shift towards forestry and away from agriculture under the *without-CAAA* scenario, indicating that the net impacts of the ozone effects on forests and agriculture would make forestry relatively more profitable than in the baseline compared with agriculture, resulting in a shift in land use. The model forecasts a sizable increase in cropland in the *without-CAAA* scenario, however there is an even greater decline in pasture as the returns to crop production rise relative to livestock production with higher crop prices.

As noted above, the model suggests that the damages attributed to higher ozone concentrations indicate that producers gain in many cases, while consumers are always substantially worse off with the ozone impacts reducing productivity. The reason that producers often are better off is that most forest and agricultural products have relatively inelastic demands, which means that a general decline in productivity will tend to increase prices by more than the reduction in quantity, increasing revenue and often profits as well. In general, FASOM attributes large price increases in response to the reductions in productivity for these inelastic products, and production declines in the *without-CAAA* scenario for most agricultural commodities, with larger declines in general for those products experiencing larger ozone impacts, and also sizable reductions in exports.

FASOM also is capable of modeling land-use changes in response to the higher ozone concentrations in the *without-CAAA* scenario. The model indicates changes in major land use categories at the national level over time under the ozone impacts scenario, which is leading to a net increase in forest of about 6.1 million acres by the 2020 model period and an increase in cropland of 7.6 million acres by 2020 in response to the productivity declines. At the same time, the model indicates that cropland pasture (high-quality land that is suitable for cropland but is being used as pasture) and pasture (lower-quality land that is not suitable for growing crops without improvement) decline by a total of 12.7 million acres and Conservation Reserve Program (CRP) land decreases by about 1 million acres. The crop experiencing the largest reduction in acreage is soybeans, while there is an increase in wheat acreage and a number of smaller shifts between alternative crops.

VISIBILITY

Air pollution impairs visibility in both residential and recreational settings, and an individual's willingness to pay (WTP) to avoid reductions in visibility differs in these two settings. Benefits of residential visibility relate to the impact of visibility changes on an individual's daily life (e.g., at home, at work, and while engaged in routine recreational activities). Benefits of recreational visibility relate to the impact of visibility changes manifested at parks and wilderness areas that are expected to be experienced by recreational visitors. For the purposes of this analysis, recreational visibility improvements are defined as those that occur specifically in federal Class I areas, and residential visibility improvements are those that occur within the boundaries of Census Metropolitan Statistical Areas (MSAs).

We calculate household WTP for improvements in both residential and recreational visibility. We base our calculations on simulations of future visibility conditions at the 36-km grid-cell level, as estimated by EPA's Community Multiscale Air Quality (CMAQ) model. The relationship between a household's WTP and changes in visibility is derived from a number of contingent valuation (CV) studies published in the peer-reviewed economics literature. The approach we apply to estimate the benefit of improvements in recreational visibility is consistent with methods EPA has used in analyses conducted since EPA's First Prospective analysis was completed. In particular, this chapter relies heavily on research completed for the PM NAAQS RIA (U.S. EPA, 2006) for the recreational visibility analysis. Our estimate of the benefit of residential visibility is consistent with methods applied in past analyses as well, but in previous reviews the Council had expressed concerns about residential visibility estimates based on WTP estimates from the McClelland et al. (1991) study. As a result, our estimates in this chapter rely on a new "benefits transfer" estimate of WTP derived from other published sources of residential visibility WTP.

According to the CMAQ simulations, the CAAA has had and will continue to have a substantial effect on visibility in both residential and recreational settings. The visibility data used in this analysis is annual mean visibility data, by county, measured in deciviews.[87] Figure 6-6 depicts the change in visibility (measured in deciviews) over the 30-year time frame, from 1990 to 2020, along the *with-CAAA* scenario. This map shows that, overall, changes in visibility due to the CAAA are greater in the eastern U.S. than the western U.S. Additionally, the largest changes in visibility occur in the Midwestern states. The county level data presented here are the basis for the residential visibility improvements we present below.

Figure 6-7 summarizes trends in visibility at the 13 most-visited U.S. National Parks. Visibility estimates (measured in deciviews) are provided for each of the seven core CAAA scenarios. Note that deciviews are inversely related to visual range, such that a decrease in deciviews implies an increase in visual range (i.e., improved visibility). Conversely, an increase in deciviews implies a decrease in visual range (i.e., decreased visibility). The figure illustrates that the CAAA greatly affects visibility at National Parks – over the 1990 to 2020 period, visibility markedly improves with the CAAA, and markedly declines without the CAAA. Particularly large differences in visibility between the *with-CAAA* and *without-CAAA* scenarios are seen at Great Smoky Mountains National Park, which is the most visited park in the U.S. Note that six of the 13 parks listed in Figure 6-7 are not included in the primary monetized recreational visibility estimates presented later in this chapter, because they were not included in the park regions studied in the underlying economic valuation study. The six parks not included are in the northern part of the country, and include Mount Rainier, Olympic, Glacier, Yellowstone, Grand Teton, and Acadia.

[87] The data was aggregated from the 36-km grid-cell level to the county level using the BenMAP version 3.0.15 "Air Quality Grid Aggregation" algorithm. The fourth quarter data is corrected for a missing day (the CMAQ runs modeled 364 days, omitting December 31) by reweighting the mean to account for the missing day.

FIGURE 6-6. ESTIMATED CHANGE IN VISIBILITY FOR WITH-CAAA SCENARIO, 1990 TO 2020

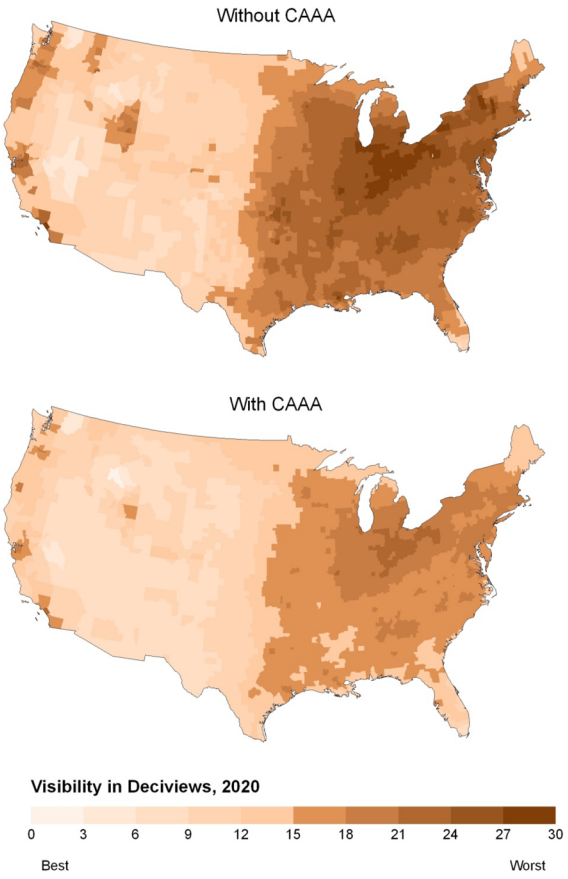


FIGURE 6-7. VISIBILITY TRENDS FOR THE 13 MOST-VISITED U.S. NATIONAL PARKS

Only one existing study provides defensible monetary estimates of the value of recreational visibility (Chestnut and Rowe, 1990b; 1990c). Although the Chestnut and Rowe study is unpublished, it was originally developed as part of the National Acid Precipitation Assessment Program (NAPAP) and, therefore, has been subject to peer-review as part of that program. The Chestnut and Rowe study measures the demand for visibility in Class I areas managed by the National Park Service (NPS) in three broad regions of the country: California, the Southwest, and the Southeast. Respondents in five states were asked about their WTP to protect national parks or NPS-managed wilderness areas within a particular region. The survey used photographs reflecting different visibility levels in the specified recreational areas. The visibility levels in these photographs were later converted to deciviews for the current analysis. The three regions assessed in the study cover 86 of the 156 Class I areas in the United States. Given that national parks and wilderness areas exhibit unique characteristics, it is not clear whether the WTP estimate obtained from the Chestnut and Rowe study can be transferred to other national parks and wilderness areas, without introducing additional uncertainty. As a

result, for the primary estimate, we value only those recreational benefits in the areas that were directly analyzed in the original Chestnut and Rowe study.

In the First Prospective analysis, we omitted the results of the benefits estimate for residential visibility from the primary benefits estimate due to technical concerns about the methodology of the study upon which our original calculations were based (McClelland et al., 1991).[88] There exists a wide range of published, peer-reviewed literature, however, that supports a non-zero value for residential visibility. As a result, we have revised our methodology for valuing residential visibility, and now include these benefits in our overall primary visibility benefits estimate.

For valuing residential visibility improvements, we rely upon a benefits transfer approach that draws upon information from the published Brookshire (1979), Loehman (1984) and Tolley (1986) studies. Each of the studies used provides estimates of household WTP to improve visibility conditions from a status quo visual range to an improved visual range. While uncertainty exists regarding the precision of these older, stated-preference residential valuation studies, we believe their results support the argument that individuals have a non-zero value for residential visibility improvements. The implied annual per-household WTP estimates from these study, for a hypothetical 10-percent improvement, ranges from $14 to $145, with a mean of $69 and median of $53. It is not surprising that such a range of values exists, as the areas of the country covered feature different landscapes and vistas, populations and prevailing visibility conditions.

Fortunately, the three recommended studies provide primary visibility values for a variety of cities throughout the United States: Atlanta, Boston, Chicago, Denver, Los Angeles, Mobile, San Francisco, and Washington D.C. We assign each of the 359 MSAs in the contiguous U.S. a value based on geographic proximity to one of the eight study cities, with two exceptions: 1) We apply the Loehman et al. (1984) value only to the six San Francisco Bay area MSAs, because the study is unique among the three in the manner in which visibility changes were described to respondents (i.e., a distribution of days versus average conditions), and 2) Values associated with Denver are not assigned on the basis of proximity but are instead assigned only to MSAs which meet an elevation range threshold of 1500 meters within the MSA, because one would expect that residents of Denver, with a dramatic view of the Rocky Mountains that is rarely obstructed by trees, would have a greater interest in protecting visibility than a city without a dramatic skyline or nearby mountains.[89]

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[88] Council review of early drafts of the First Prospective analysis noted that the McClelland et al. (1991) study may not incorporate two potentially important adjustments. First, their study does not account for the "warm glow" effect, in which respondents may provide higher willingness to pay estimates simply because they favor "good causes" such as environmental improvement. Second, while the study accounts for non-response bias, it may not employ the best available methods. As a result of these concerns, a prior Council recommended that residential visibility be omitted from the overall primary benefits estimate in the First Prospective.

[89] The geographic proximity assignment is preserved for the Los Angeles and Riverside MSAs although these MSAs meet the elevation range threshold of 1500 meters. The assignment is preserved because Los Angeles is one of the study cities and

The primary estimate of benefits of recreational and residential visibility improvements is provided in Table 6-7. The primary estimate for recreational visibility only includes benefits in the original study regions (i.e., California, the Southwest, and the Southeast). The primary estimate for residential visibility includes benefits in all MSAs. In general, benefits to visibility increase over time as visibility improves due to the CAAA. Benefits to residential visibility are approximately three times as large as benefits to recreational visibility.

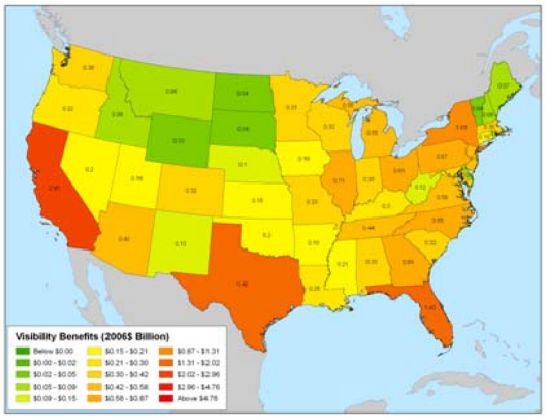
TABLE 6-7. PRIMARY ESTIMATE OF BENEFITS TO VISIBILITY (BILLION 2006$)

	2000 BENEFITS	2010 BENEFITS	2020 BENEFITS
Recreational Benefits	$3.3	$8.6	$19
Residential Benefits	$11	$25	$48
Total Benefits	$14	$34	$67

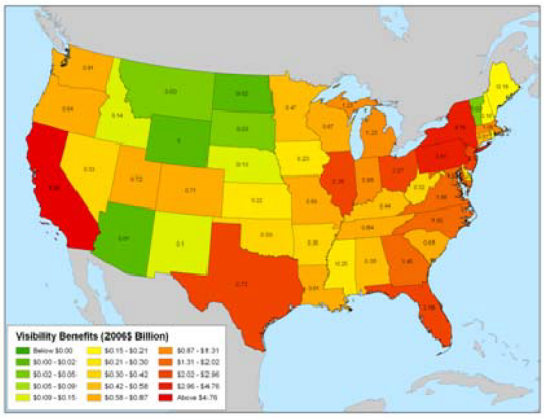
In Figures 6-8a and 6-8b below, we map the primary 2020 estimate of benefits of recreational and residential visibility improvement by state. Overall, the spatial pattern of benefits is similar for recreational and residential visibility. Recreational visibility benefits are driven by population and park location, within the original study regions of Chestnut and Rowe (1990a). These regions are California, the Southwest (Arizona, Nevada, Utah, Colorado, and New Mexico), and the Southeast (Delaware, Maryland, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida, and Mississippi). Households express WTP for visibility improvements in Class I areas located in-region as well as out-of-region. For this reason, there may be high recreational benefits in a state that has no Class I areas. Although household WTP is higher for in-region parks, this effect seems to be dominated by the effect of population. For example, less populated states such as New Mexico and Utah with Class I areas have low benefits to recreational visibility, while more populated states such as New York without Class I areas have high recreational visibility benefits.

also because Los Angeles has a particular set of location-specific characteristics that set it apart from Denver. As a conservative measure, Riverside MSA is also assigned to the Los Angeles study area because a significant portion of Riverside County itself is located in the South Coast Air Quality Management District, and therefore is considered by at least some measures to be part of the same regulated airshed as Los Angeles.

FIGURE 6-8A. PRIMARY ESTIMATE OF RECREATIONAL VISIBILITY BENEFITS IN 2020 (BILLION 2006$)



IGURE 6-8B. PRIMARY ESTIMATE OF RESIDENTIAL VISIBILITY BENEFITS IN 2020 (BILLION 2006$)



Residential visibility benefits are driven by population and visibility improvements. Overall, benefits are greater in the East. This is due in part to greater population levels as well as greater visibility improvements. Benefits are also very high in California due to the state's large population and visibility improvements, especially in and around Los Angeles and San Francisco. Residential visibility is also dependent upon the WTP value applied. Much of the West uses the WTP value for Denver, which is highest WTP value being widely applied. Yet, the West still has lower overall benefits to residential visibility.[90] This impact shows that the effect of population and visibility improvement dominates the effect of the WTP value applied.

MATERIALS DAMAGE

Since the mid-19th century air pollution has been suspected of accelerating the degradation of natural and man-made materials that are exposed to the outdoor environment. Concern over the effect of pollutants on materials has mainly been directed towards the economic consequences of damage to materials used in construction, but aesthetic damage to historic buildings and monuments is also a concern. Wet and dry acidic deposition, alone or combined with other air pollutants, contribute to the increased rate of materials damage. Acidic deposition has been shown to have an effect on materials including zinc/galvanized steel and other metal, carbonate stone (as monuments and building facings), and surface coatings (paints) (NAPAP, 1991).

Metal structures are usually coated by alkaline corrosion product layers and thus are subject to increased corrosion by acidic deposition. In addition, research has demonstrated that iron, copper, and aluminum based products are subject to increased corrosion due to pollution, in particular SO_2 (NAPAP, 1991), that acidic deposition accelerates the rate of erosion of carbonate stone (marble and limestone), and that acidic deposition has numerous negative effects on painted wood and, in general, increases the weathering rate. This analysis focuses on quantifying the impact of sulfur dioxide deposition on exterior building and infrastructural materials including carbonate stone, galvanized steel, carbon steel, and painted wood, as outlined Table 6-8 below.

[90] The WTP value for San Francisco is higher than Denver, but the San Francisco value is not applied to other MSA's.

TABLE 6-8. MATERIALS DAMAGE EFFECTS

POLLUTANT	QUANTIFIED EFFECTS—DAMAGE TO:	UNQUANTIFIED EFFECTS[a]—DAMAGE TO:
Sulfur oxides	Infrastructural materials - galvanized and painted carbon steel Commercial buildings - carbonate stone, metal, and painted wood surfaces Residential buildings - carbonate stone, metal, and painted wood surfaces	Monuments - carbonate stone and metal Structural aesthetics Automotive finishes - painted metal
Hydrogen ion and nitrogen oxides		Infrastructural materials - galvanized and painted carbon steel Zinc-based metal products, such as galvanized steel Commercial and residential buildings - carbonate stone, metal, and wood surfaces Monuments - carbonate stone and metal Structural aesthetics Automotive finishes - painted metal
Carbon dioxide		Zinc-based metal products, such as galvanized steel
Formaldehyde		Zinc-based metal products, such as galvanized steel
Particulate matter		Household cleanliness (i.e., household soiling)
Ozone		Rubber products (e.g., tires)

a The categorization of unquantified effects is not exhaustive.

This analysis applies the Air Pollution Emissions Experiments and Policy (APEEP) analysis model, described in Muller and Mendelsohn (2007, 2009), to link SO_2 emissions to ambient SO_2 levels. Using emission inputs, the air quality model in APEEP forecasts seasonal and annual average county concentrations for SO_2, amongst other pollutants.[91] As reported in Muller and Mendelsohn (2007) and detailed in the supporting online material for that publication, APEEP's air quality modeling has been statistically tested and calibrated against the predictions generated by the Community Multi-scale Air Quality Model (CMAQ), using 1996 emissions data and a CMAQ run for 1996

[91] The Project Team considered using the CMAQ SO2 air quality results directly, but the decision to implement the materials damage approach described here came too late to cost-effectively recover the relevant ambient SO2 estimates from the original CMAQ runs. The overall magnitude of the monetizable materials damage benefits is such a small part of the overall benefits of the CAAA that the impact of using APEEP's air quality tool rather than CMAQ on the overall benefits estimates is likely to be very small.

conditions. Muller and Mendelsohn (2007) also report comparisons of APEEP's results with available monitor data for this period. The results for the SO_2 air quality component used in these materials damage calculations appear to suggest good agreement for APEEP for concentrations near the mean, but APEEP appears to overpredict SO_2 concentrations for high-end concentrations. Overall, however, it is important to note that APEEP is designed to be a fast-running alternative to CMAQ for use in an integrated assessment model – the air quality component of APEEP is a statistical representation of relations that are accomplished in a far more sophisticated manner in CMAQ.

The remaining general steps in the process of estimating materials damage effects are as follows:

- **Develop a national inventory of sensitive materials**. A key piece of information needed to apply the appropriate materials damage concentration-response functions is the existing materials inventories. This analysis estimates the inventory of four exterior building and infrastructural materials in each county in the lower 48 states, including carbonate stone, galvanized steel, carbon steel, and painted wood surfaces.
- **Derive concentration-response functions that relate material mass loss to ambient SO_2.** Dose-response functions for man-made materials damages are obtained from two sources; the NAPAP studies (Atteraas, Haagenrud, 1982; Haynie, 1986) and from the International Cooperative Programme on Effects on Materials (ICP, 1998).
- **Estimate the value of lost materials.** Materials damage is valued as the cost of future materials maintenance activities. The accelerated rate of materials decay due to pollution exposure increases the frequency of regularly scheduled future maintenance activities. The change in the present value of the maintenance schedules extending into the future constitutes the monetary impact of an emission change on materials damage.

Table 6-9 summarizes the benefits of reduced materials damage attributed to CAAA programs in 2000, 2010, and 2020. Benefits are given by EPA region. Although the total benefits are relatively small compared to other categories of effect, the benefits of CAAA programs to materials damage increase over time as we would expect. The spatial distribution of the benefits is primarily owing to the distribution of the materials inventory and SO_2 exposure. The effect of SO_2 exposure is a more important driver of results than the inventory. For example, the benefits in Region 5 are approximately twice as large as those in any other EPA region. This is due to the significant decrease in SO_2 exposure associated with the CAAA in this region.

TABLE 6-9. BENEFITS OF REDUCED MATERIALS DAMAGE DUE TO CAAA PROGRAMS

EPA REGION	VALUATION (THOUSAND 2006$)		
	2000	2010	2020
1: CT, ME, MA, NH, RI, VT	$720	$2,100	$2,100
2: NY, NY	$9,000	$10,000	$12,000
3: DE, DC, MD, PA, VA, WV	$9,400	$19,000	$23,000
4: AL, FL, GA, KY, MS, NC, SC, TN	$8,400	$16,000	$21,000
5: IL, IN, MI, MN, OH, WI	$26,000	$38,000	$38,000
6: AR, LA, NM, OK, TX	$2,200	$4,000	$7,300
7: IA, KS, MO, NE	$2,000	$1,600	$1,600
8: CO, MT, ND, SD, UT, WY	$400	$570	$730
9: AZ, CA, NV	-$100	$490	$640
10: ID, OR, WA	$340	$510	$560
Total	**$58,000**	**$93,000**	**$110,000**

Notes: Results are rounded to two significant figures. Totals may not sum due to rounding.

ADIRONDACK CASE STUDY RESULTS

The Project Team was encouraged to consider case study analysis of a set of ecological effects for which national analyses might not be feasible, owing to lack of available data or methods. EPA chose to conduct a case study in the Adirondack region of New York State, focusing on two ecological service flows that provide benefits in terms of both ecosystem health and economic terms: (1) acidification of surface waters and (2) reduced yields of commercial timber. The Adirondack region of New York may exhibit the most severe ecological impacts from acidic deposition of any region in North America – acid deposition is the main cause of both of the effects we studied.[92] Adirondack Park is a State Park comprising 5,821,183 acres of State and privately owned land in upstate New York and is nearly a 100 by 100 mile box of land, intersecting fourteen counties. The Park was created in 1892 through an amendment to the State constitution, with the purpose of forest and natural resource conservation. Federal programs addressing air pollution have been particularly beneficial to the region as, due to its location downwind of the highly industrialized Ohio River Valley, most of the acid deposition in the region originates from out of state. In addition to its status as a region of particular sensitivity to lake acidification and with some existing research on the effects of air pollutants on forest

[92] Driscoll, Charles T. et al. May 2003. Chemical Response of Lakes in the Adirondack Region of New York to Declines in Acidic Deposition. Environmental Science and Technology 37(10): 2036-2042.

growth, the Adirondack Region was selected as a setting for this case study due to the existence of a regional economic random utility model describing recreational fishing behavior.

Lake Acidification in the Adirondacks

Surface waters, such as lakes and streams, may be the most susceptible systems to acidic deposition as they collect acidic precipitation not only from direct deposition on their surfaces but also in the form of runoff from their entire watershed. Acid accumulates in surface waters via three main pathways:

- precipitation, or wet deposition, in which pollutants are dissolved in rain or snow;
- dry deposition, or direct deposition of gases and particles on surfaces; and
- cloud-water deposition, involving material dissolved in cloud droplets and deposited on vegetation.[93]

As acids accumulate, ecosystems gradually lose the ability to buffer them, resulting in changes to ecosystem structure and function. Acidification of the surface water affects the trophic structure of water contributing to declines in the abundance of zooplankton, macroinvertebrates, and fish.[94]

The ecological service flow affected by lake acidification that is most amenable to economic analysis is recreational fishing. Extensive research exists focused on both the effects of lake acidification on fisheries and on individuals' willingness to pay to avoid reductions in the quality or quantity of recreational fishing opportunities. This analysis employs the following general steps to quantify the benefits of reduced lake acidification on recreational fishing in the Adirondacks. A conceptual model depicting the analytic steps in terms of inputs, outputs, and ecological and economic models is provided in Figure 6-9.

- **Forecast lake acidification levels consistent with the *with-CAAA* and *without-CAAA* scenarios.** EPA generated estimates of acidic deposition at a 36-kilometer grid cell level across the Adirondack region using the CMAQ model. We then implemented an ecological model, the Model of Acidification of Groundwater in Catchments (MAGIC), to simulate the transport of the acidic deposition through the hydrological and terrestrial ecosystems and forecast acidification levels in a subset of Adirondack lakes.
- **Extrapolate results of the ecological model within the Adirondacks region.** We developed a random effects model to explain the relationship between acidification of lakes and their specific site characteristics.

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[93] The U.S. National Acid Precipitation Assessment Program. 1991. Integrated Assessment Report. The NAPAP Office of the Director, Washington, DC.

[94] Driscoll, Charles T. et. al. March 2001. Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies. BioScience 51(3): 180-198.

- **Apply ANC thresholds to classify lakes as either "fishable" or "impaired".** Fishable lakes are those for which water quality is not deteriorated to an extent which limits recreational fishing. Impaired lakes' water quality is deteriorated so as to reduce fish populations and preclude recreational fishing. Lakes are defined as either fishable or impaired based on identified ANC thresholds. As uncertainty exists regarding the ANC threshold at which effects are experienced, this analysis considers three separate thresholds below which lakes are considered impaired.
- **Apply an economic random utility model (RUM) to quantify economic benefits of the CAAA in terms of recreational fishing in the Adirondack region.** We employ a RUM that was developed to account for fishing site choices made by recreational fishers based on attributes of sites specifically in the Adirondack region. The difference in economic welfare values between the value of fishable (i.e., not impaired) lakes in the *with-CAAA* scenario and the *without-CAAA* scenario represents the benefits to recreational fishing in the Adirondack region associated with the CAAA.

FIGURE 6-9. CONCEPTUAL APPROACH TO ESTIMATING THE ECONOMIC BENEFITS OF REDUCED ACIDIFICATION ON ADIRONDACK LAKES

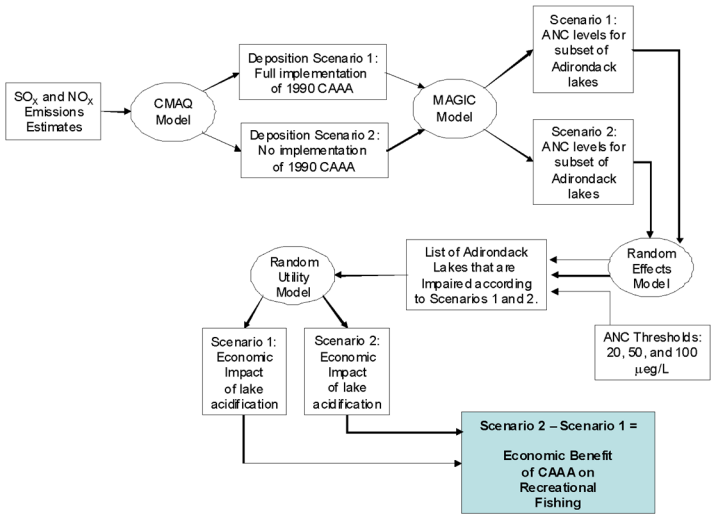


Table 6-10 summarizes the results of this analysis. Present value cumulative benefits are provided for 2000, 2010, and 2020, assuming a five percent discount rate. Single year undiscounted benefits are also given for each year. Undiscounted single year benefits

increase over time but the benefits do not follow any particular trend across alternative threshold assumptions. It should be noted that benefits in each year and under each threshold assumption reflect a different subset of lakes. Therefore, benefits are not expected to follow any particular trend across years or threshold assumptions.

Table 6-10 SUMMARY OF ANNUAL AND CUMULATIVE ESTIMATED BENEFITS TO RECREATIONAL FISHING IN THE ADIRONDACK REGION (MILLION 2006$)

YEAR	ANC THRESHOLD ASSUMPTION FOR DEFINING "FISHABLE" LAKES	ADIRONDACK REGION	
		SINGLE YEAR UNDISCOUNTED	CUMULATIVE FIVE PERCENT DISCOUNT RATE
2000	20	$7	$62
	50	$7	$57
	100	$5	$44
2010	20	$8	$143
	50	$8	$132
	100	$6	$101
2020	20	$9	$197
	50	$8	$182
	100	$6	$136

Note:
1) Cumulative benefits in year 2000 are the cumulative benefits to recreational fishing of implementing the CAAA from 1990 to 2000. Similarly, cumulative benefits in 2010 are cumulative from 1990 to 2010 and cumulative benefits in 2020 are cumulative from 1990 to 2020. The single year undiscounted benefits are the benefits to recreation fishing of implementing CAAA in that year (2000, 2010, or 2020).
2) Benefits in this case study are evaluated from 1990 (the year of the passage of the CAAA) to 2050 (the forecast horizon for the lake ANC levels with and without the CAAA). The benefits in this table are presented for years 2000, 2010, and 2020, however, to be consistent with the benefits as calculated in the broader cost-benefit analysis of the CAAA.

Commercial Timber in the Adirondacks

Reductions in NO_x and SO_x emissions due to the implementation of the CAAA are also believed to reduce forest soil acidity. Reductions in soil acidity have been shown by scientists to increase tree growth and improve overall forest health. Such changes in forest growth and health would have a positive effect on the timber industry within Adirondack Park, potentially increasing the frequency and/or the volume of timber harvests.

Quantifying the magnitude of these benefits requires a function to translate varying levels of soil acidity into corresponding tree growth productivity. Unfortunately, species-specific dose-response functions relating soil acidity levels with changes in tree growth in Adirondack Park are not available. Our analysis instead characterized the existing timber industry in Adirondack Park in terms of the types of tree species present, wood products harvested, extent of timber harvest activities, and the overall value of timber harvests

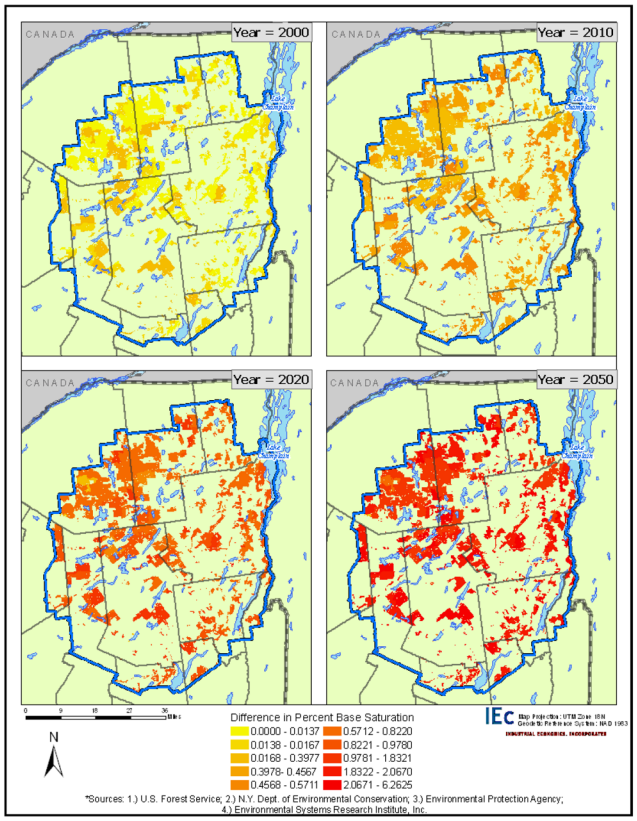
within the Park. We then estimated changes in percent base saturation (a measure of soil acidity) due to the implementation of the CAAA across the Park from 1990 to 2050, focusing on soil acidity differences in areas subject to commercial timber activity. Specifically, changes in percent base saturation levels in timber harvest areas were mapped in relation to potential changes in the growth and health of tree species present in these areas and the likely effects of altered tree growth and health on timber harvest rates and volumes. In addition, we provide some perspective on the potential order of magnitude of benefits of the CAAA on the timber industry in the Adirondacks, summarizing existing, relevant research.

We used estimates of soil percent base saturation levels for 1990, 2000, 2010, 2020, and 2050 with and without the CAAA to characterize the effect on Adirondack forests.[95] Percent base saturation is the proportion of cation exchange sites (exchange sites are areas on soil particles where ions may be adsorbed) occupied by basic cations (Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}). These basic cations buffer the soil by inhibiting the adsorption of H^{+} ions. Thus, percent base saturation is a measure of the soil's buffering capacity. High percent base saturation levels indicate large buffering capacity and low soil acidity levels, while low percent base saturation levels indicate the converse. Percent base saturation point estimates were generated using the same Model of Acidification of Groundwater in Catchments (MAGIC) as used in the lake acidification analysis described above.

Figure 6-10 presents differences in percent base saturation levels with and without the CAAA specifically within the timber harvest areas of the Park by year. There is a clear temporal trend in the difference in percent base saturation levels with and without the CAAA. Specifically, differences between percent base saturation levels with the CAAA as compared to without the CAAA increase in each year in the analysis. However, there is little spatial variability in percent base saturation differences within individual years. The lack of spatial variability becomes more pronounced as time goes on, so that by 2050 the difference in percent base saturation is between 2.07 and 6.26 percent in almost all forested resource management areas in the Park. The lack of spatial variability makes sense given the relatively small geographic scope considered in this analysis. The minor spatial variation in percent base saturation differences exhibited in 2000 and 2010 is most likely related to microhabitat factors (i.e., different soil types and differing precipitation levels).

[95] While the timeframe for this Second Prospective analysis of the CAAA is through 2020, this case study reports benefits through 2050 as we expect that reductions in emissions that occur in 2020 will continue to provide benefits to recreational fishing through this time frame.

FIGURE 6-10. DIFFERENCES IN PERCENT BASE SATURATION VALUES WITH AND WITHOUT THE CAAA IN FORESTED RESOURCE MANAGEMENT AREAS IN ADIRONDACK PARK [96, 97]



[96] The differences between percent base saturation levels with the CAAA and without the CAAA are presented rather than absolute percent base saturation levels for each scenario to highlight the changes in percent base saturation attributable to the implementation of the CAAA.

[97] The ten ranges of difference in percent base saturation values presented in Exhibit 5-8 are equal to the 10th, 20th, …, and 100th percentiles for the combined distribution of difference in percent base saturation values across all years in the analysis (2000, 2010, 2020, and 2050).

Also of importance to this analysis is the magnitude of the increase in percent base saturation levels in relation to specific forest types within resource management areas. We focused on six forest types (sugar maple/beech/yellow birch, red maple/upland, spruce/fir, eastern hemlock, eastern white pine, and paper birch) that are prevalent in the Park relative to other forest types and contain tree species of commercial value. Table 6-11 presents the area-weighted mean increase in percent base saturation levels in these forest types per year. Of the forest types of interest, the paper birch forest type experiences the greatest increase in percent base saturation due to the CAAA, followed by the eastern hemlock and the sugar maple/beech/yellow birch forest types.

TABLE 6-11. AREA-WEIGHTED MEAN DIFFERENCES IN PERCENT BASE SATURATION VALUES WITH AND WITHOUT THE CAAA IN FOREST TYPES OF INTEREST

FOREST TYPE	AREA-WEIGHTED DIFFERENCE IN PERCENT BASE SATURATION			
	2000	2010	2020	2050
Sugar Maple/Beech/Yellow Birch	0.023	0.414	0.820	1.899
Red Maple/Upland	0.025	0.377	0.758	1.755
Spruce/Fir	0.028	0.361	0.736	1.702
Eastern Hemlock	0.028	0.413	0.827	1.908
Eastern White Pine	0.018	0.419	0.814	1.882
Paper Birch	0.018	0.457	0.891	2.069
Other Forest Types	0.015	0.429	0.829	1.918

The area-weighted increase in percent base saturation levels in sugar maple/beech/yellow birch forests is in line with increases in percent base saturation levels in other forest types in Adirondack Park. This is an important point given the prevalence of sugar maple in this forest type, and the fact that sugar maple is an economically important tree species in the Park. Although dose-response functions, which would allow for estimates of growth increases in sugar maples due to increased base saturation levels, do not exist, several studies have estimated changes in sugar maple growth due to increases in soil acidity stemming from elevated nitrogen and/or sulfur deposition.[98] Changes in harvest volumes comparable to those seen in those existing studies might lead to annual wood harvest

[98] For example, Duchesne et al. (2002) found that sugar maple basal area growth rates were reduced by 17 percent, on average, in forest stands exhibiting decreasing basal area growth rates over time (declining stands) compared to sugar maple basal area growth rates in stands exhibiting increasing basal area growth rates over time (healthy stands). In addition McLaughlin (1998) found that the health of hardwood stands on shallow, poorly buffered soils similar to those found in Adirondack Park declined during the 1990s due to decreasing pH and base saturation levels and increased aluminum ion concentrations.

benefits of roughly $1 million to $1.5 million annually, based on the total stumpage values for sugar maple pulpwood/chip wood we estimate for the region.[99] Whether sugar maple growth rate changes would mirror those reported in either of these studies, however, is uncertain due to the lack of an established functional relationship. Nonetheless, we expect that all tree species in the Park would benefit, in terms of increased stand growth and vigor, from increased percent base saturation levels. In some cases, increases in growth may allow for both more frequent and larger timber harvests (i.e., more frequent timber harvests removing larger volumes of wood). Improved forest health may also provide the added benefit of increasing the resiliency of forest stands and limiting damage caused by disturbance events.

UNCERTAINTY IN ECOLOGICAL AND OTHER WELFARE BENEFITS

As noted above, limitations in the available methods and data mean that the benefits assessment in this report does not represent a comprehensive estimate of the economic benefits of the CAAA. Moreover, the potential magnitude of long-term economic impacts of ecological damages mitigated by the CAAA suggests that great care must be taken to consider those ecosystem impacts that are not quantified here. Significant future analytical work and basic ecological and economic research is needed to build a sufficient base of knowledge and data to support an adequate assessment of ecological benefits. For the current analysis, this incomplete coverage of effects represents the greatest source of uncertainty in the ecological assessment. This and other key uncertainties are summarized in Table 6-12 below.

In general, our analysis focuses on more acute and readily observable effects. Chronic ecological effects of air pollutants, on the other hand, may be poorly understood, difficult to observe, or difficult to discern from other influences on dynamic ecosystems. Disruptions that may seem inconsequential in the short-term, however, can have hidden, long-term effects through a series of interrelationships that can be difficult or impossible to observe, quantify, and model. This factor suggests that many of our qualitative and quantitative results may underestimate the overall, long-term effects of pollutants on ecological systems and resources.

[99] We estimated stumpage values of commonly harvested species in the Adirondack Region by applying average stumpage values to the pulpwood and wood chip and roundwood log harvest volume estimates. The average stumpage value for pulpwood and wood chips is estimated to be $3 per ton; while, the average stumpage value for roundwood logs is estimated to be $150 per thousand board-feet (MBF). Using these estimates, the annual harvest value of pulpwood and wood chips is estimated to be approximately $5.4 million, and the annual harvest value of roundwood logs is estimated to be $15 million.

TABLE 6-12. KEY UNCERTAINTIES ASSOCIATED WITH ECOLOGICAL EFFECTS ESTIMATION

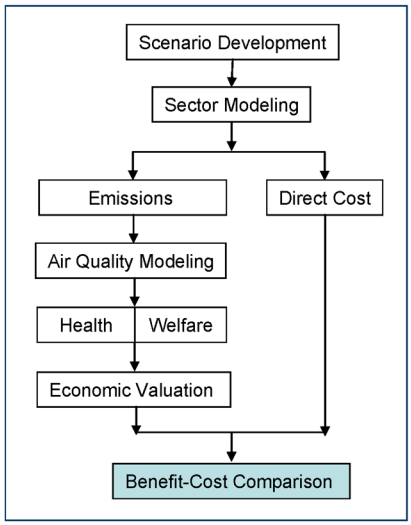
POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Incomplete coverage of ecological effects identified in existing literature, including the inability to adequately discern the role of air pollution in multiple stressor effects on ecosystems. Examples of categories of potential ecological effects for which benefits are not quantified include: reduced eutrophication of estuaries, reduced acidification of soils, reduced bioaccumulation of mercury and dioxins in the food chain.	Underestimate	Potentially major. The extent of unquantified and unmonetized benefits is largely unknown, but the available evidence suggests the impact of air pollutants on ecological systems may be widespread and significant.
Incomplete geographic scope of recreational fishing benefits associated with reduced lake acidification analysis due to case study approach.	Underestimate	Probably minor. As a case study limited to the Adirondack region of New York State, the estimated benefits to recreational fishing reflect only a portion of the overall benefits of reduced acidification on this service flow, but based on the magnitude of effects in the Adirondacks the national estimate is nonetheless likely be less than five percent of total benefits.
Incomplete assessment of long-term bioaccumulative and persistent effects of air pollutants.	Underestimate	Potentially major. Little is currently known about the longer-term effects associated with the accumulation of toxins in ecosystems. What is known suggests the potential for major impacts. Future research into the potential for threshold effects is necessary to establish the ultimate significance of this factor.
Omission of the effects of nitrogen deposition as a nutrient with beneficial effects.	Overestimate	Probably minor. Although nitrogen does have beneficial effects as a nutrient in a wide range of ecological systems, nitrogen in excess also has significant and in some cases persistent detrimental effects that are also not adequately reflected in the analysis.

POTENTIAL SOURCE OF ERROR	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS	LIKELY SIGNIFICANCE RELATIVE TO KEY UNCERTAINTIES ON NET BENEFITS ESTIMATE*
Use of CMAQ model to estimate air pollutant deposition levels.	Unable to determine. As part of a performance evaluation of CMAQ, EPA compared model predictions for some forms of deposition relevant to this analysis (wet SO2, NOx and ammonium) to observed deposition data).** The evaluation indicated that CMAQ overpredicted some forms of deposition and underpredicted others. The relative accuracy of the model's predictions varied seasonally and geographically.	Probably minor. The Adirondack lake acidification analysis uses deposition estimates as inputs, but they are calibrated to lake-level monitoring data, and the monetized benefits estimates for that component are a small part of the overall net benefits. We also use the CMAQ deposition estimates to generate maps that highlight the relative distribution of deposition for various air pollutants across the U.S. With respect to net impacts, the extent to which the forms of deposition and geographic areas that are overpredicted in the model are offset by those that are underpredicted is unknown.

* The classification of each potential source of error reflects the best judgment of the section 812 Project Team. The Project Team assigns a classification of "potentially major" if a plausible alternative assumption or approach could influence the overall monetary benefit estimate by approximately five percent or more; if an alternative assumption or approach is likely to change the total benefit estimate by less than five percent, the Project Team assigns a classification of "probably minor."

** See U.S. EPA, Office of Air Quality Planning and Standards, Emissions Analysis and Monitoring Division, Air Quality Modeling Group. CMAQ Model Performance Evaluation Report for 2001: Updated March 2005. CAIR Docket OAR-2005-0053-2149.

CHAPTER 7 - COMPARISON OF BENEFITS AND COSTS



In this chapter we present our summary of the primary estimates of monetized benefits of the CAAA from 1990 to 2020, compare the benefits estimates with the corresponding costs, and explore some of the major sources of uncertainty in the benefits estimates, including a summary of outcomes using alternative assumptions from those employed in the primary analysis.

The overall conclusion of our analysis is that the benefits of the CAAA *substantially* exceed its costs. Furthermore, the results of the uncertainty analysis imply that it is extremely unlikely that the monetized benefits of the CAAA over the 1990 to 2020 period could be less than its costs. The central benefits estimate exceeds costs by a factor of more than 30 to one, whether we are looking at annual or present value measures. By our measures, the programs associated with the 1990 Clean Air Act Amendments have been, and will likely continue to be, a very good investment.

AGGREGATING BENEFIT ESTIMATES

Our primary estimates of the monetized economic benefits for the 1990 to 2020 period derive from two types of analyses: (1) the analysis of changes in human health effects associated with reduced exposures to criteria pollutants and the valuation of these changes, summarized and described in Chapter 5; and (2) the analysis of monetized ecological and other welfare benefits (e.g., visibility), described in Chapter 6.[100] We measure the benefits and present the results from these analyses in slightly different ways,

[100] Note that the direct costs were aggregated in Chapter 3.

in part because they derive from different tools. The main differences have to do with the manner in which we conduct uncertainty analyses, as outlined below.

Although there are some differences in these two types of benefits analysis, in both cases we generate annual estimates of benefits that result from a single set of emissions and air quality modeling scenarios for the three target years of the study: 2000, 2010, and 2020. The consistent use of scenarios across all the benefit and cost analyses allows us to aggregate and directly compare monetized benefits estimates to the estimates of costs incurred in the target years. In some cases, we need to apply a discount rate to compare benefits to costs; for example, we model the effect of particulate matter on premature mortality to occur over a period of twenty years from the time of exposure, even though the costs to achieve that benefit are incurred at the time of the initial exposure change. In this case, we have accounted for the incidence of premature mortality over the assumed lag period, and discounted the valuation of this effect back to the target year. Some ecological effects, such as the effects of acid deposition on Adirondack lakes, also occur with a lag – again, we use a discounting procedure to standardize the benefits results for these estimates.

The annual estimates for the three target years also provide an indication of the trend in benefits we project will accrue over the 30-year study period. To generate a cumulative measure of benefits over the full 30-year period, however, we must make an assumption about the level of benefits that would be realized in the years between the target years. We interpolate these values, assuming a trend in benefits accrual that roughly matches the trend in emission reductions for PM precursors. Basing our estimate of the benefits trajectory on PM precursor reductions acknowledges that the majority of monetized benefits, including health and visibility, are attributable to reductions in ambient particulate matter.

The distribution of estimates we generate for the monetized benefits of human health effects incorporates both the quantified uncertainty associated with each of the health effect estimates and the quantified uncertainty associated with the corresponding economic valuation strategy. Quantitative estimates of uncertainties in earlier steps of the analysis (i.e., emissions and air quality changes) could not be developed adequately and are therefore not applied in the present study. As a result, the range of estimates for monetized benefits presented in this chapter, from the primary low estimate to the primary high estimate, is narrower than would be expected with a complete accounting of the uncertainties in all analytical components.[101]

In the health benefits analyses we estimate, for each endpoint-pollutant combination, distributions of values for both the key parameter of the concentration-response function and the valuation coefficients. We combine these distributions by using a computerized,

[101] The characterization of the uncertainty surrounding economic valuation is discussed in detail in Industrial Economics, Inc., *Uncertainty Analyses to Support the Second Section 812 Prospective Benefit-Cost Analysis of the Clean Air Act: Draft Report*, prepared for Office of Air and Radiation, US Environmental Protection Agency, April 2010.

statistical aggregation technique to estimate the mean of the monetized benefit estimate for each endpoint-pollutant combination and to characterize the uncertainty surrounding each estimate.[102]

The ecological and welfare results are not currently amenable to the same type of uncertainty analysis. The modeling procedures for estimating the effects of sulfur and nitrogen deposition in acidifying lakes, the effects of ozone in reducing timber and agricultural production, and the effects of particulate matter on visibility are all subject to uncertainty, but they require substantial resources simply to develop single point estimates. We describe key uncertainties in these estimation procedures qualitatively in Chapter 6, with some limited sensitivity analyses also presented to characterize the effect of key assumptions. The sources of uncertainty in these estimates, however, cannot as easily be disaggregated among physical effects modeling and valuation components, and they have not been assessed with the BenMAP model used for health benefits uncertainty analysis. As a result, we cannot reliably develop an aggregate estimate of the uncertainty in the sum of health and welfare benefits estimates.

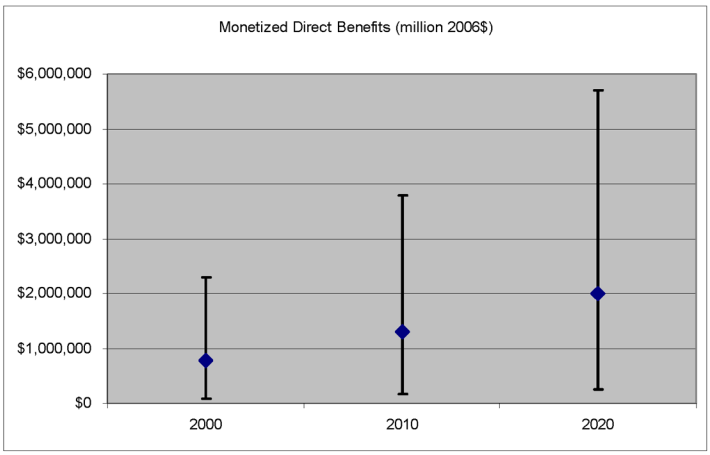
ANNUAL BENEFITS ESTIMATES

We present the results of our aggregation of primary annual health benefits estimates for the CAAA in Figure 7-1 below. The figure provides a characterization of both the primary central estimate and the range of values generated by the aggregation procedure described above, for each of the three target years of the analysis (2000, 2010, and 2020). The Primary High estimate corresponds to the 95th percentile value from the health benefits aggregation, and the Primary Low estimate corresponds to the 5th percentile value. The total benefits estimates are substantial; for example, the Primary Central estimate in 2020 is $2.0 trillion.

Table 7-1 shows the detailed breakdown of benefits estimates for 2000, 2010, and 2020. As shown in the table, $1.7 trillion of the $2.0 trillion total benefit estimate in 2020, or 85 percent, is attributable to reductions in premature mortality associated with reductions in ambient particulate matter. The remaining benefits are roughly equally divided among three broad categories of benefits: avoided premature mortality associated with ozone exposure; avoided morbidity, the largest component of which is avoided acute myocardial infarctions and avoided chronic bronchitis; and avoided ecological and other welfare benefits, the largest component of which is improved visibility. Because of the aggregation procedure used, and because we round all intermediate results to two significant digits for presentation purposes, the columns of Table 7-1 may not sum to the total estimate presented in the last row.

[102] The statistical aggregation technique applied is commonly referred to as Monte Carlo analysis. The technique involves many re-calculations of results, using different combinations of input parameters each time. For each calculation, values from each input parameter's statistical distribution are selected at random to ensure that the calculation does not always result in extreme values, or rely solely on low end or solely on high end input parameters. The aggregate distribution more accurately reflects a reasonable likelihood of the joint occurrence of multiple input parameters.

FIGURE 7-1. ANNUAL MONETIZED BENEFITS IN 2000, 2010 AND 2020



Examination of the emissions and aggregate exposure estimates suggests that most of these benefits can be attributed to air quality improvements that result from CAAA implementation, relative to conditions as they were in 1990, before the CAAA, rather than from avoiding degradation of air quality that might have occurred without the CAAA. For example, we estimate that emissions of NO_x, SO_2, and VOCs, three of the most important PM and ozone precursors, would have grown just over 20 percent from 1990 to 2020 in the *without-CAAA* scenario, which corresponds to an annual growth rate of about 0.65 percent. We also estimate that $PM_{2.5}$ emissions would have grown somewhat slower, at 0.5 percent annually, without the CAAA. Reductions along the with-CAAA scenario over the same period, however, were more than 60 percent for SO_2 and NO_x, a reduction of roughly 3 percent per year, and were roughly 45 percent for VOCs, a reduction of about 2 percent per year. As a result, about 75 percent of the difference in emissions that we estimate would occur by 2020 between the *with-CAAA* and *without-CAAA* scenario can be attributed to reductions in emissions relative to those in 1990.

TABLE 7-1. SUMMARY OF MEAN PRIMARY ANNUAL BENEFITS RESULTS

BENEFIT CATEGORY	ANNUAL MONETIZED BENEFITS (MILLION 2006$) BY TARGET YEAR			NOTES
	2000	2010	2020	
Health Effects				
PM Mortality PM Morbidity Ozone Mortality Ozone Morbidity	$710,000 $27,000 $10,000 $420	$1,200,000 $46,000 $33,000 $1,300	$1,700,000 $68,000 $55,000 $2,100	- PM mortality estimates based on Weibull distribution derived from Pope et. al (2002) and Laden et al., 2006. - Ozone mortality estimates based on pooled function
Subtotal Health Effects	$750,000	$1,300,000	$1,900,000	
Visibility				
Recreational Residential	$3,300 $11,000	$8,600 $25,000	$19,000 $48,000	Recreational visibility only includes benefits in the regions analyzed in Chestnut and Rowe, 1990 (i.e., California, the Southwest, and the Southeast).
Subtotal Visibility	$14,000	$34,000	$67,000	
Agricultural and Forest Productivity	$1,000	$5,500	$11,000	
Materials Damage	$58	$93	$110	
Ecological	$6.9	$7.5	$8.2	Reduced lake acidification benefits to recreational fishing.
Total: all categories	$770,000	$1,300,000	$2,000,000	

Note: See Chapters 5 and 6 of this report for detailed results summaries. Values presented are means from results reported as distributions. Estimates presented with two significant figures.

$PM_{2.5}$ exposure estimates also support the conclusion that more of the benefit in 2020 can be attributed to air quality improvements from implementing CAAA programs than to preventing degradation in air quality that might have resulted in the *without-CAAA* case. Although we did not estimate 1990 air quality using the CMAQ/MATS system described in Chapter 4, and the $PM_{2.5}$ monitor network was very sparse in 1990, there was an extensive PM_{10} monitor network at that time. Using PM_{10} monitor data and regional $PM_{2.5}/PM_{10}$ ratio estimates from the 1996 Particulate Matter Criteria Document, we estimated population weighted average exposure to $PM_{2.5}$ in 1990 of 19.0 $\mu g/m^3$. In addition, using the CMAQ/MATS system, we estimate population-weighted average exposure to $PM_{2.5}$ along the *without-CAAA* scenario is about 17 $\mu g/m^3$ in 2000, and increases to 17.7 $\mu g/m^3$ and 19.2 $\mu g/m^3$ in 2010 and 2020. Along the *with-CAAA* scenario, population weighted average exposure to $PM_{2.5}$ is 12.2 $\mu g/m^3$ in 2000, and declines to 10.9 $\mu g/m^3$ in 2010, and 10.5 $\mu g/m^3$ in 2020. In the *without-CAAA* scenario some improvements in air quality occurred from 1990 to 2000 as a result of the

continuing effect of the pre-1990 Clean Air Act requirements already on the books, but after 2000 the *without-CAAA* scenario shows deterioration of air quality through 2020.

As shown in Table 7-2, there is considerable uncertainty in the estimates of health benefits. As described above, the health benefit uncertainty analysis is based on underlying statistical uncertainties in the concentration-response and valuation coefficients. The low estimates are approximately an order of magnitude less than the central estimate; the high estimate is three times the central estimate. Uncertainty analyses for non-health benefits were not developed, but as they constitute only about five percent of the central estimate, their contribution to the overall uncertainty in benefits estimates is likely to be proportionately small.

TABLE 7-2. DISTRIBUTION OF PRIMARY ANNUAL BENEFITS RESULTS FOR 2020

BENEFIT CATEGORY	PRIMARY ANNUAL MONETIZED BENEFITS FOR 2020 (MILLION 2006$) LOW	CENTRAL	HIGH	NOTES
Health Effects				
PM Mortality PM Morbidity Ozone Mortality Ozone Morbidity	$170,000 $17,000 $3,200 $780	$1,700,000 $68,000 $55,000 $2,100	$5,300,000 $190,000 $170,000 $3,600	Low and high are 5th and 95th percentile estimates from health benefits uncertainty analysis
Subtotal Health Effects	$190,000	$1,900,000	$5,700,000	
Visibility				
Recreational Residential		$19,000 $48,000		Only central estimates were developed
Subtotal Visibility		$67,000		
Agricultural and Forest Productivity		$11,000		
Materials Damage		$110		Only central estimates were developed
Ecological		$8.2		Reduced lake acidification benefits to recreational fishing
Total: all categories		$2,000,000		

Note: See Chapters 5 and 6 of this report for detailed results summaries. Estimates presented with two significant figures; as a result, columns may not add to totals or subtotals.

AGGREGATE MONETIZED BENEFITS

As discussed earlier in this chapter, we interpolate benefit estimates between target years and then aggregate the resulting annual estimates across the entire 1990 to 2020 period of the study to yield a present discounted value of total aggregate benefits for the period. In this section we present the results of the aggregation.

In Table 7-3 we present the mean estimate from the aggregation procedure, along with the Primary Low (i.e., 5th percentile of the distribution) and Primary High (i.e., 95th percentile of the distribution) estimates, for all provisions we assessed. Aggregating the stream of monetized benefits across years involved discounting the stream of monetized benefits estimated for each year to the 1990 present value using a five percent discount rate.

TABLE 7-3. PRESENT VALUE OF MONETIZED BENEFITS OF THE CAAA

	PRESENT VALUE (MILLIONS 2006$)		
	PRIMARY LOW	PRIMARY CENTRAL	PRIMARY HIGH
All Provisions, 1990 to 2020	$1,400,000	$12,000,000	$35,000,000

Note: Values presented in this table are in millions of 2006$, discounted to 1990 using a 5 percent discount rate.

COMPARISON OF BENEFITS AND COSTS

Table 7-4 presents summary quantitative results for the prospective assessment, with costs disaggregated by emissions source category and benefits disaggregated by type. We present annual, Primary Central estimate results for each of the three target years of the analysis, with all dollar figures expressed as inflation-adjusted 2006 dollars. The final columns provide net present value estimates for costs and benefits from 1990 to 2020, discounted to 1990 at five percent. The results indicate that the Primary Central estimate of benefits clearly exceeds the costs of the CAAA, for each of the target years and for the cumulative estimates of present value over the 1990 to 2020 period.

As Table 7-4 indicates, a very high percentage of the benefits is attributable to reduced premature mortality associated with reductions in ambient particulate matter and ozone. The CAAA achieves ambient PM reductions through a wide range of provisions controlling emissions of both gaseous precursors of PM that form particles in the atmosphere (sulfur dioxide and nitrogen oxides as well as, to a lesser extent, organic constituents) and directly emitted PM (i.e., dust particles). Because the effects of these constituents on ambient PM are nonlinear, and because some precursor pollutants interact with each other in ways which influence the total concentration of particulates in the atmosphere, separating the effects of individual pollutants on the change in ambient PM would require many iterations of our air quality modeling system. Even with such a tool, the interactive effects of pollutants are complex – as a result the marginal impact of any particular pollutant is dependent on the levels of other pollutants as well. These factors make it difficult to reliably link specific costs to specific aggregate benefits for the pollutant source-specific components of the CAAA (e.g., electric utilities or additional local controls).

TABLE 7-4. SUMMARY OF QUANTIFIED PRIMARY CENTRAL ESTIMATE BENEFIT AND COSTS (ESTIMATES IN MILLION 2006$)

COST OR BENEFIT CATEGORY	ANNUAL ESTIMATES			PRESENT VALUE
	2000	2010	2020	
Costs:				
Electric Utilities	$1,400	$6,600	$10,000	$49,000
Industrial Point Sources	$3,100	$5,200	$5,100	$43,000
Onroad Vehicles and Fuels	$14,000	$26,000	$28,000	$220,000
Nonroad Engines and Fuels	$300	$360	$1,200	$4,500
Area Sources	$660	$690	$770	$7,600
Local Controls to Meet NAAQS	$0	$14,000	$20,000	$53,000
Total Costs	$20,000	$53,000	$65,000	$380,000
Monetized Benefits:				
Avoided Mortality	$720,000	$1,200,000	$1,800,000	$11,000,000
Avoided Morbidity	$27,000	$47,000	$70,000	$410,000
Ecological and Welfare Effects	$15,000	$39,000	$78,000	$310,000
Total Benefits	$770,000	$1,300,000	$2,000,000	$12,000,000

Table 7-5 provides the results of our more detailed comparison of primary benefits estimates to primary cost estimates. In the top half of the table we show both annual and present value estimates. The cost estimates presented in the table reflect estimates presented in Chapter 3. The monetized benefits indicate both the Primary Central estimate (the mean) from our statistical aggregation procedure and the Primary Low and Primary High estimates (5th and 95th percentile values, respectively). In the bottom half of the table we present three alternative methods for comparing benefits to costs. "Net benefits" reflect estimates of monetized benefits less costs. The table also notes the benefit/cost ratios implied by the benefit ranges, and our estimates of the costs per premature mortality avoided.

The results in Table 7-5 make it abundantly clear that the benefits of the CAAA exceed its costs by a wide margin, making the CAAA a very good investment. Our estimates rely on a particular set of data, models and assumptions we believe are most appropriate at this time. It is possible that another set of data, models, or assumptions might yield different estimates of benefits, costs, and benefit-cost comparisons. Nonetheless, the very wide margin between estimated benefits and costs, and the results of the uncertainty analysis, suggest that it is extremely unlikely that the monetized benefits of the CAAA over the 1990 to 2020 period reasonably could be less than its costs, under any alternative set of assumptions we can conceive. The central benefits estimate exceeds costs by a factor of more than 30 to one, whether we are looking at annual or present value measures, and the high estimate exceeds costs by roughly 90 to one.

TABLE 7-5. SUMMARY COMPARISON OF BENEFITS AND COSTS

	ANNUAL ESTIMATES			PRESENT VALUE ESTIMATE
	2000	2010	2020	1990-2020
Monetized Direct Costs (millions 2006$):				
Low [a]				
Central	$20,000	$53,000	$65,000	$380,000
High [a]				
Monetized Direct Benefits (millions 2006$):				
Low[b]	$90,000	$160,000	$250,000	$1,400,000
Central	$770,000	$1,300,000	$2,000,000	$12,000,000
High[b]	$2,300,000	$3,800,000	$5,700,000	$35,000,000
Net Benefits (millions 2006$):				
Low	$70,000	$110,000	$190,000	$1,000,000
Central	$750,000	$1,200,000	$1,900,000	$12,000,000
High	$2,300,000	$3,700,000	$5,600,000	$35,000,000
Benefit/Cost Ratio:				
Low[c]	5/1	3/1	4/1	4/1
Central	39/1	25/1	31/1	32/1
High[c]	115/1	72/1	88/1	92/1
Costs per Premature Mortality Avoided (2006$):				
Central	$180,000	$330,000	$280,000	Not estimated

[a] The cost estimates for this analysis are based on assumptions about future changes in factors such as consumption patterns, input costs, and technological innovation. We recognize that these assumptions introduce significant uncertainty into the cost results; however the degree of uncertainty or bias associated with many of the key factors cannot be reliably quantified. Thus, we are unable to present specific low and high cost estimates.

[b] Low and high benefits estimates based on primary results and correspond to 5th and 95th percentile results from statistical uncertainty analysis, incorporating uncertainties in physical effects and valuation steps of benefits analysis. Other significant sources of uncertainty not reflected include the value of unquantified or unmonetized benefits that are not captured in the primary estimates and uncertainties in emissions and air quality modeling.

[c] The low benefit/cost ratio reflects the ratio of the low benefits estimate to the central costs estimate, while the high ratio reflects the ratio of the high benefits estimate to the central costs estimate.

It is also clear from Table 7-5 that costs for criteria pollutant programs grow more quickly than benefits at the beginning of the CAAA compliance period, from 2000 to 2010, and that benefits grow more quickly at the end of the period, from 2010 to 2020. This is consistent with the general statement that investments in clean air tend to involve upfront costs and benefits that accrue over time. The present value estimates in Table 7-5 show, however, that the total aggregated value of benefits far exceeds the costs – by our measures, therefore, the programs associated with the 1990 Clean Air Act Amendments have been, and will likely continue to be, a very good investment.

As indicated in the table, the low estimate of net benefits for the year 2020 is positive (i.e., benefits exceed costs) and of significant magnitude - $190 billion. Our uncertainty modeling therefore indicates that the likelihood that the cost estimates of $65 billion in 2020 could exceed the benefits estimates is much less than five percent.

OVERVIEW OF UNCERTAINTY ANALYSES

Completion of a study of this breadth and complexity has required EPA to directly confront the role of uncertainty in the key analytic outcomes of the study. While the previous section establishes that the primary estimates of benefits of air pollution control greatly exceed the primary estimates of costs of CAAA compliance, it is nonetheless important to evaluate the extent to which alternative models, assumptions about scenarios, and key parameter choices might affect both benefits and costs. Cognizant of advice to the Agency from the National Research Council,[103] the Project Team developed a three step approach to uncertainty analysis:

1. Identify important sources of uncertainty in each analytical element, starting with emissions profile development. At the end of each of the preceding chapters, we provide a table of key uncertainties and our assessment of the direction and potential magnitude of the impact of this uncertainty on the key analytic output of the study, the monetized net benefits of the CAAA.
2. Quantify parameter and model uncertainty quantitatively where possible by using alternative assumptions or models to estimate intermediate and/or overall net benefit results. In addition, explore options for assessing scenario uncertainty that propagate through the complete analytic chain.
3. Compare the results from these quantitative analyses to the primary results, to inform the degree of confidence in the primary analytic results and to help identify new research directions to address or reduce uncertain and influential components of the analysis.

In the remainder of this section we review each of these three components of our uncertainty analysis.[104]

IDENTIFYING IMPORTANT SOURCES OF UNCERTAINTY

Within each of the summary uncertainty tables in the prior chapters the Project Team has distinguished sources of uncertainty that could have a potentially major impact on the overall net benefits estimate presented in this chapter, based either on quantitative analyses or, where quantitative assessments are unavailable or infeasible, the judgment of Project Team analysts. Potentially major factors are those for which a plausible alternative assumption or approach could influence the overall benefit or cost estimate by

[103] See National Research Council (2002), *Estimating the Public Health Benefits of Proposed Air Pollution Regulations*, The National Academies Press, Washington, DC, in particular Chapter 5, titled: "Uncertainty."

[104] For a more thorough description of the methods and results of these uncertainty analyses see the accompanying *report Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, March 2009.

five percent or more. We identify a total of 13 potentially major sources of uncertainty in Chapters 2 through 6; these are listed in Table 7-6 below.

TABLE 7-6. POTENTIALLY MAJOR SOURCES OF UNCERTAINTY FOR ESTIMATING THE COSTS AND BENEFITS OF THE CAAA

POTENTIAL SOURCE OF ERROR	ANALYTIC STEP	DIRECTION OF POTENTIAL BIAS FOR NET BENEFITS
Estimated emissions rates under the counterfactual *Without-CAAA* scenario	Emissions	Under-estimate
Estimated economic growth - a key driver of total emissions - under both scenarios	Emissions	Unable to determine
Forecast of the final form and compliance with EPA's revisions of the vacated Clean Air Mercury Rule and the remanded Clean Air Interstate Rule	Emissions	Unable to determine
Secondary organic aerosol (SOA) chemistry	Air Quality Modeling	Under-estimate
Inability to conclusively state that PM mortality outcome is causal based on epidemiology	Health Effects	Over-estimate
Effect of socioeconomic status on mortality from PM exposure	Health Effects	Unable to determine
Attribution of exposure to PM in epidemiology studies based on monitor data	Health Effects	Under-estimate
Omission of short-term effects of PM exposure on mortality	Health Effects	Under-estimate
Timing of reduction in mortality risk after exposure is reduced (cessation lag)	Health Effects	Unable to determine
Source of mortality risk valuation includes many older studies	Valuation	Unable to determine
Scenario of mortal risk in available valuation studies is generally different from that presented by air pollution	Valuation	Unable to determine
Valuation of risk avoidance can change over time and as income increases	Valuation	Unable to determine
Incomplete coverage of ecological effects of air pollutants, including omission of several short-term and virtually all long-term bioaccumulative and persistent effects.	Ecological	Under-estimate

* The classification of each potential source of error reflects the best judgment of the section 812 Project Team. The Project Team assigns a classification of "potentially major" if a plausible alternative assumption or approach could influence the overall monetary benefit estimate by approximately five percent or more. See tables at the end of Chapters 2 through 6 above for more information.

Perhaps not surprisingly, the key emissions estimation uncertainties involve forecasting errors, particularly related to estimating future economic and regulatory activity as well as estimating behavior under the counterfactual *without-CAAA* scenario. A key cost estimation uncertainty involves estimating NAAQS compliance, particularly when currently known emissions reductions measures are not sufficient to achieve full compliance with the standard in the future. However, in order for any uncertainty to be considered "major" the impact would need to be of a magnitude of approximately $100

billion to affect net benefits estimates by as much as five percent. In our judgment, while there are several factors that could affect direct cost estimates by a significant percentage, no cost estimation uncertainty has the potential to either more than double our current total cost estimate of $65 billion, or to reduce the cost estimate to $0 or less, which is the magnitude that would be required to constitute five percent of the net benefit estimate.

Several uncertainties that affect benefits estimates, however, could have an impact of $100 billion or greater on the net benefits estimates. Both health effects and valuation uncertainties center on estimation of the impact of air pollutants on mortal risk and the valuation of that health endpoint. The key ecological uncertainty involves identifying what is missing from our necessarily limited quantified ecological benefits. Only one potentially major factor was identified for the air quality modeling step – this may be the result of our inability to apply alternative quantitative air quality modeling tools in this already resource-intensive step in the analytic chain. It is worth noting, however, that as a whole the air quality modeling process very likely contributes a greater than 5 percent uncertainty, of indeterminate direction, to the overall uncertainty in benefits estimates. In addition, the AQMS highlighted uncertainties introduced by the *ex post* adjustment of some primary PM emissions estimates and the procedure used to re-calibrate the CMAQ air quality to account for this emissions adjustment. Although we argue that the overall effect of this source of uncertainty on the net benefits is probably minor (see Table 4-10 in Chapter 4), in some locations ambient PM from primary PM emissions can be more important than secondarily formed fine particles. Overall, we believe that our application of the MATS monitor calibration procedure, which provides a speciated calibration to ensure better agreement between air quality modeling results and comparable monitor data, provides the best agreement possible between our air quality simulation results and monitored values. In the end, however, there is no way to validate the counterfactual, *without-CAAA* scenario estimates.

Examination of the last column of Table 7-6 suggests a limited ability to estimate the joint effect of these factors on the direction of potential bias for net benefits. Seven of the factors listed have an indeterminate direction of effect; five yield a potential underestimate of net benefits; and one results in a potential overestimate of net benefits. The large number of factors with an indeterminate direction imply that the direction of the net effect of all factors taken together remains unclear, but the relative confidence that the PM exposure-mortality concentration-response function is causal, based on weight-of-evidence, that being the only uncertainty that yields a potential overestimate, suggests that our primary results may be more likely to understate net benefits than overstate them.

A comparison of the qualitative uncertainty tables from the First and Second Prospective studies indicates that significant advancements over the First Prospective include the use of improved monitoring data for $PM_{2.5}$, an improved understanding and treatment of atmospheric chemistry and the composition of $PM_{2.5}$ emissions, and the use of longer-term simulations with integrated modeling of criteria pollutants using CMAQ rather than a collection of separate air quality models.

QUANTIFYING MODEL, PARAMETER, AND SCENARIO UNCERTAINTY

The benefits values presented in this report are subject to a number of uncertainties related to data limitations, analytical choices related to models and input parameters, difficulties predicting future scenarios, and other factors. As noted above, among the most significant model uncertainties is the extensive list of benefits categories, mostly in the ecological area, for which we currently lack the data and/or tools to quantify and monetize benefits. These categories are implicitly treated as having zero value though in reality they may include physical benefits that have a positive economic value. Examples of potentially important, but unquantified ecological effects include nitrogen deposition, non-ozone effects on forest and agriculture vegetation, effects of HAPs on ecological structure and function, and synergistic effects associated with exposures to mixtures of pollutants and interactions of the effects of conventional pollutants such as ozone with climate change. The unquantified and unmonetized benefits thus represent an important underestimation bias in the summary benefit results.

The uncertainties in our quantified and monetized primary benefits estimates that are most likely to significantly influence the primary benefit results are those affecting the largest benefit category: the estimation and valuation of reductions in premature mortality due to decreases in $PM_{2.5}$. Three key uncertainties affecting economic estimates of avoided PM mortality include: (1) the C-R function estimate; (2) the PM/mortality cessation lag structure; and (3) the mortality valuation estimate. These are influential assumptions in our analysis and those for which plausible alternative quantitative estimates are available. The companion Second Prospective Section 812 report, *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, presents detailed quantitative analyses of the sensitivity of benefits results to these and other factors.

Table 7-7 presents a tabular summary of the results of the full range of uncertainty analyses for both costs and benefits, and Figure 7-2 presents a graphical illustration of the impacts of effect of alternative assumptions and models on the central estimate and distribution of monetized avoided mortality benefits, the primary contributor to monetized benefits.

COST UNCERTAINTIES

Table 7-7 shows that the impact of our alternative assumptions about mobile source cost parameters, learning curves, and unidentified local control costs each have relatively modest impacts on total costs, while the I&M failure rate and learning curve assumptions have a slightly larger impact on total costs.[105] In addition, the assumptions underlying our primary cost estimates tend to be conservative; most of the alternatives decrease total compliance costs and none increase costs more than about three percent.

[105] The estimate of the impact on total costs is derived from the relative contribution of the affected cost sector to the overall costs of compliance, assuming all other sectors are unaffected.

TABLE 7-7. QUANTITATIVE ANALYSES OF UNCERTAINTY IN THE 812 SECOND PROSPECTIVE ANALYSIS

FACTOR AND LOCATION OF UNCERTAINTY ANALYSIS DISCUSSION IN THIS REPORT (WHERE APPLICABLE)	TYPE OF UNCERTAINTY EVALUATED	ALTERNATIVE ASSUMPTIONS	IMPACT OF ALTERNATIVE ASSUMPTIONS ON 2020 PRIMARY ESTIMATE
UNCERTAINTIES RELATED TO COST ESTIMATES			
Unidentified controls (Chapter 3)	Parameter	Alternate assumption about the threshold for, and cost of, applying unidentified local controls to achieve NAAQS compliance ($10,000/ton).	-18% of local control costs; **-2.1% of total costs**
I&M program vehicle failure rates(Chapter 3)	Parameter	Alternative assumption about failure rates for I&M program testing based on NRC (2001).	-12% for mobile source costs; **-6.5% of total costs**
Learning curve assumptions (Chapter 3)	Parameter	Alternate assumptions about the learning rate (5 and 20%)	**-6.0% to 3.2% of total costs**
Fleet composition and fuel efficiency (Chapter 3)	Scenario	Alternate assumption about future fleet composition and fuel efficiency using AEO 2008.	-3.6% for mobile source costs; **-2.0% of total costs**
UNCERTAINTIES RELATED TO BENEFITS ESTIMATES			
Alternate C-R function for PM (Chapter 5)	Parameter	Alternative C-R functions - two from empirical literature (Pope et al., 2002 and Laden et al., 2006) and 12 subjective estimates from the expert elicitation study	-83% to 76%, Based on most extreme estimates from PM EE study. Rest of alternatives range from -43% to 41%
Emissions from EGU sources (Chapter 2)	Scenario	Use continuous emissions monitoring (CEM) data in place of Integrated Planning Model (IPM) results, coupled with alternative counterfactual consistent with CEM approach.	+50% in 2000 Due almost entirely to the impact of the alternative *without-CAAA* scenario.
PM/Mortality Cessation lag (Chapter 5)	Model and parameter	Alternative lag structures - one step function and a series of smooth functions (based on an exponential decay). Smooth functions in some cases also require change in C-R coefficient.	-23% to 16% when using primary C-R function. -52 to 50% when also changing C-R function.
Value of Statistical Life (Chapter 5)	Parameter	Alternative VSL estimates	-20% to 0%
Discount rates	Parameter	Alternate discount rates (5% and 7%)	-4% to 4%
Alternate C-R function for ozone (Chapter 5)	Parameter	Alternative C-R functions - three from multi-city studies, three from meta-analyses, and one from Jerrett et al. cohort study.	0% for total mortality benefits. -63% to 66% For ozone-related mortality.

FACTOR AND LOCATION OF UNCERTAINTY ANALYSIS DISCUSSION IN THIS REPORT (WHERE APPLICABLE)	TYPE OF UNCERTAINTY EVALUATED	ALTERNATIVE ASSUMPTIONS	IMPACT OF ALTERNATIVE ASSUMPTIONS ON 2020 PRIMARY ESTIMATE
Emissions changes by emitting sector	Scenario	Altering each sector-specific emissions by 10 percent	$/ton marginal benefit for proportional EGU sector reductions is about 3 times that for nonroad and on-road sectors, and 50% higher than that for area and non-EGU point source sectors.
Differential toxicity of PM components	Parameter	Potential alternative estimates of toxicity for specific PM components	N/A. No quantitative sensitivity analysis performed due to significant data gaps.
Dynamic population modeling (Chapter 5)	Model	Incorporation of dynamic population estimates to calculate life years gained and changes in life expectancy	N/A. Life years gained and changes in life expectancy are supplemental estimates of PM/mortality effects and cannot be directly compared to the primary estimate.

A further overarching issue with our direct cost methodology is that, for EGU modeling and for some components of the ozone NAAQS compliance cost assessment, the method employed assumes specific optimizing behavior by polluters. In particular, the IPM model used for EGU compliance cost assessment assumes a forward looking approach and may incorporate only limited available information on real-world constraints on optimizing behavior such as long-term fuel supply contracts. If polluters do not optimize in the manner assumed in these models, the direct costs may under-estimate the true costs of compliance. For other emitting sectors, where optimization approaches were not feasible, the potential for under-estimation from this factor does not apply.

A potential issue in considering the uncertainty in cost estimates is our inability to adequately consider the effects of the CAAA on the quality of goods overall. Our method emphasizes that the CAAA does increase the cost of products, and we attempt to hold the quality of products constant in the process. In reality it is likely that the CAAA affects both price and quality of products. One of the more straightforward examples is that motor-vehicle emission controls may reduce performance, though at the same time those controls can increase fuel economy. Other examples include substitution of other devices for charcoal lighting fluid, reformulation of VOC emitting paints, and other product changes that may have altered the quality of those products to consumers. As discussed briefly in Chapter 3, however, the CAAA could also change quality in ways that benefit consumers, but which we do not capture in our estimates – for example, low VOC paint

contributes not only to lower ambient ozone levels, but also reduces consumer exposure to VOCs in enclosed indoor environments. Unfortunately, it is very difficult to quantify the effect of this factor on our overall cost and net benefit estimates.

BENEFIT UNCERTAINTIES

On the benefits side, Table 7-7 and Figure 7-2 show that the most influential assumptions affecting benefits are the choice of the C-R function, the cessation lag model for the accrual of benefits, and the VSL distribution. While the two most extreme results from EPA's Expert Elicitation (EE) study imply substantial effects of C-R choice (about 80 percent in either direction) most of the alternatives from the EE study and the published epidemiological studies suggest effects on benefits of about 40 percent or less in either direction. By themselves, longer cessation lag alternatives can reduce monetized benefits by as much as a 23 percent and if coupled with a change in the C-R function, by close to half; however, the Council Health Effects Subcommittee advised that much of the risk reduction benefits from $PM_{2.5}$ controls are more likely to accrue sooner rather than later. Accelerating benefits increases benefits by about 16 percent when maintaining the same C-R function, but could increase them by as much as half when using a smooth function based on the Laden Six Cities follow-up effect estimate. VSL distribution choices in one case produce the same central estimate; in others they reduce VSL between 7 and 20 percent.

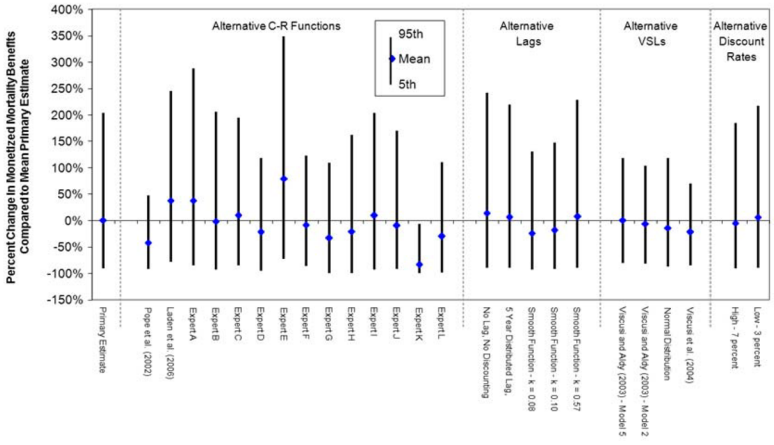
A review of the box plots in Figure 7-2 for the factors that have the greatest potential to change the central estimate shows that most of the alternatives do not have a dramatic effect on the spread of uncertainty. Some alternatives suggest the high end of the distribution could be lower, including all of the alternative VSL distributions, which give less weight to higher VSL values than the 26-study Weibull. On the other hand, only a few alternatives (from EPA's particulate matter expert elicitation study) significantly extend the upper end and hardly any extend the lower end, suggesting our primary estimate is unlikely to understate greatly the uncertainty in avoided mortality benefits. In all these cases, however, we are unable to develop a probabilistic representation of uncertainty in the emissions and air quality modeling steps; incorporating uncertainty in these factors would certainly increase the spread between the Primary Low and Primary High estimates.

LESSONS LEARNED AND NEW RESEARCH DIRECTIONS

Many of the factors contributing to uncertainty in these estimates are the result of scientific unknowns that might be addressed through additional research. Identification of research directions to address current unknowns can serve an important function - in the First Prospective, for example, we identified eight high priority research directions, six of which were addressed in the Second Prospective.[106]

[106] The six were: improved emissions inventories and inventory management tools (see Chapter 2 for a description of the improvements in the 2002 NEI, and the AirControlNET tool used to estimate emissions reductions necessary for NAAQS compliance); improved tools for assessing the full range of social costs associated with regulation, including the tax-interaction effect (see Chapter 8 of this document for a description of the economic modeling tool EMPAX-CGE); a more

FIGURE 7-2. SUMMARY OF QUANTITATIVE ANALYSIS OF UNCERTAINTY IN MONETIZED MORTALITY BENEFITS ESTIMATES



Note: These estimates represent the percent change for each alternative assumption on the total mean mortality benefits estimates. Note that the Project Team assessed the impact Of alternative ozone C-R functions on the total mortality benefits and found that these did not alter the primary estimate. Therefore, alternative ozone C-R functions are not included in this graph.

The key lessons learned in this analysis lead directly to new research directions to inform future assessments, assessments which include both Regulatory Impact Analyses of specific rules and broader, policy-oriented documents such as this Second Prospective. The key insight from this analysis is that rules that target precursors of fine particulate matter are likely to be very cost-effective. Costs per ton of PM control are similar or less than previously estimated, and benefits per ton emitted of these precursors are much larger than previously thought or estimated in the First Prospective. There are three key reasons for the large increase in benefits per ton of PM precursor emitted, involving advances in our understanding of: 1. PM species emissions, 2. the fate of these emissions as estimated by integrated national-scale air quality modeling systems, and 3. the implications of fine particulate air quality for premature mortality.

geographically comprehensive air quality monitoring network, particularly for fine particulate matter (see discussion of the MATS procedure in Chapter 4 of this document); development of integrated air quality modeling tools based on an open, consistent model architecture (see Chapter 4 for a description of the CMAQ system); increased basic and targeted research on the health effects of air pollution, especially particulate matter (see Chapter 5 for multiple examples of recent work that was applied in this analysis); continued efforts to assess the cancer and noncancer effects of air toxics exposure (see discussion of the air toxics case study in Chapter 5).

In addition, the results of the study also provide evidence of the significant benefits of avoiding mortality associated with ozone exposure, avoiding degradation of visibility in residential and recreational settings, and avoiding significant chronic and acute morbidity, including chronic bronchitis and acute myocardial infarction. The last two of these monetized benefits categories were shown, by themselves, nearly to equal the full costs of all provisions of the CAAA. There also remain large categories of health and ecological benefits for which we have no quantified or monetized benefit estimates. For example, although there is an established literature linking air pollutant exposure with increased risk of cerebrovascular accidents (stroke), as well as a literature on the medical costs of this condition, that category of effect is not yet included in our estimates of the health benefits of reducing air pollutant exposure.

Insights gleaned from completing this study suggest the following eight areas to be the highest priority research needs:

- ***Improving cost analyses for rules that are technology-forcing***. The overall cost analysis in Chapter 3 is characterized by complete coverage of the costs of many rules, but the Project Team acknowledges that in some cases, particularly involving compliance with tighter future NAAQS standards, application of the suite of known, cost-effective current pollutant control measures are not sufficient to achieve compliance in all locations. This shortcoming remains one of the important focal points for compliance cost research within the Agency. One possible direction that the Agency is considering is analysis of historical data on the cost and penetration rates of new emissions control technologies, particularly those for NAAQS compliance, which could provide insights on the process, cost, timing, and potential limits of induced innovation.
- ***Continuing efforts to incorporate a broader range of market benefits in economy-wide modeling of the impacts of regulation***. The results of Chapter 8 indicate that there are significant benefits to economic growth when we consider the labor force and health expenditure implications of cleaner air. Our demonstration of the importance of incorporating benefits-side effects in macro-economic modeling efforts, however, does not incorporate all possible market effects of cleaner air. For example, increased agricultural and forest productivity might feasibly be incorporated in the model we employed. Ultimately, it will also be important to develop new methods to characterize the large nonmarket benefits of cleaner air in these models, including most importantly the welfare enhancements (as opposed to simply the market implications) associated with reductions in premature mortality.
- ***Understanding synergies and antagonistic effects of climate change in realizing benefits, as well as for understanding co-benefits of greenhouse gas (GHG) control policies***. Consideration of climate change was outside the scope of this Second Prospective effort, but designing effective and efficient regulatory mechanisms for GHG emissions control has rapidly become an important priority for the Agency. The methods, data, and results of this study are important for

modeling co-benefits of GHG control policies, as many policies targeted at GHG reductions also reduce other, conventional pollutants, and those benefits are realized sooner than the generally long-term benefits of GHG policies. In addition, climate change likely alters the benefits achieved by conventional pollutant policies, as for example increases in mean temperature as well as increases the frequency of extreme temperature events creates conditions conducive to ozone formation. Both areas are important for further research.

- ***Developing probabilistic representation of emissions and air quality to support uncertainty analysis***. As noted earlier in this chapter, a major shortcoming of existing quantitative characterizations of uncertainty in benefits and costs of the CAAA is the inability to integrate uncertainties in emissions and air quality modeling steps. Two areas of research deserve further attention: 1. Developing more nimble tools for assessing the air quality implications of emissions control policies, or updating those that exist; 2. Developing probabilistic characterizations of key parameters that contribute to overall uncertainty in emissions and air quality analyses. Pursuit of the latter initiative will likely require application of expert elicitation, either formal or informal, to make progress.
- ***Understanding the potential for differential toxicity to play a role in benefits of control programs and, by extension, policy priorities.*** The issue of species-specific particulate matter toxicity remains very complex, involving the effects of mixtures and synergies of species that are not currently well understood. It is nonetheless important to understand the extent to which rules targeted at specific PM species might yield similar benefits as rules targeting total PM mass.
- ***Continuing to pursue evidence of the real-world public health impact of specific air quality actions.*** Sometimes referred to as *accountability analyses*, tracking the real-world instances of rapid air quality changes, either improvements or reductions in air quality, can yield important corroborating evidence of the effects found in epidemiology studies. As we found in our uncertainty analyses supporting the Second Prospective, these natural experiments also provide insights for the nature of cessation lags, and might be useful in better understanding species-specific toxicity.
- ***Expanding coverage of ecological benefits.*** There are potentially large ecological benefits of air pollution control that are not currently quantified. Some of the most important categories of unquantified effects include nitrogen deposition effects on estuarine areas, sulfur deposition effects on vegetation and other aspects of terrestrial systems, and long-term effects of air toxics. Perhaps equally important, but much more subtle, are the long-term effects of a wide range of air pollutants on ecosystem structure and function. Even potentially beneficial effects of pollutants, such as deposition of the nutrient nitrogen in terrestrial and even actively managed farms and forests, might have longer-term

detrimental effects on nutrient cycling and species selection that are currently poorly understood.

- ***Expanding coverage of health benefits.*** Great effort has been expended to better characterize the full range of health implications of air pollution. Despite this effort, it is still difficult to quantify the link between air pollution and stroke, and it is also difficult to assess the incremental effects of gaseous pollutant exposures, in part because there are only a limited set of studies that characterize the individual contributions of multiple pollutant exposures on health outcomes. While the Agency has developed robust benefits analyses for programs that control individual gaseous pollutants, such as carbon monoxide, it remains difficult to incorporate these effects in multi-pollutant models that include PM, ozone, and other gaseous pollutants typically present in many settings in the U.S.

The results of this Second Prospective study clearly provide strong evidence that the nation's investment in clean air has been a wise and cost-effective policy. Continued effort is needed to ensure that air pollution policies are pursued in the most cost-effective manner possible. Pursuit of these research goals should continue to enhance our ability to provide accurate and timely assessments of the costs and benefits of all provision authorized under the Clean Air Act and its Amendments.

CHAPTER 8 - COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

The 1990 Clean Air Act Amendments (CAAA) represent a significant change in Federal air pollution policy affecting virtually every sector of the U.S. economy, including industry as well as individual households. The cost and benefit estimates presented in the previous chapters reflect the direct impacts of the CAAA in terms of industry's and households' direct compliance expenditures and the value of the direct human health, visibility, ecological, and other benefits associated with CAAA-related improvements in air quality. The cost-benefit information is central to EPA's analysis of the Amendments, but policymakers and the public are also interested in the impact of CAAA programs on overall economic performance. Therefore, to supplement the direct cost and benefit estimates presented in the previous chapter, the Project Team applied an economy-wide computable general equilibrium (CGE) analysis of the Amendments and estimated the effect of the CAAA on U.S. gross domestic product and other macroeconomic measures. The Project Team performed this analysis with the Economic Model for Policy Analysis (EMPAX-CGE), a CGE model employed by EPA for several previous analyses of CAAA regulations, including the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$, the 8-hour Ozone NAAQS, and the Clean Air Interstate Rule.

The Project Team's CGE analysis for the Second Prospective represents a major step forward in EPA's application of CGE models in the context of air pollution policy. Unlike previous CGE analyses that focused exclusively on the macroeconomic impacts of compliance expenditures, the Second Prospective incorporates impacts related to both CAAA costs and some categories of benefits into EMPAX-CGE, to the extent feasible. Because both the costs and benefits of CAAA regulations may affect the size and composition of the U.S. economy, the Project Team's approach provides a more comprehensive and balanced view of the macroeconomic impacts of air pollution policy than previous assessments. To illustrate the extent to which including labor force and medical expenditure impacts in EMPAX-CGE affects model results, we applied the model in two ways: one model run that reflects only the costs of the CAAA (the cost-only case) and a second model run that reflects both the costs and a subset of the total benefits of the Amendments (the labor force-adjusted case).

This chapter presents the CGE analysis in four sections. In the first section, we provide an overview of EMPAX-CGE, describing the model's overall structure and highlighting the sectoral and geographic resolution of the model. The second section describes the development of the cost- and labor force and health expenditure benefit-side inputs for the analysis and documents how these inputs were incorporated into EMPAX-CGE. The third section presents the results of our analysis, both in aggregate and by industry. To

conclude the chapter, we discuss the major uncertainties of the analysis and their implications for results.

EMPAX-CGE[107]

EMPAX-CGE is a multi-industry, multi-region computable general equilibrium model of the U.S. economy. Below we describe the main features of the typical CGE model, followed by a more detailed overview of the structure and functionality of EMPAX-CGE.

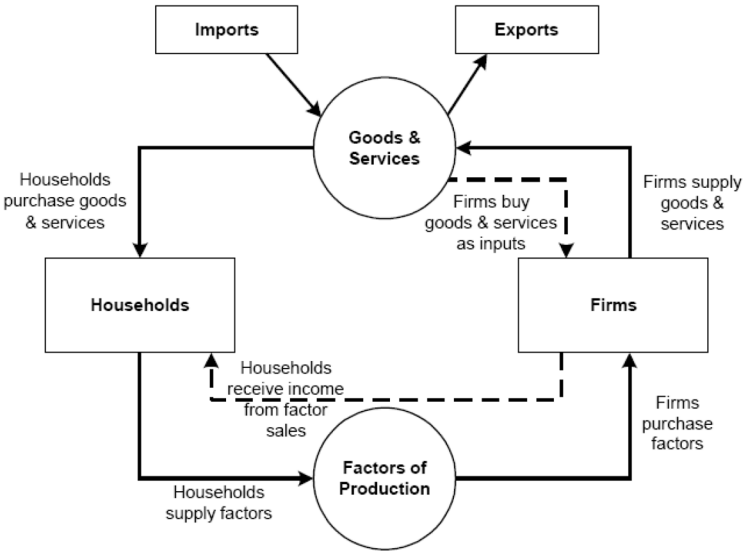
OVERVIEW OF CGE MODELING

CGE models simulate the flow of commodities and factors of production (i.e., labor, capital, and natural resources) among producers and households to assess how a change in policy or an economic shock affects the size and composition of the economy. As shown in Figure 8-1, households in CGE models own factors of production (capital, labor, and natural resources) that they supply to firms in exchange for wages and other forms of income. Firms use these factors in conjunction with intermediate inputs purchased from other industries to produce goods and services, which are sold to other industries as well as consumers. Goods and services can also be exported, and imported goods can be purchased from other countries.

In modeling the circular flow of the economy depicted in Figure 8-1, CGE models capture behavioral changes among households and firms in response to changes in prices. At the producer level, CGE models simulate the substitution of inputs as the price of one input, such as steel or labor, rises relative to the price of other inputs. This allows the simulation of producer behavior in CGE models using minimization of the cost of production as an objective, consistent with the behavior of firms in the real economy. Similarly, as the price of one good rises relative to the prices of other products and services, CGEs model the process whereby households consume less of the more expensive good and more of other goods. Related to households' substitution between different goods, CGE models also simulate household substitution between labor and leisure as real wages change. Because the productive capacity of the economy is dependent, in part, on labor supply, the labor-leisure tradeoff is critical in determining the size of the economy.

[107] The description of CGE models, in general, and EMPAX-CGE included in this section is based on RTI (2008).

FIGURE 8-1. CGE MODEL SCHEMATIC



Source: RTI International, EMPAX-CGE Model Documentation, prepared for U.S. EPA Office of Air Quality Planning and Standards, March 2008.

The general equilibrium component of CGE modeling requires a comprehensive market coverage in which all sectors in the economy are in balance and all economic flows are accounted for. Establishing equilibrium conditions requires that every commodity that is produced must be purchased by firms or consumers within the United States or exported to foreign consumers. The requirement for all markets to be in equilibrium during the time period of the model simulation is a simplifying assumption of the model, but is nonetheless a condition which, over time, is consistent with production in the actual economy. Prices of these goods reflect all costs of production. Households receive payments for their productive factors and transfers from the government (not shown in Figure 8-1), and this income must equal consumer expenditures and savings. In aggregate, all markets must clear, meaning that supplies of commodities and factors must equal demand, and the income of each household must equal its factor endowments plus any net transfers received. An important implication of this market clearing assumption is that CGE models assume that the economy is at full employment (i.e., there is no involuntary unemployment). Therefore, CGE models do not typically provide insights into the unemployment impacts of policy changes.

OVERVIEW OF EMPAX-CGE

Similar to other CGE models, EMPAX-CGE is structured to represent the complex interactions between consumers and producers in the real economy. To model these interactions, EMPAX-CGE performs thousands of calculations with the objective of maximizing household utility (well-being) while simultaneously maximizing firm profits. While complex, these calculations are a simplified representation of the real economy. The behavior of households and firms is inherently multi-faceted and dependent on a range of factors, many of which are not well understood. To model this behavior, EMPAX-CGE uses a simplified, hierarchical representation of household and firm decision-making that reduces the behavior of households and firms to a limited number of structured decisions. For example, as shown in Figure 8-2, the first decision for the household sector in EMPAX-CGE is the optimization of consumption and leisure. To model this decision, EMPAX-CGE assumes that households are free to allocate their time between labor and leisure to maximize their welfare. Time that households do not devote to leisure represents household labor supplied to producers. Therefore, in effect, the leisure-consumption decision also represents a tradeoff between leisure and labor force participation. After the consumption-leisure decision, EMPAX-CGE simulates household consumption as a series of hierarchical decisions involving consumption goods and transportation.

EMPAX-CGE also models *firm* behavior as a series of hierarchical decisions. Similar to EMPAX-CGE's treatment of households, this hierarchical structure represents a simplification of how firms decide which inputs to use in the production of goods and services. As illustrated in Figure 8-3, the first tier of this decision hierarchy is a choice between: (1) an indeterminate mix of capital, labor, and energy and (2) goods and services produced by other industries, such as steel or computer equipment. Producers then optimize among capital, labor, and energy.

Consistent with simplifying household and firm decision-making into the structured frameworks depicted in Figures 8-2 and 8-3, EMPAX also uses a simplified representation of the overall structure of the economy. Firms in the U.S. are scattered across thousands of industries and produce countless goods and services. Modeling each of these sectors individually within an economy-wide model, however, is not feasible due to data and computational processing constraints. To address this issue, EMPAX-CGE aggregates the economy into 35 distinct industries, as listed in Table 8-1. The industry classifications included in EMPAX-CGE were defined so as to maximize the level of sectoral detail among energy-intensive and manufacturing industries. EMPAX-CGE also separates the electricity industry into fossil fuel generation and non-fossil generation, which is important for assessing the impacts of policies that affect only fossil fuel-fired electricity, such as air pollutant regulations.

FIGURE 8-2. EMPAX-CGE DECISION HIERARCHY FOR HOUSEHOLDS

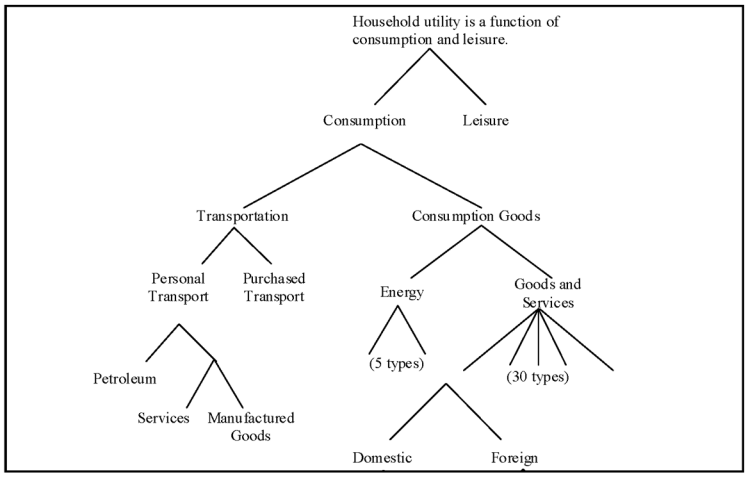
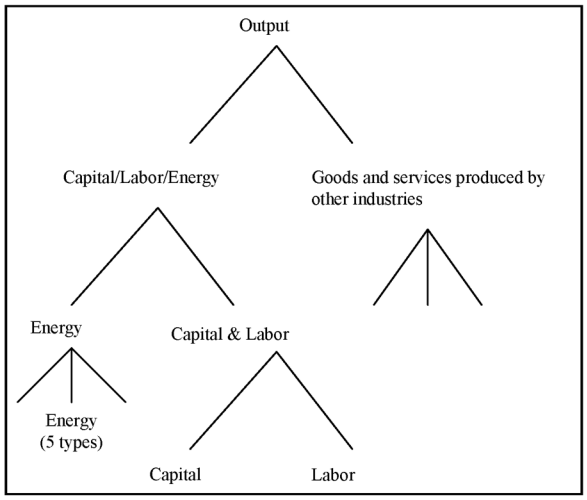


FIGURE 8-3. EMPAX-CGE NESTED STRUCTURE FOR PRODUCERS



EMPAX-CGE is also designed to reflect regional differences in the overall structure of the economy. Because the availability and cost of different production inputs, such as labor and energy, vary across different regions of the U.S., the response of a given industry to changes in policy may vary by region. To account for this effect, EMPAX-CGE models each industry separately in five different regions, as shown in Figure 8-4. The specification of the five economic regions included in the model is based, as closely as possible, on the structure of the electricity market regions defined by the North American Electric Reliability Council (NERC). [108]

TABLE 8-1. INDUSTRIES IN EMPAX-CGE

EMPAX Industry	North American Industry Classification System (NAICS)
Energy	
Coal	2121
Crude oil[a]	211111, 4861
Electricity (*fossil and nonfossil*)	2211
Natural gas	211112, 2212, 4862
Petroleum refining [b]	324, 48691
General	
Agriculture	11
Mining (w/o coal, crude, gas)	21
Construction	23
Manufacturing	
Food products	311
Textiles and apparel	313, 314, 315, 316
Lumber	321
Paper and allied	322
Printing	323
Chemicals	325
Plastic and rubber	326
Glass	3272
Cement	3273
Other minerals	3271, 3274, 3279
Iron and steel	3311, 3312
Aluminum	3313
Other primary metals	3314, 3316
Fabricated metal products	332

[108] Economic data and information on non-electricity energy markets are generally available only at the state level, which necessitates an approximation of the NERC regions that follows state boundaries.

Manufacturing equipment	333
Computers & communication equipment	334
Electronic equipment	335
Transportation equipment	336
Miscellaneous remaining	312, 337, 339
Services	
Wholesale & retail trade	42, 44, 45
Transportation [c]	481-488
Information	51
Finance and real estate	52, 54
Business/professional	53, 55, 56
Education (w/public)	61
Health care (w/public)	62
Other services	71, 72, 81, 92

[a] Although NAICS 211111 covers both crude oil and gas extraction, the gas component of this sector is addressed in the natural gas energy sector.

[b] EMPAX-CGE reports output for the petroleum refining industry based on the delivered price of petroleum products. This reflects the value of pipeline transport.

[c] Transportation does not include NAICS 4862 (natural gas distribution), which is part of the natural gas industry.

FIGURE 8-4. EMPAX-CGE REGIONS

EMPAX-CGE assumes that households have perfect foresight of future changes in policy and maximize utility over the full time horizon of the model. To adjust to future policy changes, households may alter their decisions about labor force participation and modify their consumption patterns in terms of their overall level of consumption and the mix of goods and services they choose to consume. This is in contrast to static CGEs, which model the economy without regard for time (i.e., they effectively model the economy for a single time period).

EMPAX-CGE contains four representative households in each model region, classified by income. These household income groups are:

- $0 to $14,999,
- $15,000 to $29,999,
- $30,000 to $49,999, and
- $50,000 and above.

These representative households are assumed to possess certain factors of production including labor, capital, natural resources, and land inputs to agricultural production. Factor prices are equal to the marginal revenue received by firms from employing an additional unit of labor or capital, and households allocate income from sales of these productive factors to purchases of consumption goods to maximize welfare.

The outputs generated by EMPAX-CGE include GDP, consumption, and an economic welfare measure known as Hicksian equivalent variation (EV). EV is based on the concept of willingness-to-pay, which is the maximum amount a household would pay for a particular good or service (including leisure), given its budget constraint. Willingness to pay reflects the value or welfare that a household derives from the consumption of a good or service. For a given policy scenario, the change in EV represents the additional money that a household would require (at original prices and income) to make it as well off with the new policy as it was under baseline conditions; this amount is "equivalent" to the change in utility the household derives from consumption and leisure time. It is important to note, however, that EMPAX-CGE's estimation of EV captures welfare associated with market goods and services but does not capture non-market effects. As a result, the measure would not reflect some categories of household welfare that are important to our cost-benefit analysis, such as avoided pain and suffering associated with health effects incidence, improvements in visibility, and changes in service flows that derive from well functioning ecological resources.

The baseline values for the outputs generated by EMPAX-CGE are adapted from the economic forecast in the Department of Energy's *Annual Energy Outlook 2007*. These baseline values represent the U.S. economy under the *with-CAAA* scenario for the Second Prospective.[109]

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[109] As noted in Chapter 2, the emissions projections for the Second Prospective are based on the economic forecast from *Annual Energy Outlook (AEO) 2005*, not *AEO 2007*. The *AEO 2007* forecast, however, is similar to that in *AEO 2005*. For the year 2020, the *AEO 2007* GDP forecast is approximately 3 percent lower than the projection from *AEO 2005*.

DEVELOPMENT OF MODEL INPUTS

The Project Team estimated the macroeconomic impacts of the CAAA as the difference between (1) the EMPAX-CGE reference case projections, which represent the *with-CAAA* scenario, and (2) EMPAX-CGE projections for the *without-CAAA* scenario. To conduct the model runs for the *without-CAAA* scenario, the Project Team developed model inputs related to both the costs and benefits of the Amendments. To assess the difference in costs associated with CAAA compliance, we estimated CAAA-related compliance expenditures by industry and EMPAX region. Based on these estimates, the Project Team reduced the cost of production for affected industries from the baseline costs of production to develop industry-wide cost structures for the *without-CAAA* scenario. The "cost-only" runs therefore estimate the loss in economic productivity associated with CAAA compliance costs.

As noted above, however, the CAAA also yields benefits that result in potentially substantial changes in economic production as well. The benefit-side inputs developed by the Project Team include (1) medical expenditures associated with pollution-related illness, (2) the change in workers' time endowment due to pollution-related mortality, and (3) the change in workers' time endowment due to pollution-related morbidity. The Project Team incorporated changes in medical expenditures into EMPAX-CGE as changes in household expenditure patterns. To incorporate changes in the amount of time workers can devote to labor or to leisure in the model, we first estimated how health effects and mortality estimated in Chapter 5 would affect the exposed population's ability to supply labor to firms. Estimates of lost work time associated with morbidity have been estimated in prior work or are available from BenMAP.[110] Next, we assumed that pollution-related illness and mortality among the labor force reduce workers' overall time endowment (labor and leisure) in proportion to the effect on labor supply. That is, if air pollution would reduce labor supply by *x* percent in 2020, the Project Team assumed that the overall time endowment of workers would also decline by *x* percent in 2020.

We did not attempt to incorporate time endowment effects for people outside the formal economy (e.g., retirees, students, homemakers) into EMPAX-CGE. While the "non-working" population is clearly affected by air pollution, and those effects are likely to influence the level and composition of economic activity, the structure of EMPAX-CGE is not conducive to assessing how these populations affect the economy. The results presented in this chapter therefore likely underestimate the macroeconomic impacts resulting from CAAA-related improvements in public health.

Below we describe the Project Team's approach for generating the EMPAX-CGE inputs related to the costs and benefits of the CAAA. As noted above, the Project Team used these inputs to conduct two analyses of CAAA-related macroeconomic impacts; the first reflects only the costs of the CAAA (the cost-only case), while the second reflects both the costs and selected human health benefits of the Amendments (the labor force-adjusted case).

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[110] For example, Cropper and Krupnick (1999) estimate income losses resulting from chronic bronchitis and acute myocardial infarction. Based on these estimates, we calculated the lost work time per case associated with each of these endpoints.

COST INPUTS

To assess the macroeconomic impacts of CAAA-related costs, the Project Team incorporated CAAA compliance expenditures by industry and region into EMPAX-CGE. Similar to other CGE models, EMPAX-CGE is an expenditure-based model and therefore requires expenditure-based inputs to represent the costs of the Amendments. CAAA compliance expenditures, however, are not always the equivalent of the direct costs of the Amendments presented in Chapter 3. While the direct costs of the CAAA reflect the value of the capital, labor, and other resources necessary for CAAA compliance, compliance expenditures simply represent the financial resources exchanged for CAAA compliance. For example, the direct costs of the Amendments do not include taxes, because such payments represent transfers rather than resources expended to control air pollutant emissions. In contrast, CAAA compliance expenditures *include* transfers because they represent an exchange of financial resources from one party (e.g., a firm) to another (e.g., the government) that can affect the choices made by firms.

To estimate the compliance expenditures associated with the Amendments, the Project Team made three adjustments to the direct cost estimates presented in Chapter 3:

1. ***Inclusion of fuel excise taxes:*** The Project Team included fuel excise taxes in the compliance expenditure estimates developed for the EMPAX-CGE analysis. Excise taxes were excluded from the direct cost estimates presented in Chapter 3 because such taxes are transfers.

2. ***Industry-specific discount rates:*** Unlike the direct cost estimates presented in Chapter 3, which reflect a 5 percent social discount rate, the compliance expenditures presented in this chapter reflect the private discount rates of affected industries. For each industry, we estimated the private discount rate based on the industry-specific weighted average cost of capital as reported in Ibbotson Associates' *Cost of Capital Yearbook*.[111]

3. ***Exclusion of motorist waiting time from cost estimates for inspection and maintenance programs:*** The direct cost estimates for motor vehicle inspection and maintenance (I&M) programs in Chapter 3 reflect the value of motorist waiting time. Although waiting time represents a welfare loss to society, this cost is not incurred as an expenditure. Because CGEs are expenditure-based models, we exclude motorist waiting time from the cost-side inputs incorporated into EMPAX-CGE. The exclusion of motorist waiting time is unlikely to significantly affect the results of the CGE analysis, as these costs represent only 18 percent of direct CAAA costs associated with I&M programs and less than 5 percent of direct costs for the entire on-road sector.

Based on these adjustments, we developed the compliance expenditure estimates presented in Table 8-2. For comparison, the exhibit also includes the direct cost estimates summarized in Chapter 3. As indicated in the exhibit, the estimated CAAA compliance

[111] Ibbotson Associates, *Cost of Capital Yearbook*, 1997 through 2006 editions.

expenditures in 2010 are approximately $2.0 billion greater than the Project Team's direct cost estimates for 2010. In 2020, the difference between the two increases to $3.0 billion. The estimates in Exhibit 8-6 also show that the distribution of compliance expenditures across source categories is similar to the distribution of direct costs.[112]

TABLE 8-2. SUMMARY OF ANNUAL CAAA COMPLIANCE EXPENDITURES AND DIRECT COSTS (MILLIONS OF 2006$)

	2010		2020	
SOURCE CATEGORY	COMPLIANCE EXPENDITURES (USED FOR EMPAX ANALYSIS)	DIRECT COSTS	COMPLIANCE EXPENDITURES (USED FOR EMPAX ANALYSIS)	DIRECT COSTS
Electric Generating Units	$8,470	$6,640	$13,000	$10,400
On-road Sources	$24,800	$25,800	$27,200	$28,300
Non-road Sources	$750	$359	$1,620	$1,150
Industrial Point Sources	$5,580	$5,180	$5,600	$5,140
Area Sources	$693	$693	$768	$767
Local Controls (Identified)	$5,590	$5,250	$6,790	$6,180
Unidentified Local Controls	$9,020	$9,020	$13,500	$13,500
TOTAL	$54,900	$52,900	$68,500	$65,500

[112] In most of EPA's recent EMPAX applications to air pollution rules, only a small portion of total costs have been accounted for by expenditures in the household sector. In this application, however, a large portion of total compliance costs, particularly for mobile source fuels rules, involve increased expenditures by the household sector. For this reason, the Project Team gave special consideration to the treatment of these costs. Estimated household compliance expenditures associated with petroleum products are implemented as price adjustments to reflect higher motor vehicle fuel prices. The petroleum price adjustment is calculated to match compliance expenditures related to household transportation fuel use. For other transportation compliance expenditures, the household utility function is adjusted to require additional expenditures to achieve a given utility level. These adjustments reflect the additional automotive inspections, maintenance, and technologies purchased by households to comply with the Clean Air Act. Other unidentified household compliance costs not related to transportation (e.g. non-road related local controls) are treated as lump-sum reductions to household income.

BENEFIT INPUTS

As noted above, the Project Team's analysis of the macroeconomic impacts of CAAA-related health improvements focuses on three specific effects: (1) the change in the household time endowment from pollution-related mortality impacts, (2) the change in the household time endowment from pollution-related morbidity, and (3) the change in medical expenditures associated with pollution-related morbidity. The Project Team incorporated these effects into the without-CAAA EMPAX-CGE model runs to estimate the size and composition of the economy in the absence of the Amendments. The methods employed to quantify these effects and convert them into useable inputs for EMPAX-CGE are described below.

Mortality-related Labor Force Impacts

The Project Team incorporated pollution-related mortality impacts into EMPAX-CGE as a percentage change in the time available to workers for labor and leisure activities (i.e., their time endowment). In estimating this percentage change, the Project Team focused on the dynamic population effects of premature mortality from particulate matter (PM) exposure. While ozone also leads to premature mortality, the benefits results in Chapter 5 show that reductions in ambient PM concentrations are responsible for approximately 98 percent of the avoided cases of premature mortality associated with the Amendments in both 2010 and 2020. Because of the dominant effect of PM on mortality (relative to ozone) and the lack of tools available to examine the dynamic population effects of PM and ozone in an integrated fashion, the Project Team focused the mortality component of the EMPAX-CGE analysis on changes in PM-related mortality.

The mortality-related inputs developed by the Project Team reflect the dynamic effects of PM mortality on the population over time. When PM concentrations change, the resulting population impact grows over time, as the change in population for any given year reflects changes in the incidence of PM-related mortality from prior years. For example, if PM concentrations are reduced permanently in 2015, the population (and the size of the labor force) in 2017 will reflect avoided cases of premature mortality in 2015, 2016, and 2017. Over time, this dynamic effect leads to a significant number of life years saved as the reduction in pollution-related risk is applied to successively larger populations each year (due to previous years' improvements in air quality).

To capture these dynamic effects, the Project Team used a spreadsheet-based dynamic population simulation model described in Chapter 5.[113] The model was designed to track the effect of alternative assumptions about the mortality effects of $PM_{2.5}$ on the U.S. population, but may also be used to assess how changes in $PM_{2.5}$ concentrations lead to changes in the population over time. The tool incorporates detailed life table data for historical years, by age, gender, and cause of death, obtained from the Census Bureau and the Centers for Disease Control. It also incorporates Census mortality and population projections for future years, again by age and gender, using the projected death and birth

[113] For a detailed description of the model, see the related report, *Uncertainty Analyses to Support the Second Section 812 Benefit-Cost Analysis of the Clean Air Act*, March 2010, and Industrial Economics, Inc. (2006).

rates that underlie the Census Bureau's published population projections. For a given model scenario, the model simulates the U.S. population by single year age group and gender for each year through 2050.

To estimate changes in the labor force with the population simulation model, the Project Team employed the following three-step approach:

1. ***CAAA-related change in population:*** First, the Project Team entered changes in $PM_{2.5}$ concentrations into the population simulation model based on the air quality modeling analysis described in Chapter 4. Netting the model results from baseline (*with-CAAA*) population projections, the Project Team estimated PM-related changes in population by gender and single-year age group for both the 2010 and 2020 target years (and for every other year in the model time horizon). These changes represent the estimated difference in population between the *with-CAAA* and *without-CAAA* scenarios.
2. ***CAAA-related change in the labor force:*** To estimate the change in the labor force associated with the CAAA, the Project Team applied age- and gender-specific labor force participation rates from the Bureau of Labor Statistics to the changes in population estimated in Step 1.
3. ***Percent Change in Labor Force:*** The Project Team estimated the percent change in the labor force associated with pollution-related mortality by dividing the total labor force changes estimated in Step 2 by baseline (with-CAAA) projections of the total labor force. As indicated above, the Project Team assumes that this percent change applies to the full time endowment (labor and leisure time) for the labor force.

Morbidity-related Labor Force Impacts

Similar to pollution-related mortality, pollution-related morbidity was incorporated into EMPAX-CGE as a percent change in the labor and leisure time available to workers. Unlike the Project Team's PM-based approach for mortality, the approach for morbidity accounts for both PM- and ozone-related impacts. The literature for the various PM and ozone endpoints examined use several different metrics for quantifying labor force impacts. To standardize these estimates, we converted the values obtained from the literature to the number of work days lost per case, by endpoint. We then applied these values to the yearly changes in the number of cases for each endpoint to estimate the total work days lost for any given year. These values reflect the labor force participation rate among those individuals afflicted by each health effect. Because the time endowment in EMPAX-CGE measures time on an annual basis, we converted the estimated number of work days lost to lost work years, based on an assumed work year of 235 work days.[114] To express work years lost as a percent change in the labor force, we divided the estimated work years lost for each target year by the projected size of the labor force. The resulting value represents the percent change in workers' labor time.

[114] This estimate is consistent with that used in Jorgenson et al. (2004).

As suggested above, estimating the number of work days lost per case for each endpoint is a key step in the Project Team's methodology. Table 8-3 summarizes these endpoint values for both PM and ozone. With the exception of chronic bronchitis and acute myocardial infarction (AMI), the estimates presented in Table 8-3 were applied to the annual change in incidence for each endpoint (i.e., the change in the number of new cases per year), as the duration of disease for most endpoints is no more than several weeks. Chronic bronchitis and AMI, however, affect individuals over multi-year time horizons. We therefore apply the work loss day estimates for these endpoints to changes in the prevalence of each disease (i.e., the change in the number of people with the disease, relative to the baseline).

Medical Expenditures

To estimate the medical expenditures associated with changes in PM and ozone concentrations, the Project Team relied upon cost-of-illness estimates from the published literature. Table 8-4 presents the annual medical expenditures per case for those endpoints for which medical expenditure data were available. We applied the estimates presented in the table to the respective annual changes in incidence for each endpoint, except for chronic bronchitis and AMI. For these two endpoints, we applied the values from Table 8-4 to estimated changes in prevalence.

Summary of Benefit-Related Inputs

Table 8-5 summarizes the estimated changes in the labor force (i.e., the worker time endowment) associated with the Amendments for the 2010 and 2020 target years. Using the estimates in the table, the Project Team modified the time endowment for each model household included in EMPAX-CGE. The estimates in the table suggest that the U.S. labor force would be 0.34 percent smaller in 2010 and 0.57 percent smaller in 2020 if the Amendments had not been enacted. PM mortality effects would make up more than half of this reduction. Among morbidity endpoints, AMI and chronic bronchitis would have the most significant effect. The labor force impact of ozone pollution would represent less than five percent of the reduction in the labor force for each target year.

Table 8-6 presents the estimated change in pollution-related medical expenditures associated with the Amendments. As indicated in the table, the Project Team estimates that medical expenditures related to air pollution would be approximately $12.9 billion higher in 2010 and $21 billion higher in 2020 in the absence of the Amendments. Similar to the labor force effects summarized in Table 8-5, PM-related morbidity, AMI in particular, represents most of the estimated change in pollution-related medical expenditures.

TABLE 8-3. WORK DAYS LOST PER CASE, BY MORBIDITY ENDPOINT[1]

PM[2]		
Acute Myocardial Infarction[3]	Age <25: N/A Age 25-34: 17.7 days Age 35-44: 14.5 days	Age 45-54: 23.7 days Age 55-65: 137.0 days Age>65: 0 days
Chronic Bronchitis[3]	Age <25: N/A Age 25-34: 50.3 days Age 35-44: 42.2 days	Age 45-54: 55.5 days Age 55-65: 73.5 days Age >65: 0 days
Hospital Admissions, Cardiovascular[4]	Age 0-14: N/A Age 15-44: 18.3 days	Age 45-64: 17.9 days Age >64: 7.0 days
Hospital Admissions, Respiratory[4]	Age 0-14: N/A Age 15-44: 30.7 days	Age 45-64: 30.1 days Age >64: 7.5 days
Emergency Room Visits, Respiratory[5]	Average across all age groups: 0.2 days	
Work Loss Days	Average among working age population: 1 day	
Ozone[6]		
School Loss Days[7]	Average across all age groups: 0.7 days	
Worker Productivity	Not applicable[8]	
Hospital Admissions, Respiratory[9,10]	Age <2: 0 days Age >64: 7.5 days	
Emergency Room Visits, Respiratory[5]	Average across all age groups: 0.2 days	

Notes:

N/A indicates that the underlying C-R function does not provide incidence estimates for that age group.

1. Except for chronic bronchitis and acute myocardial infarction, the number of work days lost is applied to the change in annual incidence. For chronic bronchitis and acute myocardial infarction, the work days lost presented in this table are applied to annual changes in the prevalence of each disease.
2. We did not generate separate work loss day estimates for the following PM health endpoints discussed in Chapter 5: acute bronchitis, acute respiratory symptoms, asthma exacerbation, lower respiratory symptoms, and upper respiratory symptoms. The lost work days associated with these endpoints are already reflected in the work loss day endpoint included in this table.
3. Derived from Cropper and Krupnick (1999).
4. Agency for Healthcare Research and Quality (2000), as cited in BenMAP user's guide, Abt Associates (2008).
5. We assume that each E.R. visit equals one day of lost work time per worker affected. The estimate of 0.2 days per case reflects the percentage of cases realized by the working-age population, the ratio of workdays to total days in a year (235/365), and the percent of the working-age population in the labor force.
6. We did not estimate the number of work days lost per case of acute respiratory symptoms associated with ozone exposure.
7. Derived from Abt Associates (2008). Note that 0.7 is the estimated average work loss days per school loss day, incorporating work-force participation rates for caregivers.
8. The benefits analysis presented in Chapter 5 does not estimate the number of cases for the worker productivity endpoint. Instead, worker productivity is estimated as the change in income associated with changes in ozone concentrations. We estimated the work days lost per dollar of income lost based on the average daily wages of outdoor workers.
9. Derived from Abt Associates (2008).
10. The dose-response function for ozone-related respiratory hospital admissions does not cover populations older than two years old and younger than 65. For this endpoint we do not address potential caregiver time lost for incidence in either cohort.

TABLE 8-4. ANNUAL MEDICAL EXPENDITURES PER CASE, BY MORBIDITY ENDPOINT (2006$)[1]

	2010	2020
PM[2]		
Acute Myocardial Infarction[3]	$17,600	$17,300
Chronic Bronchitis[4]	$715	$810
Emergency Room Visits, Respiratory[5]	$369	
Hospital Admissions, Cardiovascular[6]	$27,400	
Hospital Admissions, Respiratory[6]	$21,000	
Ozone[7]		
Emergency Room Visits, Respiratory[5]	$369	
Hospital Admissions, Respiratory[6]	$16,400	$17,100

Notes:

1. Except for chronic bronchitis and acute myocardial infarction, medical expenditures per case are applied to the change in annual incidence. For chronic bronchitis and acute myocardial infarction, medical expenditures per case are applied to the annual changes in the prevalence of each disease, to generate an annual rather than lifetime estimate of costs for these chronic diseases.
2. Medical expenditure estimates for the following PM morbidity endpoints were not readily available: acute bronchitis, acute respiratory symptoms, asthma exacerbation, lower respiratory symptoms, upper respiratory symptoms, and work loss days.
3. Derived from Wittels et al. (1990) and Russell et al. (1998), both as cited in Abt Associates (2008).
4. Cropper and Krupnick (1999).
5. We assume that each E.R. visit equals one day of lost work time per worker affected. The estimate of 0.2 days per case reflects the percentage of cases realized by the working-age population, the ratio of workdays to total days in a year (235/365), and the percent of the working-age population in the labor force.
6. Agency for Healthcare Research and Quality (2000), as cited in Abt Associates (2008).
7. Medical expenditure estimates for the following ozone morbidity endpoints were not readily available: minor restricted activity days, school loss days, and outdoor worker productivity.

TABLE 8-5. ANNUAL CHANGE IN LABOR FORCE DUE TO CAAA-RELATED CHANGES IN AIR QUALITY (PERCENT CHANGE IN WORKER TIME ENDOWMENT)

	2010	2020
Pollution-related Change in Worker Time Endowment	**0.34%**	**0.57%**
PM Mortality Subtotal	***0.18%***	***0.31%***
PM Morbidity Subtotal	***0.15%***	***0.25%***
Acute Myocardial Infarction	0.06%	0.09%
Chronic Bronchitis	0.05%	0.11%
Emergency Room Visits, Respiratory	<0.01%	<0.01%
Hospital Admissions, Cardiovascular	<0.01%	<0.01%
Hospital Admissions, Respiratory	<0.01%	<0.01%
Work Loss Days	0.04%	0.05%
Ozone Morbidity Subtotal	***0.01%***	***0.02%***
Emergency Room Visits, Respiratory	<0.01%	<0.01%
Hospital Admissions, Respiratory	<0.01%	<0.01%
Acute Respiratory Symptoms	<0.01%	<0.01%
School Loss Days	0.01%	0.01%
Worker Productivity	<0.01%	0.01%

TABLE 8-6. CAAA-RELATED CHANGES IN ANNUAL MEDICAL EXPENDITURES (MILLION 2006$)

	2010	2020
Pollution-related Change in Medical Expenditures	**$11,900**	**$19,600**
PM Morbidity Subtotal	***$11,600***	***$19,000***
Acute Myocardial Infarction	$9,500	$15,500
Chronic Bronchitis	$375	$919
Emergency Room Visits, Respiratory	$29	$39
Hospital Admissions, Cardiovascular	$1,228	$1,900
Hospital Admissions, Respiratory	$467	$683
Ozone Morbidity Subtotal	***$310***	***$580***
Emergency Room Visits, Respiratory	$2	$4
Hospital Admissions, Respiratory	$311	$575

EMPAX-CGE MODEL RESULTS

Using the inputs summarized in the previous section, the Project Team estimated the macroeconomic impacts of the Amendments under both the cost-only case and the labor force-adjusted case. As described above, the former captures the general equilibrium effects of CAAA compliance expenditures, whereas the latter accounts for the impacts of

these expenditures as well as the labor force and medical expenditure impacts associated with the Amendments. We present the results of both analyses below.

MACROECONOMIC IMPACTS OF CAAA COMPLIANCE EXPENDITURES

Table 8-7 summarizes the results of the EMPAX-CGE cost-only model run. As the results in the table indicate, the Project Team estimates that the compliance expenditures associated with the Amendments will reduce GDP and consumption by approximately 0.5 percent in 2010 and 2020, relative to the without-CAAA scenario. The total estimated GDP reduction of $79 billion in 2010 and $110 billion in 2020 are 50 to 70 percent larger than the total primary cost estimates of $53 billion in 2010 and $65 billion in 2020. The difference is attributable to secondary effects of compliance costs on the overall economy, a large portion of which are likely the result of increases in energy prices, which has broad effects on overall production. Another factor is that investment in pollution control capital can divert capital from the purpose of enhancing long-term productivity within the industrial sector.

The percent reduction in equivalent variation is smaller than the corresponding reductions in GDP and consumption, at approximately 0.4 percent for both target years. This disconnect between the percent reduction in EV and the reductions in GDP and consumption suggests that, under the *with-CAAA* scenario, households allocate a greater share of their time endowment to leisure (and less to labor) than under the *without-CAAA* scenario. This increase in leisure partially offsets the welfare loss associated with reduced consumption.

TABLE 8-7. SUMMARY OF ANNUAL MACROECONOMIC IMPACTS: COST-ONLY CASE[1]

VARIABLE	MODEL RUN	2010	2015	2020
GDP	With Clean Air Act ($ billion)	$15,027	$17,338	$20,202
	Without Clean Air Act ($ billion)	$15,106	$17,430	$20,312
	Change ($ billion)	−$79	-$93	−$110
	% change	−0.52%	-0.53%	−0.54%
Consumption	With Clean Air Act ($ billion)	$10,969	$12,699	$14,881
	Without Clean Air Act ($ billion)	$11,023	$12,761	$14,956
	Change ($ billion)	−$54	-$62	−$75
	% change	−0.49%	-0.49%	−0.50%
Hicksian EV (annual)	Change ($ billion)	−$54	-$62	−$75
	% change	−0.38%	-0.38%	−0.39%

Notes:

1. Results are expressed in year 2006 dollars.

Figure 8-5 presents the percent change in output by industry as estimated by EMPAX-CGE for the year 2020. The values in the table are typically highest among those

industries with the most significant CAAA compliance expenditures relative to baseline industry revenue. For example, the electricity industry accounts for approximately 20 percent of CAAA compliance expenditures (approximately $14 billion, or 3.3 percent of benchmark electricity revenue); as a result, EMPAX-CGE estimates that output from the electricity industry declines by just less than 4 percent under the *with-CAAA* scenario relative to a U.S. economy without Clean Air Act programs. Because the power industry is the largest consumer of coal in the U.S., the reduction in output from the electricity industry also results in the secondary effect of reducing coal output by approximately 1.5 percent. The electricity industry's CAAA compliance expenditures also leads to higher electricity prices that prompt energy-intensive industries to switch to other energy sources (e.g., natural gas and oil) and/or seek energy efficiency improvements in their production process. In addition, because of CAAA requirements for cleaner (more expensive) fuels, petroleum sector output is projected to decline approximately 1.5 percent. The results in Figure 8-5 also suggest that the other minerals sector experiences the largest reduction in output, in proportional terms, among all industries (over 5 percent). This reflects the industry's high compliance expenditures relative to its size and the industry's energy-intensive production processes.

The industry-level results presented in Figure 8-5 also reflect the extent to which economic activity associated with CAAA compliance, such as new purchases of environmental protection goods and services, may partially offset the output losses associated with CAAA compliance expenditures. As a result of the CAAA, the demand for environmental protection goods and services will be higher relative to a U.S. economy without the Amendments.

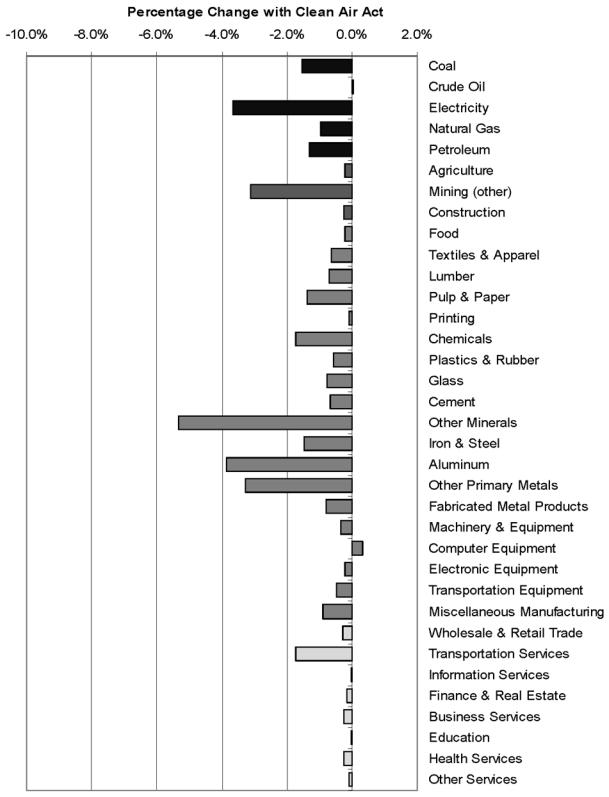
MACROECONOMIC IMPACTS OF CAAA COMPLIANCE EXPENDITURES AND HUMAN HEALTH BENEFITS

Building upon the results presented above, Table 8-8 summarizes the results of the EMPAX-CGE analysis for the labor force-adjusted case, which captures the full CAAA compliance expenditures as well as the labor force and medical expenditure benefits of the Amendments. The results presented in the table suggest that over time, the positive macroeconomic impacts of CAAA-related labor force and medical expenditure impacts slightly outweigh the negative macroeconomic effects of CAAA compliance costs.[115] For 2010, the results for the labor force-adjusted case show a reduction in GDP and consumption relative to the *without-CAAA* scenario, but the corresponding changes become positive in 2020. This largely reflects the rapid growth in the CAAA labor force effect between 2010 and 2020 (67 percent) relative to the growth in CAAA compliance expenditures (25 percent). We expect the CAAA-related labor force effect to grow more quickly than CAAA compliance expenditures during this period because, unlike compliance expenditures, the labor force effect is cumulative for the health endpoints with the most significant effect on the size of the labor force (i.e., premature mortality,

[115] The EMPAX model results do not isolate the impact of the labor force effect on GDP or the impact of changes in medical expenditures, as the two were modeled simultaneously.

chronic bronchitis, and AMI). In addition, the mortality effect is delayed relative to the time costs are incurred to reduce exposures because of the impact of the cessation lag.[116]

FIGURE 8-5. PERCENT CHANGE IN INDUSTRY OUTPUT IN 2020: COST-ONLY CASE



[116] Note that results for the labor force-adjusted case for years after 2020 indicate that the beneficial effects on the economy grow over time, through 2030, from $5 billion in 2020 to $14 billion in 2025 to $24 billion in 2030. EMPAX results for 2030, however, are considered less reliable because of the greater uncertainty in forecasting GDP and industry-level productivity 20 years into the future.

TABLE 8-8. SUMMARY OF ANNUAL MACROECONOMIC IMPACTS: LABOR FORCE-ADJUSTED CASE[1]

VARIABLE	MODEL RUN	2010	2015	2020
GDP	With Clean Air Act ($ billion)	$15,027	$17,338	$20,202
	Without Clean Air Act ($ billion)	$15,059	$17,350	$20,197
	Change ($ billion)	-$32	-$12	$5
	% change	-0.21%	-0.07%	0.02%
Consumption	With Clean Air Act ($ billion)	$10,969	$12,699	$14,881
	Without Clean Air Act ($ billion)	$10,972	$12,696	$14,876
	Change ($ billion)	-$3	$3	$5
	% change	-0.03%	0.02%	0.03%
Hicksian EV (annual)	Change ($ billion)	$11	$22	$29
	% change	0.08%	0.13%	0.15%

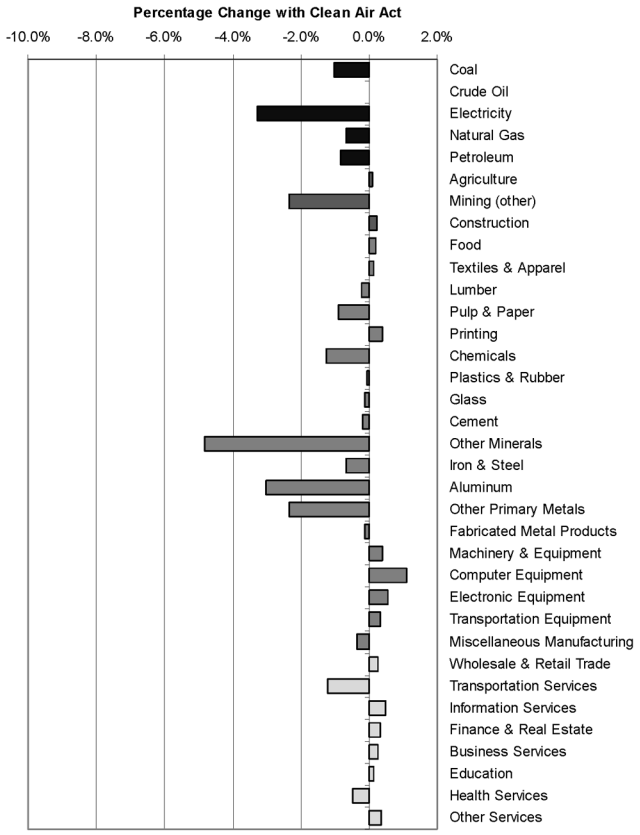
Notes:

1. Results are expressed in year 2006 dollars.

The results in Table 8-8 also suggest that the Amendments lead to an increase in household welfare, measured as the change in EV, under the labor force-adjusted case for both the 2010 and 2020 target years. The projected 0.8 percent *increase* in welfare for 2010 stands in contrast to the projected 0.21 percent *reduction* in GDP for that year and the 0.03 percent reduction in consumption. The fact that welfare rises while economic output declines indicates that, under the *with-CAAA* scenario, households allocate a greater share of their time endowment to leisure (and less to labor) than under the *without-CAAA* scenario. This reallocation of household time also occurs under the cost-only case, but it only partially offsets the negative welfare impact of reduced consumption. Under the labor force-adjusted case, the increase in leisure more than offsets the welfare loss associated with reduced consumption.

Figure 8-6 presents, by industry, the estimated percent change in output in 2020 for the labor force-adjusted case. The results in the figure indicate that, when labor force and medical expenditure impacts are accounted for, the CAAA leads to increased output for many industries and a decline in output for others. Consistent with the cost-only results, output in the computer equipment industry increases. The other sectors projected to experience an increase in output include many industries that tend to be labor-intensive and would benefit from a larger labor pool, such as most service industries. Output for health services declines, however, due to the reduction in health services demand associated with CAAA-related health improvements. Most of the other industries experiencing a reduction in output are either energy producers (e.g., electricity) or industries with energy-intensive production processes (e.g., iron and steel).

FIGURE 8-6. PERCENT CHANGE IN INDUSTRY OUTPUT IN 2020: LABOR FORCE-ADJUSTED CASE



The results presented in Table 8-8 and Figure 8-6 show that the conclusions drawn from macroeconomic analyses of air pollution policy depend significantly on whether such analyses capture both the costs and at least some of the benefits of air policy. While the results of the EMPAX-CGE cost-only case suggest that the CAAA reduces the output of the U.S. economy by approximately 0.5 percent each year, the labor force-adjusted case shows that analyzing benefits in conjunction with costs can either reduce the magnitude or change the sign of model results. Therefore, general equilibrium analyses that

examine cost-side macroeconomic impacts but ignore or overlook the impacts of policy-related labor force and health improvements may yield incomplete results that misinform policymakers and the public. The analysis presented in this chapter illustrates the feasibility of avoiding this outcome by examining both the costs and (a portion of the) benefits of air policy in a general equilibrium framework. It is important to note, however, that assessing expenditure-based output impacts should not replace the current practice of estimating the welfare (i.e., willingness-to-pay) benefits of avoided health effects. Unlike willingness-to-pay estimates, the results of CGE models do not reflect the non-market value that people place on avoided adverse health impacts. The outputs of such models represent a supplement to willingness-to-pay estimates rather than a substitute for such estimates.

Further work is needed, however, to reflect a much broader set of benefits in CGE models. As noted earlier, the results in this chapter are designed to supplement, but not replace, the more complete primary estimates of benefits and costs. The CGE model represents flows of products, labor, and capital between and among producers and consumers, but it excludes improvements in well-being due to enhanced longevity and health, except to the extent that these increase time available for labor and leisure among the workforce and reduce some medical costs. As a result, the vast majority of monetized benefits, many but not all of which represent benefits that are not traded in markets, cannot currently be reflected in a CGE model. This is the main reason that the beneficial results to the economy estimated in this chapter are substantially smaller than the primary estimate of benefits based on willingness to pay estimates. It is nonetheless important to realize that even the partial set of benefits-related impacts that are reflected in this chapter (i.e., labor force and medical expenditure impacts) more than compensate for the market costs we estimate to achieve CAAA compliance.

ANALYTIC LIMITATIONS

While the analysis presented in this chapter provides a reasonable approximation of the macroeconomic impacts of the CAAA, we note the following limitations:

- ***Exclusion of labor force and leisure effects for individuals outside the formal economy:*** Given the uncertainty surrounding the macroeconomic impacts of retirees, children, and other populations who do not participate in formal labor markets and the fact that CGE models are ill-suited to address these uncertainties, the inputs developed by the Project Team for this analysis did not reflect changes in the time endowment for these individuals. To the extent that people outside formal labor markets contribute to the economy, we may underestimate the positive macroeconomic impacts of the Amendments.
- ***Exclusion of ozone mortality***: As described in the methods section, our analysis captures PM-related changes in mortality but does not account for mortality impacts from ozone exposure. Therefore, we likely underestimate the positive macroeconomic impacts of the Amendments.

- ***Exclusion of nonmarket and some market benefits:*** Our assessment of the macroeconomic impacts of the Amendments also excludes several other CAAA-related benefits that may improve economic performance or consumer welfare, such as visibility improvements, productivity enhancements in the agriculture and forestry sectors, reduced materials damage, and reduced pain and suffering from pollution-related illness. Because we do not capture these effects, we very likely underestimate the positive macroeconomic impacts of the Amendments.
- ***Assumption of separable benefits categories:*** Our modeling assumes labor supply and environmental quality are separable components of the utility function for households. This separability does not always hold, however; for example, cleaner air may encourage leisure activities such as birding and fishing, making air quality a complement to leisure. Prior work suggests that assuming separability may affect benefits by up to 30 percent in some cases.[117]
- ***Perfect foresight:*** EMPAX-CGE assumes that households have perfect foresight of future changes in policy and modify their current economic behavior accordingly. In reality, households often have imperfect information of future policy changes. Whether the assumption of perfect foresight leads to overestimation or underestimation of impacts is uncertain.
- ***EMPAX-CGE parameter uncertainty***: Similar to other CGE models, EMPAX-CGE requires the specification of several model parameters (e.g., elasticity values). Although the model relies upon credible values from the literature, the range of published estimates for many parameters varies widely across studies. It is uncertain whether the parameters included in EMPAX lead to overestimation or underestimation of impacts.

[117] We are grateful to the SAB Council for sharing this observation. For further information, see, for example, J.C. Carbone and V.K. Smith. 2008. Evaluating policy interventions with general equilibrium externalities. J. Public Econ. 92:1254-1274.

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American Academy of Pediatrics • American College of Preventative Medicine
American Heart Association • American Lung Association
American Medical Association • American Public Health Association •
American Thoracic Society • Asthma and Allergy Foundation of America
Children's Environmental Health Network
National Association of County and City Health Officials
National Association for Medical Direction of Respiratory Care
Health Care Without Harm • Trust for America's Health

March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue
Washington, DC 20460
Sent via A-and-R-Docket@EPA.Gov

Re: EPA Docket I.D. No: EPA-HQ-OAR-2008-0699

Dear Administrator McCarthy:

As national organizations representing medical societies, public health and patient advocacy organizations, we write to provide comments to the U. S. Environmental Protection Agency on the proposed Ozone National Ambient Air Quality Standards. Our organizations appreciate and would like to express our support to the EPA for moving forward to update the current ozone standard, and welcome this opportunity to provide input to this process, which we hope will result in a standard that is better protective of public health. Our organizations urge you to select a level for the primary health standard that will meet the Clean Air Act requirement to protect the health of the public with an adequate margin of safety: 60 parts per billion (ppb).

EPA Must Protect the Health of the Public, including Sensitive Populations

The Clean Air Act establishes the primary National Ambient Air Quality Standard to protect public health from the nation's most widespread air pollutants. The Clean Air Act directs the Administrator to set standards that are "requisite to protect public health" with "an adequate margin of safety" (42 U.S.C. § 7409 (b) (1)).

The list of populations who risk demonstrated harm from ozone pollution has grown significantly from the previous review. Children, people with asthma and other lung diseases, seniors, outdoor workers and people who have low socioeconomic status have long been shown to be vulnerable to ozone. Newer evidence shows some otherwise healthy adults are especially sensitive to ozone exposure because of limitations in some nutrients and certain genetic variants. In addition to these groups, the

EPA's *Integrated Science Assessment* has documented evidence that suggests increased risk to fetal development and to cardiovascular harm (EPA, Integrated Science Assessment, 2013). Health-based standards must be set at levels that will protect all people, but particularly these sensitive groups.

Ozone poses a grave threat to public health at levels well below the current standard

The current standard of 75 ppb fails to meet the requirements of the Clean Air Act. Clinical and epidemiological studies have repeatedly shown that breathing ozone can threaten life and health at concentrations far lower than the 75 ppb 8-hour average standard.

Extensive, public reviews of the large body of evidence by EPA's independent science advisors, the Clean Air Scientific Advisory Committee (CASAC), and by EPA staff scientists have confirmed that the 2008 primary ozone standard is set at a level that is too weak to protect public health. In fact, three successive CASAC panels -- each under different leadership -- have reached the same conclusion: the 2008 standard should not be retained.

- As part of the advice to the EPA during the previous review that ended in 2008, CASAC sent letters repeatedly supporting a standard between 60 and 70 ppb (Henderson, 2006; Henderson, 2007). After EPA published its final decision in 2008, CASAC sent a rare letter to the Administrator commenting on the decision. The CASAC stated unequivocally that they disagreed with the decision to set the standard at 75 ppb. These scientists notified the Administrator that they "*do not endorse the new primary ozone standard as being sufficiently protective of public health*." (Emphasis in the original.) They urged that the Administrator or his successor "select a more health-protective" standard in the next review cycle (Henderson, 2008). It is important to note that their decision was based on the scientific evidence as it stood in 2006, the close of that review period.
- When asked to reevaluate the evidence during EPA's ill-fated reconsideration of the 2008 standard in February 2010, CASAC again was explicit: "EPA has recognized the large body of data and risk analyses demonstrating that retention of the current standard would leave large numbers of individuals at risk for respiratory effects and/or other significant health consequences including asthma exacerbations, emergency room visits, hospital admissions and mortality" (Samet, 2010).
- Now, the current CASAC has echoed this consensus again. In their letter to EPA on June 14, 2014, they stated it simply: "The CASAC finds scientific justification that current evidence and the results of the exposure and risk assessment call into question the adequacy of the current standard" (Frey, 2014).

We share the conclusion repeatedly presented to EPA by the CASAC: EPA cannot justify retention of the current standard based on the health evidence.

Multiple CASAC reviews have recommended a standard between 60 and 70 ppb.

Not only have the three separate CASAC committees, under three different Chairs, unanimously confirmed that the current ozone standard is not protective of public health, but each recommended that the standard should be set in the range of 60 to 70 ppb.

In each of the three comment letters the CASAC wrote to EPA Administrator Stephen L. Johnson, the independent experts charged with advising EPA unanimously recommended selection of an 8-hour average ozone NAAQS within the range of 60 to 70 ppb (Henderson 2006; Henderson 2007; Henderson 2008).

During the reconsideration of the 2008 Ozone NAAQS, CASAC reaffirmed its support for the selection of an 8-hour average ozone NAAQS within the 60 – 70 ppb range (Samet, 2010). Again, that recommendation came based solely on the studies that had been available during the prior review, a period that closed in 2006.

Now able to fully consider the additional studies available in the 2007 to 2012 period, the most recent CASAC summarized extensive scientific evidence in their recommendations to EPA for a range from 70 to 60 ppb:

> "The CASAC further concludes that there is adequate scientific evidence to recommend a range of levels for a revised primary ozone standard from 70 ppb to 60 ppb. The CASAC reached this conclusion based on the scientific evidence from clinical studies, epidemiologic studies, and animal toxicology studies, as summarized in the Integrated Science Assessment (ISA), the findings from the exposure and risk assessments as summarized in the HREA, and the interpretation of the implications of these sources of information as given in the Second Draft PA" (Frey, 2014).

However, the CASAC concluded that new evidence showed that even that range is too broad, noting that "based on the scientific evidence, a level of 70 ppb provides little margin of safety for the protection of public health particularly for sensitive subpopulations" (Frey, 2014).

> "At 70 ppb, there is substantial scientific evidence of adverse effects as detailed in the charge question responses, including decrease in lung function, increase in respiratory symptoms, and increase in airway inflammation. Although a level of 70 ppb is more protective of public health than the current standard, it may not meet the statutory requirement to protect public health with an adequate margin of safety" (Frey, 2014).

CASAC concluded the evidence showed that a level of "60 ppb would certainly provide more public health protection than a standard of 65 or 70 ppb and would provide an adequate margin of safety" (Frey, 2014).

The significantly stronger scientific and medical evidence available in this current review led CASAC to provide even more explicit comments than during the 2008 review and the subsequent reconsideration process. Their explicit conclusion that 60 ppb meets the requirement to provide more protection and an adequate margin of safety raises questions about EPA's decision to exclude 60 ppb from the proposal.

Our organizations offer evidence that demonstrates why 60 ppb should be adopted as the level of the health-based standard.

The evidence for a standard of 60 ppb has grown.

The scientific and medical understanding of the mechanisms by which exposure to ambient ozone pollution harms human health has grown considerably stronger since 2007. The EPA evaluated 1,000 new studies in the current review, studies that have been published since the completion of the 2006 Criteria Document. These studies inform our understanding of the health impacts of ozone at low concentrations.

Multiple chamber studies provide robust evidence of harm to healthy adults down to 60 ppb. Adding to previous research by Adams (2002) and Adams (2006), both Brown et al (2008) and Kim et al (2011) provide still more evidence that exposures down to 60 ppb can reduce lung function and cause inflammation that meets the American Thoracic Society's criteria for judging adversity. The subjects in these chamber studies were healthy young adults -- not children, the elderly, or people with asthma who are more susceptible to ozone. The chamber studies establish solid evidence that concentrations above 60 ppb would provide significant risk not only to many healthy adults, but most critically, to susceptible populations, including children, seniors and people with asthma and other chronic lung diseases.

Epidemiological studies provide real-world evidence for the need for 60 ppb. The analysis presented in the *Policy Assessment* digs deeper into six epidemiological studies in the U.S. and Canada and provides further real-world evidence that a standard of either 70 ppb or 65 ppb fails to provide adequate protection. These studies (Bell et al., 2006; Cakmak et al., 2006b; Dales et al., 2006; Katsouyanni et al., 2009, Mar and Koenig, 2009; Stieb et al, 2009) examined the positive and statistically significant associations from the most serious health threat—premature death—as well as from hospital admissions and emergency department visits. In most locations where increased risk was found, the ozone levels would have met the weaker standards of either 70 or 65 ppb, but would have failed to meet a standard set at 60 ppb. (*Policy Assessment,* pp. 4-13 to 4-15).

A standard of 60 ppb would result in a far greater reduction in premature morbidity and mortality. The EPA's estimates show that compared to meeting a standard of 65 ppb or 70 ppb, meeting a standard of 60 ppb would prevent many more premature deaths and hospital admissions, asthma attacks and days missed at work and school. Looking just at the parts of the nation expected to meet a standard of 60 ppb by 2025 (not including California), EPA provides a table of these estimates based on established modeling projections.

Nationwide Benefits of Attaining Standard in 2025 Throughout the United States (except California)			
Measure	**60 ppb**	**65 ppb**	**70 ppb**
Premature Deaths Avoided in 2025	**7,900**	4,300	1,440
Asthma Attacks Avoided in Children in 2025	**1,800,000**	960,000	320,000
Respiratory Hospital Admissions Avoided in 2025	**2,900**	1,500	510
Asthma Emergency Department Visits Avoided in 2025	**4,100**	2,300	1,400
Missed School Days Avoided in 2025	**1,900,000**	1,000,000	330,000

Taken from Table ES -11 of the U.S. EPA, Regulatory Impact Analysis of the Proposed Revision to the National Ambient Air Quality Standards for Ground-level Ozone, November 2014. EPA -452/P-14-006. Estimates based on modeling and assumptions explained in detail in the document. California was excluded because it is not expected to meet these standards in 2025.

In 2025, the reduction in premature deaths expected with a standard of 60 ppb is projected to be nearly *double* that of a standard set at 65 ppb and *more than five times* the benefit of a standard set at 70 ppb.

Growing evidence expands health effects of ozone exposure

Your decision must be founded in the strongest requirement of the Clean Air Act: that the NAAQS not only protect public health, but include an adequate margin of safety. In both the prior review ending in 2008 and in the 2010 reconsideration, our organizations recommended strongly that the primary 8-hour standard should be 60 ppb based on the available evidence. In addition to the strong evidence of increased morbidity from ozone down to 60 ppb, multiple well-reviewed studies had identified a new, strong association with premature death, with no discernable threshold, that made the risks to the large, vulnerable groups even graver. Even during the prior reviews, the evidence demonstrated that standards between 65 and 70 ppb would not be effective in protecting public health with an adequate margin of safety.

Since the 2008 standard, new research has added weight to the evidence showing the extensive impact of ozone. Research not only confirms the previous conclusions about ozone's impact on human health, but adds to and clarifies the impact on multiple physiologic systems, including respiratory and cardiovascular. Examination of long-term exposure has identified outcomes beyond the traditional concerns to include the central nervous system and reproductive and developmental effects. The growing evidence of effects associated with breathing ozone for longer periods adds to the urgency to set the most protective standard now to reduce those exposures.

Respiratory Health Effects, including Premature Mortality

The largest body of research documents the impact of ozone on respiratory symptoms, lung function changes, emergency department visits for respiratory disease, and hospital admissions. Since the previous review large studies examining exposures in multiple cities and continents have shown the consistent and pervasive threats to respiratory health.

New studies confirm the impact on children with asthma. Multiple studies demonstrated increased pulmonary inflammation (Berhane et al., 2011; Khatri et al., 2009; Barraza-Villerreal et al, 2008), and increased risk of hospital admissions (Silverman and Ito, 2010; Strickland et al., 2010).

Several large studies looking at single cities and multiple cities confirm that breathing ozone increases the risk of hospital admission and emergency department visits for respiratory conditions (Katsouyanni et al, 2009; Lin et al., 2008a; Wong et al., 2009; Darrow et al., 2011); Stieb et al., 2009). Multiple- and single-city studies showed increased risk of respiratory hospital admissions and emergency department visits in cities that met the current ozone standard of 75 ppb (Cakmak et al., 2006; Dales et al., 2006; Katsouyanni et al., 2009; Stieb et al., 2009) or where most cities would have met standards set at either 65ppb or 70 ppb (Cakmak et al., 2006; Katsouyanni et al., 2009; Stieb et al. 2009).

The American Thoracic Society summarized some of the new studies in the attached editorial in the *American Journal of Respiratory and Critical Care Medicine* advocating EPA adoption of a standard of 60 ppb (Rice, et al., 2015).

> "Highlights of this new body of evidence include a study of emergency department visits among children aged 0 to 4 in Atlanta, which found that each 30 ppb increase in the 3-day average of ozone was associated with an 8% higher risk of pneumonia and a 4% higher risk for upper respiratory infection(5)[Darrow et al 2014]. Several studies have demonstrated dose-response relationships between ozone exposure and childhood asthma admissions at exposure levels in the 60 to 80 ppb range (6–9)[Strickland et al 2014, Strickland et al 2010, Gleason et al 2014, Silverman et al 2010]. Similar associations have been found for adult admissions for asthma(9–11) [Silverman and Ito 2010, Glad et al 2012, Meg et al 2010] and COPD(12, 13)[Ko and Hui 2012, Media-Ramon et al 20076]. A population-based cohort study of generally healthy adults found that FEV1 was 56 mL lower after days when ambient ozone ranged from 59 to 75 ppb compared to days with levels under 59 ppb(14) [Rice et al 2013]. Controlled human exposure studies have re-affirmed lung function decrements in healthy adults after exposure to 60 to 70 ppb of ozone (15,16) [Schelegle et al 2009, Kim et al 2011]. Perhaps of greatest concern, there is now stronger evidence of increased mortality in association with ozone (17–19)[Peng et al 2013, Romieu et al 2012,Zanobetti and Schwartz 2008], particularly among the elderly and those with chronic disease(20, 21)[Medina-Ramon and Schwartz 2008, Zanobetti and Schwartz 2011]".

Cardiovascular Health Effects, including Premature Mortality

Evidence is accumulating about the cardiovascular effects of ozone, with the strongest evidence for increased risk of premature death. Previous studies have shown adverse associations between ozone exposure and various cardiovascular health endpoints, including alterations in heart rate variability in older adults (Park et al., 2005), cardiac arrhythmias (Rich et al., 2006), strokes, (Henrotin et al., 2007)

heart attacks (Ruidavets et al., 2005), and hospital admissions or cardiovascular diseases (Koken et al., 2003). Newer large epidemiologic studies from the U.S. (Zanobetti and Schwartz, 2008b), Europe (Samoli et al., 2009) and Asia (Wong et al 2010) have provided evidence of premature death from cardiovascular effects, including two large studies that confirmed the effect after controlling for particulate matter exposure (Katsouyanni et al 2009; Stafoggia, 2010).

Reproduction and Development Effects

A growing body of research raises concerns about longer-term exposure to ozone, particularly during pregnancy. Some toxicological studies warn that ozone may affect development of the pulmonary system and central nervous system. Several large studies in California and Australia point to association of prenatal ozone exposure with low birth weight and impaired fetal growth (Salem et al., 2005; Morello-Frosch, et al. 2010; Hansen et al 2007, Hansen et al 2008;Mannes et al 2005). Low birth weight is linked to increased risk of chronic disease as adults (Rogers et al., 2012; Berends et al., 2012).

Central Nervous System Effects

Increased research since the last review has expanded evidence of the potential effects on the central nervous system. Toxicological studies provide evidence that short- or long-term exposure to ozone may affect cognitive abilities, such as memory (Rivas-Arancibia et al., 1998), and may produce changes similar to those seen in human neurodegenerative disorders (Rivas-Arancibia et al., 2010; Santiago-López et al., 2010; Guevara-Guzman et al., 2009). The only human epidemiological study found an association for long-term ozone exposure with reduced performance on specific tests (Chen and Schwartz 2009). While more research is clearly needed, these studies provide added weight for selecting the most protective level.

Mortality Effects

Breathing ozone can kill. Short-term increases in ozone were found to increase deaths from cardiovascular and respiratory causes in a large 14-year study in 95 U.S. cities. The relationship between mortality and ozone was evident even on days when pollution levels above 60 ppb were excluded from the analysis. (Bell, et al., 2004). A series of meta-analyses and multi-city studies has documented an increase in premature death following ozone exposures below 75 ppb, particularly among the elderly (Bell, et al., 2005; Levy et al., 2005; Ito et al., 2005). Furthermore, research has focused on controlling for weather variables in assessing the effect of ozone on mortality. A case crossover study (Schwartz, 2005) of more than one million deaths in 14 U.S. cities found that "the association between ozone and mortality risk is unlikely to be confounded by temperature."

Multiple new studies have confirmed that ozone causes premature deaths (Zanobetti and Schwartz, 2008b; Samoli et al., 2009; Wong et al 2010) and provided evidence that these deaths occur even after controlling for other pollutants, including particulate matter (Stafoggia, 2010; Katsouyanni et al., 2009). Of special concern the risk of premature death from ozone showed up more frequently in communities with higher unemployment or that had a higher percentage of Black/African-American population, as well as in individuals who were Black/African-American or who had lower socioeconomic status. (Median-Ramón and Schwartz, 2008). EPA needs to ensure the strongest, most protective standards are in place to prevent this deadly pollutant from threatening the lives of thousands of Americans.

Millions of Americans face greater risk from breathing ozone pollution

Research has shown that many groups face greater risk from breathing ozone pollution or are more vulnerable to the harm because of their activities or residence. Their greater risk may come from age, preexisting diseases or genetics, as well as income. Greater vulnerability may stem from outdoor occupations or activities or from living in areas with higher ozone exposures.

Children and adolescents

Children are acutely vulnerable to the hazardous effects of air pollution(AAP, 2004). Relative to adults, children tend to spend more time out of doors, they are often more physically active, they breathe more rapidly, their airways are narrower and they inhale relatively more pollutants in proportion to their body weight (AAP, 2003). Additionally, lung growth continues long after birth, with as much as 80 percent of the alveoli developing during childhood and adolescence (Diertert et al., 2000). Epidemiologic evidence indicates that children face additional health risks beyond the adverse effects observed in the general population. Children experience acute effects such as difficulty breathing (Triche et al., 2006), increased hospitalizations (Burnett et al., 2001), and emergency room visits (Tolbert et al., 2000) from ozone exposure at concentrations below the current standard and may suffer long-lasting effects such as stunted lung function in young adulthood (Tager et al., 2005).

A national standard of 60 ppb would reduce children's exposures of concern from ozone by 95 to 100 percent. A standard of 60 ppb would provide critical protection for children from the dangers from ozone compared to the current standard, according to EPA's *Risk and Exposure Assessment*. The strength of that protection draws a stark comparison to the far weaker options of 65 ppb to 70 ppb. By contrast, a standard of 70 ppb would reduce such exposures by only 15 to 35 percent, while a standard of 65 would reduce such exposures by 30 to 65 percent (EPA, *Risk and Exposure Analysis*, 2014).

Older Adults

Multiple factors place older adults at greater risk from ozone and other air pollutants, including greater time spent outdoors after age 65, the gradual decline in the functioning of the body's systems that accompany aging and an increase in the responsiveness to ozone (EPA, ISA 2013). Recent studies also added to the existing evidence that older adults face greater risk of premature death from ozone (Medina-Ramón and Schwartz 2008; Zanobetti and Schwartz, 2008a; Cakmak et al 2011).

Chronic Disease

Individuals with preexisting lung disease face substantial risks. People with asthma, particularly children but also adults, have shown exacerbated respiratory symptoms in multi-city studies (Mortimer et al., 2002, Romieu et al., 1996 and 1997; O'Connor et al., 2008). Studies have tracked increases in hospitalization among adults suffering from chronic obstructive pulmonary disease (Peel et al., 2007; Median-Ramón, et al., 2006). Newer research, in a large, multi-continent study, also shows increased risk of premature death from cardiovascular disease triggered by ozone pollution (Katsouyanni et al., 2009).

Outdoor workers and exercisers

Outdoor workers as well as active adults who exercise outdoors (Brauer et al., 1996; Korrick et al., 1998) are particularly vulnerable to ozone exposure due to greater exposure because of time spent outdoors and activity levels. A recent study of lifeguards in Galveston, Texas, provided evidence of the impact of even short-term exposure to ozone on healthy, active adults. Testing the breathing capacity of these outdoor workers several times a day, researchers found that many lifeguards suffered increased obstruction in their airways when ozone levels were higher (Thaller et al., 2008).

Socioeconomic Status

Several large studies have identified that individuals who have low socioeconomic status or who live in communities with low socioeconomic status face higher risk of hospital admissions and emergency department visits associated with ozone pollution (Lin et al., 2008; Cakmak et al., 2006b; Burra et al., 2009). As noted earlier, additional studies have identified people who live in communities with high unemployment or other markers of low socioeconomic status as having greater risk of premature death from ozone pollution (Bell and Dominici , 2008; Katsouyanni et al., 2009). Meeting a standard of 60 ppb would provide greater protection to groups already facing substantial challenges.

We call on EPA to adopt a standard of 60 ppb

The Clean Air Act requires that the EPA set the standard based on the need to protect public health "with an adequate margin of safety." In 2001, the Supreme Court unanimously ruled that protecting health was the only legal basis for the standard. The existing standard fails to protect public health with a margin of safety. EPA must strengthen it.

Given the weight of evidence, we urge you to set the eight-hour ozone standard at 60 ppb to protect against known and anticipated adverse health effects and to provide a margin of safety as required by the Clean Air Act.

Sincerely,

American Academy of Pediatrics

American College of Preventive Medicine

American Heart Association

American Lung Association

American Medical Association

American Public Health Association

American Thoracic Society

Asthma and Allergy Foundation of America

Children's Environmental Health Network

Health Care Without Harm

National Association of County and City Health Officials

National Association for Medical Direction of Respiratory Care

Trust for America's Health

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Scientific Evidence Supports Stronger Limits on Ozone

In 2007, 2010, and now again in 2015, the American Thoracic Society has recommended that the U.S. Environmental Protection Agency (EPA) adopt an 8-hour ozone national ambient air quality standard of 60 ppb to adequately protect public health (1, 2). Although the recommended standard endorsed by the American Thoracic Society has not changed during this time, the scientific evidence supporting this recommendation has significantly strengthened. The scientific evidence available 7 years ago justifying this recommendation has been supplemented by an even greater understanding of the health effects of ozone exposures, including infant respiratory problems, worse childhood asthma control, reduced lung function, and increased mortality in adults.

On November 25, 2014, the EPA proposed a standard in the range of 65–70 ppb, which is lower than the current standard of 75 ppb (the standard is defined as the annual fourth highest maximum daily 8-hour ozone average averaged over 3 years). Although we applaud the EPA for proposing a stricter standard, we believe the scientific evidence clearly calls for a standard of 60 ppb to protect human health. We are currently in the public comment period for the proposed ozone rule and urge the EPA to issue a more protective standard of 60 ppb. This is the second time the Obama Administration has reviewed the current ozone standard of 75 ppb. The previous administration established the current standard outside the range recommended by the Clean Air Science Advisory Committee of 60–70 ppb (3). In 2010, the Clean Air Science Advisory Committee reaffirmed its initial recommendation as part of an early reassessment of the ozone standard, an effort that was ultimately abandoned in 2011 (4). Because a new science assessment was not conducted as part of that review, the current review of the ozone standard is the first to consider new scientific evidence since 2006.

Since 2006, much more evidence has accumulated that ozone exposures in the range of 60–75 ppb have adverse physiologic effects across the entire age spectrum, from infants to older adults. Although there is also some evidence of health effects of ozone exposure below 60 ppb, the strongest evidence supports the conclusion that serious adverse health effects occur across all ages at levels above 60 ppb.

Highlights of this new body of evidence include a study of emergency department visits among children aged 0 to 4 years in Atlanta, Georgia, which found that each 30-ppb increase in the 3-day average of ozone was associated with an 8% higher risk of pneumonia and a 4% higher risk for upper respiratory infection (5). Several studies have demonstrated dose–response relationships between ozone exposure and childhood asthma admissions at exposure levels in the 60–80 ppb range (6–9). Similar associations have been found for adult admissions for asthma (9–11) and chronic obstructive pulmonary disease (12, 13). A population-based cohort study of generally healthy adults found that FEV_1 was 56 ml lower after days

when ambient ozone ranged from 59 to 75 ppb compared with days with levels lower than 59 ppb (14). Controlled human exposure studies have reaffirmed lung function decrements in healthy adults after exposure to 60–70 ppb of ozone (15, 16). Perhaps of greatest concern, there is now stronger evidence of increased mortality in association with ozone (17–19), particularly among the elderly and those with chronic disease (20, 21).

In making this recommendation, we acknowledge that challenges exist in reducing ambient ozone concentrations. Unlike other pollutants regulated by the Clean Air Act, ozone is a secondary pollutant formed from precursor pollutants through photochemical reactions in the atmosphere. This presents challenges in designing successful abatement plans. For example, the natural presence of precursor chemicals and long-range transport of ozone from beyond U.S. jurisdictional boundaries can each contribute to background ozone levels (22). However, the adverse health effects of ozone do not discriminate on the basis of the source of precursor pollutants, nor do these complexities change the reality that serious adverse health effects occur at concentrations higher than 60 ppb. Although the science surrounding background ozone is still emerging, the evidence of adverse health risks of ozone is clear.

Another challenge for ozone management is that the secondary formation of ozone can result in higher concentrations downwind from the primary sources of precursor pollutants, cutting across jurisdictions. As a result, integrated planning across jurisdictional boundaries and compliance with the "good neighbor" provision of the Clean Air Act will be necessary to reduce regional ozone to levels that adequately protect public health (23).

Although controlling ambient ozone will be a challenge, it will also present opportunities for innovation and leadership. State Implementation Plans will vary in how counties across the United States plan to remediate unhealthy levels of ozone. Although all plans will take time to achieve the needed results, the best approaches will be identified and serve as a model that other regions can follow to protect public health.

The timing is excellent for revision of the ozone standard to 60 ppb, as the new standard can build on substantial recent progress. In March 2014, the EPA finalized new standards for motor vehicle emissions and cleaner fuels that are expected to reduce ozone levels significantly (24). Already-adopted revisions to standards for particulate matter and air toxics are also likely to further reduce ozone formation (25). Above all, however, we are entering an era of technological innovation, infrastructure reconstruction, and commitment to sustainability in which obsolete technologies are being replaced by more efficient and less-polluting innovations. This is exactly the right time to lay down the correct performance criteria and design specifications for the new technology before we commit to a new energy and transportation regime that could limit our choices in the future.

The U.S. EPA has taken significant actions in the past when justified by scientific evidence, most notably by reducing the permissible concentrations of airborne lead by 90% in 2008 and reducing the permissible annual concentrations of fine particle pollution by 20% in 2013 (26). We encourage the EPA administrator, with the full support of the president, to acknowledge the large body of scientific evidence documenting the harms caused by ozone pollution and set a standard of 60 ppb to protect the health of the American public. ▩

Author disclosures are available with the text of this article at www.atsjournals.org.

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Union of Concerned Scientists The Equation *a blog on independent science + practical solutions*

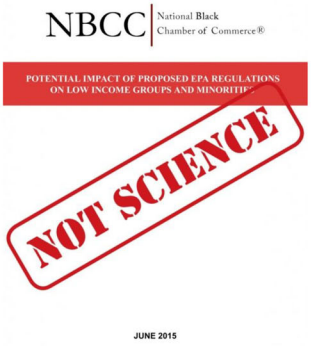
New Flawed Study of the Clean Power Plan: How the MISI Study Gets It So Wrong

John Rogers, senior energy analyst, Clean Energy **June 12, 2015**

An op-ed in yesterday's *Investor's Business Daily* uses a new study to make unsubstantiated claims about the economic impacts of the proposed Clean Power Plan on vulnerable communities. Since the op-ed didn't provide a link to the actual analysis, we hunted it down and took a look behind the headlines. And when we did, we found that the foundations of this new "analysis" are shaky indeed.

A house built on sand

The new study, conducted by Management Information Services, Inc. (MISI) on behalf of the National Black Chamber of Commerce (NBCC), purports to look at a range of EPA regulations, but focuses on the Clean Power Plan (CPP).



But here's the first of the study's fatal flaws: it depends, as it explicitly says (p. 21), on the findings of seven other studies, which it lists. But those seven include:

- Three studies that **came out *before* the EPA published the draft CPP**, meaning they don't actually study the CPP as proposed—even though that's the supposed focus of the NBCC/MISI analysis
- One that was just (self-described) "preliminary analysis" from the United Mine Workers of America, a group you'd be hard-pressed to characterize as an **unbiased voice** in this debate
- Three other studies **funded by other fossil fuel interests** who oppose the Clean Power Plan

Two of those studies were the focus of a recent UCS webinar showing how such studies use bad assumptions and get used to sow confusion and spread disinformation about the CPP.

One of those, done by IHS on behalf of the U.S. Chamber of Commerce, is the report most cited in this new work, even though it was one of those that came out before the draft CPP, and even though there was, as the Chamber itself admitted, "a big difference" between what they'd modeled and what EPA put forth (which the new study doesn't acknowledge).

The flaws in the study by Energy Ventures Analysis (EVA) for Peabody Energy (the largest U.S. coal company) are also clear. The Center for Climate and Energy Solutions has pointed out that, unlike other studies, EVA's didn't even show a business-as-usual case, meaning that any CPP results were floating in a vacuum, without reference to a base case of shifting energy costs and other economic factors.

Ignoring the bedrock

Equally telling are the studies that didn't make NBCC/MISI's literature review:

- The EPA's own cost-benefit analysis, which showed investments in energy efficiency under the Clean Power Plan will ultimately generate **savings on electricity bills**nationally
- Studies from academic sources, which show the CPP delivering **widespread health co-benefits** by reducing harmful air pollution from power plants
- One by the NAACP that has documented the **costly and disproportionate impacts** of power plant pollution on "low-income communities and communities of color"
- Another recent analysis by researchers at the University of Maryland suggesting the CPP will lead to a **net increase in jobs**.

But you wouldn't glean any of that from the new NBCC/MISI report. No, it follows in the footsteps of previous misleading studies by exaggerating the costs and ignoring the benefits of climate action.

The elephant in the neighborhood

And that brings up another of the study's fatal flaws: **it forgets about climate change**. In the op-ed, the only mention of "mitigation" is about avoiding the supposed impacts of the regulation. And even in the study itself, nary a word.

Hard to believe, I realize. But somehow the author **makes it through the entire study without mentioning global warming.** This, a purported study of a regulation, but it doesn't even acknowledge the incredible amount of science behind the need for just such a regulation. All it's got is one mention of "warmer climates" and the importance of air-conditioning… which, it turns out, we'll need more of as the climate warms.

And who is going to be **disproportionately affected** by that warming climate and other impacts? In many cases, the same vulnerable populations that the new study is supposedly defending. On the other hand, that grievous omission isn't entirely surprising, since the author of the study has claimed—despite **the wealth of information very much to the contrary**—that more carbon dioxide is actually a good thing. Not so much.

Poor science, bad policy

It all adds up to a study that Juan Declet-Barreto of the Natural Resources Defense Councilcalls:

"…a cynical attempt at co-opting the Latino and African American communities into rejecting the most significant controls to power sector air pollutants and toxics affecting their health and communities."

The Clean Power Plan is about the **fundamental need to address climate change**, including on behalf of those who are least equipped to deal with its impacts. A study of the CPP that forgets that isn't worth the electrons it's printed on.

Poor science may make for good headlines, but it definitely **makes for bad policy**.

Posted in: Energy, Global Warming Tags: Clean Power Plan

About the author: John Rogers is a senior energy analyst with expertise in renewable energy and energy efficiency technologies and policies. He co-manages the Energy and Water in a Warming World Initiative (EW3) at UCS that looks at water demands of energy production in the context of climate change. He holds a master's degree in mechanical engineering from the University of Michigan and a bachelor's degree from Princeton University. See John's full bio.

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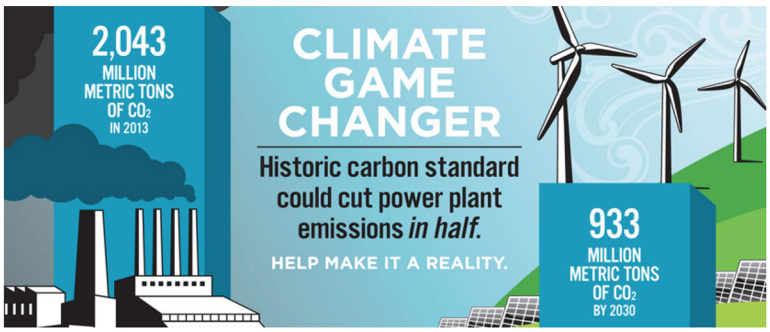

July 15, 2015

Re: Environmental Protection Agency (EPA) Clean Power Plan

Dear Members,

On behalf of the U.S. Black Chambers, Inc. (USBC), I am writing today to express my strong support of the Environmental Protection Agency (EPA) Clean Power Plan. The initiative will cut carbon pollution from the power sector. All across the United States, Power plants emit the largest source of carbon pollution, creating dangerous levels in the ozone, destroying our eco-system and producing adverse effects on public health. The USBC supports any endeavor that will create businesses and jobs, stimulate the economy, increase employment while simultaneously creating a safe and healthy living environment in the US, preeminently, those underserved communities that are hit the hardest.

It is my understanding that the utilization and execution of this Action Plan will a) reduce carbon pollution b) prepare the USA for effects of climate change c) and pioneer global efforts to defeat and prepare for climate change impacts. The Center for Disease Control (CDC) and EPA have issued countless reports detailing the devastating effects climate change has on the African American community. Studies have shown that African Americans are suffering an increase in asthma and respiratory issues with many black families living near power plants and/or areas with unhealthy ozone levels. The EPA has devised a plan to have clean energy and build a low-carbon economy—and the Clean Power Plan is the solution. The implementation of the Clean Power Plan will reduce health related respiratory risks, create jobs in the clean energy industry and will also set a criterion to be replicated globally. The United States needs to spearhead this initiative of creating new ways to battle and prepare for climate change that has already impacted areas throughout the world.

The U.S. Black Chambers, Inc. is committed to supporting the Clean Power Plan. USBC believes this action plan is the first step in combating climate change. Therefore, I urge you to give consideration and support to the EPA's Clean Power Plan.

In the Spirit of Success,

Ron Busby

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